Environmental Research of
the Federal Ministry for the Environment,
Nature Conservation and Nuclear Safety

Task focus

Grant Number (UFOPLAN) (FKZ 3711 43 330 2)

Determination of the Best Available Techniques for preservation of wood and wood products in Germany considering cross-media environmental impacts

Final Report

Alexander Potrykus
Milos Milunov

BiPRO GmbH
Grauertstr. 12
81545 München

on behalf of
Federal Environment Agency (Umweltbundesamt)

28 February 2013

Report Cover Sheet

Report No.	UBA-FB 00
Report Title	Determination of the Best Available Techniques for preservation of wood and wood products in Germany considering cross-media environmental impacts
Author(s) (Family Name, First Name)	Alexander Potrykus Milos Milunov
Performing Organisation (Name, Address)	BiPRO GmbH Grauertstr. 12 81545 München www.bipro.de
Funding Agency	Umweltbundesamt Postfach 14 06 06813 Dessau-Roßlau
Report Date	February 2013
Project No. (FKZ)	3711 43 330 2
No. of Pages	92
Supplementary Notes	
Keywords	Preservation of wood and wood products, Best Available Techniques, BAT, BAT-conclusions, Best Available Techniques Reference Document, BREF, Seville-Process, Directive 2010/75/EU on industrial emissions, IED

Abstract

Directive 2010/75/EU on industrial emissions (IED) is the EU wide basis for the approval of environmentally relevant industrial installations. The IED aims to harmonize the environmental standards for industrial facilities at a high level. The Directive includes several new activities, among other the preservation of wood and wood products with chemicals with a production capacity exceeding 75 m^3 per day other than exclusively treating against sapstain is classified as environmentally relevant activity. Therefore, as part of the Seville process, a new Best Available Techniques (BAT) Reference Document (BREF) for the preservation of wood and wood products with chemicals will be established.

The aim of this UFOPLAN research project is to determine the best available techniques in the field of preservation of wood in Germany. During the project, specific data and examples of advanced integrated production and end-of-pipe measures in facilities for wood preservation with chemicals are collected and analysed in close cooperation with industry representatives and facility operators. This final report summarises the main results and aims to provide, via the Federal Environment Agency, the German contribution to the Seville Process for the preparation of the BREF for the preservation of wood and wood products with chemicals and thus to contribute to further developing the production-integrated environmental protection at European level.

Table of content

Figures

Tables

Abbreviations

BREF	Best available technique Reference Document
BAT	Best Available Technique
IED	Industrial Emissions Directive 2010/75/EU
ISPM 15	International standards for phytosanitary measures No 15
UBA	Umweltbundesamt (Federal Environment Agency)
VDI	Verein Deutscher Ingenieure
VOC	Volatile Organic Compounds
WGK	Wassergefährdungsklasse (water hazard class)
WHG	Wasserhaushaltsgesetz (Federal Water Act)
WP	Wood Preservative

The term “creosote“ is used as synonym to “coal tar oil” in this report

1 Summary

1.1 Introduction and Objective

The Federal Environmental Agency has commissioned BiPRO GmbH to perform a study on "Determination of the best available techniques for preservation of wood and wood products in Germany considering cross-media environmental impacts."

The aim of the project is to determine the best available techniques in the field of preservation of wood in Germany. The results of the project will be incorporated as the German contribution to the Seville process for the preparation of the Best Available Techniques (BAT) reference document (BREF) for the preservation of wood and wood products with chemicals and therefore to contribute to further developing production-integrated environmental protection at European level.

Directive 2010/75/EU (IED = Industrial Emissions Directive) on industrial emissions is the EU wide basis for the approval of environmentally relevant industrial installations. It has to be transposed into national legislation by Member States until 2013 and it replaces, inter alia, the IPPC Directive 2008/1/EC. The IED aims to harmonize environmental standards for industrial facilities at a high level. Pursuant to the IED, a European wide exchange of information with stakeholders (The Seville Process) on "Best Available Techniques" is organised, which results will be published as BREFs. Based on the BREFs, the European Commission establishes BAT conclusions through a committee procedure. BREFs, which are also worldwide well regarded, set EU standards for production-integrated environmental protection and sustainable production. The legal and practical importance of the BREFs was increased with the entry into force of the IED, compared to the previous IPPC Directive. The BAT conclusions are used as a reference document for setting the permit conditions. Within four years of publication of decisions on BAT conclusions it is to be ensured, that all permit conditions for the installations concerned, are reconsidered and, if necessary, updated to ensure compliance.

According to paragraph 6.10 of Annex I of the IED, the preservation of wood and wood products with chemicals with a production capacity exceeding 75 m^3 per day other than exclusively treating against sapstain is classified as environmentally relevant activity. Therefore, as part of the Seville process a new BAT reference document (BREF) for the preservation of wood and wood products with chemicals will be established. The Federal Environmental Agency is the national coordinator for the Seville Process. Intensive participation of Germany in the Seville process helps to align the industrial environmental standards in the EU to a high level and make a significant contribution to international climate protection. Possible distortions of competition can be compensated by a single European environmental protection standard.

During this research project, specific data and examples of advanced integrated production and end-of-pipe measures in facilities for wood preservation with chemicals are collected and analysed in close cooperation with industry representatives and facility operators. This final report summarises the main results and aims to provide, via the Federal Environment Agency, the German contribution to the Seville Process for the preparation of the BREF for the preservation of wood and wood products with chemicals.

The installations which apply the following techniques are affected:

- Wood impregnation process using pressure and non-pressure processes (immersion and superficial processes)
- Chemical wood modification, i.e. acetylation, furfurylation, polymerisation

- Hydrophobisation

Thermal wood modification is outside the scope of this report, as this technique does not employ chemicals for wood preservation.

Within the present research project, concrete installations data on hydrophobisation/impregnation processes with wood preservatives (WP) (pressure and no-pressure processes) were collected and analysed as a basis for determining the BAT.

1.2 General Information

The relevant industry carrying out preservation of wood and wood products often consists of small or family businesses with a small production capacity of 5-20 m^3/day. Only a limited number of companies operate at higher capacities.

In the course of data collection within Germany about 70 companies that perform preservation of wood were contacted. Based on the this approach (i.e. determination of relevant companies) and due to the support of relevant industry associations (DHV, DHMV, GIH, SGH and BSHD), it can be assumed that the majority of relevant companies were encouraged to participate.

1.2.1 Relevant installations in Germany

According to currently available information, it can be expected that in some installations in Germany, which operate with pressure and non-pressure processes, the production capacity of 75 m^3 of wood per day can be exceeded. However, it is unclear whether and by how many installations this capacity is exceeded. The production capacity of the installations inspected in the course of the project (on purpose installations with relatively high production capacity were selected) was estimated to be in the range of slightly below 75 m^3 to about 200 m^3 of wood per day.

In many companies, the wood preservation has only minor significance in the production, while the core business lies in other operational areas, such as timber cutting. The German sawmilling industry, with about 2,000 factories, is the most important link between the forest and timber industry. Its factories constitute the first processing stage of the harvested roundwood. Many sawmills have expanded their product range and offer both sawn timber and timber treated by impregnation products for the next processing step. It is not known how many companies are significantly involved in impregnation. Usually such companies work with non-pressure processes (dipping or impregnation).

Whether an industrial installation is subject to a permit pursuant to IED depends on the activity carried out and on the daily production capacity. The obligation to hold a permit is to be assessed for each installation on an individual basis, considering the installation specific conditions.

1.2.2 Environmental relevance

In relevant installations for impregnation/preservation of wood either water-soluble wood preservatives (WPs) or WPs on the basis of creosote are applied (see Chapter 5.1.2).

The main sources of emissions into the environment are the following:

- Water-soluble WPs: (1) water vapor and aerosols in the air, (2) WPs in water or soil, (3) wastewater (4) formation of contaminated waste wood.

- Creosote based WPs: (1) steam (from the wood) and gases/aerosols in the air (odor), (2) WPs in water or soil, (3) waste, (4) contaminated waste wood.

In the existing plants in Germany, emissions are avoided or minimized by technical measures (e.g. thermal exhaust air purification, drip trays, soil sealing with repatriation, shelter, proper disposal of waste).

1.3 Applied processes and technologies

1.3.1 Delivery, reception, storage and transport

The impregnated semi-finished wood products such as logs, construction timber, poles and sleepers, are directly produced in the associated sawmill or are purchased. After quality inspection, the incoming wood products are usually stored in open or in roof-covered area. The transportation of timber to the impregnation plant is usually done by industrial fork lift or by a crane.

WPs are stored in original containers or in an approved container in order to minimize the risks of accidental leakages. In addition, it ensures that unauthorized personnel does not have access to wood preservatives. The storage of wood protection products must comply with the relevant statutory provisions. Provisions on water pollutants are provided in the Section 3 of the Federal Water Act (Wasserhaushaltsgesetz, WHG). Installations for storing, filling, production and processing of water polluting substances as well as installation which use water-polluting substances in the field of trade and industry and in the area of public facilities shall be designed and built, operated and decommissioned in a way to prevent adverse changes in the properties of water bodies (§ 62 (1) WHG). The concrete technical design and the corresponding obligations including approval process and assessment procedures for installations are defined in the ordinances on industrial installations regulating the handling of water contaminating substances (VawS) in the German Federal States.

Since the federal reform in 2006, the Federal Government has extended its legislative powers providing the space for a Federal Regulation as well as the derogations in normative rules for the polluting substances and installations. A draft has been available since late 2010[1]. Until the adoption of the Federal Regulation, the Federal States Ordinances shall continue to apply in addition to a transitional Federal Regulation[2].

1.3.2 Treatment processes for wood preservation

The following figure gives an overview of different types of treatment processes that are used for wood preservation with chemicals and additionally or exclusively for alteration of the certain product characteristics (ammonia treatment, heat treatment). The latter, however, are not covered by the IED and are only partly discussed in the course of this project in order to provide an overall picture of wood treatment processes. The thermal modification is also not in the scope of the project as chemicals are not used for wood preservation. The chemical modification lies in scope of the project, however, currently in Germany this processes in not performed on

[1] See http://www.bmu.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/vauws_entwurf.pdf

[2] Verordnung über Installation zum Umgang mit wassergefährdenden Stoffen vom 31. März 2010 (BGBl. I S. 377) http://www.gesetze-im-internet.de/bundesrecht/wasgefstanlv/gesamt.pdf

an industrial scale, therefore plant-specific data for this technique could not be collected within the project.

Figure 1: Overview of different wood treatment processes (according to Table 5 [VDI 3462])

Wood preservation and/or enhancement process		
	Immersion/impregnation (with wood preservatives)	
		Pressure process Retort pressure treatment process: Vacuum-pressure process, alternating pressure process, RUEPING process, double RUEPING process Low-pressure process: Double vacuum process, modified Lowry process
		Non-pressure process Immersion process: Trough impregnation process, dipping, hot-cold bath treatment; Superficial process: Brief dipping, deluging, spray tunnel process, spray application
	Wood modification (with or without chemicals)	
		a) Thermal wood modification (not relevant for the scope of this project) Open systems (atmospheric pressure) with or without steam injection, Closed systems (pressurised) with steam injection, Closed systems (vacuum) without steam injection, Oil/heat treatment, Inert gas process
		b) Chemical wood modification (in Germany not performed on industrial scale, status 2012) Acetylation , Furfurylation, Polymerisation
		c) Impregnation with resins
	Hydrophobisation (with chemicals)	
		Soaking in and/or impregnation with hydrohobisation agents such as oils, waxes (as emulsion of melt)
	Ammonia treatment (fuming) (not relevant for the scope of this project)	
		Fuming at temperatures of up to 90 °C at atmospheric pressure or under pressurised conditions to adjust the pH necessary for chemical reaction
Other wood treatments (not relevant for the scope of this project)		
	Heat treatment (phyto-sanitary measures)	
		Method as per ISPM 15: Heat treatment in chambers (continuous minimum temperature of 56 °C for a period of 30 minutes throughout the wood cross-section

The processes are described in Chapter 4.2 of the report.

1.3.3 Storage and transport of treated wood

The storage of freshly treated wood is usually protected from rain and/or on fixed surfaces. Relevant information, e.g. technical specification sheets or information available on wood preservative containers must be observed and respected (see [DBC 2012]).

Impregnated wood with non-fixating wood preservatives stored in warehouses or in product storage areas should be either protected from weather conditions (with roof, tops) and/or stored liquid-impervious sealed surface.

The transport of treated wood after completed fixation is organised by truck or where sufficient infrastructure is in place, by train.

1.3.4 Measures for prevention or reduction of emissions

Techniques for prevention and reduction of emissions include different process-integrated measures (primary measures) and preventive measures for the reduction of gaseous emissions, wastewater and waste, as well as preventive measures for soil and water conservation. Measures are described in detail in Chapter 4.4 of the report.

1.4 Current emissions and consumption levels

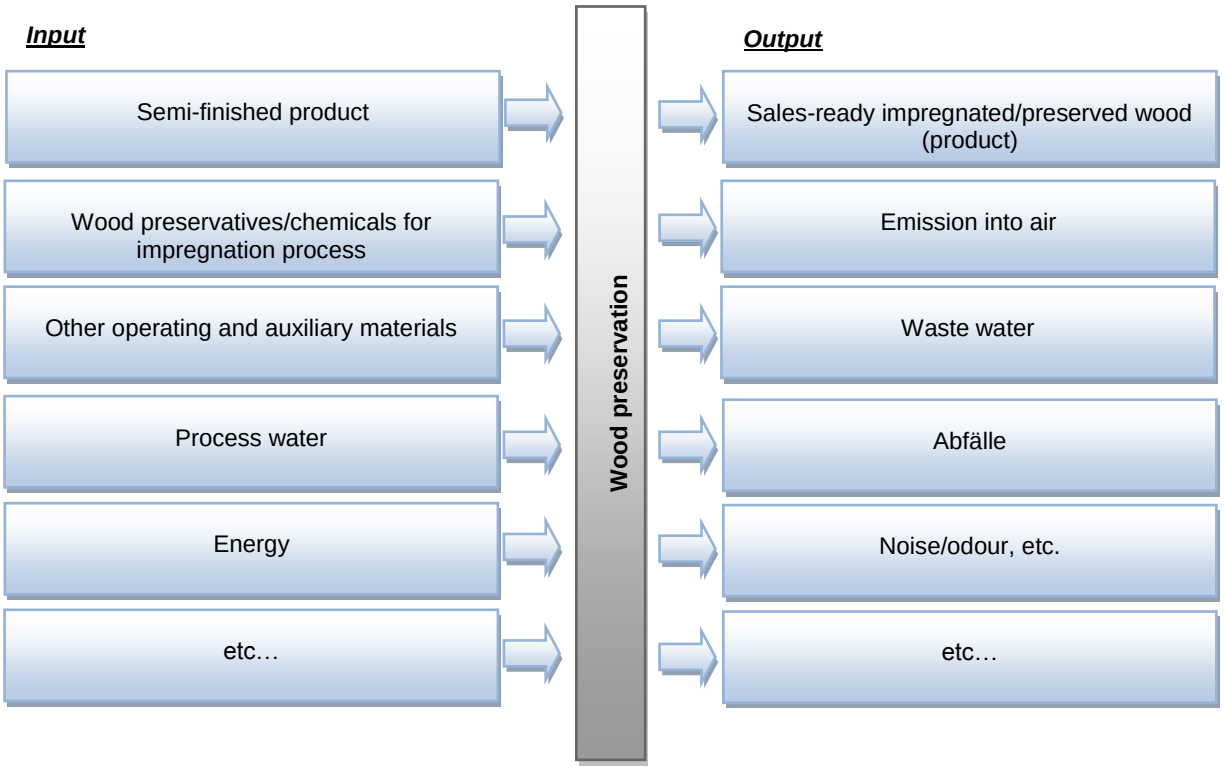
Chapter 5 provides the entire spectrum of the current emissions and consumption levels for the overall process along with an indication of techniques used. To provide an idea of the relative environmental performance of comparable activities, information regarding production levels is summarised to allow expressing the emission/consumption levels per production unit.

Information includes current consumption levels of energy, water and raw materials. Furthermore, the data include the emissions of key pollutants to air and water as well as generation of residues/waste and where relevant, emissions of noise and odour which are arising from the activities.

Figure 2 gives an overview of the main consumption and emissions for installations for the preservation of wood with chemicals.

Typical consumption and emission levels collected at the installations level are presented in Chapter 5.3. These can be used as a basis for determining BAT.

Figure 2: Main input and output data for wood preservation installations



The most important consumption quantities (used wood, chemicals, auxiliary materials, water and energy), emissions, as well as typical emissions and consumption values are described in detail in Chapter 5 of the report.

1.5 Techniques to be considered for determination of BAT

The following techniques should be considered for determination of BAT:

- Techniques for the prevention and reduction of fugitive emissions to air
- Precautionary measures for water and soil protection
- Water recirculation (soil sealing and collection drip tray)
- Wood moisture measurement
- Drip tray impregnation installation
- Thermal oxidation
- Variable pump control
- Substitution of chromium containing protective products with chromium-free products
- Roofed-over construction for drying, dripping and fixing areas

Besides the techniques description, they are characterized by the following:

- Achieved environmental benefits
- Environmental performance and operational data
- Cross-media effects
- Technical considerations relevant to applicability
- Economics
- Driving force for the application
- Example installation
- Reference literature

Techniques to be considered when determining BAT are described in Chapter 6 of the report.

1.6 Proposals for conclusions on best available techiques

1.6.1 Preliminary remarks

The conclusions on the best available techniques will be derived from the information exchange performed on the European level within the framework of the Seville process. This information collected from participating Member States and the definition of 'best available techniques' in Article 3 paragraph 10 and the criteria in Annex III of the Directive 75/2010/EU have been taken into account for the conclusions on best available techniques for this sector.

For the derivation of the conclusions, overarching environmental performance criteria of the different techniques, including cross-media effects, as well as the related costs have been examined.

The expression "BAT conclusions" pursuant to Article 3(12) IED is a document which contains the the following parts of the BREF:

- conclusions on the best available techniques,
- their description
- information about the assessment of their applicability

- the associated emissions of the best available techniques
- the corresponding surveillance measures
- the respective consumption values
- and applied site remedial actions.

In the context of the present report, which aims to support the German contribution to the Seville process and contributes to the essential elements of the BAT-conclusions, proposals for potential BAT-conclusions should be formulated. This contribution to the BREF document reflects the German point of view to preservation of wood and wood products with chemicals; it will be complemented by experiences from other Member States, and the European BATs will be later derived.

The proposed BATs were formulated on the basis of the techniques which need to be taken into account for the determination of BAT (see Chapter 6).

The information on formulation of BAT-conclusions is provided in the Commission's implementation decision (see [EC 2012]).

1.6.2 Elements of the BAT-conclusions

The following section presents the selected proposals for the elements of the BAT-conclusions. These proposals are based on data from German installations (see Chapter 4) and are not considered final conclusions. Unless otherwise stated, the findings in the following section are universal by applicable to existing and new installations.

Techniques to reduce and avoid fugitive emissions into air, soil and water

To avoid emissions into air, soil and water, the BATs are applicable individually or in combination:

Measures for the reduction and prevention of fugitive emissions of organic substances during processing, conveyance, decanting or storage of impregnating oils:

a) Reduce emissions of organic compounds and odour through the use of creosote grade C instead of grade B

b) Avoidance of emissions of organic compounds and odour via application of impregnating oils considering their usability and proportionality

c) In the case of hot-cold bath treatment process, use of closed impregnating system and suction of the exhaust gases until the treated wood has reached the ambient temperature, as well as cleaning of the collected exhaust gases through flue gas cleaning or the adsorption on activated carbon filters

d) Collection of vapour, filling below the surface level, and suction with flue gas cleaning during the decanting of organic substances

e) Extraction of emissions generated during impregnation process, and feeding into the flue gas cleaning system

f) Discharge of exhaust gases from pressure relief valves and drain facilities into the gas collection system or feeding into exhaust flue gas cleaning system

g) Avoid formation of aerosols in vacuum pumps which do not work according to the principle of the liquid ring pumps, by equipping the pumps with a liquid separator

h) Storage of liquid organic substances in fixed-roof tanks connected to a gas collecting pipe or flue gas cleaning system,

i) In the case of above-ground storage tank provide all-year-round heating or coating with the paint of a total heat reflectivity of at least 70%

j) Post-combustion of exhaust gases from inspection and cleaning processes of storage tanks, or equivalent measures to reduce emissions

k) Technically tight pumps, flanged joints, valves and feeders

Measures to avoid emissions from process using aqueous wood preservatives:

l) In the case of pressure processes, prevention and control of aerosols is achieved by sufficient retention time between achieving the pressure balance and opening of the boiler

Precautionary measures for the water and soil conservation

Non-pressure processes:

- Impervious drip tray (Federal Water Act-approved container) or appropriate size collecting container placed on the floor of the installation for the collection of substances hazardous to water and in the storage area
- Floor in immediate vicinity of installation working area and in the dripping zone of freshly treated wood should be sealed and impervious to wood preservatives
- Weather protection of the interim storage, impregnation facility, extracting rail area, drip zone, fixing warehouse, warehouse for non-fixing WPs (e.g. planning, roofs)
- Leakage and overflow protection of the impregnation facility
- Single-wall impregnation tank with sufficiently large and wood preservative solution impervious drip tray, fender and automatic leak alarm device in the case of non-visible drip tray or
- Double-wall impregnation tank with leak alarm device
- Recirculation of wood preservative solution
- Avoid contact with the soil of freshly impregnated timber
- Storage of waste (e.g. impregnated residual wood) in suitable containers and in suitable areas

Pressure processes:

- Impervious drip tray (WHG-approved container) or appropriate size collecting container placed on the floor of the installation for the collection of substances hazardous to water and in the storage area for preservatives
- Inspection and control of containers and pipes
- Weather protection of the interim storage, impregnation facility, extracting rail area, drip zone, fixing warehouse, warehouse for non-fixing WP (e.g. tarpaulins, roofs)
- Recirculation of residual liquids and dripping solution
- Avoidance of opening of boiler when under pressure
- Floor in vicinity of installation should be sealed and impervious to wood preservative solutions (in impregnation facility- if available, in the area of on pipes above ground and

in a separate engine room with pumps - if there are no drip trays) as well as in interim storage area, in the area of extraction rails, dripping zone and fixing area of the freshly treated timber

- Inspection and control of containers and pipes
- By application of impregnating oils: separation of oils and water from the generated waste water and condensate and recirculation and adequate treatment
- Weather protection (e.g. tarpaulins, roofs)
- Avoid contact with the soil of freshly impregnated timber
- Storage of waste (e.g. impregnated residual wood) in suitable containers and in suitable areas

Soil sealing, drip container and drip tray

To avoid WP emissions into soil and water in normal operation and in the case of accidents the application of the following techniques is considered to be BAT:

	Technique	Description
a	Soil sealing and collecting container for dripping water for recirculation and use of drip water as process water	The collected wood preservative is returned to the impregnation process via soil sealing of the working space and collecting container for dripping water.
b	Sufficient size of the drip tray of the impregnation installation	The system components for treatment with wood preservates are placed in adequately sizes drip tray (capacity = content of the impregnation tank; in the presence of several impregnation containers, in the case of non-pressure process: see when not printing: see Table 5). Collected WPs are recirculated back to the impregnating process.

Water recirculation

In order to reduce the use of fresh water and to avoid generation of waste water, the water recirculation and reuse in the system is considered to be BAT.

	Technique	Description
a	Water recirculation	The water recirculation is made possible via soil sealing of the working space and drip tray for collection of drip water. For impregnating processes with water-soluble salt or emulsion concentrates contaminated surface water (if necessary including rainwater) is collected and recirculated to be reused in the process. When using impregnating oils in the pressure process, the collected condensates are initially left to settle and then filtered via activated carbon filter. The purified water can be reused in the process, such as process water for impregnating processes with water-soluble salt or emulsion concentrates, as long as these are used in the system. Contaminated condensate can be disposed of as liquid waste.

Application

In the case of installations which exclusively use impregnating oils, possibly there is no need for process water.

The effluent must be treated then otherwise, e.g. it can be fed into municipal sewage treatment plant or properly disposed of as liquid waste. Regardless of whether a water recirculation can be realised, the soil sealing and collecting bunker are considered to be BAT.

Wood moisture measurement

To reduce application of chemical and resource consumption, the determination of BAT for wood moisture content is made by the following techniques either individually or in a combination:

	Technique	Description
a	Automatic electric resistance measurement for the determination of the wood moisture content	In the case of automatic and manual resistance measurement the wood moisture content is determined by means of electrodes (sensor), which are introduced into the wood and the measurements of the generated electric flows.
b	Manual electric resistance measurement for the determination of the wood moisture content	
c	Weighing procedures for determination of wood moisture content	The wood moisture content is estimated by means of weighing the wood before the impregnation

Wood moisture measurement allows impregnation at optimum moisture content in order to ensure the required quality of impregnated wood, as well as to achieve the aim of wood protection. Wood with suboptimal moisture content is brought to the optimal wood humidity level before the treatment (e.g. through repeated storage or active drying). This procedure allows avoidance of repeated impregnation process and extends the shelf life of the products. It also reduces the resource consumption i.e. WP and wood (and its alternatives).

Flue gas cleaning in installations employing impregnating oils (coal-tar oils)

In order to prevent emissions into the air which could be generated by burning of the organic components of the exhaust gasses coming from installations using impregnating oils (creosote), cleaning of the exhaust gas by application of the following BATs (individually or in combination):

	Technique	Description
a	Thermal post-combustion	Exhaust gases generated from the tanks of the creosote impregnating installation are fed into the thermal exhaust gas cleaning facility (TAR; see VDI 2442). Organic components in the exhaust gas are burned. The thermal post-combustion is the process of oxidation of flammable gases and aromatic substances in the exhaust gas stream where the mixture of air or oxygen with pollutants is heated with natural gas in a combustion chamber long enough to be over the auto flammability point in order to reach the nearly complete combustion to CO_2 and water.
b	Activated carbon filtering	Exhaust air from the tanks of the creosote impregnation is fed to an activated carbon filtering (see VDI 3674). Organic components are removed from the exhaust air.

By application of these BATs the following emission ranges (half-hourly average values) are reached or the emission values are under these ranges, under the normal operating conditions (273 K, 1013 hPA, dry):

Table 1: Possible BAT emission ranges for the relevant parameters

Parameter	BAT-associated emission ranges
CO	100 mg/m³
NOx	100 bis 200 mg/m³
Total C	20 bis 30 mg/m³
Benzo[a]pyren	0,002 mg/m³

The emission ranges specified in Table 17 are based only on measurements in one installation. These have to be supported with further examples in the course of information exchange to the BREF.

BAT is to determine the emissions into the air according to the following table:

Table 2: Information on determination of the relevant parameters in the exhaust gas

Parameter	Sampling	Measurement process	Measuring accuracy	Measuring frequency
CO	In accordance with VDI 2066 part 1	In accordance with VDI 2459, sheet 6	± 5%	annually
NOx		In accordance with VDI 2456, sheet 9	± 5%	annually
Total C		In accordance with VDI 3481, sheet 1 und EN 12619	± 5%	annually
Benzo[a]pyren		In accordance with DIN EN 1948 and VDI 3873, sheet 1	± 5%	annually

The technique is applicable only for the impregnation of wood with creosote.

Energy efficiency

In order to use energy efficiently, BAT is to employ the required pressure conditions during wood treatment by pressure processes by applying the following techniques:

	Technique	Description
a	Variable pump control	By the variable pump control a relatively high power is used for creation of desired working pressure in boiler. After reaching the working pressure the system is switched to a more energy-efficient pressure pump with lower power.
b	Other techniques are used, but could not be investigated.	

Weather protection

Following techniques are BATs for avoidance of emissions of HSM in soil and water by leaching of fixed not HSM:

	Technique	Description
a	Roof cover of extracting rail area, drip area and fixing area	Roof cover of the workspace and/or of the storage area for freshly treated wood allows that the treated timber is protected against weather /rain fall during the transport and storage until the complete fixation of the wood preservative (usually two days). This completely prevents that the rainwater enters the impregnation

	Technique	Description
		installation and the leaching of not completely fixed wood preservatives.
b	Storage under tarpaulins until the complete fixation	Freshly treated wood is stored under tarpaulins until the wood preservatives are completely fixed (usually two days)

Substitution of wood preservatives when applying wood preservatives on creosote basis

To avoid or reduce odour and emissions of organic compounds when using wood preservatives on the basis of creosote, BAT includes the following techniques either individually or in combination:

	Technique	Description
a	Substitution of creosote grade B with creosote grade C	The impregnation process is changed from impregnation with creosote grade B to creosote grade C. As a result, the emission of volatile organic compounds (VOC) and odour can be reduced.
b	Substitution of coal tar oil WPs with coal tar oil free WPs	The impregnation process is changed from impregnation with coal tar oil WPs to coal tar oil free WPs. The latter can be applied at ambient temperature and contain no VOC. As a result, the VOC and the odour emissions are prevented and the energy consumption is reduced.

Application

The technique is applicable for existing and new installations. A prerequisite for application of this technique is that the effectiveness and suitability of substitutes for the respective application is examined and ensured on the individual basis. The technical applicability for reaching respective aim for protection as well as the economic viability for substitution should be also considered. Where appropriate, the existing installations must be adapted in order to perform substitution. In the case of techniques described under a) in the table above, the storage tanks and pipes must be heatable in order to ensure safe processing of creosote grade C.

1.7 Emerging techniques

Currently it is assumed that the impregnation with a wood preservative with reduced content of coal tar oil can have a similar effect as the use of coal-tar oil preparations, but is associated with lower environmental impact. A wood preservative which is currently in a testing phase is a concentrated emulsion for impregnation in the retort pressure treatment process with 8-10 bar at normal temperature. It can be applied in conventional retort pressure treatment process (such as aqueous salt solution). The emulsion has been extensively tested according to international norms and standards and proved to be effective and suitable for application (BAM and EMPA, no concrete information about norms and standards).

The above mentioned emulsion concentrate is formulated of:

- 70 parts of coal tar oil grade B or grade C
- 20 parts of modified linseed oils co-emulsifier and fixative
- 10 parts of N,N-Didecyl-N-methylpoly(oxethyl)- ammoniumpropionat, co-biocide and emulsion stabilizer

According to the expert group (technical discussion of the 17.01.2013), further developments of creosote alternatives are under way, with the aim to reduce or substitute creosote application.

Comparison of performance (of above given emulsion concentrate) with existing BAT (here: application of creosote):

- Lower content of coal-tar oil and especially benzo [a] pyrene and VOCs.
- Reduced odour of treated wood with lower VOC share which remains in the wood
- Applicability in conventional pressure processes (such as aqueous salt solution)
- Processing without heating of the immersion impregnating medium, lower energy consumption
- Pollution reduction (e.g. prevention of odor pollution, lower creosote contamination) through lower emission of VOC from coal tar oils.
- Reduction in energy consumption due to no need to heat the WP

The technique is applicable for existing and new installations. The efficiency and suitability of substitutes must be ensured in each individual case. Where appropriate, existing installations must be adapted in order to be eligible for application of substitute. Long-term experience is not available with the above described product.

2 Foreword

2.1 Introduction and Objective

The Federal Environmental Agency has commissioned BiPRO GmbH to perform a study on "Determination of the best available techniques for preservation of wood and wood products in Germany considering cross-media environmental impacts."

The aim of the project is to determine the best available techniques in the field of preservation of wood in Germany. The results of the project will be incorporated as the German contribution to the Seville process for the preparation of the Best Available Techniques (BAT) reference document (BREF) for the preservation of wood and wood products with chemicals and therefore to contribute to further developing production-integrated environmental protection at European level.

Directive 2010/75/EU (IED = Industrial Emissions Directive) on industrial emissions is the EU wide basis for the approval of environmentally relevant industrial installations. It has to be transposed into national legislation by Member States until 2013 and it replaces, inter alia, the IPPC Directive 2008/1/EC. The IED aims to harmonize environmental standards for industrial facilities at a high level. Pursuant to the IED, a European wide exchange of information with stakeholders (The Seville Process) on "Best Available Techniques" is organised, which results will be published as BREFs.

Based on the BREFs, the European Commission establishes BAT conclusions through a committee procedure. BREFs, which are also worldwide well regarded, set EU standards for production-integrated environmental protection and sustainable production.

The legal and practical importance of the BREFs was increased with the entry into force of the IED, compared to the previous IPPC Directive. The BAT conclusions are used as a reference document for setting the permit conditions (see IED Article 14 (3)). Within four years of publication of decisions on BAT conclusions it is to be ensured, that all permit conditions for the installations concerned, are reconsidered and, if necessary, updated to ensure compliance (see IED Article 21 (3)).

Compared to the IPPC Directive, the IED includes some new activities. Among other, according to paragraph 6.10 of Annex I of the IED, the preservation of wood and wood products with chemicals with a production capacity exceeding 75 m^3 per day other than exclusively treating against sapstain is classified as environmentally relevant activity. Therefore, as part of the Seville process a new BAT reference document (BREF) for the preservation of wood and wood products with chemicals will be established. The Federal Environmental Agency is the national coordinator for the Seville Process.

Intensive participation of Germany in the Seville process helps to align the industrial environmental standards in the EU to a high level and make a significant contribution to international climate protection. Possible distortions of competition can be compensated by a single European environmental protection standard.

2.2 State of play

During this research project, specific data and examples of advanced integrated production and end-of-pipe measures in facilities for wood preservation with chemicals are collected and analysed in close cooperation with industry representatives and facility operators. This final report summarises the main results and aims to provide, via the Federal Environment Agency,

the German contribution to the Seville Process for the preparation of the BREF for the preservation of wood and wood products with chemicals.

2.3 Scope

According to paragraph 6.10 of the Annex I of the IED, the preservation of wood and wood products with chemicals with a production capacity exceeding 75 m^3 per day, other than exclusively treating against sapstain, will be classified as environment related activities.

2.4 Relevant processes

The installations which apply the following techniques are affected:

- Wood impregnation process using pressure and non-pressure processes (immersion and superficial processes)
- Chemical wood modification, i.e. acetylation, furfurylation, polymerisation
- Hydrophobisation

Thermal wood modification method is outside the scope of this report, as this technique does not employ chemicals for wood preservation.

A basic description of the current techniques for the preservation of wood with chemicals, including description of the chemical and thermal modification processes, as well as of the standard and techniques in Germany for the prevention or reduction of emissions are available in the VDI Guideline VDI 3462 Part 1 ([VDI 3462]; publication expected in April 2013).

Within the present research project, concrete installations data on hydrophobisation/impregnation processes with wood preservatives (WP) (pressure and no-pressure processes) were collected and analysed as a basis for determining the BAT.

2.5 Relevant production capacity

The production capacity of installations is of the crucial concern. Affected are only installations with production capacity exceeding 75m^3 of wood per day. The definition of the termproduction capacity is crucial for the number of affected installations in Germany and for the individual installation itself.

The definition according to the IPPC Directive reads as follows:

"The coherent meaning of "capacity" is the maximum capacity to which the installation is limited technically or legally... it is the capacity of the installation to operate 24 hours a day, provided that the equipment is not technically or legally restricted from operating in that way."

Based on this definition, the following proposal was derived to define the production capacity:

*The daily production capacity of an impregnation plant is calculated within 24 hours in an installation *) taking into account maximum impregnable timber volume. Both the technically related specifications, maximum load factor (dependent on the used method of wood preservation, the used wood preservatives, wood species, the degree of processing, the particular specifications of the client, the requirements of the relevant standards, the technical design of the installation, etc.), as well as individual circumstances for individual operator (e.g. approved operating hours) and other government restrictions, need to be*

observed. The available and officially approved storage area can additionally limit the calculated production capacity.

A calculation of the daily production capacity is based only on the content of impregnating boiler i.e. content of the impregnation troughs is incorrect.

**)* Abstract from 4. *BImschV:* The conditions specified in the Annex are also applicable in the case when a number of installations of the same type are placed in a close spatial and operational context (common installation) and together achieve or exceed the relevant performance limits or installation size. A close spatial and operational context is given, if the installations:

- are placed on the same premises
- are inter connected with common facilities, and
- serve to a comparable technical purpose.

An installation fulfills the definition of "daily production capacity" only in the case when all of three conditions available in the footnote are met.

Facilities solely used for the purpose of treating against sapstain are not considered part of the wood preservative treatment installation and are not used to calculate the daily production capacity (see IED, Annex I, No. 6.10).

2.6 Impact on individual installation

Whether an installation is subject to a permit pursuant to IED depends on the activity carried out and on the daily production capacity. The obligation to hold a permit for each installation is made on the individual basis, considering the installation specific conditions (see above).

In order to support a proper decision on permit conditions for installation operators and for regulatory agencies, spreadsheets have been developed in the frame of this project, which allow the calculation of the production capacity at the facility level for different products (poles, sleepers, garden timber), procedures, types of wood and production conditions. Using the spreadsheet, the capacity of a concrete installation pursuant to the requirements of IED can be assessed. The spreadsheets are available in the Annex. They were provided to UBA in typical data form and are available for the interested installations operators and regulatory agencies.

3 General Information

The relevant industry carrying out preservation of wood and wood products often consists of small or family businesses with a small production capacity of 5-20 m^3/day. Only a limited number of companies operate at higher capacities.

The interests of the wood preservation industry in Germany are represented by several associations, and the three of them are briefly described in the following table:

Table 3: Overview associations in Germany

Organisation	Short description
DHV – Deutscher Holzschutzverband e.V.	The DHV is an association of manufacturers of outdoor wood products as well as the suppliers active in this area, service providers, associations and organizations. It is the professional body of the German manufacturers of wood products for the garden and landscaping, playgrounds including piles for the vineyards and orchards and noise barriers, which are impregnated in the retort pressure and hot-cold bath treatment (50 members)
DHMV – Deutscher Holzmastenverband e.V.	The DHMV gathers all major manufacturers of telecommunications masts and pylons for low-voltage and medium-voltage networks (1,000 volts to 50 kV) in Germany. (8 members)
DSH – Deutsche Säge- und Holzindustrie e.V.	The BSHD represents the interests of the sawmill and wood industry at the federal level and in the European and international organizations and affairs. (approx. 600 members)
SGH - Studiengesellschaft Holzschwellenoberbau	The SGH represents the main producers, users and impregnator in Germany and neighboring countries. Its members provide the best possible solutions for users from the following product range: regular sleepers made from beech, oak and pine sleepers for switches made from oak and pine sleepers for bridges made from oak and pine other sleepers, fixation material and rails as well as accessories for track. (9 members).
Deutsche Bauchemie e.V.	The German industry association for manufacturers of construction chemical products (about 120 members) and represents the interests of the wood preservative manufacturers in the Association at national and European level.

In the course of data collection within Germany about 70 companies that perform preservation of wood were contacted. Based on the this approach (i.e. determination of relevant companies) and due to the support of the DHV, the DHMV, GIH, SGH and the involvement of BSHD, it can be assumed that the majority of relevant companies were encouraged to participate.

3.1 Relevant installations in Germany

According to currently available information, it can be expected that in some installations in Germany, which operate with pressure and non-pressure processes, the production capacity of 75 m^3 of wood per day (and more) can be exceeded. However, it is unclear whether and by how many installations this capacity is exceeded. The production capacity of the installations inspected in the course of the project (on purpose installations with relatively high production capacity were selected) was estimated to be in the range of slightly below 75 m^3 to about 200 m^3 of wood per day.

In many companies, the wood preservation takes only minor significance in the production, while the core business lies in other operational areas, such as timber cutting. The German sawmilling

industry, with about 2,000 factories, is the most important link between the forest and timber industry. Its factories constitute the first processing stage of the harvested roundwood. Many sawmills have expanded their product range and offer both sawn timber and timber treated by impregnation products for the next processing step. It is not known how many companies are significantly involved in impregnation. Usually such companies work with non-pressure processes (dipping or impregnation).

Whether an industrial installation is subject to a permit pursuant to IED depends on the activity carried out and on the daily production capacity. The obligation to hold a permit is to be assessed for each installation on an individual basis, considering the installation specific conditions.

3.2 Environmental relevance

In relevant installations for impregnation/preservation of wood either water-soluble wood preservatives (WPs) or WPs on the basis of creosote are applied (see Chapter 5.1.2).

The main sources of emissions into the environment are the following:

- Water-soluble WPs: (1) water vapor and aerosols in the air, (2) WPs in water or soil, (3) wastewater (4) formation of contaminated waste wood.
- Creosote based WPs: (1) steam (from the wood) and gases/aerosols in the air (odor), (2) WPs in water or soil, (3) waste, (4) contaminated waste wood.

In the existing plants in Germany, emissions are avoided or minimized by technical measures (e.g. thermal exhaust air purification, drip trays, soil sealing with repatriation, shelter, proper disposal of waste).

4 Applied processes and technologies

4.1 Delivery, reception, storage and transport

The impregnated semi-finished wood products such as logs, construction timber, poles and sleepers, are directly produced in the associated sawmill or are purchased. After quality inspection, the incoming wood products are usually stored in open or in roof-covered area. The transportation of timber to the impregnation plant is usually done by industrial fork lift or by a crane.

WPs are stored in original containers or in an approved container in order to minimize the risks of accidental leakages. In addition, it ensures that unauthorized personnel does not have access to wood preservatives. The storage of wood protection products must comply with the relevant statutory provisions. Provisions on water pollutants are provided in the Section 3 of the Federal Water Act (Wasserhaushaltsgesetz, WHG). Installations for storing, filling, production and processing of water polluting substances as well as installation which use water-polluting substances in the field of trade and industry and in the area of public facilities shall be designed and built, operated and decommissioned in a way to prevent adverse changes in the properties of water bodies (§ 62 (1) WHG). The concrete technical design and the corresponding obligations including approval process and assessment procedures for installations are defined in the ordinances on industrial installations regulating the handling of water contaminating substances (VawS) in the German Federal States.

Since the federal reform in 2006, the Federal Government has extended its legislative powers providing the space for a Federal Regulation as well as the derogations in normative rules for the polluting substances and installations. A draft has been available since late 2010[3]. Until the adoption of the Federal Regulation, the Federal States Ordinances shall continue to apply in addition to a transitional Federal Regulation[4].

4.2 Treatment processes for wood preservation

The following figure gives an overview of different types of treatment processes that are used for wood preservation with chemicals and additionally or exclusively alteration of the certain product characteristics (ammonia treatment, heat treatment).

The latter, however, are not covered by the IED and are only partly discussed in order to provide an overall picture of wood treatment processes. The thermal modification is also not in the scope of the project as chemicals are not used for wood preservation. The chemical modification lies in scope of the project, however, currently in Germany this processes in not performed on an industrial scale, therefore plant-specific data for this technique could not be collected within the project.

[3] See http://www.bmu.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/vauws_entwurf.pdf

[4] Verordnung über Installationn zum Umgang mit wassergefährdenden Stoffen vom 31. März 2010 (BGBl. I S. 377) http://www.gesetze-im-internet.de/bundesrecht/wasgefstanlv/gesamt.pdf

Figure 3: Overview of different wood treatment processes (according to Table 5 [VDI 3462])

Wood preservation and/or enhancement process	
	Immersion/impregnation (with wood preservatives)
	Pressure process Retort pressure treatment process: Vacuum-pressure process, alternating pressure process, RUEPING process, double RUEPING process Low-pressure process: Double vacuum process, modified Lowry process
	Non-pressure process Immersion process: Trough impregnation process, dipping, hot-cold bath treatment; Superficial process: Brief dipping, deluging, spray tunnel process, spray application
	Wood modification (with or without chemicals)
	a) Thermal wood modification (not relevant for the scope of this project) Open systems (atmospheric pressure) with or without steam injection, Closed systems (pressurised) with steam injection, Closed systems (vacuum) without steam injection, Oil/heat treatmen, Inert gas process
	b) Chemical wood modification (in Germany not performed on industrial scale, status 2012) Acetylation , Furfurylation, Polymerisation
	c) Impregnation with resins
	Hydrophobisation (with chemicals)
	Soaking in and/or impregnation with hydrohobisation agents such as oils, waxes (as emulsion of melt)
	Ammonia treatment (fuming) (not relevant for the scope of this project)
	Fuming at temperatures of up to 90 °C at atmospheric pressure or under pressurised conditions to adjust the pH necessary for chemical reaction
Other wood treatments (not relevant for the scope of this project)	
	Heat treatment (phyto-sanitary measures)
	Method as per ISPM 15: Heat treatment in chambers (continuous minimum temperature of 56 °C for a period of 30 minutes throughout the wood cross-section

The processes are described in the VDI guideline, Section 5 (see [VDI 3462]).

4.2.1 Wood impregnation

The area of wood impregnation with preservatives can be divided into pressure and non-pressure processes (see Figure 3). The processes are described below.

4.2.1.1 Pressure process/Retort pressure

“Impregnation by pressure processes is carried out in closed plants. Main factors determining the duration of the treatment process are the type of process, the penetrability of the wood to be treated, the level of processing of the wood to be treated (roundwood or sawn timber), the wood preservative employed as well as the requirements for the impregnation quality (retention and depth of penetration) defined in the applicable standards/specifications and/or specified by the users/customers“. [VDI 3462].

“To prevent or reduce aerosol formation and emissions, all pressure processes can be operated with a drip-off and/or condensation phase at the end of the impregnation process before the treatment vessel is opened for removing the treated wood”.[VDI 3462].

The following processes are employed in commercial practice (the process data indicated are an example only and will usually vary from plant to plant).

- Full-cell impregnation process/vacuum pressure process
- “The charge of wood is sealed in the treating cylinder and an absolute pressure of max. 0.10 bar (preliminary vacuum) is applied to drive out the air. The required preliminary vacuum has to be maintained for a minimum of 30 minutes. Following the vacuum period, the treating cylinder is flooded without breaking the vacuum followed by pressurisation to a minimum absolute pressure of 9 bar. The pressure period should last 45 minutes as a minimum. Treatment has to be continued until the wood no longer takes up any noticeable amounts of wood preservative (not more than 5 litres per m3 wood in two successive pressure cycles within 15 minutes = end phase check). After completion of the pressure period, a final vacuum is normally applied (depending on the product) for a period of 10 to 20 minutes.” [VDI 3462].
- Alternating pressure process (Hendricksson process)
- “After a preliminary pressure phase of at least 30 minutes at a minimum pressure of 9 bar (absolute pressure) in the flooded cylinder, the wood is subjected to an alternating pressure treatment comprising a minimum of 160 cycles (1 cycle consisting of one pressure and one vacuum period) over a minimum period of 10 hours. The treating pressures in this phase must not exceed 0.35 bar (abs.) during the vacuum period and must not be less than 9 bar during the pressure period. The cycle time must be 1 minute at the beginning and 7 minutes at the end of the treatment. The pressure period should account for about 50 % of the cycle time at the beginning and for about 85 % of the cycle time at the end of the alternating pressure phase. After completion of the alternating pressure phase, a final vacuum is normally applied (product-dependent) for a period of 10 to 20 minutes.”[VDI 3462].
- Modified alternating pressure process ("Hamburger process")
- “After a preliminary pressure phase of at least 30 minutes at a minimum pressure of 9 bar (absolute pressure) in the flooded treating cylinder, the wood is subjected to an alternating pressure treatment comprising 60 cycles over a total of 10 hours. The treating pressures during this phase must not exceed 1 bar (abs.) during the vacuum period and must not be less than 9 bar during the pressure period. It will be sufficient to reach the maximum pressure; a defined retention time at the maximum pressure is not needed. The duration of the pressure buildup period during the alternating pressure phase should be approx. 5 minutes. After completion of the alternating pressure phase, a final vacuum is normally (product-dependent) applied for a period of 10 to 20 minutes.”[VDI 3462].
- Rueping process
- “The simple RUEPING process is the process of choice for treating spruce, larch and oak wood. This process uses exclusively impregnating oil (creosote). Air under pressure is forced into the treating cylinder which contains the wood charge. Air pressures employed range from 1.5 bar to 5.0 bar (absolute pressure), depending on the required penetration of the sapwood through to the heartwood boundary and the required level of preservative retention. This preliminary air pressure has to be maintained for a minimum period of 15 minutes. In a next step, the treating cylinder is flooded with hot impregnating oil at a temperature of 110 °C to max. 120 °C while maintaining the air pressure. Heat losses of the impregnating oil in the treating cylinder must be promptly made up by reheating to 110°C +/- 10 °C. This temperature must be maintained throughout the pressure period, the duration of which varies with the wood species. In the simple RUEPING process, a thermal conditioning step can be carried out before proceeding to the pressure phase. Once the preliminary air pressure has been

established, the wood is thermally conditioned under preliminary air pressure conditions in an impregnating oil bath for varying periods of time. Thermal conditioning raises the temperature of the impregnating oil (lower viscosity) and hence, improves oil penetration into the wood. In a next step, the pressure (absolute) is increased to 9 bar at a minimum. The oil pressure level and the duration of the oil pressure period are determined by the required depth of penetration of the sapwood through to the heartwood boundary and the required preservative retention as well as by the wood species, wood condition and wood dimensions. The process ends with the depressurisation of the treating cylinder to atmospheric pressure, return of the impregnating oil to the storage tank and the application of as high a final vacuum as possible which has to be maintained for a defined period. "[VDI 3462].

- The double RUEPING process is the preferred method for deciduous wood, e.g. beech, which can be readily impregnated over the entire cross-section in axial direction. The process likewise uses impregnating oil (creosote). The double RUEPING process is basically a combination of two single RUEPING processes. "[VDI 3462].

4.2.1.2 Non-pressure processes

The non-pressure process can be divided into two categories, the immersion process and superficial process. They differ primarily in the type of procedure, the immersion and availability of wood preservatives. In practice the following procedures are used:

- Immersion processes (trough impregnation/dipping, hot-cold bath treatment)

  „In the trough impregnation process, the timber to be treated is completely immersed in a liquid wood preservative over a period of one to several days. In the dipping process - these days the prevalent method for treating structural timber - the timber is immersed over a period of several minutes up to several hours. Modern impregnation troughs are typically executed as double-wall tanks and provided with corrosion protection. For older single-wall impregnation tanks, a separate secondary containment system is mandatory to ensure reliable retention of the impregnating solution in the case of leakage. The trough impregnation system has to be installed under cover to ensure protection against precipitation." [VDI 3462].

  „The **hot-cold bath process** for the treatment of wooden posts (supports for vineyards and orchards as well as horticulture and landscaping applications: e.g. vineyard posts, fruit tree and tree support posts) is only allowed in closed systems." [VDI 3462].

  "The posts are placed into the treatment tank filled with impregnating oil (creosote), the contact depth depending on the length of the post to be protected. The impregnating oil is then heated to 110 °C and maintained at this temperature for 120 minutes before being cooled to a temperature of 50 °C to 60 °C (temperature difference depending of the site-specific conditions and the required level of preservative retention). Once this temperature is attained, the posts are lifted out of the impregnating fluid by a lifting cage. The lifting cage is held over the treatment tank in the area of the exhaust gas extraction system for a minimum period of 60 minutes (dripping and condensing phase) before the system is opened." [VDI 3462].

  "When the system is opened for removing the treated wood, temporary emissions of organic and odour compounds may be released to the atmosphere. Fugitive emissions of the same compounds, although at declining concentrations, may occur during

subsequent storage. These emissions can be significantly reduced when using W.E.I. Grade C impregnating oils." [VDI 3462].

4.2.1.3 Superficial processes (Brief dipping, deluging, spray tunnel process)

In the superficial treatment, the wood preservative penetrates only into the outer layers of the wood. The superficial processes can be divided into brief dipping, deluging, spray tunnel process, spray application.

"With the brief dipping method, the timbers are immersed in the impregnating fluid (aqueous solution or water-dilutable emulsion concentrate) for a period of several seconds to several minutes. This treatment method is predominantly used in the manufacture of windows and carried out in closed buildings (production buildings, etc.)."[VDI 3462].

"Impregnating oils also lend themselves to application by the deluging method. Here, the timbers are placed above a suitable, liquid-impervious containment pad and the deluging lance is run over the timbers by hand. The outlet opening of the deluging lance is designed such that the wood preservative exits in the form of a liquid plume, flooding the surface to be treated. As against spraying, this method largely avoids the risk of mist formation."[VDI 3462].

"Drippage and excess fluid runoff is collected and recirculated, a basket-type strainer retaining wood chips and other coarse debris. The strainer has to be checked and cleaned at regular intervals."[VDI 3462].

"Spray tunnel systems come as mobile and permanently installed systems. The spraying units used in the spray tunnels are sealed against the ambient air. These systems use impregnating fluids providing either preventive wood protection only or an additional decorative effect."[VDI 3462].

"The arrangement of the spray nozzles in the spray chamber is selected such as to ensure that preservative is applied to all sides of the timber as it is continuously moved through the spray chamber by a conveyor. Overspray or drippage flows back to the storage tank and can be reused. To ensure uniform preservative application while at the same time minimising dripping losses on the drying side, the spray chamber is usually followed by a squeegeeing device. As a matter of principle, the timbers have to be moved through the system individually."[VDI 3462].

4.2.2 Wood modification

The wood modification can be divided into three categories, thermal wood modification, chemical modification of wood and hydrophobisation with resins. Thermal and chemical modifications of wood are not relevant in the context of this project. The techniques are described in [VDI 3462].

"Wood modification is aimed at enhancing the wood properties. This involves in particular the improvement of the durability and resistance to wood-destroying fungi, the enhancement of the form and dimensional stability, the reduction of moisture takeup and the modification of the colour shades. In wood modification processes, the chemical composition of the wood (cell wall components) is altered without the use of biocides. Wood modification opens the door to new applications for native wood species having no or poor durability." [VDI 3462].

"Modified timber is usually used in applications exposed to the elements and moisture (veranda flooring, facade cladding, windows, doors, wood for horticulture and landscaping applications etc.)." [VDI 3462].

4.2.3 Hydrophobisation

“Another option of wood enhancement is the impregnation with hydrophobisation agents such as oils, waxes or silicon compounds, for instance. Impregnation of wood with a melt of natural waxes and resins or paraffin resins significantly increases its durability and (compressive) strength. Plants of this type are operated inter alia in Germany and Austria.“ [VDI 3462].

“As the enhancement agents used in wood hydrophobisation contain either aqueous emulsions or melts of hydrophobisation agents, no relevant emissions are to be expected from this enhancement process. Data from dedicated studies are currently not available.” [VDI 3462].

“If liquid organic hydrophobisation agents (e.g. paraffins) are used, the applicability of 31st BImSchV has to be checked on a case-by-case basis.” [VDI 3462].

4.3 Storage and transport of treated wood

The storage of the freshly treated wood is usually protected from rain and/or on fixed surfaces. Relevant information, e.g. technical specification sheet or information available on wood preservative container must be observed and respected (see [DBC 2012]).

Impregnated wood with non-fixating wood preservatives stored in warehouses or in product storages areas should be either protected from weather conditions (with roof, tops) and/or stored under liquid-impervious sealed surface.

The transport of the treated wood after successful fixation is organised by truck or where sufficient infrastructure is in place, by train.

4.4 Measures for prevention or reduction of emissions

4.4.1 Process-integrated measures (primary measures)

Relevant measures are described in Section 6 of the VDI 3462 Part 1.

4.4.1.1 Delivery, storage and transport

“Emissions on delivery (unloading) of the impregnating oil shall be avoided, preferably by using vapour balancing. Level, impervious, paved traffic ways in the delivery area help prevent contamination of the soil and other environmental compartments in the case of accidental spillage. “[VDI 3462].

“An impervious collecting tray (collecting vessel approved under the German Water Resources Act) or a sufficiently sized perimeter bund in the storage room serves the same purpose. The storage room shall ensure adequate protection against major surface water runoff, firefighting water runoff and flooding. The floor of the impregnating solution transfer and dissolving station shall be resistant to attack by the impregnating fluid, be sufficiently sized and installed with a slope to the bund.” [VDI 3462].

4.4.1.2 Impregnation

“When using impregnating oils (creosotes), the substitution requirement as per § 3, para. 2 of 31st BImSchV shall be taken into account. Accordingly, the impregnating oil has to be substituted by another product within the shortest possible time to the extent feasible, taking into account the fitness for use and application of the substitute product well as the proportionality of costs and benefits. For the typical applications in the wood processing industry, the substitution of impregnating oil is, however, currently not feasible.“ [VDI 3462].

“To reduce or prevent fugitive emissions of organic compounds during processing, conveying, transfer or storage, the following measures will be required if the impregnating oils used exceed defined concentrations of environmentally harmful substances (see No. 5.2.6 TA Luft). These concentrations are normally exceeded by organic impregnating oils due to their creosote content.” [VDI 3462].

- “Leak-free pumps such as canned-motor pumps, magnetically coupled pumps, pumps fitted with multiple mechanical seals operated with quench or buffer fluids, pumps with multiple mechanical seals and atmosphere-side dry-running seal, diaphragm pumps or bellows pumps shall be used for pumping impregnating oils.” [VDI 3462].
- “Flanged connections shall not be used unless required for process, safety or maintenance reasons. In such cases, leak-free flanged connections according to guideline VDI 2440 shall be selected. Gasket selection and the design of the flanged connections shall be based on the gasket characteristics defined in DIN EN 13555 or DIN EN 1591-1 and DIN EN 1591-2. Conformance with a specific leak rate of 10-5 kPa l/(s·m) shall be demonstrated by a type test certificate according to guideline VDI 2440 or by a corresponding warranty of the manufacturer. ” [VDI 3462].
- “High-quality seals such as metal bellows seals followed by a secondary containment packing gland or equivalent sealing systems shall be used for stem bushings of shutoff or control valves and dampers. Sealing systems shall be deemed to be equivalent to the above systems if compliance with the temperature-specific leak rates can be demonstrated by a test according to guideline VDI 2440. ” [VDI 3462].
- “Sampling locations shall be enclosed or provided with shut-off valves such as to preclude emissions outside the sampling periods. During sampling, the initial fluid stream shall be either returned or completely captured. ” [VDI 3462].
- “Measures to be observed for the transfer of liquid organic substances primarily comprise air pollution control measures such as vapour balancing or submerged loading. Vent vapour extraction and subsequent cleanup in an air pollution control system is state of the art where vapour balancing is not technically feasible or would require a disproportionate effort. ” [VDI 3462].
  Vapour balancing systems shall be operated and interlocked in such a way that liquid flow is not released until after their connection and that, except for emergency pressure-relieving events, no emissions are vented to the atmosphere by the vapour balancing system and the connected equipment while in operation. ” [VDI 3462].
- “Liquid organic substances shall be stored in fixed-roof tanks connected to a vapour collection system or an air pollution control device. Where storage tanks are installed and operated above ground, the tank outside walls and tank roof shall be provided with a suitable paint coating that consistently ensures a coefficient of total heat reflectance of not less than 70 %. The requirements for the paint coating can be dispensed with if the storage tanks are heated year-round. Unless otherwise required from safety aspects, gases and vapours vented from pressure relief valves and drain valves shall be discharged into the vapour collection system or directed to an air pollution control device. Exhaust gases released during inspection or cleaning of the storage tanks shall be treated in a thermal oxidiser or equivalent emission control measures shall be applied. ” [VDI 3462].

Pressure processes

“Emissions of organic compounds and odour emissions generated during the heatup phase, depressurization, evacuation (vacuum pump) and when opening the treatment vessel

(pressurised cylinder) as well as during recirculation of the impregnating oil to the storage tank (preheater) and storage of the freshly impregnated timber can be significantly reduced when using W.E.I. Grade C impregnating oils.“ [VDI 3462].

“Aerosol releases when opening the treatment vessel can be reduced or prevented by allowing a sufficient time to elapse between depressurisation and opening of the system.“ [VDI 3462].

Superficial processes (spray tunnel system)

“Potential emissions from the use of certain wood preservatives can be reduced by enclosing the system.“ [VDI 3462].

Immersion methods (hot-cold bath treatment)

“The use of a fully enclosed impregnation system will prevent the release of organic emissions to the atmosphere during the impregnation process. Emissions including odour emissions released when opening the system for removing the treated timber and during subsequent storage of the treated timber can be significantly reduced by using W.E.I. Grade C impregnating oils. “ [VDI 3462].

4.4.1.3 Hydrophobisation

“Currently, only one hydrophobisation plant is being operated in Germany. Information on relevant emissions and their control is not available.“ [VDI 3462].

4.4.2 Reduction of gaseous emissions

Relevant measures are described in Section 6 of the VDI 3462 Part 1.

4.4.2.1 Impregnation with creosote

“Impregnation processes using impregnation oils require exhaust gas capture and cleaning systems for the reduction of gaseous emissions.“ [VDI 3462]

Pressure processes

“Emissions generated during the heatup phase, depressurisation evacuation (vacuum pump), recirculation of the impregnating oil to the storage tank (preheater), subsequent storage of the freshly treated still hot wood and when opening the treating cylinder (pressure vessel) unless the batch is cooled in-situ after the impregnation process should be captured and directed to an air pollution control device. Exhaust gas cleaning technologies installed downstream of pressure treatment plants include in particular thermal oxidisers and activated carbon adsorbers.“ [VDI 3462].

“Aerosol releases from vacuum pumps not operating on the liquid-ring pump principle can be reduced by providing the pumps with an entrainment separator. “ [VDI 3462].

Non-pressure processes

“Emissions from the hot-cold bath treatment process, both when opening the plant for removing the treated timber and when lifting the charge out of the bath, should be extracted until the timber has cooled to ambient temperature, and be directed to an air pollution control device. Existing hot-cold bath treatment plants use exhaust gas scrubbers (see VDI 3679 Part 2) and activated carbon adsorbers (see VDI 3574) for exhaust gas cleanup.“ [VDI 3462].

4.4.2.2 Wood modification

Hydrophobisation

“There is currently only one hydrophobisation plant in Germany. Information on relevant emissions and their control is not available.“ [VDI 3462].

4.4.3 Waste water

Waste water generated by preventive chemical wood preservation processes

Measures for the prevention and treatment of wastewater are described in section 7.1 of the guideline VDI 3462 Part 1.

Impregnation processes using water-based salt or emulsion concentrates which are operated according to the BAT are basically wastewater-free processes.

“Suitable secondary containment and recirculation systems prevent condensates and cooling water from the impregnation plant or surface water contaminated with aqueous preservatives from entering the soil, the groundwater or adjacent water courses. The water collected or retained by the above measures is returned to the production process (closed circuit).“[VDI 3462]

“In pressure treatment plants using impregnating oils (creosote), waste water streams are generated only in the form of condensates during depressurisation of the treatment vessel and during the vacuum periods. These condensate volumes are collected, allowed to settle and treated in an activated carbon filter. The water so treated is either reused (closed circuit) or discharged into the public sewer system.” [VDI 3462]

4.4.4 Waste

Relevant measures are described in Section 7.2 of VDI 3462 Part 1.

“Preservative-treated waste wood generated as part of the production process is assigned to wood waste category A IV of the German Ordinance on Requirements for the Recovery and Disposal of Wood Waste (Altholzverordnung – AltholzV) .“ [VDI 3462].

“§ 10 of the AltholzV provides that waste wood generated in quantities greater than 1 m^3 of loose bulk volume or 0.3 tonnes per day or coal tar oil-treated wood waste must be collected separately at the point of generation by the waste producer or waste holder and stored in segregated storage areas insofar as this is necessary to meet the requirements for recovery, placing onto the market and disposal of the wood waste. The requirements for recovery/disposal of wood waste derive from the AltholzV. Normally, waste wood is routed to energy recovery in facilities regulated by 4th BImSchV in conjunction with 17th BImSchV.“ [VDI 3462].

“Preservative residues and slurries are likewise classified as hazardous waste and have to be disposed of in authorized facilities.” [VDI 3462].

“For the thermal disposal of preservative-treated wood waste classifying as hazardous, the requirements for registration and documentation (waste manifest) of the German Ordinance on Waste Recovery and Disposal Records shall be observed. Mixing hazardous wastes with other wastes, substances or materials is prohibited.” [VDI 3462].

Other relevant information on waste handling in wood preservatives are listed in a leaflet on dealing with wood preservatives (see [DBC 2012]):

“Unused wood preservative residues, which cannot be reused or recycled, according to waste legislation, must be disposed of as hazardous waste by approved waste treatment establishment.

This also applies to residues from impregnation plants (e.g. impregnation tank residues)". [DBC 2012]

In the case of hazardous waste, the entire disposal process including final shipment of the waste will to be recorded in the documentary evidence, which then releases the original waste holder from its liability.

"On one hand, the disposal of empty containers is controlled by the Packaging Ordinance, while on the other hand, it depends on the hazardous potential of the pervious container contents. In the case when the content of the containers is not subject to labeling according to the Hazardous Substances Ordinance, after emptying or cleaning, the containers can be reused or recovered. The disposal symbols printed on the container, facilitates not only the proper handling, but also provides evidence that the manufacturer of wood preservatives has paid the waste disposal charge for the container. "[DBC 2012].

The return of the standard containers for wood preservatives, such as transport containers (IBC) is organised via return agreement by manufacturers of wood preservatives or containers.

"Packaging of the wood preservatives with hazardous properties very toxic, toxic or harmful to health may not be reused, unless these containers are specifically intended for reuse, reload or refill by the container manufacturer or distributor. When recycling or reuse of the empty containers is not possible, these must be accordingly disposed of, usually as hazardous waste". [DBC 2012]

4.4.5 Precautionary measures for water and soil protection

Relevant measures are described in Section 7.3 of VDI 3462 Part 1.

"The wood preservative used for impregnation, the prepared preservative solution or leaching of preservative components from freshly treated timber where fixation is not yet complete basically pose a potential hazard. Effective measures to preclude soil and groundwater contamination are an appropriate design and layout of the plant or individual plant equipment." [VDI 3462].

"Thus, it has to be ensured that an impervious drip tray (collection vessel permitted under the German Water Resources Act) or a bund of sufficient size is provided underneath plant equipment handling water-polluting substances and in the storage room. The storage room shall offer adequate protection against major surface water runoff, firefighting water runoff and flooding. The floor of the preservative transfer and dissolving station shall be sufficiently sized, resistant against attack by the impregnating fluid and sloped towards the bund." [VDI 3462].

"As wood impregnation plants are plants using water-polluting substances in terms of § 62, para. 1 of the German Water Resources Act, the regulations of the German Länder governing plants handling water-polluting substances ((VawS) Federal VawS expected to enter into force in 2013) have to be observed. The requirements depend on the hazard potential of the plant, in particular the plant volume and the water pollution class of the preservative used (hazard level). Besides structural requirements, the VawS also regulate the operator duties, e.g. the notification duty, plant monitoring (self-monitoring according to operating procedure and third-party monitoring by VawS experts prior to commissioning and thereafter recurrently at 5-year intervals) ." [VDI 3462].

The subsequent table presents an overview of precautionary measures for soil and water protection at plants using non-pressure processes - Superficial processes

Table 4: Precautionary measures for plants using non-pressure processes – Superficial processes ([VDI-3462], Table 8])

Plant areas posing a potential hazard	Precautionary measures
1. Impregnation plants	▪ Brief dipping: Requirements identical with those for the trough impregnation and dipping processes (immersion processes) ▪ Deluging: Timber to be placed above a suitable liquid-impervious containment pad, collection of drippage and recirculation
2. Interim storage area/flash-off area/ dripping area/fixation area	▪ Permanent weather protection e.g. roof or similar ▪ Liquid-impervious sealed surface
3. Product storage area (only when using non-fixating wood preservatives)	▪ Liquid-impervious sealed surface of sufficient size ▪ Permanent weather protection e.g. by tarpaulins, a roof or similar
4. Waste storage area (waste wood)	▪ Storage in suitable containers on sealed surfaces specifically provided for this purpose (in the case of wastes posing a risk of water-polluting substances being released, these surfaces must be executed as bunds in addition).

The following table presents and overview of precautionary measures for soil and water protection at plants using non-pressure processes - Immersion processes

Table 5: Precautionary measures for plants using non-pressure processes - Immersion processes ([VDI-3462], Table 9])

Plant areas posing a potential hazard	Precautionary measure
1. Impregnation plant	▪ Besides meeting structural design requirements, the entire floor surface in the working area shall be executed such as to preclude preservative components entering the soil, water courses or the sewer system. ▪ Installation under a roof for protection against the elements and pelting rain; if required with additional provisions to prevent entry of surface water; ▪ Type of construction, construction materials, corrosion protection and monitoring equipment to be such as to preclude liquid leaks; ▪ Overflow switch that automatically trips the lifting mechanism so as to prevent liquid overflow. ▪ Tanks ▪ Single-wall: Tank to be bunded over its full length; bund to ensure permanent liquid tightness, be resistant to attack by the impregnating solution and adequately sized (bund capacity = volume of impregnating tank; when several impregnating tanks are installed, the volume of the largest tank shall be the criterion for the bund capacity. All other tanks can be placed into smaller bunds which must, however, be connected to the main bund via drain pits; if an impregnating tank is already installed in the bund and secondary containment systems of other impregnating tanks are connected to this bund via drain pits, the free volume of the bund shall be at least equal to that of the largest connected tank); bunds to have no floor drains; impact protection to be provided along the impregnating tank circumference, minimum distances between bunds and impregnating tanks: 40 cm from a minimum of two adjacent walls, 25 cm from the other walls, 10 cm floor clearance with supports arranged perpendicular to the impregnating tank; single-wall tanks installed in bunds

Plant areas posing a potential hazard	Precautionary measure
	without visibility to be provided with automatic leak detectors. ▪ Double-wall: ▪ To be fitted with an automatic leak detector
2. Interim storage area/flash-off area/ dripping area	▪ Permanent weather protection (e.g. by tarpaulins, roof) ▪ Sealed surface resistant to attack by the preservative components - surface with sufficient storage capacity ▪ Requirements for hot-cold bath treatment plants using impregnating oil ▪ Dripping area to be executed as liquid-impervious containment pad resistant to attack by the impregnating solution; with provisions for return of drippage to the drip box or the storage tank, for instance.
3. Fixation area (unless accelerated fixation methods are used)	▪ Permanent weather protection e.g. by tarpaulins, roof, etc. ▪ Sealed surface resistant to attack by the preservative components - surface with sufficient storage capacity ▪ Treated wood to be placed on supports (approx. 20 cm high) to avoid contact with the ground)
4. Product storage area (only when using non-fixating wood preservatives)	▪ Liquid-impervious sealed surface of sufficient size ▪ Weather protection e.g. by tarpaulins, roof or similar
5. Waste storage area (waste wood)	▪ Storage in suitable containers on sealed surfaces (in the case of wastes posing a risk of water-polluting substances being released, these surfaces must be executed as bund).

The following table presents and overview of precautionary measures for soil and water protection at plants using pressure processes.

Table 6: Precautionary measures for plants using pressure processes ([VDI-3462], Table 10)

Plant areas posing a potential hazard	Precautionary measure
1. Impregnation plant	▪ Treatment vessel and storage tank to be bunded over their full length; bund to have a sealed surface resistant to attack by the impregnating solution (normally steel-reinforced concrete provided with a protective liner, if necessary); with no floor drains and with a capacity equalling that of the largest storage tank installed. ▪ Above-ground tanks with constant visibility and to be accessible for inspection at all times; no floor drain or other openings ▪ In the case of storage tanks installed on the bund floor: Accessibility for inspection to be ensured by an appropriate clearance between the bund wall and tank and a defined clearance between the bottom tank head and the bund floor ▪ Double-wall tanks installed in a bund without visibility to be provided with an automatic leak detector ▪ Storage vessel holding the same preservative fluid extending into the dripping area or separate drip boxes within the bund underneath the

Plant areas posing a potential hazard	Precautionary measure
	treatment vessel openings to allow residual fluid released when opening the vessel door to be returned to the preservative circuit ▪ Safety interlock to prevent the treatment vessel from being opened as long as it is pressurised and/or filled ▪ Impervious flooring in separate machine room housing the necessary pumps and the plant control panel ▪ Measuring vessel, if installed in the machine room to measure the preservative consumption, to be mounted in a secondary containment or drip tray with drain to a collection vessel ▪ Piping (unless run above the bund) to be installed under floor in open water-tight ducts with good visibility and laid with a slope to the bund or - in the case of above-floor installation - on impervious sealed surfaces using underfloor ducts for returning leakage or spillage to the bund ▪ Rinsing connection with shutoff valve to allow the impregnation plant to be isolated from the pump during plant operation ▪ Additional or special requirements for pressure treatment plants using impregnating oils ▪ Bund to be sized to accommodate the entire liquid volume of the preheater ▪ Separate drip boxes within the bund before the individual openings of the treatment vessel ▪ Impervious flooring in the treatment building housing the process equipment ▪ Measuring vessels and pumps to be mounted on a liquid-impervious building floor ▪ Underfloor pressure piping to be installed in accessible liquid-impervious ducts provided with a drain to the bund; above-floor piping to be accessible for visible inspection during operation ▪ Production effluents and vacuum condensate: separation of impregnating oil in oil separators or similar and return to the process circuit; treatment of the aqueous phase in an activated carbon filter and/or treatment for reuse or thermal energy recovery
2. Interim storage area/flash-off area/ dripping area	▪ Sealed surfaces that are resistant to attack by the preservative components with a sufficient storage capacity and installed with a slope to the collecting/storage tank/bund. ▪ Tracks in the flash-off area to be laid in an impervious, double-wall bund that is resistant to attack by the preservative solution and return of the drippage to e.g. the dripping box or the storage tank (if the bund is classified as a storage tank, piping must either be installed above-floor or executed as double wall piping!). ▪ Weather protection (e.g. roof, tarpaulins) ▪ Strainer to retain wood shavings/debris ▪ Additional or special requirements for pressure treatment plants using impregnating oils

Plant areas posing a potential hazard	Precautionary measure
	▪ Floor to be provided with return launder to drip box or to the pump sumps
3. Fixation area **Note:** Hot steam fixation (accelerated fixation) is frequent practice when using chromate-containing wood preservatives. In such a case, a fixation hold area will be needed.	▪ Weather protection e.g. by tarpaulins, roof or similar ▪ Sealed surfaces that are impervious to the preservative components ▪ Provision of supports underneath the treated wood stacks (approx. 30 cm high)
4. Product storage area (only when using non-fixating wood preservatives)	▪ Impervious sealed surface of sufficient size ▪ Permanent weather protection e.g. by tarpaulins, a roof or similar
5. Waste storage area (waste wood)	▪ Storage in suitable containers on sealed surfaces specifically provided for this purpose (in the case of wastes posing a risk of water-polluting substances being released, these surfaces must be executed as bunds in addition).

“Soil protection at thermal or chemical wood modification plants and hydrophobisation plants is to be ensured by implementing the measures described above for impregnation plants.“ [VDI 3462].

5 Current emissions and consumption levels

Chapter 5 provides the entire spectrum of the current emissions and consumption levels for the overall process along with an indication of techniques used.

To provide an idea of the relative environmental performance of comparable activities, information regarding production levels is summarised to allow expressing the emission/consumption levels per production unit.

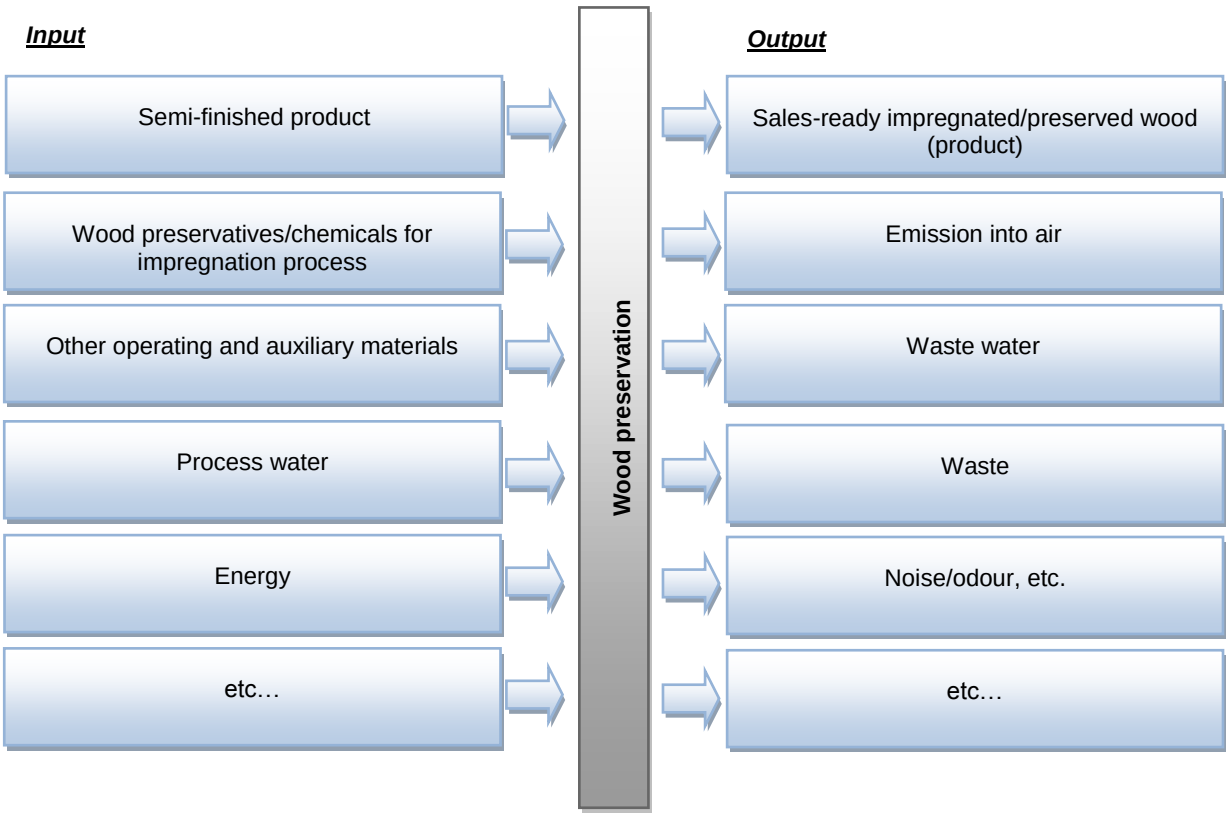
Information will include current consumption of energy, water and raw materials. Furthermore, the data will include the emissions of key pollutants to air and water as well as generation of residues/waste and where relevant, emissions of noise and odour which are arising from the activities.

5.1 General information for consumption

Figure 4 gives an overview of the main consumption and emissions for installations for the preservation of wood with chemicals.

Typical consumption and emission levels collected at the installations level are presented in the Chapter 5.3. These can be used as a basis for determining BAT.

Figure 4: Main input and output data for wood preservation installations



The main consumption data are described in the following.

5.1.1 Employed wood species

Different wood species could be impregnated. In regard to quantitative relevance, species such as pine and spruce are important. In addition, beech, oak and other wood species are used (see Chapter 5.3.1).

5.1.2 Employed chemicals

"The term "wood preservative" includes a group of different preparations for the protection of wood products. Their common characteristic is that they all contain one or more biocides. Depending on their properties, wood preservatives can be used for preventive or curative treatment against wood-pests and for protection of wood from further destruction" [DBC 2012].

Wood preservatives are subject to EU biocide legislation (The Biocidal Product Directive 1998/8/EC; from 01.09.2013 Biocides Regulation (EU) No 528/2012 applies). Accordingly, wood preservatives can be placed on the market only if the active substance(s) in the product is (are) still in the evaluation process (until the substance(s) is (are) included in the Annex I or Annex IA of Biocide Directive), biocidal product is in authorisation procedure or is already authorised. For product authorisation according to Biocial Product Directive, only active substances which are listed in the Annex I or Annex IA for the product-type 8 (wood preservative) [5] can be used[6].

5 Product type 8: Wood preservatives according to Biocides Directive 1998/8/EC: This product type includes both preventive and curative." Products used for the preservation of wood, from and including the saw-mill stage, or wood products by the control of wood-destroying or wood-disfiguring organisms. This product type includes both preventive and curative products

Wood components for structural purposes can be preventively or curatively treated against wood pest only with building code compliant wood preservatives approved by the German Institute for Building Technology (DIBt) in Berlin (see [DBC 2012]).

Wood preservatives differ according to their composition, application scope and application process as well as according to their effectiveness. Depending on their commercial size and packaging, wood preservatives can be distinguished into two categories: aqueous and water – dilutable, and solvent based (organic) wood preservatives (see [DBC 2012]).

Aqueous solutions and water –dilutable emulsion concentrates occupy the largest market share: these wood preservatives are usually purchased as dilutable salt concentrates which are diluted to ready-to-use solution direct in commerce. They are in particular suitable for treatment of dry to moist wood, and in specific procedures, also for juicy fresh wood. These are processed by specialized facilities in specialized procedures.

"Another commercially used form of aqueous based wood preservatives are emulsions, which are fine mixtures of water soluble and water insoluble components. Emulsions are also supplied as either ready-to-use mixtures or as a water-dilutable concentrates." [DBC 2012].

Solvent-based (organic) wood preservatives are supplied in ready-to-use form and can be therefore used directly. They are particularly suitable for treating dry to semi-dry wood. Some of these products may be used only for professional use (see [DBC 2012]).

Table 7 provides an overview of building code-compliant active substances in Germany and the frequency of their use in authorized wood preservatives (as of June 2012).

Table 7: Overview of the authorised active substances in Germany according to DIBt (name and CAS number) and their frequency of use (number of authorised WP in Germany with corresponding active substance)

Active substance	CAS Number	Frequency of use
Tebuconazol	107534-96-3	2
Propiconazol	60207-90-1	6
Boron acid	10043-35-3	21
Dinatriumtetraborat	wasserfrei - 1330-43-4 Pentahydrat - 12179-04-3 Decahydrat - 1303-96-4	5
Fenoxycarb	72490-01-8	4
Copper hydroxide	20427-59-2	4
Copper (II)-oxid	1317-38-0	3
Basic cooper carbonate	12069-69-1	6
Alkyldimethylbenzylammoniumchlorid	68424-85-1	6
N, N-Didecyl-N-methyl-poly(oxethyl)ammoniumpropionat	94667-33-1	2
Cypermethrin	52315-07-8	1

6 Status 12/2012: 28 active substances are included in the Annex I of Directive 98/8/EC for protuct type 8 [http://ec.europa.eu/environment/biocides/annexi_and_ia.htm as well as http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:327:0031:0033:DE:PDF]; 14 Active ingredients are still in the review programme (see [EC 2013]. With the decision for inclusion of an active substance in annex I or IA of Directive 98/8/EC are also the deadlines for application and the marketability of the device connected. Approx. 4 years pass from the time of the decision concerning the inclusion of an active substance and an accompanying wood preservative authorisation.

Active substance	CAS Number	Frequency of use
Didecylpolyoxethylammoniumborat	214710-34-6	1
Bis-(N-cyclohexyldiazeniumdioxy)-copper	312600-89-8	3

5.1.2.1 Water-soluble wood preservatives

The water-soluble wood preservatives include boron salts (inorganic boron), CC-salts (chromium-copper compounds), CCB-salts (chromium-copper-boron compounds), Quat salts (quaternary ammonium compounds), Quat-boron formulations (with boron, and quaternary ammonium compounds), chromium-free copper formulations (Cu-boron, and Cu-HDO formulations, Cu, boron and triazole compounds, Cu-Quat) and formualtions containing combinations of organic substances (for example, triazoles, pyrethroids carbamate).

The further distinction can be made according to fixating and non-fixating wood preservatives products (see [UBA report 2001]).

The fixating wood preservatives include CC –salts, CCB-salts, the Cu-HDO formulations, the Cu-boron and Cu-triazole formulations, Quat-boron formulations (only conditionally), and Cu-Quat formulations. The non-fixating WPs include boron salts.

Short characterisation (Source: adopted from GISBAU[7])

Boron salts

Wood preservatives based on boron compounds are odorless, highly water-soluble products with different color control. The products contain borates or boric acid as active substances. Furthermore, amines (for example, 2-aminoethanol-1) may be included as a solubiliser.

Wood preservatives on the basis of boron formulations are applicable to timber elements which are protected from weather conditions. They are not applicable to the timber which is exposed to atmospheric precipitation, humidity or in contact with water. Boron compounds WPs are preventively used against insects and/or fungi in wood and wood products used in load-bearing building components or other structural functions (general building-code compliant certificate)

The processing is done by brushing, dipping, spraying only in stationary installations, trough impregnation process and retort pressure immersion but also by foaming, glue mixing and borehole immersion.

CC-salts

Chromium and copper-containing wood preservatives are odorless, highly water-soluble pastes and liquids.

The products contain copper compounds (such as copper oxide) as active substances up to 25% as well as fixing auxiliary chromium-VI compounds (e.g. chromic acid/chromium trioxide) up to 55%.

They are used preventively against insects and/or fungi infestation in wood elements used as load-bearing building components or with other structural functions ((general building-code compliant certificate, in particular for timber in gardening and landscaping, as well as for construction of cooling towers, poles, vine and tree piles.

[7] http://www.gisbau.de/giscodes/Liste/GRUPPE_11.htm, Stand 11.12.2012

Chromium and copper-containing wood preservatives are applicable only for exterior wooden elements, preferably for wood with strong risk of leaching, in ground contact or constant contact with water.

The processing takes place only via retort pressure treatment processes in stationary systems.

CCB-salts

These products contain as active ingredients, copper compounds (such as copper oxide) up to 15% and of boric acid below 5.5%, as well as fixing auxiliary chromium VI compounds (chromic acid/chromium trioxide) up to 35%.

They are used preventively against insects and/or fungi infestation in wood elements used as load-bearing building components or with other structural functions (general building-code compliant certificate), in particular for timber in gardening and landscaping, as well as for construction of cooling towers, poles, vine and tree piles.

Chromium, copper and boron-containing wood preservatives are applicable only for exterior wooden elements, preferably for wood with strong risk of leaching, in ground contact or constant contact with water.

The processing takes place only via retort pressure treatment processes.

Quat -boron formulations

Wood preservatives on the basis of boron and quaternary ammonium compounds are water-soluble liquids with different coloration.

The products contain quaternary ammonium salts and boron compounds as active substances, as well as other active substances such as Fenoxycarb up to 0.25%. For instance, 2-aminoethanol, and glycols may be included as solubilisers.

Quat-boron WPs are used preventively against insects and/or fungi infestation in wood elements used as load-bearing building components or with other structural functions (general building-code compliant certificate).

Depending on their composition, the wood preservative on the basis of boron and quaternary ammonium compounds could be only used in interior constructions or in exterior constructions without soil contact.

The processing usually is done by trough impregnation process via dipping, brush application, deluging or spraying in tunnel process or via retort pressure treatment processes.

Cu-boron und Cu-HDO formulations

Wood preservatives on the basis of copper- HDO, copper and boron compounds are blue, odorless and high water-soluble concentrates.

The products contain copper- HDO, boron and copper compounds as active substances.

They are preventively used against wood-destroying fungi in elements made of wood and wood products, which are used as load-bearing building components or with other structural functions (general building-code compliant certificate), in particular for timber in gardening and landscaping, as well as for construction of cooling towers, poles, vine and tree piles.

Depending on their composition, the wood preservative on the basis of copper and boron compounds are applicable in interior constructions or in exterior constructions with or without soil contact.

The processing takes place via retort pressure treatment processes or trough impregnation in stationary systems.

Copper, boron and triazole formulations

Wood preservatives based on copper, boron and triazole compounds are blue, odorless, highly water-soluble concentrates.

The products contain triazoles, copper compounds, boron compounds as active substances, as well as solubilisers (e.g.2-aminoethanol-1).

They are preventively used against wood-destroying fungi in elements made of wood and wood products, which are used as load-bearing building components or with other structural functions (general building-code compliant certificate).

Depending on their composition, the wood preservative on the basis of copper, boron and triazole compounds are applicable in interior constructions or in exterior constructions with or without soil contact.

The processing takes place via retort pressure treatment processes.

Formulations with copper and quaternary ammonium compounds

Wood preservatives based on copper and quaternary ammonium compounds are fixating water-soluble concentrates.

The products contain quaternary ammonium compounds as well as copper compounds (e.g. copper(II)hydroxide carbonate). Furthermore, solubilisers may be included (for example, 2-aminoethanol-1, ethylene glycol).

They are used preventively against insects and/or fungi infestation in wood elements used as load-bearing building components or with other structural functions (general building-code compliant certificate), in particular for timber in gardening and landscaping, as well as for construction of cooling towers, poles, vine and tree piles.

Depending on their composition, the wood preservative on the basis of copper and quaternary ammonium compounds are applicable in interior constructions or in exterior constructions with or without soil contact.

The processing takes place via retort pressure treatment processes or trough impregnation

5.1.2.2 Solvent-based wood preservatives

This group includes WPs with organic solvents. The solvent-based formulations consist of 80% - 95% of organic solvents (see [BMVBS 2012]). It can be distinguishes between the following solvent-based wood preservatives (detailes see GISBAU14):

- Curative and preventive, without aromatics
- Curative and preventive, aromatics poor
- Curative and preventive, aromatics rich

Solvent-based WPs are usually applied by hand in surface processes. They are not used in Germany in the industrial sector[8] and are therefore irrelevant in the context of this project.

[8] Personal communication Deutsche Bauchemie, 19.6.2012

5.1.2.3 Coal tar oils/creosote

Coal tar impregnating oils (creosote) are applicable for scantlings which are constantly in contact with soil and water.

They consist of polycyclic aromatic hydrocarbons (PAHs), including benzo [a] pyrene classified as carcinogenic. For this reason, creosotes are subject to the following restrictions in the EU:

- benzo[a] pyrene conncentration of 50mg/kg by mass and the share of water-soluble phenol concentration of 3% should not be exceeded
- creosotes are to be sold in the packaging of at least 20 liters and shall not be sold to private customers
- they are to be used only for industrial and professional purposes

Creosote containing biocidal products can be authorized for specific application (use) in the authorizing Member State, only in the case when the applicant provides technical and economic assessment for substitution and other requested information to authorizing authority in the Member States and based on the available information concludes that that there are no suitable alternatives.

Member States which allow such products on their territory, shall provide the Commission with a report not later than 31 July 2016 in which they justify their conclusion regarding the lack of suitable alternatives, and explain strategies for promotion of development of alternatives (see Biocidal Product Directive BPD 98/8/EC).

The main use of creosotes is for the treatment of railway wooden sleepers, but also wooden poles utilized for distribution of electricity or telecommunication, for fences, agricultural posts and vineyard posts.

According to the DIN EN 13991, creosotes can be differentiated into grades A, B and C (later marking W.E.I.-Grade A, W.E.I.-Grade B und W.E.I.-Grade C):

- Grade A (not authorised in Germany)

The strong benzo (a) pyrene-containing impregnation solution of grade A is prohibited, in accordance with Annex 17 of the ChemVerbotsV, because it exceeds the limit of 50 mg/kg benzo [a] pyrene.

- Grade B

„The authorised W.E.I. grades B and C differ in particular in their respective concentrations of organic and odour compounds“ [VDI 3462]. These creosotes consist in average of lower boiling oils and consequently do not exceed the 50 mg/kg benzo [a] pyrene limit. Nevertheless, grade B creosotes have similar behavior as insecticides and fungicides such as in the case of grade A (see [Rutgers 2007]).

The advantages of grade B creosotes (compared to grade C) are that they have a lower tendency to cristallisation and therefore are easier to store and process. Moreover, their low viscosity promotes a faster and deeper penetration into the woods (see [DGFH undated]).

- Grade C

“When using W.E.I grade C products, the requirements of No. 12.2.1. of Annex III to 31st BImSchV are deemed to be met as this wood preservative type has a VOC concentration of less than 2 %. Novel further-developed W.E.I grade C products have reduced benzo(a)pyrene concentrations (max. 10 ppm)).“ [VDI 3462].

In the development of creosotes grade C, the focus is on the reduction of evaporation of the impregnating agent after the treatment, which is very prominent in the case of low boiling coal tar oils. For this purpose the low-boiling oils are removed which increases the crystallisation temperature of the impregnating oil. To ensure safe handling, storage tanks and piping must be heated (see [Rutgers 2007] and [DGFH undated]).

The advantages of the grade C impregnating oils are their low odor, their reduced tendency to sweating and their increased effectiveness compared to grade A oils (see [Rutgers 2007] and [DGFH undated]).

5.1.3 Applied auxiliary materials/feedstock

Besides wood preservatives (see above) and water (see below) for the mixing of aqueous wood preservatives are oil, grease and lubricants in micro and small quantities used.

Installation specific data are available in the Chapter 5.3.3.

5.1.4 Water consumption and generation of waste water

According to the best available technology, by the process of impregnation with water diluted salt or emulsion concentrates, waste water is not generated. Installation specific data are available in the Chapter 5.3.4.

5.1.5 Energy consumption

Installation specific data are available in the Chapter 5.3.5.

5.2 General information on emissions

Table 1 in [VDI 3462] provides an overview of the possible environmental impacts of different wood processing operations. Dust, noise and vibrations are not relevant in any of the relevant treatments.

5.2.1 Emissions to water

“The wood preservative used for impregnation, the prepared preservative solution or leaching of preservative components from freshly treated timber where fixation is not yet complete basically poses a potential hazard. Effective measures to preclude soil and groundwater contamination are an appropriate design and layout of the plant or individual plant equipment.“ [VDI 3462].

Precautionary measures for water and soil protection are described in Section 7.3 of VDI 3462 Part 1. Plant-specific data can be found in Chapter 5.3.6.

5.2.2 Air emissions

Section 8 of the guideline VDI 3462 Part 1 provides an overview of

- Emission limit values in Germany and mass concentrations attained according to the best available techniques for air pollutants, and
- Special requirements for impregnation plants employing impregnating oils (creosote)

Plant-specific data on emissions into the air can be found in Chapter 5.3.7.

Table 8: Emission values and attainable mass concentrations ([VDI 3462], part of the Table 12)

Air pollutant	Emission values)[a]	Achievable mass concentrations reflecting the state of the art)[a]	Remark
Wood treatment processes			
Preventive chemical wood preservation processes (wood impregnation/preservation)			
Impregnation plants with downstream thermal oxidiser)[b c]			
Benzo(a)pyren	0,05 mg/m³ or 0,15 g/h(Nr. 5.2.7.1. Klasse I TA Luft)		
Nitrogen monoxide and nitrogen dioxide, expressed as nitrogen dioxide	0,10 g/m³(Nr. 5.2.4 TA Luft)		
Carbon monoxide (Nr. 5.2.4 TA Luft)	0,10 g/m³		
Wood treatment with impregnating oils (creosote)[b]			
Organic substances expressed as total carbon	20 mg/m³(Nr. 5.4.5.4 TA Luft)		The requirements of No. 5.2.5 TA Luft for emissions of Class I and Class II organic substances are not applicable.
Benzene	1 mg/m³or 2,5 g/h(Nr. 5.2.7.1. Klasse III TA Luft)		

a) The emission values and mass concentrations indicated relate to dry exhaust gas at standard temperature and pressure conditions (273 K, 1013 hPa).

b) As no measured emission values were available to the Committee at the time this guideline was established, particulate emission values of comparable plants in the wood processing industry were used as a basis. The applicability of these values (see Table 12, column 3) shall be checked, taking into account the proportionality principle.

c) Emission limits shall be checked on a case by case basis as a function of the fuel used.

For impregnation plants which use impregnating oils (creosote), the following requirements apply:

“Pursuant to Annex III No. 12.2.1 of 31st BImSchV, the total emissions of a wood impregnation plant using tar oils (creosotes), reported in kilograms of emitted volatile organic compounds per m3 of treated timber, must not exceed 11 kg/m3

- for plants based on the hot-cold bath treatment processes
- and plants using other processes with a solvent consumption of not greater than 25 t/a.

For plants using other processes and having a solvent consumption of greater than 25 t/a, the total emissions reported in kilograms of emitted volatile organic compounds per cubic metre of treated timber must not exceed 5 kg/m3.“ [VDI 3462].

“The total emissions are defined as the sum of fugitive emissions and contained emissions of volatile organic compounds.“ [VDI 3462].

“The limit value for the total VOC emissions is deemed to be met if the plant uses exclusively tar oils with a mass concentration of volatile organic compounds not greater than 2 %.“ [VDI 3462].

"In addition, the mass flow of the creosote fraction exceeding a vapour pressure of 0.01 kPa at a temperature of 293.15 K must not exceed 2.5 g/h or a mass concentration of 1 mg/m³ in the contained exhaust gas (§ 3 para. 2 sentence 3 in conjunction with § 2 sentence 1 No. 11 of 31st BImSchV). The requirement for the mass concentration in the contained exhaust gas of creosote and carcinogenic substances such as benzene and polycyclic aromatic hydrocarbons using benzo(a) pyrene as a surrogate can normally be consistently met by treatment in a thermal oxidiser provided that the emission value or organic compounds is reliably complied with." [VDI 3462].

5.2.3 Residues/Waste

See Chapter 4.4.4and 5.3.8.

5.3 Typical emission and consumption levels

5.3.1 Wood

Table 9 provides an overview of the employed wood species and wood products in the visited installations.

Table 9: Installation-specific data for used wood species and wood products

	Installation 1	Installation 2	Installation 3	Installation 4
Production quantity (m³ impregnated wood/year)	12.200	13.000	9.000	7.739
Oak (m³/year) and products	500 sleepers	150 poles		
Beech (m³/year) and products	2.000 sleepers			
Pine (m³/year) and products	7.700 Sleepers, poles, lumber	2.000 Poles, palisades, logs, construction timber	9.000 Masts	
Spruce (m³/year) and products	1.500 poles, lumber	6.900 Poles, palisades, logs, construction timber		7.739 construction timber
Sonstige (m³/year) and products	500 No specification	4.000 Poles, palisades, logs, construction timber		

In the visited installations a total of almost 42,000 m^3 of wood per year is impregnated, mainly pine wood (18,700 m^3/year) and spruce (16,139 m^3/year). Other relevant wood species include beech (2,000 m^3/year), oak (650 m3/year) and other species (4,500 m3/year). The main products manufactured in these plants are sleepers, poles, lumber (wood construction) posts, palisades and other roundwood.

5.3.2 Wood preservatives

Table 10 provides an overview of the employed wood preservatives (concentrates), quantities and specific production volumes in the inspected installations.

Table 10: Installation-specific data for employed wood preservatives, quantities and specific production volumes

	Installation 1	Installation 2	Installation 3	Installation 4
Production quantity (m^3 impregnated wood/year)	12.200	13.000	9.000	7.739
Product	Sleepers, poles, lumber	Garden timber, construction timber	Masts	Construction timber
Process	Pressure process (a)	(short) pressure-process	Pressure-process	hot-cold bath treatment process
Creosote	TYP B/C 783 t/year			
Quat-Boron formulations		13,2 t/year		9.7 t/year
Chromium-copper formulations	28,5 t/year			
Chromium free-copper formulations	14,3 t/year	8,4 t/year	100 t/year	
Quat-preparation	0,6 t/year			
Total quantity WP(t/year)	826,4	21,6	100,0	9,7
Specific production quantities (m3 impregnated wood per ton of applicable WP)	14,8	601,9	90,0	797,8

(a) on the demand of consumers hot-cold bath treatment process is applied

The specific production volumes cover a wide range from about 15 to about 800 m^3 of treated wood per ton of inserted wood preservatives. Per cubic meter of wood between 1.3 (plant 4) and 67.7 kg (plant 1) of WP is absorbed. This large range can be mainly attributed to the different wood species, product requirements and accordingly applicable production methods as well as properties of the WP. In particular important are the following aspects:

- Product type: for sleepers and poles a complete impregnation of impregnable zone is performed, up to the heartwood. The beech sleepers require a throughout impregnation process (→ high WP demand). For wood used in construction, a non-pressure impregnation process is applicable (→ lower WP demand).
- Characteristics of WPs: In the case of aqueous WP, the wood absorbs also water next to the impregnation product (→ lower WP demand), whereas the creosotes penetrate "undiluted" into the wood (→ high WP demand).

5.3.3 Auxilary materials and feedstock

According to the installation operators auxiliary substances and materials are typically used in small and micro quantities.

Table 11 provides an overview of used auxiliary materials.

Table 11: Installation-specific data for auxilary substances and materials

Auxiliary substances and materials	Installation 1	Installation 2	Installation 3	Installation 4
Lubricants	Small quantities	Negligible	< 100 kg/a	Negligible
Cooling agents	Small quantities	Negligible		Negligible
Others	No data	No data	No data	No data

5.3.4 Water and waste water

Table 12 summarizes the amounts of process water and the generation of waste water into the plants visited.

Table 12: Installation-specific data for application of process water and generation of waste water

	Installation 1	Installation 2	Installation 3	Installation 4
Production quantity (m^3 impregnated wood/year)	12.200	13.000	9.000	7.739
Product	Sleepers Masts Lumber	Garden timber Construction timber	Masts	Construction timber
Process	Pressure process (a)	(short) Pressure process	Pressure process	Immersion process
Total quantity WP (t/year)	826,4	21,6	100,0	9,7
Process water (consumption in m^3/year)	570 (b)	2000 (c)	2550 (d)	120 (e)
Waste water (generation in m^3/year)	0 (f)	0	0	0
Specific consumption of process water per timber (Liter per m^3 of treated timber)	46,7	153,8	283,3	15,5
Specific consumption of process water per consumption of aqueous WP (m^3 per ton WP)	13,1 (7,1%) (g)	92,6 (1,1%) (g)	25,5 (3,8%) (g)	12,4 (7,5%) (g)

(a) Upon request is sporadically immersion process performed
(b) 570 m3/year of water for impregnation process (from sealed surfaces of the installation) and 1160 m3/year for steam generation (from wells)
(c) from wells
(d) from sealed surfaces of the installation and from the roofs
(e) from the public water supply network
(f) generation of liquid waste: 40 t/year (see Chapter 5.3.8) condensates from the creosote impregnation
(g) theoretically calculated concentration of the impregnating solution calculated from the data on the usage of process water and aqueous WPs. The actual concentrations may vary.

Water is usually used for mixing the adequate impregnation solution during the process of wood preservation. In the impregnation process with creosote (relevant for the installation 1) water is not used for mixing. In installation number 1, 1160 m^3 water is annually used for steam generation for heating the impregnating oils. This amount of water was not taken into account when calculating the amount of used process water, since the water is not coming in the contact with the product (impregnated wood).

The specific quantities of processed water which are used cover a wide range between approximately 15 to 285 liter/m^3 of wood. This wide range can be explained due to different wood species, product requirements and appropriate production processes, as well as properties of WPs. In particular important are the following aspects:

- Product type: for sleepers and poles a complete impregnation of impregnable zone is performed, up to the heartwood. The beech sleepers require a throughout impregnation process (→ high WP demand). For the timber used in construction, a non-pressure impregnation process is applicable (→ lower WP demand).

- Characteristics of WPs: Aqueous WPs are diluted with water before they are applied. Adequate level of protection is achieved via the appointed concentration of the working solution. Creosote based WPs are used without water.

Waste water is not generated in the inspected installations. Dripping water and rainfall water from sealed areas is used in impregnation process.

Water, which is displaced in tar-oil impregnation process in the installation number 1, is then separated and used for the impregnation in an aqueous production line or discarded as waste water, in rare cases (see Chapter 5.3.8).

5.3.5 Energy consumption

Table 13 provides an overview on amount of energy used.

Table 13: Installation-specific data for utilisation of energy

	Installation 1	Installation 2	Installation 3	Installation 4
Production quantity (m^3 impregnated wood (year)	12.200	13.000	9.000	7.739
Product	Sleepers Masts Lumber	Garden timber Construction timber	Masts	Construction timber
Process	Pressure process	(short) Pressure process	Pressure process	Immersion process
Electricity	198.900 kWh/year (for heating, pumps, engineering)	15.200 kWh/year (for motors of impregnating installation, estimation)	<200.000 kWh/year (including office and other operating costs)	Power for the lifting unit(app. 4,5 kW; performance of the motors) and for the heating in winter(6 kW; performance of heating system)
Natural gas	1.440.000 kWh/year (natural gas for impregnating installation, fixing)			
Heating oil			~ 295.000 kWh/year (~25 t/year; including office and other operating costs)	
Specific energy consumption in relation to the above information given in kWh/year (kWh/year per m3 wood)	134,3	1,2	55,0	n.a.

(a) Upon request is sporadically immersion process performed

The data on energy consumption are related to different system boundaries. Information on the actual energy consumption of the impregnation process is not available because the corresponding consumptions are not recorded separately. The calculated specific energy

consumption refers to the details provided by concerned installations. Due to the different system boundaries the values cannot be compared. The relatively high specific energy consumption in installation number 1 is explained by high operating temperature for the coal tar oils impregnation at 110 °C and the operation of thermal flue gas cleaning. Therefore, the coal tar oil impregnation process is energy intensive in comparison to other examined impregnation processes.

Detailed information on energy efficiency is available in the BREF document on energy efficiency (see [BREF EE 2009]). Information on the consumption of non-renewable and renewable energy sources in the life cycle of railway sleepers made from oak and beech wood are available in a comparative life cycle analysis for railway sleepers (see in particular Section 6.1.3 and Annex 4 [Werner, 2008]).

The following installation-specific measures are worthwhile to mention in relation to energy efficiency:

The working temperature during impregnation with creosote in installation number 1 is about 110 ° C. Waste heat from the impregnation process is exploited by a heat exchanger. The flue gas cleaning operates with natural gas at a temperature of 750°C. The hot exhaust gas is used to preheat the air which will be burned, as well as to preheat the water to 80 °C which is used for the steam generation.

In installation number 1, a variable pump control is used (see Chapter 6.7). For generation of the desired operating pressure in the boiler, a pressure pump with a relatively high power is used which is, after reaching the operating pressure, replaced by more energy efficient pressurizing pump with less power. The operator estimates a reduction of energy consumption by about 25% through the use of this technique (about 6.000 kWh/pump/year).

In installation number 1, approximately 1/3 of the total annual electricity consumption is generated by roof solar panels (approximately 60,000 kWh/year).

In installations 2 and 4, the heat is provided from an in-house wood boiler. For energy production exclusively internally generated wood residues are used (e.g. wood bark). In these installations significant part of energy consumption is used for other activities independent from process of impregnation itself (especially for drying).

In installation number 3, in 2009/10 both pressure boilers have been technically upgraded to more energy efficiently reach required vacuum.

5.3.6 Emissions to water

Since no waste water occurs, and the inspected installations are equipped with suitable sealed surfaces, recirculation systems and collecting drip trays, usually there are no relevant emissions into the water.

5.3.7 Air emissions

Table 14 provides an overview on the relevant emissions into the air in the inspected installations.

Table 14: Installation-specific data for emissions into air

	Installation 1	Installation 2	Installation 3	Installation 4
Production quantity (m^3 impregnated wood (year)	12.200	13.000	9.000	7.739
Product	Sleepers Masts Lumber	Garden timber Construction timber	Masts	Construction timber
Process	Pressure process (a)	(short) Pressure process	Pressure process	Immersion process
Emissions into air	500.000 m^3/Jahr (CO: 0,049 g/m^3; NOx: 0,104 g/m^3; ges. C: 14 mg/m^3)	n.r.	n.r.	n.r.
Specific emissions (m^3 into the air per m^3 treated wood)	41,0	n.a.	n.a.	n.a.

(a) Upon request is sporadically immersion process performed

Relevant air emissions occur only in installation 1 from the thermal flue gas cleaning. Annually 500,000 m^3 of purified exhaust gas is emitted and 41m^3 per m^3 of treated timber. Indicated concentrations are equivalent to annual pollutant load of 24.5 kg/year of CO, 52 kg/year of NOx, 7 kg/year total carbon and less than 0,001 kg of benzo [a] pyrene. The TAR is only temporary in the installation and emissions take place discontinuously. These annual loads are considered low. They are in the range of hourly minor mass flow for benzo (a) pyrene, and nitrogen oxides (see item 4.6.1.1 Clean Air Act, for nitrogen oxides = 20 kg/h, for benzo (a) pyrene = 0.0025 kg/h).

5.3.8 Residues/waste

Table 15 provides an overview of generation of wastes.

Table 15: Installation-specific data for wastes

	Installation 1	Installation 2	Installation 3	Installation 4
Production quantity (m^3 impregnated wood (year)	12.200	13.000	9.000	7.739
Product	Sleepers Masts Lumber	Garden timber Construction timber	Masts	Construction timber
Process	Pressure process (a)	(short) Pressure process	Pressure process	Immersion process
Liquid waste	40 t/year (ASN 130899*)	0		0
Solid waste	8 t/year (ASN 170204*)	0	negligible	0
Sludges	negligible	0,75 t/Jahr (ASN 110109)	negligible	negligible
Total waste	48 t/year	0,75 t/Jahr	n.a.	0
Specific waste quantity (waste	3,9	0,06	n.a.	0

	Installation 1	Installation 2	Installation 3	Installation 4
in kg per m^3 treated wood)				

(a) Upon request is sporadically immersion process performed

Waste only occurs in installations 1 and 2. At installations 3 and 4, the amount of waste is negligible or there is no waste. Per m^3 of product up to 3.9 kg of waste arise. By far the largest amount of waste is liquid waste from coal tar oil impregnation (3.3 kg per m^3 of treated wood in installation 1).

5.3.9 Noise and vibrations

The impregnation processes does not produce any noise or vibrations.

6 Techniques to consider in the determination of BAT

The following techniques should be considered for determination of BAT:

- Techniques for the prevention and reduction of fugitive emissions in the air (Chapter 6.1)
- Precautionary measures for water and soil protection (Chapter 6.2)
- Water recirculation (soil sealing and collection drip tray) (Chapter 6.3)
- Wood moisture measurement (Chapter 6.4)
- Drip tray impregnation installation (Chapter 6.5)
- Thermal oxidation (Chapter 6.6)
- Variable pump control (Chapter 6.7)
- Substitution of chromium containing protective products with chromium-free products (Chapter 6.8)
- Roofed-over construction for drying, dripping and fixing areas (Chapter 6.9)

Besides the techniques description, they are characterized by the following:

- Achieved environmental benefits
- Environmental performance and operational data
- Cross-media effects
- Technical considerations relevant to applicability
- Economics
- Driving force for the application
- Example installation
- Reference literature

The process flows, existing system components and associated system components of the relevant installations 1 to 4, and other relevant information about these installations are documented in a separate annex to this report.

6.1 Techniques for prevention and reduction of air emissions

Description

Possible measures to reduce and prevent fugitive emissions of organic substances in the processing, conveyance, transfer or storage of impregnation oils are the following:

a) Prevention of emissions of organic compounds and development of odour by application of creosote grade C instead of creosote grade B.

b) Prevention of emissions of organic compounds and development of odour by application of impregnation oils taking into account usability and proportionality

c) In the case of installations with hot-cold bath treatment, a closed impregnation installation should be used and the extraction system for exhaust gases until the treated wood reaches the ambient temperature, along with cleaning of the collected gases by scrubbing or adsorption on activated carbon filters

d) Gas displacement, submerged loading or extraction with emission control during the decantation of organic substances

e) Extraction of emissions generated during the impregnation process and allocation to air pollution control device (see 4.2.4)

f) Discharge of exhaust gases from pressure relief valves and drain facilities into the gas collection system or feeding into flue gas treatment system

g) Avoidance of aerosol releases from vacuum pumps not operating on the liquid-ring pump principle by providing the pumps with an entrainment separator.

h) Storage of liquid organic substances in fixed-roof tanks connected to a vapour collection system or an air pollution control device.

i) Storage tanks installed and operated above ground provided with year-round heating system or paint coating with coefficient of total heat reflectance of not less than 70 %.

j) Treatment in a thermal oxidiser or equivalent emission control measures of exhaust gases released during inspection or cleaning of the storage tanks

k) Leek-free pumps, leak-free flanged connections valves and dampers

Measures for prevention of emissions by application of aqueous wood preservatives:

l) Aerosol releases by pressure process can be reduced or prevented by allowing a sufficient time to elapse between de-pressurisation and opening of the system.

Achieved environmental benefits

Avoidance of organic substances emissions into the air

Environmental performance and operational data

The environmental performance of the techniques described under a) to l) result in a significant reduction of the total fugitive emissions into the air, but cannot be quantified in detail.

Cross-media effects

No significant effects.

Technical considerations relevant to applicability

The listed techniques are used in installations either individually or in a combination: techniques described under a) - c) are used in systems for impregnation with creosote; technique described under l) is used in installations where impregnation is performed with aqueous wood preservatives. The application of different techniques should be considered for individual cases.

Especially in the case of technology described under b) the sustainment of the usability and the proportionality must be observed.

Economics

No data available.

Driving force for application

Environmentally responsible action of the operator.

Reaching certification approval for the installation.

Example installation

The techniques described under a) – k) are applied in the German installation either individually or in a combination.

The technique described under l) is used in the German installations where impregnation is performed with aqueous wood preservatives.

Reference literature

[VDI 3462]

6.2 Precautionary measures for water and soil protection

Description

Possible precautionary measures for protection of water and soil are the following:

Non-pressure processes:

- An impervious collecting tray (collecting vessel approved under the German Water Resources Act) or a sufficiently sized perimeter bund on the floor of the installation and in the storage room for the collection of water pollutants
- WP impermeable paved floor
- Weather protection for interim storage area, impregnation area, drying area, dripping area, fixing area and distribution warehouse (e.g.tarpaulins, roofing)
- Drainage and overflow protection in impregnation installation
- Single-wall impregnation with sufficiently large and WP resistant drip tray, fender and automatic leak detection device in the case of non-visible drip tray
- Double-wall impregnation tanks with an automatic leak detector
- Recirculation of drippage
- Avoidance of contact of fresh treated wood and soil Avoidance of the soil
- Storage of wastes (e.g. impregnated wood residues) in suitable tanks and on suitable surfaces

Pressure-processes:

- Impervious drip tray (collection vessel permitted under the German Water Resources Act) or a bund of sufficient size is provided underneath plant equipment handling water-polluting substances and in the storage room
- visibility and controllability of containers and pipes
- recirculation of residual liquids and drippage
- prevention of opening of the boiler when under pressure
- WP impermeable paved floor
- visibility and controllability of containers and pipes
- by application of impregnation oils: separation of oil and water from the waste water and condensate and recirculation and adequate treatment
- weather protection (e.g. tarpaulins, roofing)

- Avoidance of contact of fresh treated wood and soil Avoidance of the soil
- Storage of wastes (e.g. impregnated wood residues) in suitable tanks and on suitable surfaces

Achieved environmental benefits

Preventing contamination of soil and ground water with wood preservatives or WP impure process water

Environmental performance and operational data

Contamination of soil and ground water with wood preservatives is avoided. The environmental benefits of listed techniques are not separately quantified.

Cross-media effects

None

Technical considerations relevant to applicability

The above techniques are universal and applicable to existing and new installations.

Economics

No data available.

Driving force for application

Environmentally responsible action of the operator.

Reaching certification approval for the installation.

Example installation

Installations in Germany

Reference literature

[VDI 3462]

6.3 Water recirculation (soil sealing and containment bunker for drippage)

Description

During the process of impregnation with water soluble salt or emulsion concentrates, the contaminated surface water is collected by suitable collection and recirculation systems and reused in the impregnation process.

In pressure treatment installations which use impregnating oils, the collected condensates are allowed to settle and then are treated in an activated carbon filter. The water treated can be reused in the impregnation process for an example as process water for impregnation process with water soluble salt or emulsion concentrates, as long as these are used in relevant installation. The contaminated condensates can be discharged as liquid waste.

Recirculation of water is facilitated via soil sealing of the working area and containment bunker for drippage. In the case of installations 1, 2 and 3 the collected water is used as process water for impregnation process. In installation 4 the dripping water flows directly back into the trough.

Technical description

Installation 1:

The floor in the area of extraction rails of the installation is extensively sealed (1500 m^2). The rain water from the sealed area of extraction rails is collected in a 50m^3 cistern over an oil-sludge collector and used as process water. The oil sludge collector is cleaned regularly and accumulated waste is disposed of properly (ASN 130899 *; variable quantities depending on waste formation). If the capacity of the cistern is not enough there is the possibility of storing rainwater in a wagon. If the cistern is full in the case of heavy rain events, the surface water in the cistern is directed into the drainage channel.

The floor sealing consists of a double bottom plate of water impervious concrete. The detention reservoir is made of water impervious concrete.

Installation 2:

The extraction rail area and storage area for fresh treated wood is sealed (approximately 2.500 m^2) and supplied with inlet channel. Dripping water flows either in drip tray or into inlet channel. The dripping water from inlet channel is over the drainage channel, oil-sludge collector and pipes and lines conducted to collecting tray (50m^3) and returned back to the process.

The floor sealing consists of water impervious concrete with upper and lower steel mesh (thickness approximately 20 cm).

The sealed surface is covered and protected on the sides from rain (a new roof is under construction). The extraction rail area and the storage surface is sloped to allow that flowing liquids drain into the drip tray or inlet channel and from there pass over the oil-sludge collector, pipes and lines into collecting tray (50 m^3). The oil-sludge collector is regularly cleaned and accumulated waste disposed accordingly (about 750 kg/year, waste code 110109).

The collecting container is double-walled underground tank coated with epoxy resin coating resistant to impregnating solution. The pump placed in the container is controlled over one float indicator, and when reaching certain level, the collected liquid is pumped back into the impregnation installation. The acoustic warning signals the pump malfunction.

Installation 3:

The transport roads on the premises are flat and fixed. The floor in the area of extraction rails is extensively sealed. The seal consists of the following layers:

- ≥ 3 cm of asphalt concrete
- ≥ 15 cm bituminous base
- 20-30 cm gravel base (partly available)

The dripping water and rain water is via drainage channel (POLY DRAIN, class E) led to the collection bunker and used as process water (approx. 2.5% inclination). If necessary, the water (along with roof runoff water) can be intermediately stored in designated tanks. Beside the roof runoff water and the water collected from the sealed area, no additional process water is used in the installation.

The collecting bunker made of water resistant concrete serves as a buffer. The return of the water to the impregnating process is done automatically (automatic return at a certain water level in the collecting bunker by means of float indicator and submerge pump (1.85 kW).)

Installation 4:

The entire floor area of the installation's workspace is paved (approx. 40 m^2). The draining water runs back into the trough.

Floor sealing is made of concrete. The concrete surface is also covered and protected on the sides against rain. The extraction rail area and the area for draining are inclined to facilitate back flow of discharged liquids in the drip tray.

Achieved environmental benefits

In the case of an accident and also in daily business (dripping water) soil contamination is prevented. The sealed surface prevents that the wood preservatives and their constituents are absorbed by soils, or reach the surface water and the sewer system.

There is a potential for water savings through the use of rain water as process water.

No generation of wastewater.

In the installations 1, 2 and 3, the collected drippage is returned and reused as process water for the impregnation process.

In addition, the roof runoff water can be used as process water in installation 3 (roof system for collection of rain water).

Environmental performance and operational data

The technique is not vulnerable, must be regularly maintained and checked (technical inspection by approved certifying bodies).

Operators of installations 1 and 2 indicate that the technical inspection should be performed every 5 years by approved certifying body and that collecting containers should be drained out and cleaned before the technical examination.

The operator of installation 3 indicates that the collected water is even more suitable for the impregnation process then the well water (due to the high proportion of precipitation water, which is essentially demineralised water). The well water has a lower pH value of 6.14 and a moderate nitrate pollution of 19.9 mg/l. It can be described as "metallic". The pH value of the wood preserving salt solution is 10.2 to 10.4. The indicated amount of water is equivalent to the specified range.

The operator of installation 4 specifies that the "in-house" system for the technical inspection is maintained and performed.

Rain water falling on the sealed surfaces and on roof can be used as process water. In the case of installations 1 and 3 large areas of the sealed surfaces are not covered with a roof. This can save significant amounts of fresh water (saving plant 1: 570 m^3;) saving system 3: 2550 m^3).

Cross-media effects

In general, any soil sealing negatively affects the natural water balance in the soil, as accumulated rainfall can no longer penetrate into the ground.

However, it is clear that the environmental benefits of preventing soil contamination prevail in the case of all 4 installations.

In the case of installation 4, the surface sealing is not specifically accomplished due to impregnation system, because it is only a designated section within the overall company. Even in the case that there would be no impregnation system in the installation 4, this area would be

also sealed, because it covers relatively small surface in comparison to the entire area of the installation.

Technical considerations relevant to applicability

The technique can be applied for existing and new installations. In the installations which exclusively employ impregnating oils there is possibly no need for process water. The effluents must be then otherwise treated, e.g. fed into a municipal sewage treatment plant or properly disposed of as liquid waste. In such cases a water recirculation is not possible. Regardless of whether a water recirculation can be realized or not, the soil sealing and collecting bunker techniques has to be taken into account when determining BAT.

Economics

Reduced costs for water and wastewater treatment.

Installation 1:

Cost savings for impregnation due to water saving of approx. 570 m3 per year

Installation 2:

- Costs for soil sealing/collecting bunker: estimated at around 800 €/m^2
- Approximate annual operating and maintenance costs (personnel, spare parts, certification, etc): every 5 years about €3000 for technical certification by approved certifying bodies (the same amount again to prepare for testing →approx. €6000).
- The operation and maintenance costs are minimal.

Installation 3:

- Investment costs for applied technoloqies (soil sealing and collecting bunker): 85 €/ m2 in 1998 (including sand blasting); approximately €24,000 for the collecting bunker with 125 pressure piping (production costs in 1998)
- Approximate annual operating and maintenance costs (personnel, spare parts, certification, etc.): 8000 €/year
- Annual cost savings by reducing water consumption (2550 m^3/a): the self-provision of water through the installation's well is up on the annual water analysis free of charge. This allowance is exceeded by an additional use of water for the impregnation and additional water abstraction charge (2011: 4.5 ct/m^3) would have to be paid for the process water.

Installation 4: no data

Generally, the cost of a possible elimination of environmental damage could be avoided in all installations.

Driving force for application

Installations 1, 2 and 3:

- Certification approval (from external or internal certification body)
- Prevention of soil and water contamination
- Water saving and better water quality for the impregnation process
- Reduction of operating costs
- Independence from fresh water sources

The prevention of soil and water contamination is prominent at installation 4.

Example installation

Installations 1 to 4

Reference literature

Refernce document for the safe operation of retort pressure treatment process with water soluble wood preservatives (Merkblatt für den sicheren Betrieb von KesseldruckInstallationn mit wasserlöslichen Holzschutzmitteln (Deutsche Gesellschaft für Holzforschung e.V., DGfH))

[VDI 3462]

6.4 Wood moisture measurement

Description

Wood moisture measurement for determining the impregnating maturity by means of electric resistance measurement or by weighing procedures.

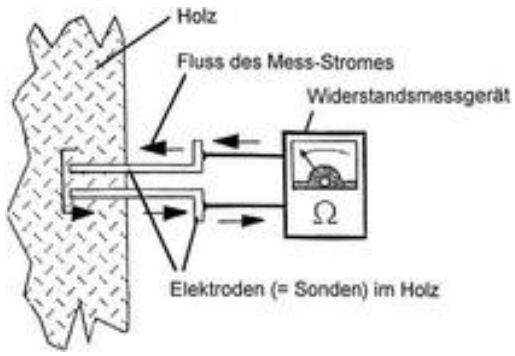
Technical description

Any impregnation process requires certain wood moisture, in order to ensure an optimal result of impregnation.

Checking the moisture content ("impregnating maturity") can be performed by means of electric resistance measurement (automatically or manually). The resistance measurement is a relatively simple, robust and reliable measuring procedure according to installations operators.

The basic principle of electric wood moisture measurement is shown in the following figure:

Figure 5: Presentation of the basic principle of electric wood moisture measurement



Source: bm-online.de (accessed: 14.12.2012)

Wood moisture measurement can be done manually using a handset for electric resistance measurement (e.g. samples taken by employees on the milling machine, planing machine, etc.).

Figure 6: Manual wood moisture measurement (Installation 2)

The electrical resistance measurement can be performed automatically. Wood moisture measurement is performed and controlled by an employee. Measurement is supported by computer and the measured values can be digitally recorded and documented.

The automatic measurement runs technically as follows (based on the example of the mast production; installation 3):

- Issuing table for the automatic separation of the load and feeding of individual trunks in the measuring system
- Electrodes penetrate about 5-6 cm (sapwood heartwood boundary) in the raw wood (in the case of masts, usually the measurement area is on the soil-air boundary, as approx. 1/6 of the mast is dug into the ground)
- 4 transducers/sensors are used for detecting moisture nests (which arise in particular from the storage of wood)
- If the measurement of humidity is not optimal, the measurement is repeated at the point 30 cm above and below the first measuring point. If the moisture content is not correct after the second measurement, the raw wood must be dried further
- When the optimal moisture content is reached, each mast is allocated with a number and over a rail sent to impregnation plant and impregnation is carried out.

Figure 7: Installation for automatic wood moisture measurement (installation 3)

A simplified procedure for the determination of wood moisture which can be applied in certain cases (e.g. in dipping process), is the weighing process (weighing the package weight before and after dipping and derivation of the gross weight). The measurement of the weight of the package is carried out via scales integrated on the lift truck.

Achieved environmental benefits

The wood moisture measurement will ensure the required quality of impregnated wood and contributes to the use reduction in the required resources such as wood preservatives, wood and energy (by avoiding repeated impregnation, increase the durability of the products and reduction/prevention of early failure). The product life of impregnated wood is a decisive factor for its ecological profile.

Environmental performance and operational data

- According to installations‘ operators - simple, robust and reliable technology
- Significant reduction in the rate of return (at installation 2 halving the return rate from 30% to 15%), thus optimizing storage utilization

Cross-media effects

- Extended storage of CO_2
- Improvement of substitution possibilities of finite resources with renewable raw materials

Technical considerations relevant to applicability

The technique can be applied for existing and new installations. The process is suitable in particular for wood with a moisture content of 7% to 30%.

Economics

Automatic measurement of resistance

- Investment costs installation 3 approx. 300.000-€400.000 (payback period approx. 10 years)
- Operating costs installation 3: electrodes: 1Pin = €4 (PIN consumption approx. 350-400 pieces/year)
- Estimated staff costs installation 3: 70-80 €/year (1.5 employees)

- Prevention of failures and associated warranty can be very expensive (250-€500 for a new mast and approx. €1.000 for the replacement of the mast; training and installation costs)

No cost information for the manual measurement of resistance and the weighing procedure. The costs are regarded to be low.

Driving force for application

- Higher quality of products
- Exact wood moisture determination is of crucial importance in the application of not creeping wood preservatives

Example installation

Automatic resistance measurement: Installation 3 (automated only in Germany, 2 more impregnating installations apply a simplified procedure, however, the test result is more usable for spruce masts).

Manual resistance measurement (handset): installation 2, installation 1 (handsets for raw wood moisture determination are Europe-wide in use).

Weighing procedures/weighing: installation 4, installation 1

Reference literature

[BDZ 2004], [Wagenführ 2008]

Moisture content of a piece of lumber - DIN EN 13183-1 (determination by Darren procedure, DIN EN 13183-2 (estimated by electrical resistance measurement), DIN EN 13183-3 (estimated by capacitive measuring method)

6.5 Drip tray for impregnation installation

Description

The leading components of wood preservative in the impregnation installation are arranged inside an adequately sized WP impervious tray.

Technical description

Installation 1:

The drip tray is made of water-impermeable concrete (without coating). The volume of the tray is greater than the volume of the entire warehouse stock.

Installation 2:

The impregnating boiler and mixing tank are installed over the entire length in a dense, impregnating solution resistant drip tray. The drip tray is made of water-impermeable concrete. The concrete is coated with a with epoxy paint, which is chemically resistant to the impregnating solution. Junctions are sealed with epoxy resin. The drip tray is accessible and constantly visible and controlled. The volume of the drip tray is about 25% larger than the volume of the impregnating boiler and thus greater than the volume of preservatives in use.

The tray is equipped with container for collection of the liquid. The pump placed in the container is controlled over one float indicator, and when reaching certain level, the collected liquid is pumped back into the impregnation installation.

To prevent an overflowing of the drip tray with fresh water running in, the fresh water supply automatically stops when the certain water level is reached (electrical contact).

Installation 3:

The impregnating boiler and storage tank are installed over the entire length in a dense impregnating solution resistant drip tray (concrete bucket with special coating, foil technique with welded foil).The drip tray is constantly visible and controlled. The volume of the tray is greater than the volume of the entire warehouse stock.

Installation 4:

The drip tray is made of concrete. The concrete is coated with a with epoxy paint, which is chemically resistant to the impregnating solution. Junctions are sealed with epoxy resin. The drip tray is accessible, available, and thus controllable. The volume of the tray is greater than the volume of preservatives in use.

- trough size: 7.5 m x 1.5 m x 1.0 m = 11.3 m^3
- tray size: 11.0 m x 2.6 m x 0.6 m = 17.7 m^3

Achieved environmental benefits

In the case of an accident and also in daily business the soil and water contamination is prevented. The drip tray prevents that the wood preservatives and their constituents are absorbed by soils, or enter the surface water and the sewer system.

Environmental performance and operational data

Contamination of soil and water will be completely prevented. The installation operators indicate that the technique is not vulnerable, however must be regularly maintained and checked.

The operator of installation 2 indicates that the technical certification is performed every 5 years.

The operator of installation 4 specifies that the regular maintenance and inspection is carried out by own staff. Verification is not required according to Regulation on installations for the handling of substances hazardous to water (VAwS[9]). The used WPs are classified as water hazard class 1 (WGK 1). The content is less than 10 m^3. Thus the installation is assigned to the risk level A, and therefore is not subject to inspection.

Cross-media effects

No impacts.

Technical considerations relevant to applicability

The technique can be applied for existing and new installations.

Economics

Installation 1: no information

Installation 2:

- Operating and maintenance costs are negligible

[9] Regulation on installations for the handling of substances hazardous to water (Verordnung über Installationn zum Umgang mit wassergefährdenden Stoffen und über Fachbetriebe (VAwS))

Installation 3:

- Investment costs for the technology: ~ approx. €120,000 in the 1970s)
- Operating and maintenance costs: approx. €5000 per year
- Avoidance of costs for the elimination of environmental damage

Installation 4:

- Investment costs for the technology: no information
- Operating and maintenance costs are negligible

Driving force for application .

- Certification approval (from external or internal certification body)
- Avoid any remedial measures

Example installation

Installations 1 to 4

Reference literature

Refernce document for the safe operation of retort presurre treatment process with water soluble wood preservatives (Merkblatt für den sicheren Betrieb von KesseldruckInstallationn mit wasserlöslichen Holzschutzmitteln (Deutsche Gesellschaft für Holzforschung e.V., DGfH))

VDI Directive [VDI 3462]

6.6 Thermal oxidation (coal-tar oil impregnation)

Description

Exhaust air from the coal-tar oil impregnation tanks is fed to a flue gas cleaning plant. Organic components in the exhaust air are burned with natural gas at a temperature of 750°C.

Technical description

The thermal flue gas cleaning works with natural gas at a temperature of 750° C. The hot exhaust gases are used to pre-heat the combustion air, as well as to heat water to 80° C to produce steam for the steam generator. The flue gas cleaning runs only when the air is displaced or extracted by suction from the tanks of the creosote production line. For this purpose the system is shortly heated to 750° C for 15 minutes. The clean air is blown into the system for 15 minutes. In another 15 minutes the temperature is controlled and stepwise reduced, to avoid a too rapid cooling. The supply of air for burning is equipped with a fire safety device.

The ventilation for the burner has performance of 0.76 kW and the exhaust fan has a capacity of 7.5 kW. Accumulated hot water from the heat exchanger of the flue gas cleaning is with a condenser pump (0,46 kW) returned in the steam cycle system and heated to 80 ° C in the thermal flue gas cleaning. The exhaust gases of thermal flue gas cleaning are inspected in regular intervals (measurement according to § 28 BIMSchG). The results of the measurements are specified in half hour averages. Following values come from a typical measurement protocol (normal operating conditions, presentable for the thermal flue gas cleaning, mass concentration, related to dry exhaust gas, standard condition, 273 K, 1013 hPA, no reference oxygen set, measuring accuracy: ±5%):

Table 16: Emission values of the exhaust gas in the thermal flue gas cleaning in the coal tar oil impregnation installation

Parameter	Half hour average values	Limit values	Sampling point	Measurement procedure
CO	49 mg/m³	100 mg/m³	The sampling point is located directly in front of the fan in the exhaust duct.[10]	in accordance with VDI 2459, part 6
NOx	104 mg/m³	200 mg/m³		in accordance with VDI 2456, part 9
Total C	14 mg/m³	50 mg/m³		VDI 3481, part 1 und EN 12619
Benzo[a]pyren	< 0,002 mg/m³	0,1 mg/m³		Sampling in accordance with DIN EN 1948 and analysis according to VDI 3873, part 1

The total exhaust gas volume amounts to 500,000 m³ per year. On the basis of specified concentrations, this corresponds to annual pollution load of 24.5 kg/year of CO, 52 kg/year of NOx, 7 kg/year of total carbon and less than 0.001 kg of benzo [a] pyrene. Emissions occur discontinuously as the thermal flue gas cleaning is only temporarily in the operation. This annual pollution loads are estimated as low. They are in the range of hourly values of the Technical Instructions on Air Quality Control (TA Luft) for benzo (a) pyrene and oxides of nitrogen (see point 4.6.1.1 TA Luft; for oxides of nitrogen = 20 kg/h; = 0.0025 kg/h for benzo (a) pyrene).

Achieved environmental benefits

Reduction of air emissions (volatile organic compounds (VOCs) from used coal tar oils)

Environmental performance and operational data

Natural gas consumption: 1,440,000 kWh/year for thermal flue gas cleaning and associated steam generation (to the heat supply for the impregnation processes in the system).

Cleaning performance of the thermal post combustion approximately 500,000 m3/year

Cross-media effects

Energy use for the post combustion (CO_2 emissions; use of natural gas).

Technical considerations relevant to applicability

Applicable only in the case of coal tar oils impregnation process.

Economics

Investment costs: no information

Operating costs: cost for (un)certain share of 1.440.000 kWh/year of natural gas;

Personnel costs for the operation, maintenance and technical certification. Specific costs are not available.

[10] The sampling point is not the recommendation of the VDI 2066 part 1. For practical reasons, inlet and outlet conditions are not respected. The results obtained are representative in the sense of no. 5.3.2.2 TA Luft of 24.07.2002. A plausibility check is located in the measurement protocol.

Driving force for application

Regulations (certification, TA Luft 2002)

Example installation

Installation1

Reference literature

BREF document, for example. [BREF STS 2007] Chapter 20.11.4.2, [BREF CWW 2011] (Draft) Chapter 4.12.2 (Thermal oxidation), Measurement protocol

6.7 Variable pump control

Description

After reaching the required working pressure, the system is switched to a pump with reduced performance and energy consumption.

Technical description

A pressure pump with relatively high power is used for building the desired working pressure in the boiler. After reaching the working pressure the system is switched to a more energy efficient pressure pump with lower power.

Achieved environmental benefits

Reduction in energy consumption

Environmental performance and operational data

The operator estimates reduction of energy consumption by 25% (6,000 kWh/a/pump)

Cross-media effects

None

Technical considerations relevant to applicability

The technique can be applied for existing and new installations.

Economics

Investment costs: approx. €5.000 (payback period at an average price of electricity for industrial customers in Germany in 2011 (11.3 cents/kWh): approx. 7 years)

Driving force for application

Reduction of energy consumption (cost savings)

Example installation

Installation 1

Reference literature

unspecified

6.8 Substitution of chromium containing protective products with chromium-free products

Description

Substitution of chromium containing protective products with chromium-free products

Technical description

The installation 3 converted the impregnation process from chrome-containing wood preservatives to chromium-free in 2010. A water-soluble, liquid, fixating wood preservatives are used on the basis of copper complex compounds and a quaternary ammonium compound.

The impregnation installation and the impregnating process need to be adapted to the applied preservatives (e.g. structural measures, reduced boiler filling level due to formation of foam, respecting the process parameters, etc.).

Achieved environmental benefits

The chrome-free copper-containing preservative is not mobile, i.e. it has no creep properties, also in the wood (there is no 'flowing'). Chromium-free preservatives are, in contrast to chromium-containing products, immobile in the soil. Chromium-containing wood preservatives can cause environmental pollution of the groundwater and related contaminated site, due to mobile properties of chromium VI (CR VI is mobile; after fixation it transferred to CR III which is immobile).

The chrome-free wood preservatives are self fixing and fixing process is relatively fast (binding on the wood fiber; after 12 hours ~ 97%; after 48 hours ~ 99%).

Environmental performance and operational data

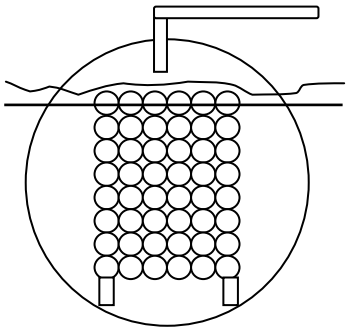
Due to the properties of chrome-free preservatives, the system parameters have to be more accurately followed, as before the substitution (this requires additional controlling measures such as viscometer, electrical measurement, switching from the acidic (pH 3-4) to alkaline medium (pH 10.2-10.4)).

In the container containing wood preservative, the salt components can sink to the bottom of the tank; It is a partial segregation. After the longer non-operating time (e.g. during the weekends), the container contents need to be stirred before the use in order to mix the wood preservative components.

In the installation 3 which uses chromium-free wood preservatives, the vacuum must be gradually applied to reduce the foaming of the alkaline medium. Further on a stronger vacuum is required to reach the required depth of impregnation (since the chromium-free preservatives have no creep properties, the stronger vacuum is required to reach heart wood area by creeping, for example the remaining 5 mm).

The filling level of the impregnating boiler must be reduced due to the increased formation of foam resulting from the application of chromium-free wood preservatives in the installation 3 (approx. ½ m less filling). In addition, it has to be checked that there are no dry spots on the top edges of the impregnation boiler (due to lower filling level, the wood preservative does not reaches the wood) and that the wood is completely impregnated. The filling level of the impregnation boiler has to be precisely set in advance to impregnation process and the impregnation boiler capacity can be exploited to a slightly lesser degree (reduced production capacity, see sketch below).

Figure 8: Reduction of filling level (installation 3)



Cross-media effects

Lower degree of capacity utilization in the installation through reduced filling level of the impregnating boiler. In the case of dry area formation, the wood must be repeatedly treated.

After service life, the impregnated wood products can be incinerated for energy use in appropriate combustion plant. Chrome-free WP induces chromium-free incineration ash.

Technical considerations relevant to applicability

For the vacuum pressure impregnation, there are generally no restrictions for the application of chromium-free preservatives. The following aspects have to be inter alia respected:

- Increased, partly strong foaming
- accurate adjustment of the process parameters and necessity for additional control measures/instruments
- lower filling level and thus lower production capacity
- Application of vacuum must be used at different location, if necessary
- Corrosion or incrustations may occur

The constrains cannot be excluded by application of other impregnation processes e.g. by alternating pressure process there is strong formation of foam. In this case, a precise selection of adequate impregnating agent and impregnation process is required (for example, in collaboration with the wood preservative manufacturer).

Economics

The chromium-free preservative is about 30% more expensive. Only low levels of investment are required for the system adaptation (vacuum pressure impregnation) which usually do not significantly go beyond the normal operating expenses (e.g. substitution of oil-cooled pumps to water-cooled pumps due to foam formation; replacement of corroded/encrusted lines/seal).

Driving force for application

Based on the provisions of Biocidal Product Directive the manufacturers of copper chromium containing wood preservatives must submit a complete authorization dossier until February 2014, in order to place their product on the market throughout 2014.

Example installation

Installation 3

Reference literature

No specifications

6.9 Roofed-over construction for drying, dripping and fixing areas

Description

Roof cover for protection from washing out of wood preservatives.

Technical description

Installation 2:

The area of extraction rails as well as the transport area to the storage areas for fresh impregnated wood (storage under the roof at least for two days, often longer) are covered and protected from the sides against the wind and rain (a new roof is under construction: roof, rafters/purlin roof structure with profiled sheeting partially with insulation and roof covering made of PVC). The relevant area of the roof is approx. 2,500 m^2.

Installation 4:

Roofing in the area of troughs and the drip area is for the protection against rain and wind-driven rain and there is additional equipment for prevention of surface water accession.

Gradient of the adjacent transportation areas is directed away from the building so that surface water cannot access the impregnation area.

Roofing in the fixing area serves the protection against rain and wind-driven rain and washing out of non-fixed wood preservatives. .

Storage under the roof depends on the product properties as well as the geometry of the impregnated wood. Besides, the fixing time depends on applied wood preservatives and the weather conditions. In spring to autumn the fixing time is approximately 24 hours. For the winter months no representative data are available. The roof is in the area of troughs and the drip area approx. 150 - 200 m2 (equivalent to the roof in the area of troughs including drip area without fixing storage and storage for impregnating agents). The roof of the fixing storage is about 200 m2.

Figure 9: Roof cover in the area of troughs (Installation 4)

Achieved environmental benefits

Installation 2:

After the impregnation, the treated wood is exclusively transported and stored under roof for at least two days until the complete fixation (after 48 hours) of the self-fixating wood preservative. This ensures that the wood preservatives cannot be washed out by the rain prior to full fixation.

Installation 4:

The wood is dry stored after impregnation until to the complete fixation in the fixing storage. This ensures that the wood preservatives cannot be washed out by the rain prior to full fixation.

Environmental performance and operational data

Installation 2:

- Washing out of non fixed wood preservatives is prevented.

Installation 4:

- Through the existing drainer and subsequent storage in the fixing storage (covered) it is ensured that the fixation is completed and the leaching of not fixed wood preservative is reduced to a minimum.

Cross-media effects

No effects

Technical considerations relevant to applicability

Technology is universal and applies to existing and new installations.

Economics

Installation 2:

- Investment costs: approx. 40 €/m^2 roof surface
- Operating and maintenance costs are negligible

Installation 4:

- Investment costs: no specifications as the impregnation area is situated in the hall
- Operating and maintenance costs are negligible

Driving force for application

Installation 2:

- Quality assurance (prevents the leaching of wood preservatives by precipitation)
- Hold storm water from the process cycle (precipitation water would get in too large quantities via the inlet chute of the storage into the drip tray)

Example installation

Installation 2, Installation 4

Reference literature

VDI Directive [VDI 3462]

7 Proposals for conclusions on best available techiques

7.1 Preliminary remarks

The conclusions on the best available techniques will be derived from the information exchange performed on the European level within the framework of the Seville process. This information collected from participating Member States and the definition of 'best available techniques' in Article 3 paragraph 10 and the criteria in Annex III of the Directive 75/2010/EU have been taken into account for the conclusions on best available techniques for the sector of preservation of wood and wood products.

For the derivation of the conclusions, overarching environmental performance criteria of the different techniques, including cross-media effects, as well as the related costs have been examined.

The expression "BAT conclusions" pursuant to article 3(12) IED is a document which contains the the following parts of the BREF:

- conclusions on the best available techniques,
- their description
- information about the assessment of their applicability
- the associated emissions of the best available techniques
- the corresponding surveillance measures
- the respective consumption values
- and applied site remedial actions

In the context of the present report, which aims to support the German contribution to the Seville process and contributes to the essential elements of the BAT-conclusions, proposals for potential BAT-conclusions should be formulated. This contribution to the BREF document reflects the German point of view to preservation of wood and wood products with chemicals; it will be complemented by experiences from other Member States, and the European BATs will be later derived.

The proposed BATs were formulated on the basis of the techniques which need to be taken into account for the determination of BAT (see Chapter 6).

The information on formulation of BAT-conclusions is provided in the Commission’s implementation decision (see [EC 2012]).

7.2 Elements of the BAT-conclusions

In the following are formulated the selected proposals for the elements of BAT-conclusions. These proposals are based on data from German installations (see Chapter 4) and are not considered final conclusions. Unless otherwise stated, the findings in the following section are universal by applicable to existing and new installations.

7.2.1 Techniques to reduce and avoid fugitive emissions into air, soil and water

To avoid emissions into air, soil and water, the BATs are applicable individually or in combination:

Measures for the reduction and prevention of fugitive emissions of organic substances during processing, conveyance, decanting or storage of impregnating oils:

a) Reduce emissions of organic compounds and odour through the use of creosote grade C instead of grade B

b) Avoidance of emissions of organic compounds and odour via application of impregnating oils considering their usability and proportionality

c) in the case of hot-cold bath treatment process, use of closed impregnating system and suction of the exhaust gases until the treated wood has reached the ambient temperature, as well as cleaning of the collected exhaust gases through flue gas cleaning or the adsorption on activated carbon filters

d) Collection of vapour, filling below the surface level, and suction with flue gas cleaning during the decanting of organic substances

e) Extraction of emissions generated during impregnation process, and feeding into the flue gas cleaning system (see 4.2.4)

f) Discharge of exhaust gases from pressure relief valves and drain facilities into the gas collection system or feeding into exhaust flue gas cleaning system

g) Avoid formation of aerosols in vacuum pumps which do not work according to the principle of the liquid ring pumps, by equipping the pumps with a liquid separator

h) Storage of liquid organic substances in fixed-roof tanks connected to a gas collecting pipe or flue gas cleaning system,

i) In the case of above-ground storage tank provide all-year-round heating or coating with the paint of a total heat reflectivity of at least 70%

j) Post-combustion of exhaust gases from inspection and cleaning processes of storage tanks, or equivalent measures to reduce emissions

k) Technically tight pumps, flanged joints, valves and feeders

Measures to avoid emissions from process using aqueous wood preservatives:

l) In the case of pressure processes, prevention and control of aerosols is achieved by sufficient holding time between pressure balance and opening of the boiler

<u>Precautionary measures for the water and soil conservation</u>

Non-pressure process:

- Impervious drip tray (Federal Water Act-approved container) or appropriate size collecting container placed on the floor of the installation for the collection of substances hazardous to water and in the storage area
- Floor in immediate vicinity of installation working area and in the dripping zone of freshly treated wood should be sealed and impervious to wood preservatives
- Weather protection of the interim storage, impregnation facility, extracting rail area, drip zone, fixing warehouse, warehouse for non-fixing WPs (e.g. planning, roofs)
- Leakage and overflow protection of the impregnation facility
- Single-wall impregnation tank with sufficiently large and wood preservative solution impervious drip tray, fender and automatic leak alarm device in the case of non-visible drip tray or
- Double-wall impregnation tank with leak alarm device
- Recirculation of wood preservative solution

- Avoid contact with the soil of freshly impregnated timber
- Storage of waste (e.g. impregnated residual wood) in suitable containers and in suitable areas

Pressure processes:

- Impervious drip tray (WHG-approved container) or appropriate size collecting container placed on the floor of the installation for the collection of substances hazardous to water and in the storage area for preservatives
- Inspection and control of containers and pipes
- Weather protection of the interim storage, impregnation facility, extracting rail area, drip zone, fixing warehouse, warehouse for non-fixing WP (e.g. tarpaulins, roofs)
- Recirculation of residual liquids and dripping solution
- Avoidance of opening of boiler when under pressure
- Floor in vicinity of installation should be sealed and impervious to wood preservative solutions (in impregnation facility- if available, in the area of on the ground running lines and in a separate engine room with pumps - if there are no drip trays) as well as in interim storage area, in the area of extraction rails, dripping zone and fixing area of the freshly treated timber
- Inspection and control of containers and pipes
- By application of impregnating oils: separation of oils and water from the generated waste water and condensate and recirculation and adequate treatment
- Weather protection (e.g. tarpaulins, roofs)
- Avoid contact with the soil of freshly impregnated timber
- Storage of waste (e.g. impregnated residual wood) in suitable containers and in suitable areas

7.2.2 Soil sealing, drip container and drip tray

To avoid WP emissions into soil and water in normal operation and in the case of accidents is the application of the following techniques is considered to be BAT:

	Technique	Description
a	Soil sealing and collecting container for dripping water for recirculation and use of drip water as process water	The collected wood preservative is returned to the impregnation process via soil sealing of the working space and collecting container for dripping water.
b	Sufficient size of the drip tray of the impregnation installation	The system components for treatment with wood preservatives are placed in adequately sized drip tray (capacity = content of the impregnation tank; in the presence of several impregnation containers, in the case of non-pressure process: see Table 5). Collected WPs are recirculated back to the impregnating process.

7.2.3 Water recirculation

In order to reduce the use of fresh water and to avoid generation of waste water, the water recirculation and reuse in the system is considered to be BAT.

	Technique	Description
a	Water recirculation	The water recirculation is made possible via soil sealing of the working space and drip tray for collection of drip water. For impregnating processes with water-soluble salt or emulsion concentrates contaminated surface water (if necessary including rainwater) is collected and recirculated to be reused in the process. When using impregnating oils in the pressure process, the collected condensates are initially left to settle and then filtered via activated carbon filter. The purified water can be reused in the process, such as process water for impregnating processes with water-soluble salt or emulsion concentrates, as long as these are used in the system. Contaminated condensate can be disposed of as liquid waste.

Application

In the case of installations which exclusively use impregnating oils, possibly there is no need for process water.

The effluent must be treated then otherwise, e.g. it can be fed into municipal sewage treatment plant or properly disposed of as liquid waste. Regardless of whether a water recirculation can be realized, the soil sealing and collecting bunker are considered to be BAT.

7.2.4 Wood moisture measurement

To reduce application of chemical and resource consumption, the determination of BAT for wood moisture content is made by the following techniques either individually or in a combination:

	Technique	Description
a	Automatic electric resistance measurement for the determination of the wood moisture content	In the case of automatic and manual resistance measurement the wood moisture content is determined by means of electrodes (sensor), which are introduced into the wood and the measurements of the generated electric flows.
b	Manual electric resistance measurement for the determination of the wood moisture content	
c	Weighing procedures for determination of wood moisture content	The wood moisture content is estimated by means of weighing the wood before the impregnation

Wood moisture measurement allows impregnation at optimum moisture content in order to ensure the required quality of impregnated wood, as well as to achieve the aim of wood protection. Wood with suboptimal moisture content is brought to the optimal wood humidity level before the treatment (e.g. through repeated storage or active drying). This procedure allows avoidance of repeated impregnation process and extends the shelf life of the products. It also reduces the resource consumption i.e. WP and wood (and its alternatives).

7.2.5 Flue gas cleaning in installations employing impregnating oils (coal-tar oils)

In order to prevent emissions into the air generated by burning of the organic components of the exhaust gas coming from installations using impregnating oils (creosote), it is necessary to clean the exhaust gas by application of the following BATs (individually or in combination):

	Technique	Description
a	Thermal post-combustion	Exhaust gases generated from the tanks of the creosote impregnating installation are fed into the thermal flue gas cleaning facility (TAR; see VDI 2442). Organic components in the exhaust gas are burned. The thermal post-combustion is the process of oxidation of flammable gases and aromatic substances in the exhaust gas where the mixture of air or oxygen with pollutants is heated with natural gas in a combustion chamber long enough to be over the auto flammability point in order to reach the nearly complete combustion to CO_2 and water.
b	Activated carbon filtering	Exhaust air from the tanks of the creosote impregnation is fed to an activated carbon filtering (see VDI 3674). Organic components are removed from the exhaust air.

By application of these BATs the following emission ranges (half-hourly average values) are reached or the emission values are under these ranges, under the normal operating conditions (273 K, 1013 hPA, dry):

Table 17: Possible BAT emission ranges for the relevant parameters

Parameter	BAT-associated emission ranges
CO	100 mg/m³
NOx	100 bis 200 mg/m³
Total C	20 bis 30 mg/m³
Benzo[a]pyren	0,002 mg/m³

The emission ranges specified in Table 17 are based only on measurements in one installation. These have to be supported with further examples in the course of information exchange to the BREF.

BAT determine the emissions into the air according to the following table:

Table 18: Information on determination of the relevant parameters in the exhaust gas

Parameter	Sampling	Measurement procedure	Measuring accuracy	Measuring frequency
CO	In accordance with VDI 2066 part 1	In accordance with VDI 2459, sheet 6	± 5%	annually
NOx		In accordance with VDI 2456, sheet 9	± 5%	annually
Total C		In accordance with VDI 3481, sheet 1 und EN 12619	± 5%	annually
Benzo[a]pyren		In accordance with DIN EN 1948 and VDI 3873, sheet 1	± 5%	annually

The technique is applicable only for the impregnation of wood with creosote.

7.2.6 Energy efficiency

In order to use energy efficiently, BAT is to employ the required pressure conditions during wood treatment by pressure processes by applying the following techniques:

	Technique	Description
a	Variable pump control	By the variable pump control a relatively high power is used for creation of desired working pressure in boiler. After reaching the working pressure the system is switched to a more energy-efficient pressure pump with lower power.
b	Other techniques are used, but could not be investigated.	

7.2.7 Weather protection

Following techniques are BATs for avoidance of emissions of WPs into the soil and water by leaching of non-fixed WPs:

	Technique	Description
a	Roof cover of extracting rail area, drip area and fixing area	Roof cover of the workspace and/or of the storage area for freshly treated wood allows that the treated timber is protected against weather /rain fall during the transport and storage until the complete fixation of the wood preservative (usually two days). This completely prevents that the rainwater enters the impregnation installation and the leaching of not completely fixed wood preservatives.
b	Storage under tarpaulins until the complete fixation	Freshly treated wood is stored under tarpaulins until the wood preservatives are completely fixed (usually two days)

7.2.8 Substitution of wood preservatives when applying wood preservatives on creosote basis

To avoid or reduce odour and emissions of organic compounds when using wood preservatives on the basis of creosote,BAT includes the following techniques either individually or in combination:

	Technique	Description
a	Substitution of creosote grade B with creosote grade C	The impregnation process is changed from impregnation with creosote grade B to creosote grade C. As a result, the emission of volatile organic compounds (VOC) and odour can be reduced.
b	Substitution of coal tar oil WPs with coal tar oil free WPs	The impregnation process is changed from impregnation with coal tar oil WPs to coal tar oil free WPs. The latter can be applied at ambient temperature and contain no VOC. As a result, the VOC and the odour emissions are prevented and the energy consumption is reduced.

Application

The technique is applicable for existing and new installations. A prerequisite for application of this technique is that the effectiveness and suitability of substitutes for the respective application is examined and ensured on the individual basis. The technical applicability for reaching respective aim for protection as well as the economic viability for substitution should be also considered. Where appropriate, the existing installations must be adapted in order to perform substitution. In the case of techniques described under a) in the table above, the storage tanks and pipes must be heatable in order to ensure safe processing of creosote grade C.

8 Emerging techniques

8.1 Application of coal tar oil alternatives

8.1.1 Description

Use of alternatives for wood preservatives on the basis of coal tar oils.

8.1.2 Technical description

Currently it is assumed that the impregnation with a wood preservative with reduced content of coal tar oil can have a similar effect as the use of coal-tar oil preparations, but is associated with lower environmental impact. A wood preservative which is currently in a testing phase is a concentrated emulsion for impregnation in the retort pressure treatment process with 8-10 bar at normal temperature. It can be applied in conventional retort pressure treatment process (such as aqueous salt solution). The emulsion has been extensively tested according to international norms and standards and proved to be effective and suitable for application (BAM and EMPA, no specific information about norms and standards).

The above mentioned emulsion concentrate is formulated of:

- 70 parts of coal tar oil grade B or grade C
- 20 parts of modified linseed oils co-emulsifier and fixative
- 10 parts of N,N-Didecyl-N-methylpoly(oxethyl)- ammoniumpropionat, co-biocide and emulsion stabilizer

8.1.3 Comparison of performance (of above given emulsion concentrate) with exiting BAT (here: application of creosote)

- Lower content of coal-tar oil and especially benzo [a] pyrene and VOCs.
- Reduced odour of treated wood with lower VOC share which remains in the wood
- Applicability in conventional pressure processes (such as aqueous salt solution)
- Processing without heating of the immersion impregnating medium, lower energy consumption
- Pollution reduction (e.g. prevention of odor pollution, lower creosote contamination) through lower emission of VOC from coal tar oils.
- Reduction in energy consumption due to no need to heat the WP

The technique is applicable for existing and new installations. The efficiency and suitability of substitutes must be ensured in each individual case. Where appropriate, existing installations must be adapted in order to be eligible for application of substitute. Long-term experience is not available with the above described product.

8.1.4 Preliminary cost-benefit estimate

- The costs are comparable to conventional impregnating methods.

According to the expert group (technical discussion of the 17.01.2013), further developments of creosote alternatives are under way, with the aim to reduce or substitute creosote application.

8.1.5 Approximate period of time in which the technology is expected to be commercially available

- No information

8.1.6 Example installation

Installation 1

8.1.7 Reference literature (for above described emulsion concenrate)

IWW Woodcare: http://www.impraegnierwerk.de/index.php?content=IWW-Woodcare

9 References

[BDZ 2004]

Bund Deutscher Zimmermeister im ZDB, Merkblatt – Elektrische Holzfeuchtemessung, Ausgabe 02/2004

[BMVBS 2012]

Bundesministerium für Verkehr, Bau und Stadtentwicklung: http://www.wecobis.de/jahia/Jahia/cache/offonce/Home/Bauproduktgruppen/Oberflaechenbehandlungen/Holzschutzmittel;jsessionid=E5C849EAD545003A876FBD68BA4E90F6

[BREF CWW 2011]

European Commission, Reference Document on Best Available Techniques for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector, Working Draft in Progress, Draft 2, 20 July 2011

[BREF EE 2009]

European Commission, Reference Document on Best Available Techniques for Energy Efficiency, February 2009

[BREF STS 2007]

European Commission, Reference Document on Best Available Techniques on Surface Treatment using Organic Solvents, August 2007

[CCSG 2008]

„Creosote and Biocidal Producers Directive – Creosote Council Position Paper"(European Chemical Industry Council) 2008

[DBC 2012]

Deutsche Bauchemie. 2012. "Merkblatt für den Umgang mit Holzschutzmitteln". Merkblatt, 2. Ausgabe Juni 2012.

[DGFH o.J.]

„Schutzmittel aus Steinkohlenteeröl für die Imprägnierung von Holz" (DGFH, Studiengesellschaft Holzschwellenoberbau e.V.)

[EC 2012]

Durchführungsbeschluss der Kommission vom 10. Februar 2012 mit Leitlinien für die Erhebung von Daten sowie für die Ausarbeitung der BVT-Merkblätter und die entsprechenden Qualitätssicherungsmaßnahmen gemäß der Richtlinie 2010/75/EU des Europäischen Parlaments und des Rates über Industrieemissionen. Amtsblatt der Europäischen Union, L 63 vom 2.3.2012

[EC 2013]

European Commission. List of participants and applicants whose dossiers are being examined under the Review Programme for existing active substances used in biocidal products (Substances classified by product-types), 09.01.2013

[Rütgers 2007]

„CREOSOTE Preservative for Industrial Wood Impregnation" (Rütgers Chemical GmbH)

[UBA Gutachten 2001]

„Gutachten zur Erhebung struktureller Daten über industrielle und gewerbliche Anwender von Holzschutzmitteln in Deutschland“ (Förderkennzeichen 360 04 008)

[VDI 3462]

Verein Deutscher Ingenieure. Emissionsminderung Holzbearbeitung und –verarbeitung, Rohholzbearbeitung und –verarbeitung. VDI 3462 Blatt 1. Veröffentlichung voraussichtlich 2013. (bei der Erstellung des vorliegenden Berichts berücksichtigte Grundlage: 21. Vorentwurf (Vorlage Gründruck) vom 19. Dezember 2012)

[Wagenführ 2008]

André Wagenführ, Frieder Scholz (Hrsg.), Taschenbuch der Holztechnik, Hanser Verlag, 2008

[Werner 2008]

Werner, Frank. Ökologische Bilanzierung von Eisenbahnschwellen Vergleich von Schwellen aus Buchenholz, Eichenholz, Beton und Stahl. Studie im Auftrag der Studiengesellschaft Holzschwellenoberbau e.V., November 2008

Annex

The following tables provides overview for calculating costs to determine the daily production capacity for impregnation installation or system components for wood impregnation (with typical values for different methods). The capacity of a relevant installation in the sense of the IED can be assessed by using this spreadsheet.

Calculation of typical capacities (spreadsheet available only in German)

Einlagerungsverfahren			**Konstruktionsholz**		Erläuterung der Beschränkung und Einfluss auf die Berechnung
Minimale Prozessdauer			0,67	Stunden	40 Minuten Tauchzeit, Beispiel aus konkreter Installationnbesichtigung
Maximale Arbeitsdauer/Tag			24	Stunden	
Tauchbecken 1					
Länge			7,5	M	
Breite			1,5	M	
Höhe			1	M	
Volumen			11,25	m^3	Üblich dimensionierter Trog, Beispiel aus konkreter Installationnbesichtigung
Maximale Holzbeladung			37%		Beispiel aus konkreter Installationnbesichtigung
Technische Beschränkung 1			0,33	Stunden	Manipulationszeit, Beispiel aus konkreter Installationnbesichtigung
Technische Beschränkung 2					
…					
Gesetzliche Beschränkung 1			8	Stunden	Beispiel: Betriebsdauer am Standort gesetzlich auf 16 Stunden begrenzt; --> 8 Stunden werden von maximaler Arbeitsdauer abgezogen
Gesetzliche Beschränkung 2					
…					
Kapazität pro Tag			**66,6**	**m^3/d**	Kapazität pro Tag und Trog im 2-Schichtbetrieb
Kapazität pro stunde			4,2	m3/h	

Druckverfahren Teeröl			**Schwelle**		Erläuterung der Beschränkung und Einfluss auf die Berechnung
Minimale Prozessdauer			7	Stunden	Eichenschwellen, Beispiel aus konkreter Installationnbesichtigung
Maximale Arbeitsdauer/Tag			24	Stunden	
Kessel 1					
Länge			25	M	
Durchmesser			2	m	
Volumen			79	m³	
Maximale Holzbeladung			34%		Typische Auslastung, Berechnung aufgrund typischer Daten
Technische Beschränkung 1			1	Stunden	Be- und Entladen, Beispiel aus konkreter Installationnbesichtigung
Technische Beschränkung 2					
…					
Gesetzliche Beschränkung 1			8	Stunden	Beispiel: Betriebsdauer am Standort gesetzlich auf 16 Stunden begrenzt; --> 8 Stunden werden von maximaler Arbeitsdauer abgezogen
Gesetzliche Beschränkung 2					
…					
Kapazität pro Tag			**54,0**	**m³/Tag**	Kapazität pro Tag und Kessel im 2-Schichtbetrieb
Kapazität pro Stunde			3,4	m3/Stunde	

Druckverfahren wässrig	**Gartenholz**	**Schwelle**	**Mast**		Erläuterung der Beschränkung und Einfluss auf die Berechnung
Minimale Prozessdauer			13,5	Stunden	Kiefernmasten, Beispiel aus konkreter Analgenbesichtigung. Unterberücksichtigung der Zeit für Abtropfen und Ausdampfen wird ein Zyklus pro Tag gefahren.
Maximale Arbeitsdauer/Tag			24	Stunden	
Kessel 1					
Länge			25	m	
Durchmesser			2	m	
Volumen			79	m³	
Maximale Holzbeladung	23,56%	43%	26,00%		Typische Auslastungen, Berechnung aufgrund Analgenbesichtigung und typischer Daten
Technische Beschränkung 1			10,5	Stunden	Abtropfen, Ausdampfen; Beispiel aus konkreter Installationnbesichtigung
Technische Beschränkung 2					
…					
Gesetzliche Beschränkung 1			0	Stunden	

Gesetzliche Beschränkung 2					
...					
Kapazität pro Tag			**20,4**	**m³/Tag**	Kapazität pro Tag und Kessel
Kapazität pro Stunde			0,9	m3/Stunde	

Explanation for the derivation of the daily production capacity is available in the following tables (tables available only in German)

Erläuterungen zur Herleitung der Tagesproduktionskapazität
auf den Datenblättern Gartenholz-, Schwellen- und Masteproduktio (Anlage)

Position		Position	
1	*Rechner. Volumenherleitung anhand der gen. Beispielmaße: π /4 x d*	20	*Pos. 19 multipl. mit Pos. 8* *- 2 Werte a) und b) - je nach Tränkbarkeit der Holzart*
2	*1 % von Pos. 1 (Praxiswert)*	21	*Pos. 20 multipl. mit individ. Korrekturfaktor (im Beispiel mit 0,7)* *- 2 Werte a) und b) - je nach Tränkbarkeit der Holzart*
3	*55 % von Pos. 1 (Praxiswert)*	22	*Pos. 21 multipl. mit individ. Korrekturfaktor (im Beispiel mit 1,0)* *- 2 Werte a) und b) - je nach Tränkbarkeit der Holzart*
4	*1 % von Pos. 1 (Praxiswert)*	23	*Max. Tagesproduktionskapazität innerhalb 24 Stunden* *- 2 Werte a) und b) - je nach Tränkbarkeit der Holzart* *(entspricht Pos. 22)*
5	*Pos. 1 minus Pos. 2, 3 und 4*	24	*Pos. 23 multipl. mit 100 dividiert durch 75 (cbm)* *- 2 Werte a) und b) - je nach Tränkbarkeit der Holzart*
6	*24 % von Pos. 5 (Praxiswert)*		
7	*individueller Korrekturfaktor (nur bei Tauchtränkanlagen)*		
8	*Pos. 5 minus Pos. 6 und 7*		
9	*Pos. 8 multipl. mit 100 dividiert durch Pos. 1*		
10	*Zeit für den reinen Imprägnierprozess (technische Erfordernisse)* *- 2 Werte a) und b) - je nach Tränkbarkeit der Holzart*		
11 bis 16	*Korrekturzeiten (Praxiswerte)*		
17	*Pos. 10 plus Korrekturzeiten (Pos. 11 bis 16)* *- 2 Werte a) und b) - je nach Tränkbarkeit der Holzart*		
18	*Pos. 17 dividiert durch 60 (Minuten)* *- 2 Werte a) und b) - je nach Tränkbarkeit der Holzart*		
19	*24 (Stunden) dividiert durch Pos. 18* *- 2 Werte a) und b) - je nach Tränkbarkeit der Holzart*		

Derivation of the daily production capacity for garden timber

Herleitung der Tagesproduktionskapazität Gartenholzproduktion (Stand 07.09.2012)												
(Beispiele)					Anlagenspezifische Beispiele für Kessel mit den Maßen l = 15 m, d = 1,80 m							
A. Max. mögliches Imprägniervolumen je Imprägnierkessel / max. Auslastungsgrad des Kessels												*Berechnung*
					Verfahren	*Verfahren*	*Verfahren*	*KVD*	*Rüping*			*(Erläuterungen zur den*
Korrektur					*GH*	*Mast*	*Schwelle*	*Gartenholz*	*GH-RH*			*(Positionen - siehe Anlage)*
+/-					Anteil	Anteil	Anteil	Menge	Menge			
					%	%	%	cbm	cbm			
	Rechnerisch hergeleitetes Volumen des Imprägnierkessels/Tauchbeckens				100	100	100	38,00	38,00			*1*
-	Volumen nicht für die Imprägnierung nutzbarer Bereiche des Kessels (Endkappen, Verschlussteile) bzw. Tränkbeckens				3	1	1	1,14	1,14			*2*
-	Volumen für Tränkwagen incl. Rungen, Schienen, manipulationstechn. erford. Abstand zur Kesselinnenwand,				65	55	55	24,70	24,70			*3*
	insbes. nach oben u.a. bzw. (bei einer Tauchtränkanlage) für Flächenheizung, Holzauflage, Niederhalter und Hubwerk usw.											
-	Volumen der Distanzhölzer				1	1	1	0,38	0,38			*4*
= Imprägniervolumen I					31	43	43	11,78	11,78			*5*
-	Volumendifferenz zwischen Rund- und Schnittholz (nur bei Rundholzeinsatz!)				24	24	24	2,83	2,83			*6*
	(Auslastungsgrad bei Rundholz um 24 % geringer als bei Schnittholz - bei Verw. von Distanzhölzern)											
-	Korrekturfaktor für max. Belastbarkeit von Querförderfahrzeug und/oder Holzauflage/Hubwerk Tränkbecken (nur bei Tauchtränkanlage)							-	-			*7*
= Imprägniervolumen II								8,95	8,95			*8*
= Auslastungsgrad (%)								23,56	23,56			*9*
Auslastungsgrad lt. Umfrage								20 (30)	20 (30)			
B. Zeitaufwand zur Imprägnierung einer Charge nach Zeile 22												
								Minuten	Minuten			
	Imprägnierprozess (normal)					a) gut tränkbare HA		360,00	420,00			*10*
						b) schwer tränkbare HA		520,00	520,00			
Korrektur +/-												
+	Zeit für Endphasenkontrolle (nur bei Vollzelltränkung = KVD) = 2 x 15 Minuten							30,00	-			*11*
+	Beladen des Tränkwagens bzw. der Holzauflage, Beschicken des Kessels bzw. des Tauchbeckens							40,00	40,00			*12*
+	Zeit für Abtropf- bzw. Kondensierphase							70,00	70,00			*13*
+	Zeit für Entnahme des imprägnierten Holzes aus dem Kessel bzw. dem Tauchbecken							35,00	35,00			*14*
+	Rüstzeiten (Nachjustieren d. Anlage, Nachfüllen von HSM, Einstellen der Imprägnierlösung, Problembeheb. usw.							20,00	20,00			*15*
+	Zeit zur Berücksichtigung des verlängerten Imprägnierprozesses bei Verwendung chromatfreier HSM							60,00	-			*16*
= Gesamtzeitaufwand für die Imprägnierung				... in Minuten		a) gut tränkbare HA		615,00	585,00			*17*
						b) schwer tränkbare HA		775,00	685,00			
				... in Stunden		a) gut tränkbare HA		10,25	9,75			*18*
						b) schwer tränkbare HA		12,92	11,42			
= Max. mögl. Zahl d. Tränkchargen						a) gut tränkbare HA		2,34	2,46			*19*
(gerechnet auf 24 Stunden)						b) schwer tränkbare HA		1,86	2,10			
= Tagesproduktionskapazität I						a) gut tränkbare HA		20,96	22,04			*20*
						b) schwer tränkbare HA		16,63	18,82			
Korrektur *												
*	Korrekturfaktor für Kapazitätsbegrenzung durch **behördliche Beschränkungen**					a) gut tränkbare HA		14,67	15,43			*21*
	(Beispiel: 2-Schichtbetrieb - 2 x à 8 Std. = 16 Std. ⇒ Faktor 0,7)					b) schwer tränkbare HA		11,64	13,17			
*	Korrekturfaktor zur Anpassung der Tagesproduktionskapazität an die **verfügbare u. behördlich zugelassen Lagerfläche**											
	(Individualfaktor, generell ≤ 1 - Beispiel: Faktor 1,0					a) gut tränkbare HA		14,67	15,43			*22*
						b) schwer tränkbare HA		11,64	13,17			
= Tagesproduktionskapazität II = max. Tagesproduktionskapazität innerhalb von 24 Stunden - cbm						a) gut tränkbare HA		14,67	15,43			*23*
(gem. Definition vom 26.07.2012)						b) schwer tränkbare HA		11,64	13,17			
In Prozent von IED-Grenzwert 75 cbm/24 Std. - %						a) gut tränkbare HA		20%	21%			*24*
						b) schwer tränkbare HA		16%	18%			

LEGENDE:	KVD = KesselvakuumDruckVerfahren	D.R., Doppel-R. = DoppelrüpingVerfahren	GH-SH = Gartenholz-Schnittholz
	WD = WechseldruckVerfahren		GH-RH = Gartenholz-Rundholz

Zu beachten ist, dass jede Imprägnieranlage vor Ort einer Einzelbewertung unterzogen werden muss!

Derivation of the daily production capacity for sleepers

Herleitung der Tagesproduktionskapazität Schwellenproduktion (Stand 27.09.2012)								
(Beispiele)				**Anlagenspezifische Beispiele für Kessel mit den Maßen l = 25 m, d = 2,0 m**				
A. Max. mögliches Imprägniervolumen je Imprägnierkessel / max. Auslastungsgrad des Kessels								***Berechnung***
						Rüping-V.	*Verb. Doppel-R.*	***(Erläuterungen zur den***
Korrektur +/-						*Schwelle*	*Schwelle*	***(Positionen - siehe Anlage)***
					Anteil	**Menge**	**Menge**	
					%	**cbm**	**cbm**	
	Rechnerisch hergeleitetes Volumen des Imprägnierkessels/Tauchbeckens				**100**	80,00	80,00	***1***
-	Volumen nicht für die Imprägnierung nutzbarer Bereiche des Kessels (Endkappen, Verschlussteile) bzw. Tränkbeckens				1	0,80	0,80	***2***
-	Volumen für Tränkwagen incl. Rungen, Schienen, manipulationstechn. erford. Abstand zur Kesselinnenwand,				55	44,00	44,00	***3***
	insbes. nach oben u.a. bzw. (bei einer Tauchtränkanlage) für Flächenheizung, Holzauflage, Niederhalter und Hubwerk usw.							
-	Volumen der Distanzhölzer				1	0,80	0,80	***4***
= Imprägniervolumen I					**43**	**34,40**	**34,40**	***5***
-	Volumendifferenz zwischen Rund- und Schnittholz (nur bei Rundholzeinsatz!)				24	-	-	***6***
	(Auslastungsgrad bei Rundholz um 24 % geringer als bei Schnittholz - bei Verw. von Distanzhölzern)							
-	Korrekturfaktor für max. Belastbarkeit von Querförderfahrzeug und/oder Holzauflage/Hubwerk Tränkbecken (nur bei Tauchtränkanlage)					-	-	***7***
= Imprägniervolumen II						**34,40**	**34,40**	***8***
= Auslastungsgrad (%)						43,00	43,00	***9***
Auslastungsgrad lt. Umfrage						40 (45)	40 (45)	
B. Zeitaufwand zur Imprägnierung einer Charge nach Zeile 22								
						Minuten	**Minuten**	
	Imprägnierprozess (normal)				a) gut tränkbare HA	600,00	720,00	***10***
					b) schwer tränkbare HA	550,00	-	
Korrektur +/-								
+	Zeit für Endphasenkontrolle (nur bei Vollzelltränkung = KVD) = 2 x 15 Minuten					-	-	***11***
+	Beladen des Tränkwagens bzw. der Holzauflage, Beschicken des Kessels bzw. des Tauchbeckens					95,00	95,00	***12***
+	Zeit für Abtropf- bzw. Kondensierphase					80,00	80,00	***13***
+	Zeit für Entnahme des imprägnierten Holzes aus dem Kessel bzw. dem Tauchbecken					70,00	70,00	***14***
+	Rüstzeiten (Nachjustieren d. Anlage, Nachfüllen von HSM, Einstellen der Imprägnierlösung, Problembeheb. usw.					30,00	30,00	***15***
+	Zeit zur Berücksichtigung des verlängerten Imprägnierprozesses bei Verwendung chromatfreier Holzschutzmittel					-	-	***16***
= Gesamtzeitaufwand für die Imprägnierung			**... in Minuten**		a) gut tränkbare HA	875,00	995,00	***17***
					b) schwer tränkbare HA	825,00	-	
			... in Stunden		a) gut tränkbare HA	14,58	16,58	***18***
					b) schwer tränkbare HA	13,75	-	
= Max. mögl. Zahl d. Tränkchargen					a) gut tränkbare HA	1,65	1,45	***19***
(gerechnet auf 24 Stunden)					b) schwer tränkbare HA	1,75	-	
= Tagesproduktionskapazität I					a) gut tränkbare HA	56,61	49,78	***20***
					b) schwer tränkbare HA	60,04	-	
Korrektur *								
*	Korrekturfaktor für Kapazitätsbegrenzung durch **behördliche Beschränkungen**				a) gut tränkbare HA	39,63	34,85	***21***
	(Beispiel: 2-Schichtbetrieb - 2 x à 8 Std. = 16 Std. ⇒ Faktor 0,7)				b) schwer tränkbare HA	42,03	-	
*	Korrekturfaktor zur Anpassung der Tagesproduktionskapazität an die **verfügbare u. behördlich zugelassen Lagerfläche**							
	(Individualfaktor, generell ≤ 1 - Beispiel: Faktor 1,0				a) gut tränkbare HA	39,63	34,85	***22***
					b) schwer tränkbare HA	42,03	-	
= Tagesproduktionsikapazität II = max. Tagesproduktionskapazität innerhalb von 24 Stunden - cbm					a) gut tränkbare HA	**39,63**	**34,85**	***23***
(gem. Definition vom 26.07.2012)					b) schwer tränkbare HA	**42,03**	**-**	
In Prozent von IED-Grenzwert 75 cbm/24 Std. - %					a) gut tränkbare HA	**53%**	**46%**	***24***
					b) schwer tränkbare HA	**56%**	-	

LEGENDE:	**KVD = KesselvakuumDruckVerfahren**	**D.R., Doppel-R. = DoppelrüpingVerfahren**	**GH-SH = Gartenholz-Schnittholz**
	WD = WechseldruckVerfahren		**GH-RH = Gartenholz-Rundholz**

Zu beachten ist, dass jede Imprägnieranlage vor Ort einer Einzelbewertung unterzogen werden muss!

Derivation of the daily production capacity for masts

Herleitung der Tagesproduktionskapazität Masteproduktion (Stand 20.09.2012)-CSK											
(Beispiele)				Anlagenspezifische Beispiele für Kessel mit den Maßen l = 25 m, d = 2,0 m							
A. Max. mögliches Imprägniervolumen je Imprägnierkessel / max. Auslastungsgrad des Kessels											Berechnung
				Verfahren	*Verfahren*	*Verfahren*	*KVD*	*WD*	Verb. Rüping-V.		(Erläuterungen zur den
Korrektur				*GH*	*Mast*	*Schwelle*	*Mast*	*Mast*	*Mast*		(Positionen - siehe Anlage)
+/-				Anteil	Anteil	Anteil	Menge	Menge	Menge		
				%	%	%	cbm	cbm	cbm		
	Rechnerisch hergeleitetes Volumen des Imprägnierkessels/Tauchbeckens			100	100	100	80,00	80,00	80,00		1
-	Volumen nicht für die Imprägnierung nutzbarer Bereiche des Kessels (Endkappen, Verschlussteile) bzw. Tränkbeckens			3	1	1	0,80	0,80	0,80		2
-	Volumen für Tränkwagen incl. Rungen, Schienen, manipulationstechn. erford. Abstand zur Kesselinnenwand,			65	55	55	44,00	44,00	44,00		3
	insbes. nach oben u.a. bzw. (bei einer Tauchtränkanlage) für Flächenheizung, Holzauflage, Niederhalter und Hubwerk usw.										
-	Volumen der Distanzhölzer			1	1	1	0,80	0,80	0,80		4
= Imprägniervolumen I				31	43	43	34,40	34,40	34,40		5
-	Volumendifferenz zwischen Rund- und Schnittholz (nur bei Rundholzeinsatz!)			24	24	24	8,26	8,26	8,26		6
	(Auslastungsgrad bei Rundholz um 24 % geringer als bei Schnittholz - bei Verw. von Distanzhölzern)										
-	Korrekturfaktor für max. Belastbarkeit von Querförderfahrzeug und/oder Holzauflage/Hubwerk Tränkbecken (nur bei Tauchtränkanlage)						-	-	-		7
= Imprägniervolumen II							26,14	26,14	26,14		8
= Auslastungsgrad (%)							32,68	32,68	32,68		9
Auslastungsgrad lt. Umfrage							30 (35)	30 (35)	30 (35)		
B. Zeitaufwand zur Imprägnierung einer Charge nach Zeile 22											
							Minuten	Minuten	Minuten		
	Imprägnierprozess (normal)				a) gut tränkbare HA		860,00	-	420,00		10
					b) schwer tränkbare HA		1.200,00	1.300,00	450,00		
Korrektur +/-											
+	Zeit für Endphasenkontrolle (nur bei Vollzelltränkung = KVD) = 2 x 15 Minuten						30,00	-	-		11
+	Beladen des Tränkwagens bzw. der Holzauflage, Beschicken des Kessels bzw. des Tauchbeckens						95,00	95,00	95,00		12
+	Zeit für Abtropf- bzw. Kondensierphase						80,00	80,00	80,00		13
+	Zeit für Entnahme des imprägnierten Holzes aus dem Kessel bzw. dem Tauchbecken						70,00	70,00	70,00		14
+	Rüstzeiten (Nachjustieren d. Anlage, Nachfüllen von HSM, Einstellen der Imprägnierlösung, Problembeheb. usw.						30,00	30,00	30,00		15
+	Zeit zur Berücksichtigung des verlängerten Imprägnierprozesses bei Verwendung chromatfreier Holzschutzmittel						60,00	60,00	-		16
= Gesamtzeitaufwand für die Imprägnierung		... in Minuten			a) gut tränkbare HA		1.225,00	-	695,00		17
					b) schwer tränkbare HA		1.565,00	1.635,00	725,00		
		... in Stunden			a) gut tränkbare HA		20,42	-	11,58		18
					b) schwer tränkbare HA		26,08	27,25	12,08		
= Max. mögl. Zahl d. Tränkchargen					a) gut tränkbare HA		1,18	-	2,07		19
(gerechnet auf 24 Stunden)					b) schwer tränkbare HA		0,92	0,88	1,99		
= Tagesproduktionskapazität I					a) gut tränkbare HA		30,73	-	54,17		20
					b) schwer tränkbare HA		24,06	23,03	51,93		
Korrektur *											
*	Korrekturfaktor für Kapazitätsbegrenzung durch **behördliche Beschränkungen**				a) gut tränkbare HA		21,51	-	37,92		21
	(Beispiel: 2-Schichtbetrieb - 2 x à 8 Std. = 16 Std. ⇒ Faktor 0,7)				b) schwer tränkbare HA		16,84	16,12	36,35		
*	Korrekturfaktor zur Anpassung der Tagesproduktionskapazität an die **verfügbare u. behördlich zugelassen Lagerfläche**										
	(Individualfaktor, generell ≤ 1 - Beispiel: Faktor 1,0				a) gut tränkbare HA		21,51	-	37,92		22
					b) schwer tränkbare HA		16,84	16,12	36,35		
= Tagesproduktionskapazität II = max. Tagesproduktionskapazität innerhalb von 24 Stunden - cbm					a) gut tränkbare HA		21,51	-	37,92		23
(gem. Definition vom 26.07.2012)					b) schwer tränkbare HA		16,84	16,12	36,35		
In Prozent von IED-Grenzwert 75 cbm/24 Std. - %					a) gut tränkbare HA		29%	0%	51%		24
					b) schwer tränkbare HA		22%	21%	48%		

LEGENDE:	KVD = KesselvakuumDruckVerfahren	D.R., Doppel-R. = DoppelrüpingVerfahren	GH-SH = Gartenholz-Schnittholz
	WD = WechseldruckVerfahren		GH-RH = Gartenholz-Rundholz

Zu beachten ist, dass jede Imprägnieranlage vor Ort einer Einzelbewertung unterzogen werden muss!