

Meeting the goals of the NEC directive, reducing carbon footprint and earning money on top?

EPF IED Task Force meeting
Brussel, September 5th, 2024

Prof. Dr.-Ing. Bernd Bungert

Contents

- 1) Current and new environmental legislation in wood-based-panel industry
- 2) New process for MDF
- 3) Benefit 1: Compliance with EU emission limits
- 4) Benefit 2: Elimination of costs for RTO
- 5) Benefit 3: Revenue from turpentine production
- 6) Meeting the goals of the NEC directive
- 7) New process for OSB and particleboard
- 8) Project information and outlook

New limits for emissions in the wood-panel industry

- (EU) 2015/2119
- Valid since 24.11.2019
- Germany TA-Luft: 1.12.2021
- Für MDF/ HDF increasing **tightening**:
 - Reduction from **300mg/m³** to **120mg/m³**
 - Due to change in reference value from wet to dry basis: 120 mg/m³ at 55°C off-gas temperature equivalent **101mg/m³** according to old method
- Main component of VOCs: terpenes



JRC SCIENCE FOR POLICY REPORT

Best Available Techniques (BAT)
Reference Document for the
Production of Wood-based Panels

*Industrial Emissions Directive
2010/75/EU
(Integrated Pollution
Prevention and Control)*

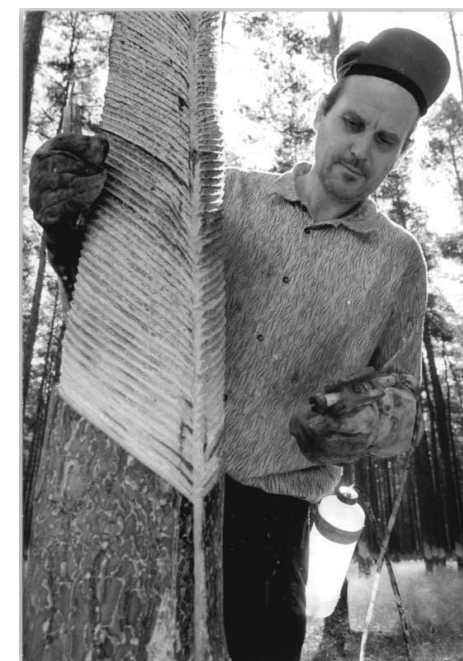
Kristine Raunkjær Stubdrup,
Panagiotis Karlis, Serge Roudier,
Luis Delgado Sancho

2016



Terpene – only the smell of resin and forest?

- resin = sticky liquid from softwood like pine, larch and to some extent spruce
- resin = resin acids (rosin, „amber“) + terpenes
- terpene = essential oils
(α -Pinen, β -Pinen, Δ -3-Caren, Limonen, ...)
- Composition and amount depends on pine species
- Mixture of terpenes is called turpentine („genuine turpentine“)
- Smell like freshly cut wood or perfume?

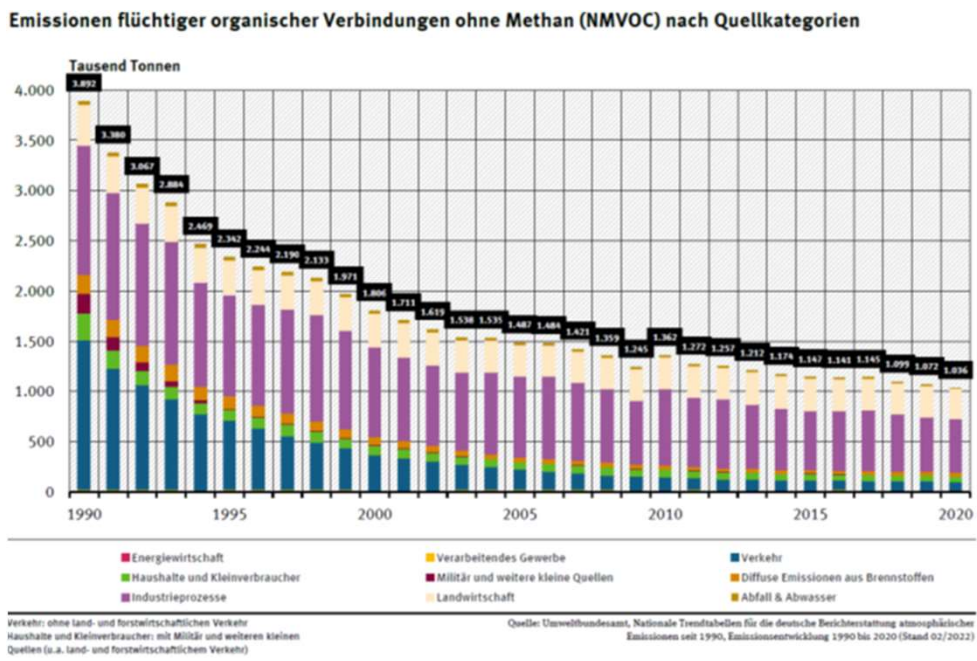


Terpene – only the smell of resin and forest? **No!**

- Terpenes = most important group of VOC that form **photooxidants**
- Photooxidants arise from nitrous oxides (NO_x), VOC and oxygen
- Most important Photooxidant is **ozone**
- Surface near ozone is **extremely harmful**

VOCs in Germany

- NEC-guideline („National Emission Ceilings Directive“) demands reduction requirement for VOCs and NMVOC (non-methane VOC)



- Reduction at **FBB** by **1.200 t/a** equals **0,1% of all German VOC emissions.**

New emission values: change of reference state

Old value old
reference

New
value new
reference New
value old
reference

Tabelle 6. Beispiele für die Abhängigkeit der Emissionswerte für Gesamt-C vom Wassergehalt des Abgases

$T_{\text{Ab-luft}}$ in °C	p_w^{LV} (temperaturabh. Dampfdruck) in bar	φ (relative Luftfeuchte)	x_w (Wassergehalt) in kg/kg	Emissionsanforderung gemäß TA Luft 2002 Bezugszustand feucht in mg/m ³	Emissionsanforderung gemäß TA Luft 2002 Bezugszustand trocken in mg/m ³	Neue Emissionsanforderung gemäß TA Luft 2021 Bezugszustand trocken in mg/m ³	Neue Emissionsanforderung gemäß TA Luft 2021 Bezugszustand feucht in mg/m ³	Bemerkung: typische Temperaturen für
50	0,123	1,0	0,087	300	342,2	120	105,2	
55	0,157	1,0	0,116	300	356,0	120	101,1	MDF
60	0,199	1,0	0,154	300	374,6	120	96,1	
65	0,249	1,0	0,207	300	399,9	120	90,0	
70	0,311	1,0	0,281	300	435,6	120	82,6	
75	0,385	1,0	0,389	300	487,9	200	123,0	Span
75	0,385	1,0	0,389	400	650,6	400	245,9	OSB

For MDF, PB, OSB drastic reduction



(27) In order to support decarbonisation, resource efficiency and a circular economy, the BAT conclusions should include binding environmental performance levels associated with BAT, and indicative environmental performance levels associated with emerging techniques, for individual processes that have similar characteristics, such as energy carriers, raw materials, production units and final products, and a high degree of homogeneity across the Union, in cases where the data made available in the exchange of information supporting the determination of BAT are sufficiently robust. The BAT conclusions should also include indicative benchmarks for other cases to be included by operators in their EMS, in cases where environmental performance is highly dependent on specific circumstances of the processes. The environmental performance levels associated with BAT and the benchmarks could include consumption levels, resource efficiency levels and reuse levels covering materials, water and energy resources, and waste and other

(30) BAT conclusions should identify emerging techniques and best available techniques that industrial operators can implement to transform installations to be consistent with the Union's objective of a sustainable, clean, circular and climate-neutral economy. Competent authorities should be allowed to grant industrial operators sufficient time to implement deep industrial transformation requiring substantial investment via BATs or emerging techniques which involve a major change in design or technology, or to replace an existing installation, as described in the BAT conclusions and laid down in a transformation plan.

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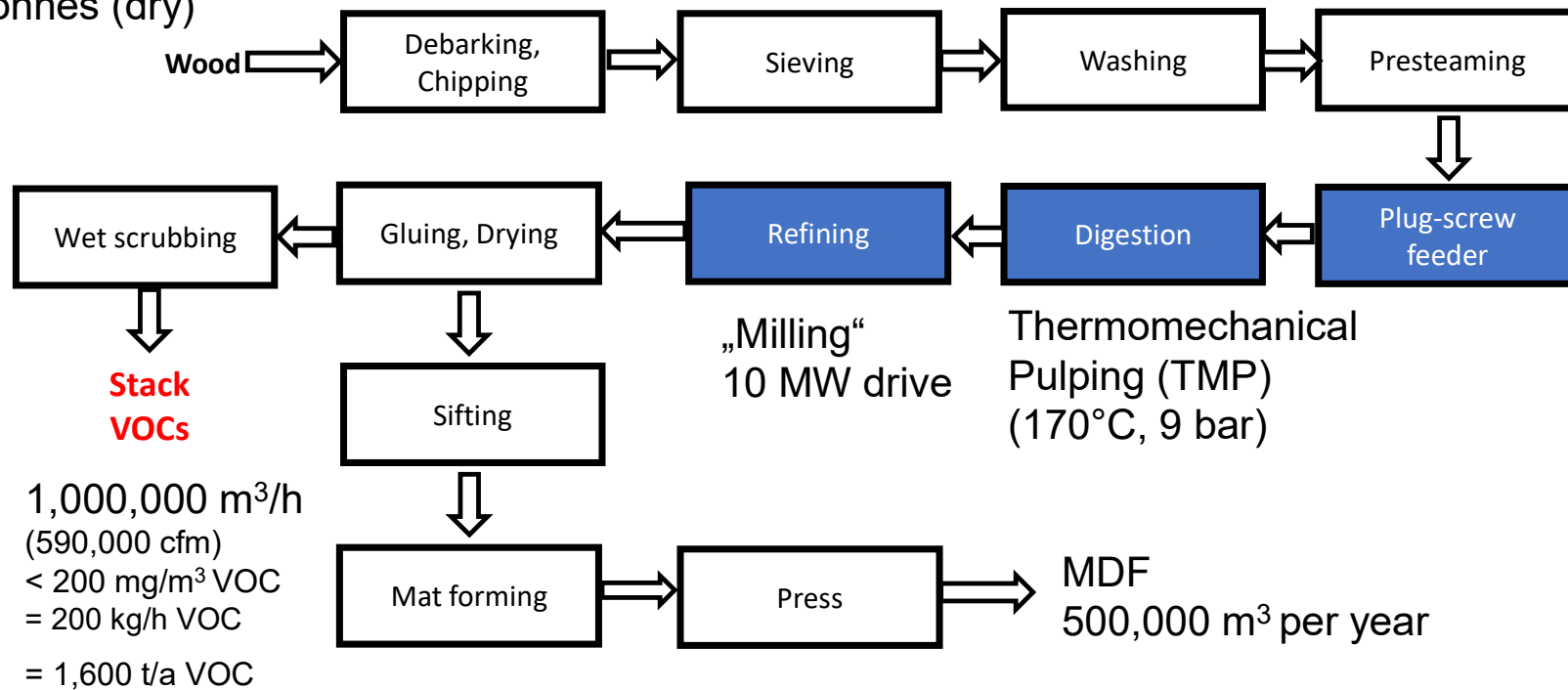
Fiberboard in Baruth/Mark



VOC: Volatile Organic Components

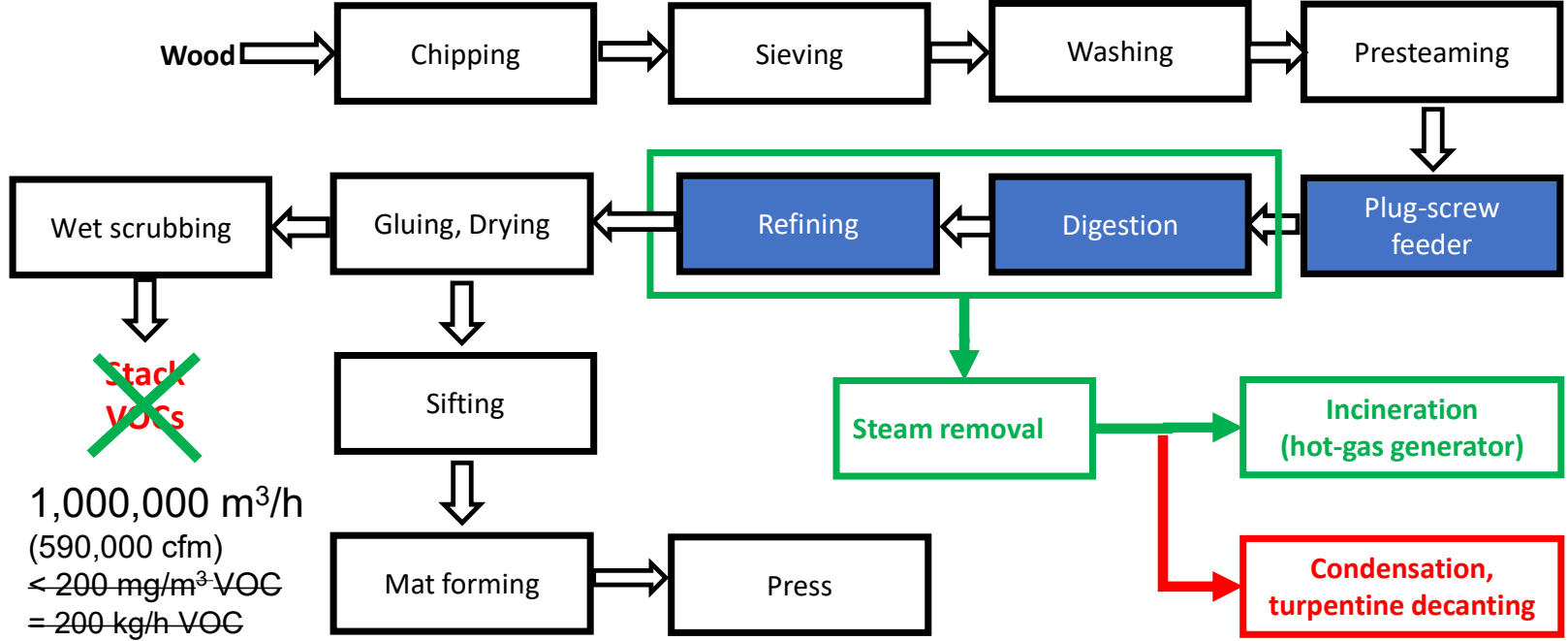
MDF Process

400,000 tonnes (dry)
per year



MDF-process

with VOC reduction
with turpentine production



~~Stack VOCs~~
1,000,000 m³/h
(590,000 cfm)
< 200 mg/m³ VOC
= 200 kg/h VOC
= 1,600 t/a VOC
50 mg/m³ VOC
50 kg/h

150 kg/h
1,200 t/a

System installation



Steam removal



Pipe to hot-gas
generator

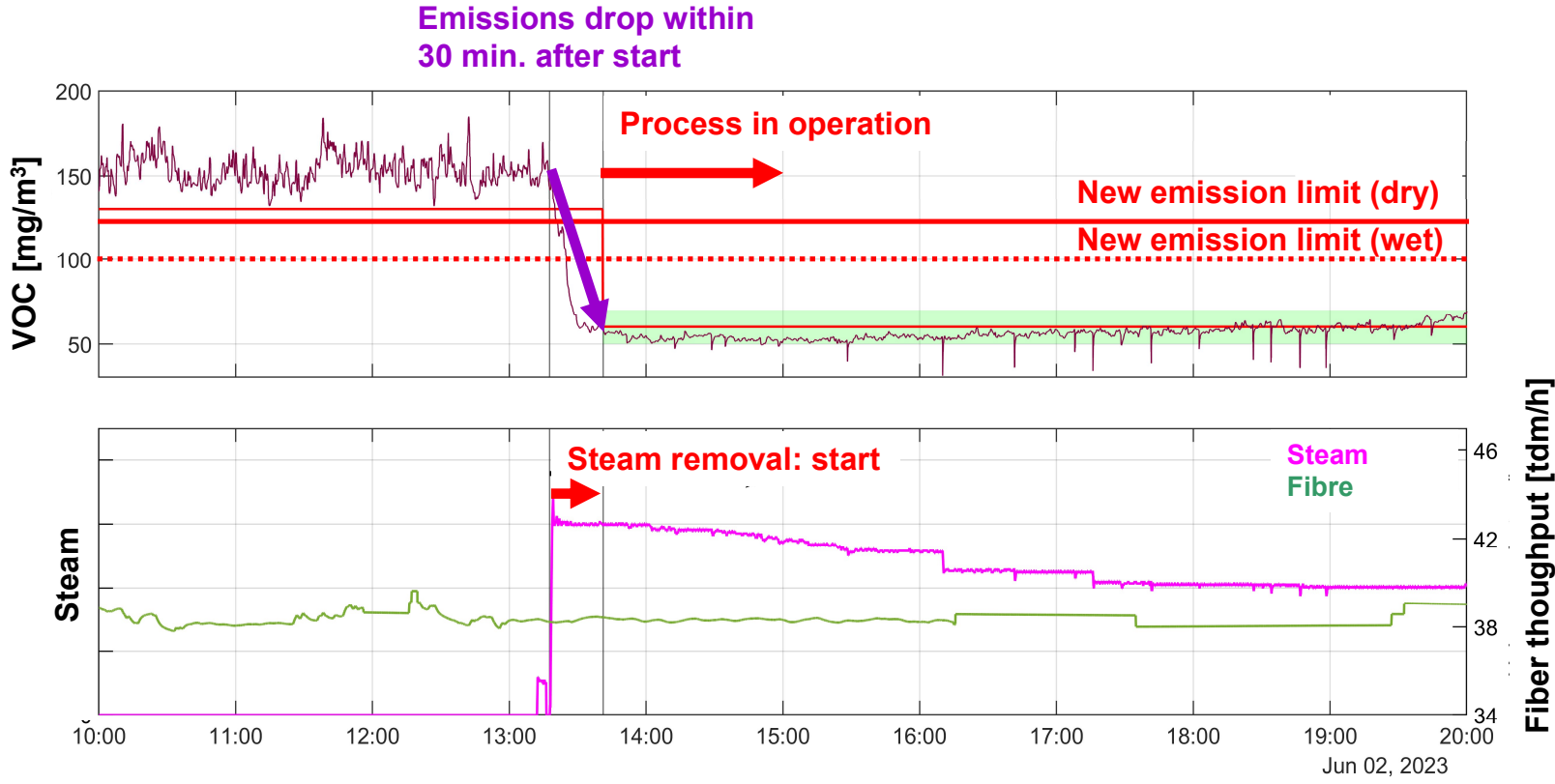


Combustion-
chamber inlet

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1) Compliance with EU legislation



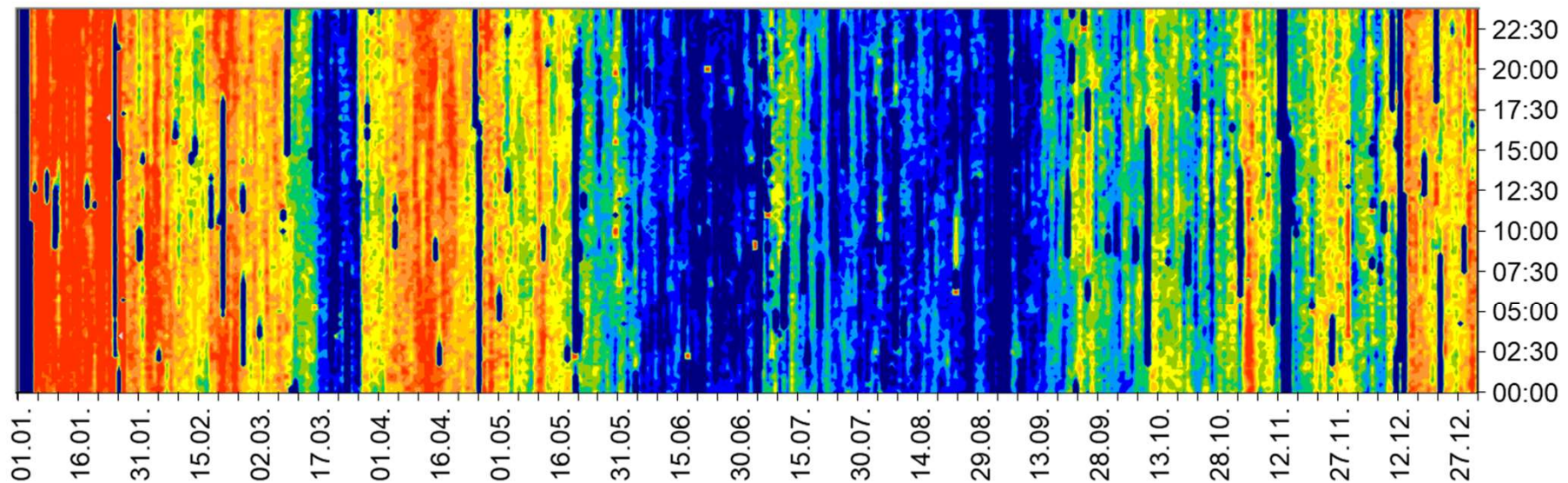
- ✓ Reliable attainment of emission limits
- ✓ Proven in industrial operation

VOC Emissions 2017 from online measurement (90% plan utilization, 70% pine)

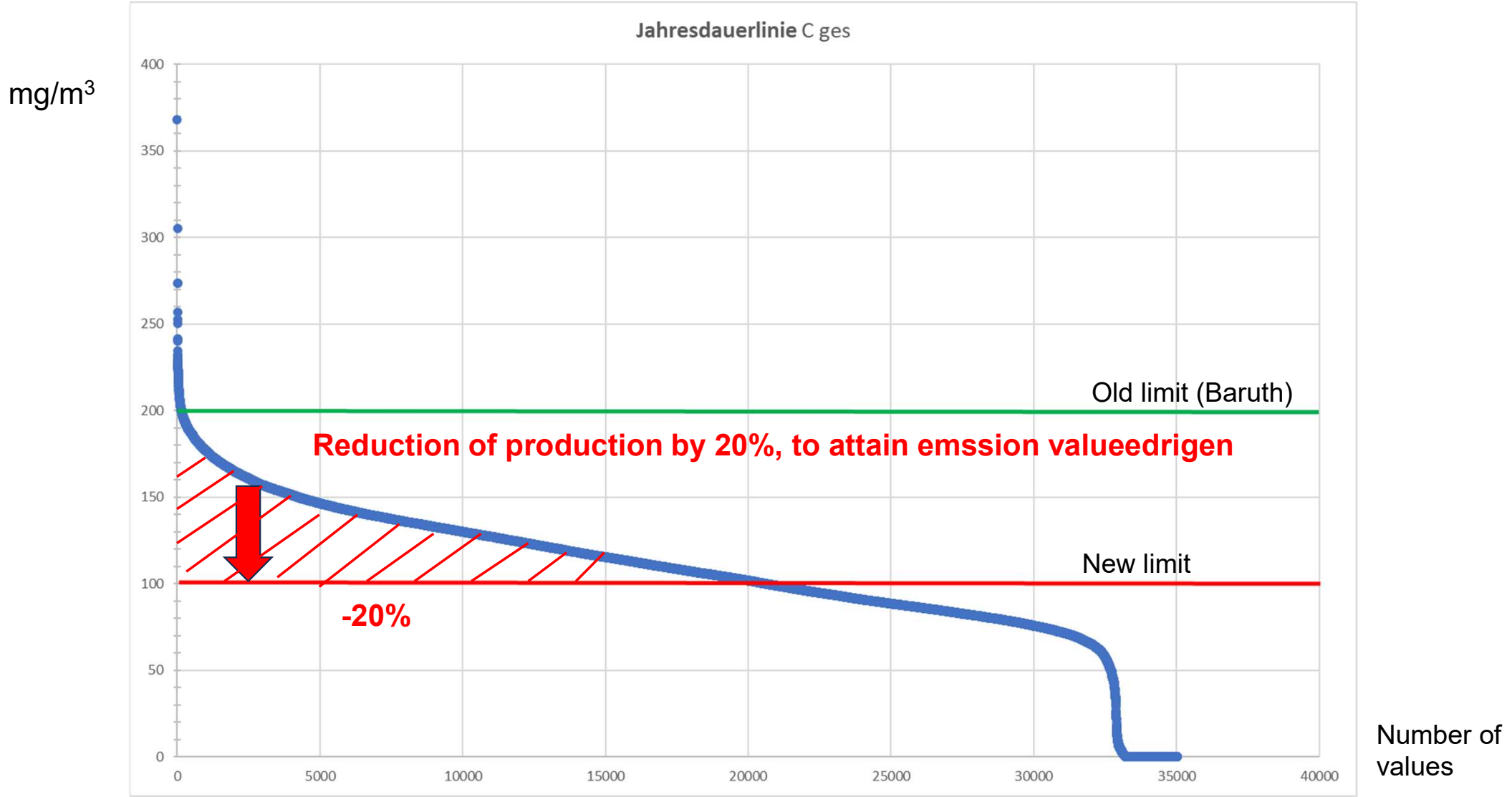
- blau: Grenzwert eingehalten
- grün, gelb, rot: Grenzwert überschritten (Basis trocken)



-> Solution: reduce pine or reduce production



Annual –duration line in mg/m³ (Data sorted according to size)



Simple calculation: 2017 at 90% utilization and 70% pine

Project:	MDF-VOC
Title:	VOC Konzentration Baruth
Date:	04.09.2025
Author:	Bungert
Revision:	R06



Durchsatz	500.000	m ³ /a	
Holzmenge	440.000	t atro/a	
Volllaststunden	7500	h/a	
Kiefernanteil	0,70	-	
Sunds Dampf %	0,00		Steam recovery from blowline
Terpentin in Kiefer	3,5	kg/t atro	Messwerte Baruth
Abluftmenge	1.000.000	m ³ /h	
Terpentin Abluft	144	kg/h	
Terpentin Produktion	1.078	t/a	
Durchschnittserlös	1.200	€/t	
Jahreserlös	1.293.600	€	
Spezifischer Erlös	2,59	€/m ³	€/m ³ MDF
Konzentration	144	mg/m ³	feucht
Konzentration	171	mg/m ³	trocken



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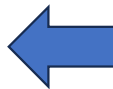
2) Replacing RTO

- ✓ Economical analysis (detailed study):
 - 2 sites in USA
 - Comparing RTO – Bioscrubbing + MDF-VOC
 - **Savings of € 10 / m³ MDF**
- ✓ No CO₂ emissions from burning of natural gas
 - > carbon footprint (scope 1+2) dramatically reduced**
- ✓ Additional NO_x emissions from RTO eliminated
- ✓ System is essentially energy neutral

2) Replacing RTO by Classen system + bioscrubber

- Detailed analysis
- Energy prices: EIA.gov; South Atlantic
- Calculation bioscrubber based on Classen plant in Baruth
- Summary:

Off-gas volume: 1.000.000 m ³ /h								
500.000 m ³ /a MDF								
	Cost	Price [€/kWh]	RTO [kW]	RTO [€/a]	RTO [€/m ³]	Bioscrubber + Classen [KW]	Bioscrubber + Classen [€/a]	Bioscrubber + Classen [€/m ³]
1)	Electricity	0,075	1.700	1.020.000	2,04	1.126	675.600	1,35
2)	Natural gas	0,017	22.000	2.992.000	5,98	-	-	-
3)	Wash down & burn out			1.680.000	3,36	-	-	-
	Summe			5.692.000	11,38		675.600	1,35
Data: EIA.gov, south atlantic				Difference: € 10,03/m³				



▪ **Difference: € 10/ m³ MDF/HDF**

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3) Revenue from Turpentine Production

- ✓ Turpentine = essential oil from pines
- ✓ Price depends on composition (α -pinene, β -pinene content)
- ✓ Turpentine is a sought after renewable raw material:
 - Flavour and fragrance industry
 - Chemical industry: tires, adhesives, ink
 - Sustainable Aviation Fuel (SAF)
- ✓ Turpentine recovery system (MDF-T) in Baruth will come onstream in 2025 to give 1200 tonnes per year of turpentine
- ✓ **Amortization time well under 2 years**
- ✓ **Revenue: € 3...8/m³ MDF**

Softwood: turpentine composition and yield

- Turpentine composition and yield are compiled from all over the world

- Additional data is generated by steam distillation in lab

- Evaluation of quality by
 - Yield [kg turpentine/ t dry wood]
 - α pinene and β pinene content
 - Quality factor = α , β pinene content relative to *Pinus eliottii* from Brasil

Project: Turpentine composition and yield
 Author: J.P. de Gooijer, R. Burger
 Date: 2011

Tree	Scientific name	Region	Yield	α pinene	β pinene	γ pinene	δ pinene	ϵ pinene	ζ pinene	η pinene	θ pinene	ι pinene	κ pinene	λ pinene	μ pinene	ν pinene	ξ pinene	\omicron pinene	π pinene	ρ pinene	Other	Date
Black Pine	<i>Pinus nigra</i>	Spain	1.5	8.0	1.2	0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2005
Pinus sp.	<i>Pinus sp.</i>	Spain	1.0	8.0	1.2	0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2005
Pinus sp.	<i>Pinus sp.</i>	Spain	1.0	8.0	1.2	0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2005

Business case examples: MDF Turpentine from 6 locations

- For purposes of illustration only
- A hypothetical price* was calculated from the (α + β pinene) content based on
 - 14 year average price index for Brazilian Gum Turpentine
 - Source: Comexstat, Brazilian foreign trade statistics
 - BT = \$ 2300/ ton (€ 2150/ton)
 - Price = Quality factor * BT
- Business cases:

1) Baruth Germany	(500,000 m ³ /a; Pinus Sylvestris)
2) Brasil	(600,000 m ³ /a; Pinus Elliottii)
3) USA	(300,000 m ³ /a; Pinus Elliottii)
	(300,000 m ³ /a; Pinus Taeda)
4) Australia, New Zealand	(300,000 m ³ /a; Pinus Radiata)
5) Portugal, Spain	(300,000 m ³ /a; Pinus Pinaster)
6) Turkey	(880,000 m ³ /a; Pinus Sylvestris)

Comparison of 6 business cases

Nr.	Site	pine	MDF m ³ /a	Wood t/a	Turpentine kg/t	Turpentine t/a	(a+b)/ (a+b) e	Turpentine €/t *	Estimated* Revenue [€]	€/m ³ MDF
1	Baruth, Germany	pinus sylvestris	500.000	400.000	3	1.200	0,55	1.183	1.419.000	2,8
2	Brasil	pinus elliottii	600.000	480.000	4,6	2.208	1,00	2.150	4.747.200	7,9
3	USA	pinus elliottii	300.000	240.000	4,6	1.104	1	2.150	2.373.600	7,9
		pinus taeda	300.000	240.000	3,2	768	1,02	2.193	1.684.224	5,6
4	Aus, NZ	pinus radiata	300.000	240.000	1,7	408	1,09	2.344	956.148	3,2
5	Spain, Portugal	pinus pinaster	300.000	240.000	4	960	1,02	2.193	2.105.280	7,0
6	Turkey	pinus sylvestris	880.000	704.000	3,5	2.464	0,68	1.462	3.602.368	4,1

- All cases are interesting for the MDF industry to start turpentine recovery

* No business information, only meant to assess an order of magnitude

Data analysis of MDF plants worldwide

- Detailed list of (all) MDF/ HDF plants weltweit N = 178 (without China, Russia, Belarus)
- Data: Capacity, gas treatment, wood mix, pine species
- For 78 of 178 plants wood mix and pine species is known
- Europe turpentine (VOC) potential = 20.000 t/a
- Worldwide turpentine (VOC) potential = 120.000 t/a

Region	Capacity [m3/a]	turpentine production [t/ year]	Turpentine Revenue [€]	Remarks
Asia East	2.333.000	335	785.655	
Asia Southeast	6.125.500	-		
Aus, NZ	1.331.667	2.876	10.034.662	
<i>China</i>	65.000.000			
Europe Central and North	13.109.000	13.954	16.744.320	
<i>Europe East</i>	5.306.000			
Europe Southwest	1.973.000	5.592	11.897.928	
Asia Middle East, India Iran	5.321.000	3.213	5.157.938	
North America	6.137.000	8.866	18.199.555	
South America	9.625.600	8.503	18.280.518	
Africa	468.000	-	0	
Turkey	9.596.000	9.875	14.417.792	
Total known	120.188.767	53.215	95.518.368	known
		120.756	216.753.219	extrapolated

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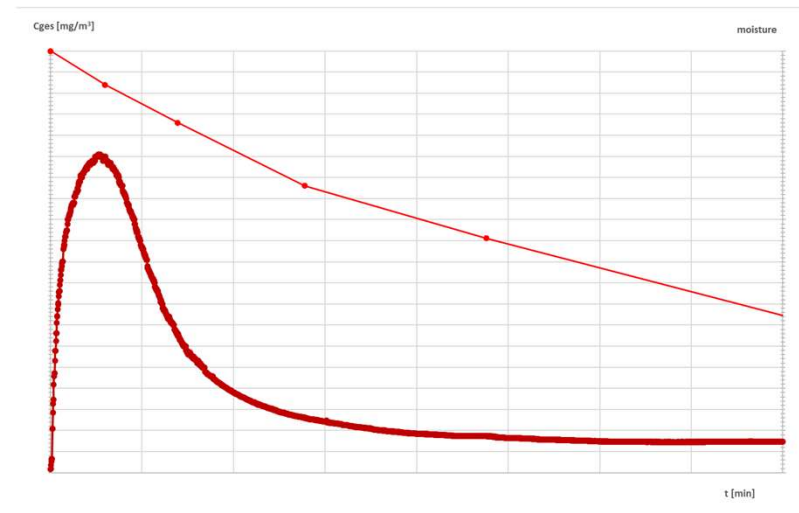
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Application for OSB, Particleboard, Pellet

- ✓ Concept: additional predryer can remove essentially all the terpenes.
Size is 5-10% of main dryer
- ✓ Development on pilot-plant scale (20 kg/h) successfully demonstrated
- ✓ VOC emissions reduced drastically
- ✓ Additional benefit: reduction of interior emission of terpenes, organic acids and their decomposition products (e.g. hexanoic acid, hexanal)
- ✓ Partner for industrial development wanted



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‘Chapter IIa

Enabling and promoting innovation’;

(30) Article 27 is replaced by the following:

‘Article 27

Emerging techniques

Member States shall, where appropriate, **encourage** the development and application of **emerging techniques**, in particular where such techniques have been identified in the BAT conclusions, the BAT reference documents or the **findings of the innovation centre for industrial transformation and emissions** referred to in Article 27a.’;

(30) BAT conclusions should identify **emerging techniques** and best available techniques that industrial operators can implement to transform installations to be consistent with the Union’s objective of a sustainable, clean, circular and climate-neutral economy. **Competent authorities should be allowed to grant industrial operators sufficient time to implement deep industrial transformation requiring substantial investment via BATs or emerging techniques which involve a major change in design or technology, or to replace an existing installation, as described in the BAT conclusions and laid down in a transformation plan.**

(31) the following articles are inserted:

‘Article 27a

Innovation centre for industrial transformation and emissions

1. The Commission shall establish and operate **an innovation centre for industrial transformation and emissions (the ‘centre’ or ‘INCITE’)**.
2. The centre shall **collect and analyse information on innovative techniques**, including emerging and transformative techniques, which contribute inter alia to minimisation of pollution, decarbonisation, resource efficiency, a circular economy using fewer or safer chemicals, relevant to activities within the scope of this Directive, and characterise their level of development and their environmental performance. The Commission shall take into account the findings of the centre when preparing the work programme for the exchange of information referred to in Article 13(3), point (b), and when drawing up, reviewing and updating the BAT reference documents referred to in Article 13(1).

Contact

André Hennig

Hennig@Fiberboard.de

+49 – 173 668 1906

Prof. Dr.-Ing. Bernd Bungert

Bungert@IB-Bungert.de

+49 – 176 5532 6667

Moritz Menier

moritz.menier@classen.de

Mobil US: +01 (336) 425 – 1179

Mobil DE: +49 (160) 712 – 8152

Maciej Górecki

maciej.gorecki@classen.com.pl

+48 602 134 928