



TEHNOLOGIAD HEITE PIIRVÄÄRTUSTE SAAVUTAMISEKS

Alar Konist
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TALLINNA
TEHNIAÜLIKOOOL

Põletusseadmete heite piirväärtused (mg/Nm₃) 1-5 MW

(punasega on märgitud uute seadmete piirväärtused)

Saaste-aine	Tahke biomass	Muud tahke	Vedel-kütused-muu kui gaasiõli	Gaasiõli	Maagaas	Gaas-kütused
SO ₂	200/200	1100/400	350/350	-/-	-/-	200/35
NO _x	650/300	650/300	650/300	200/200	250/100	250/200
Osakesed	50/20	50/20	50/20	-/-	-/-	-/-

Põletusseadmete heite piirväärtused (mg/Nm₃) üle 5 MW

(punasega on märgitud uute seadmete piirväärtused)

Saaste-aine	Tahke biomass	Muu tahke	Gaasiõli	Vedel-kütused	Maagaas	Muud gaasi-kütused
SO ₂	200/200	400/400	-/-	350/350	-/-	35/35
NO _x	650/300	650/300	200/200	650/300	200/100	250/200
Osakesed	30/20	30/20	-/-	30/20	-/-	-/-

Õhuheitmeid mõjutavad

TSP

- Katla ehitus, tüüp ja opereerimistingimused.
- Kütuse tüüp ja kvaliteet.
- Puhastusseadmed.

NOx

- Katla ehitus, tüüp ja opereerimistingimused.
- Kütuse tüüp, koostis ja kvaliteet.
- Puhastusseadmed.

SO₂

- Katla ehitus, tüüp ja opereerimistingimused.
- Kütuse väävlisisaldus
- Puhastusseadmed

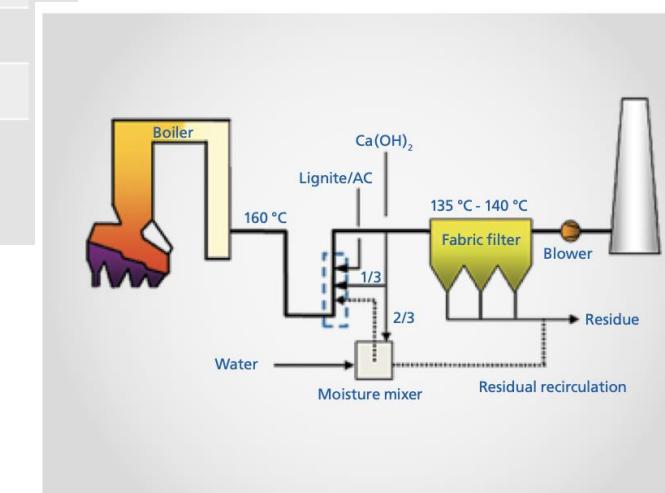
Püüdelahendused

Technologies for removal of different pollutants

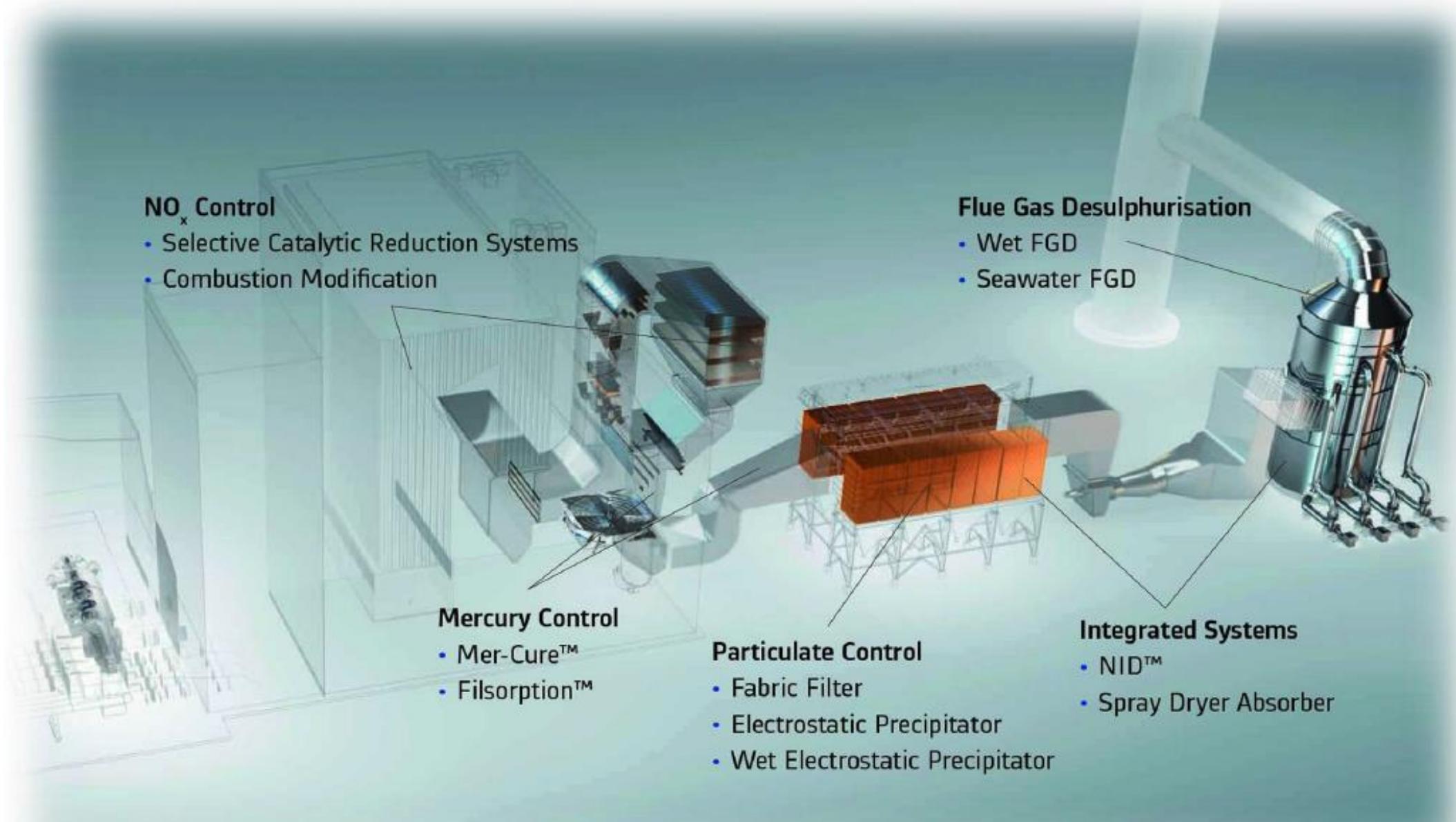
	Electrostatic precipitators	Wet electrostatic precipitators	Fabric filters	Semi-dry FGD *	Limestone-gypsum FGD *	Dual-loop-limestone-gypsum FGD *	Seawater-FGD *	CIRCUSORB®	SCR-catalyst	SNCR
Dust	X	X	X	X	(X)	(X)	(X)	X		
HCl			X ¹	X	X	X	X	X		
HF			X ¹	X	X	X	X	X		
SO ₂			X ¹	X	X	X	X	X		
SO ₃			X	X ¹	X	(X)	(X)	(X)	X	
Droplets, aerosols			X							
Mercury / Hg			X ²	X ²	(X)	(X)	(X)	X ²		
Other heavy metals	(X)	(X)	X	X	(X)	(X)	(X)	X		
NO _x								X	X	
Dioxins / furans and aromatic hydrocarbons			X ²	X ²			X ²	X		

(X) There is a moderate removal efficiency as a side effect | X¹ dosing alkaline absorbents | X² dosing carbon -based absorbents

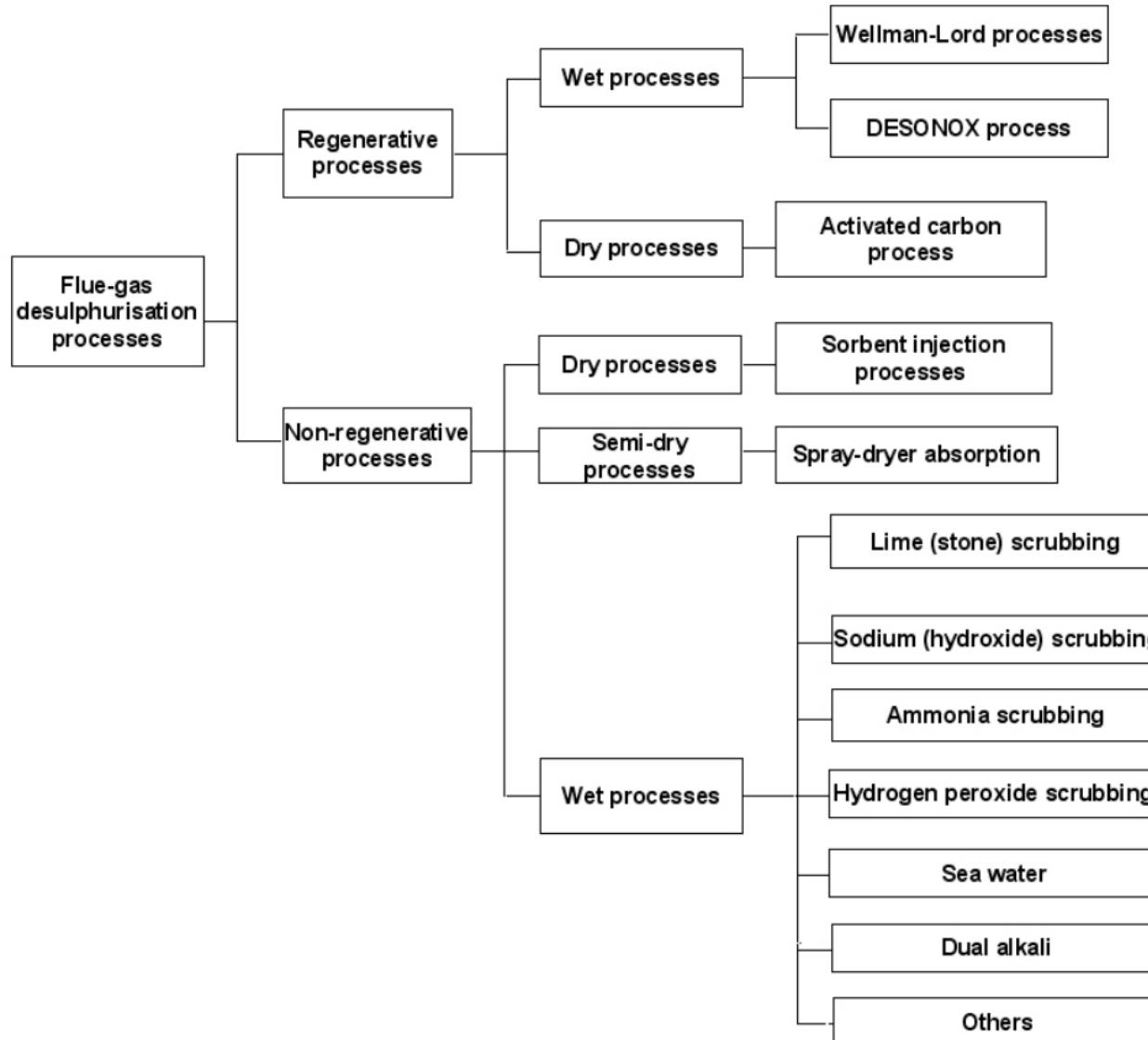
* FGD = flue gas desulphurisation system



PÜÜdelahendused

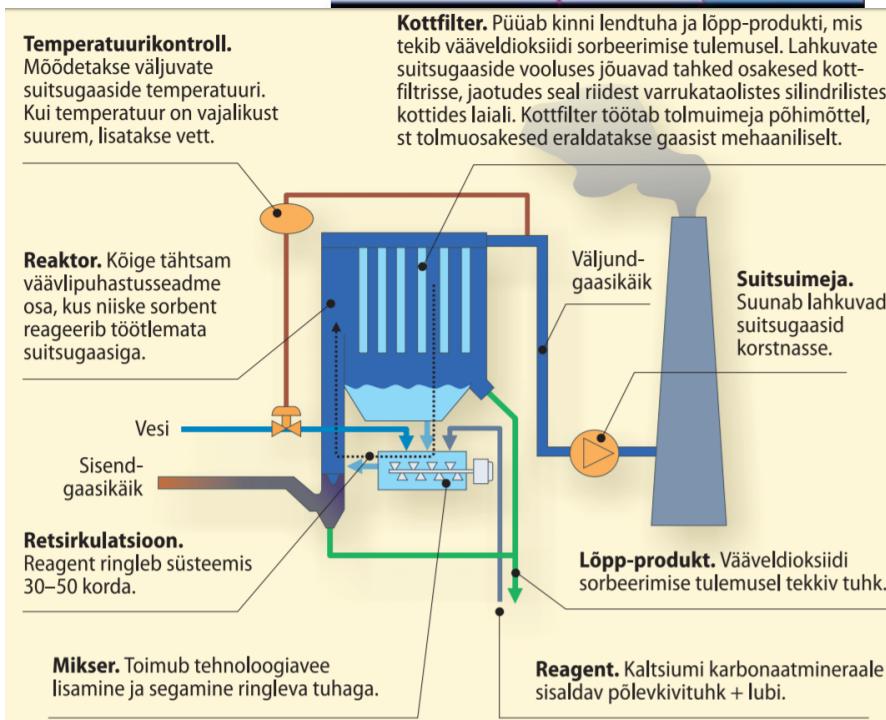
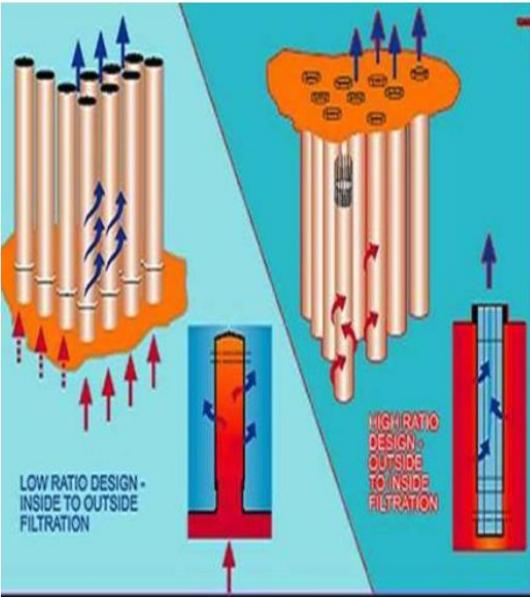


Püüdelahendused – SO₂



Poolkuival meetodil SO₂ püüdmine

1. Dust particles are captured on Filter media surface - inside for Low Ratio and outside for High Ratio
2. Accumulated dust layer on fabric surface assists in fine filtration
3. Dust removed from fabric surface by Reverse Gas flow or Compressed Air pulse
4. Discharge of the dust from FF Hoppers



Key Benefits of NID

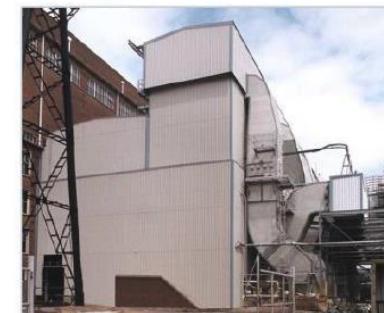
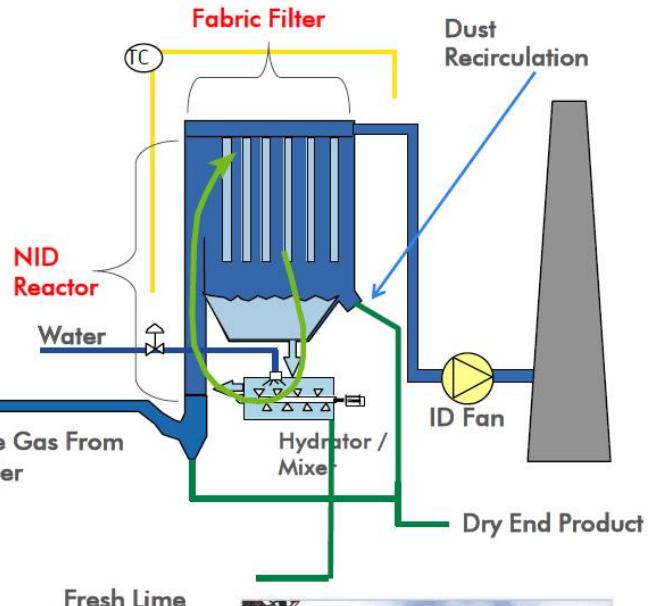
Multi-pollutant control: High efficiency removal of SO₂, SO₃, PM, HCl, HF and Hg

- SO₂ removal: ≤ 98%
- SO₃ emissions: < 1 ppm
- PM (filterable): < 15 mg / Nm³

Lime-based semi-dry FGD technology

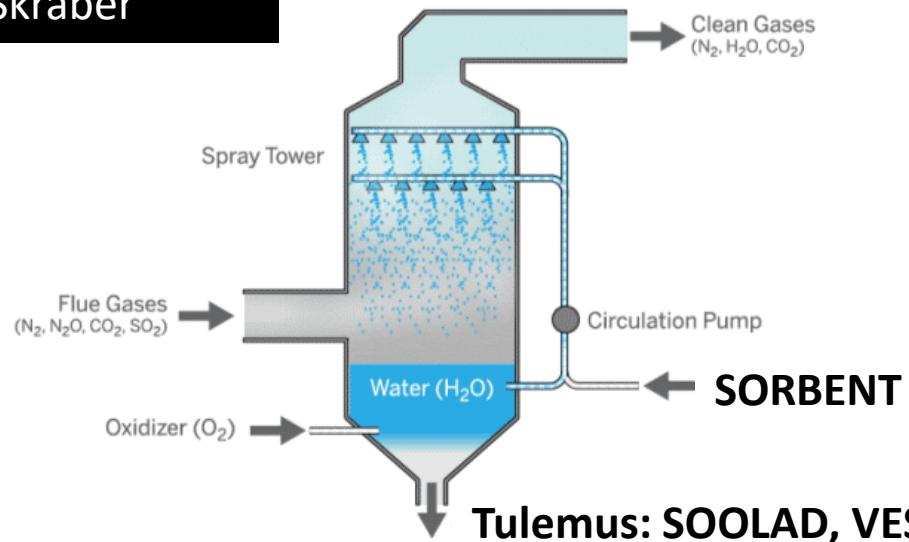
- Patented, integrated hydrator/mixer – no slurry handling
- Zero liquid discharge – no waste water/treatment
- Low water consumption; ability to use low quality water: CTB, WFGD purge

Fuel flexibility of up to 2.5% sulphur coal or higher

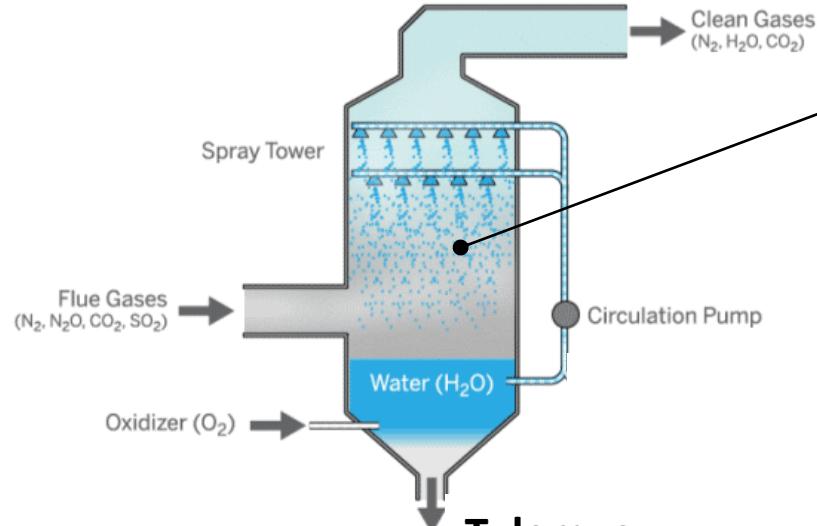


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Skraber



Suitsugaaside kondensaator



väävelhape



soolhape

+ SOOJUS

kuna kondensaati tuleb pidevalt juurde,
juhitakse osa sellest pidevalt eemale,
neutraliseeritakse selle happeline koostis
leeliste lisamisega kergelt aluseliseks (ph 7,5-8)
ning juhitakse seejärel drenaaži või kasutatakse
soojusvõrgu järeltoiteks.

Püüdelahendused - NOx

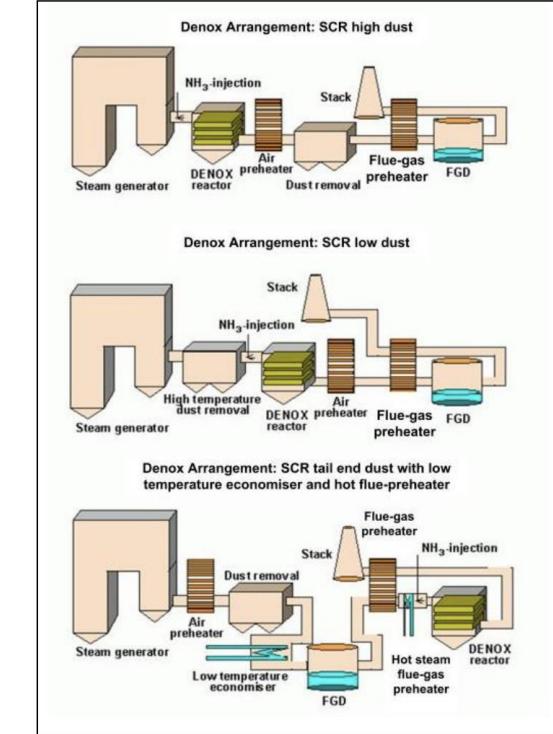
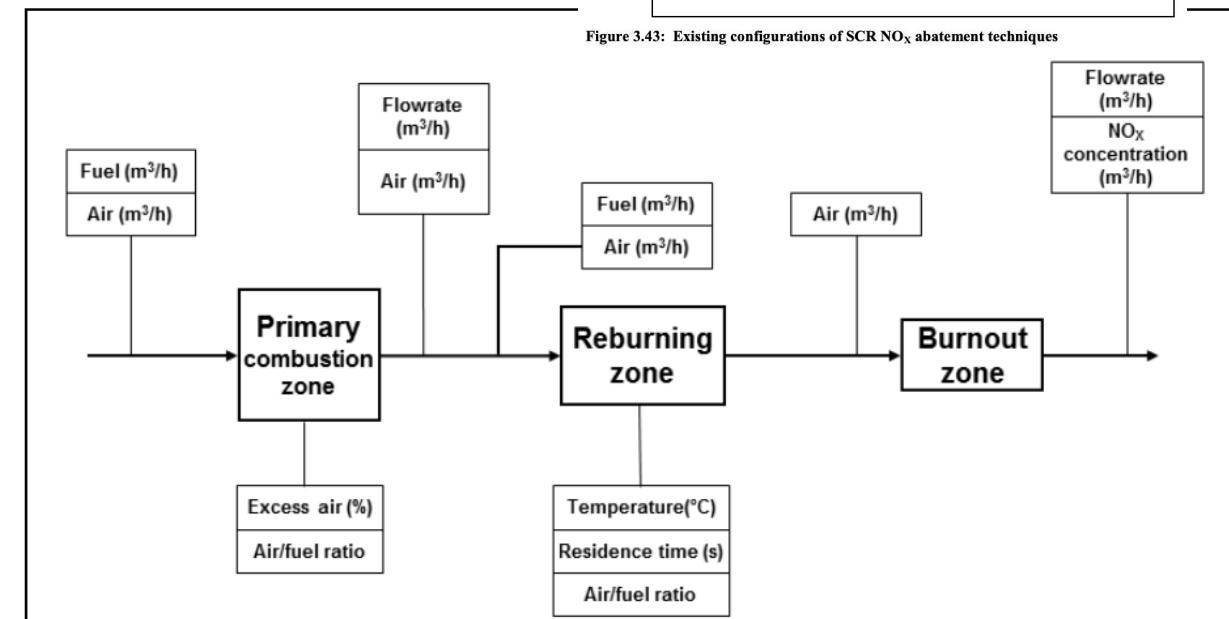
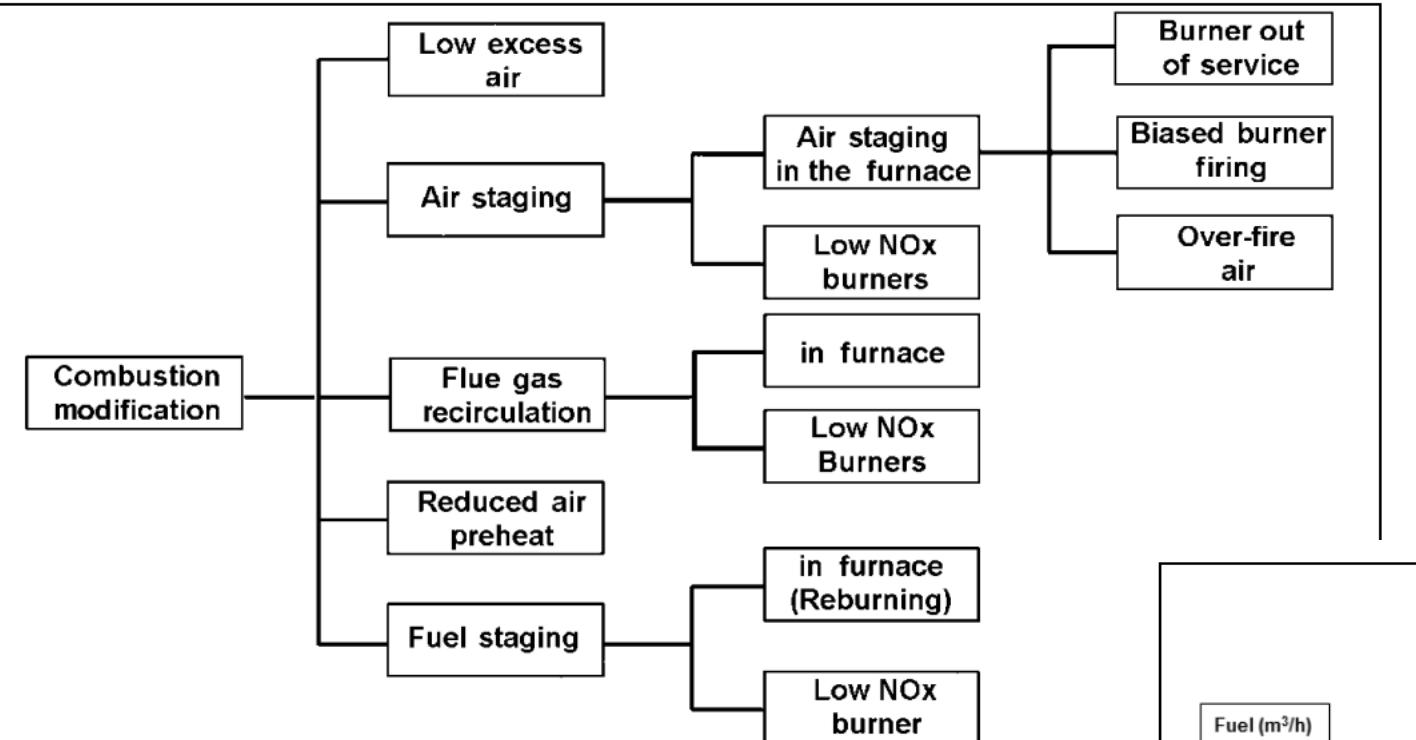
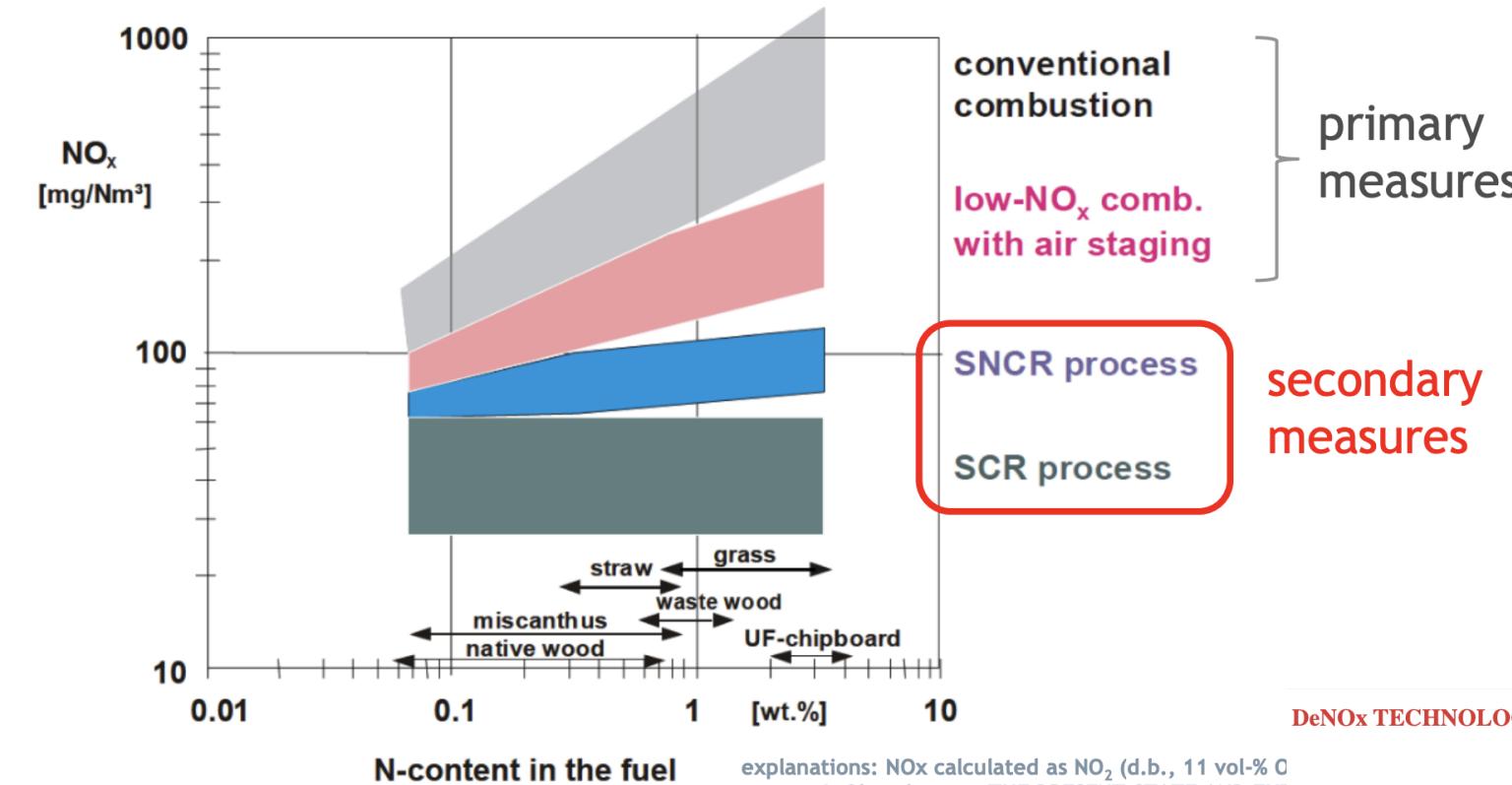


Figure 3.43: Existing configurations of SCR NO_x abatement techniques

FUEL NITROGEN - NOx IN THE FLUE GAS DENOX TECHNOLOGIES

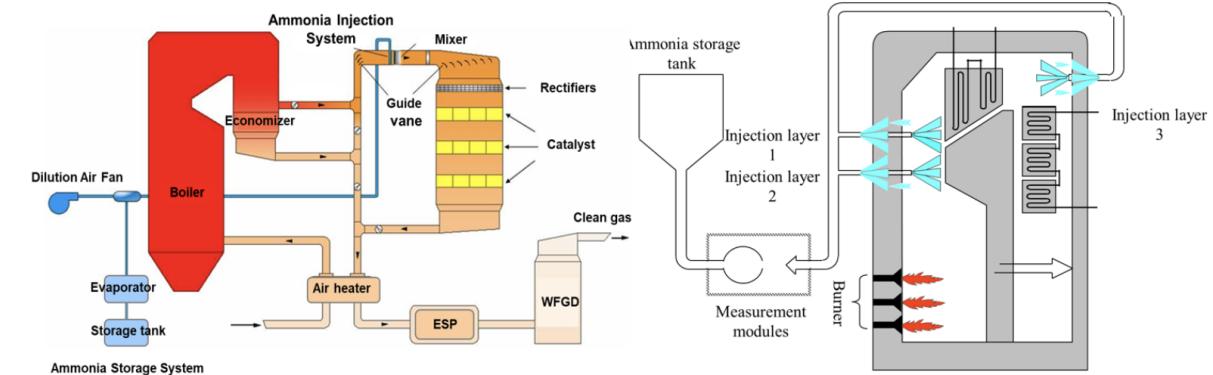


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<https://programme2014-20.interreg-central.eu/Content.Node/ENTRAIN/6-ENTRAIN-TT3-Basics-of-flue-gas-cleaning-AEE-Ramerstorfer.pdf>
<http://www.cnbmkvay.com/power-plants/>

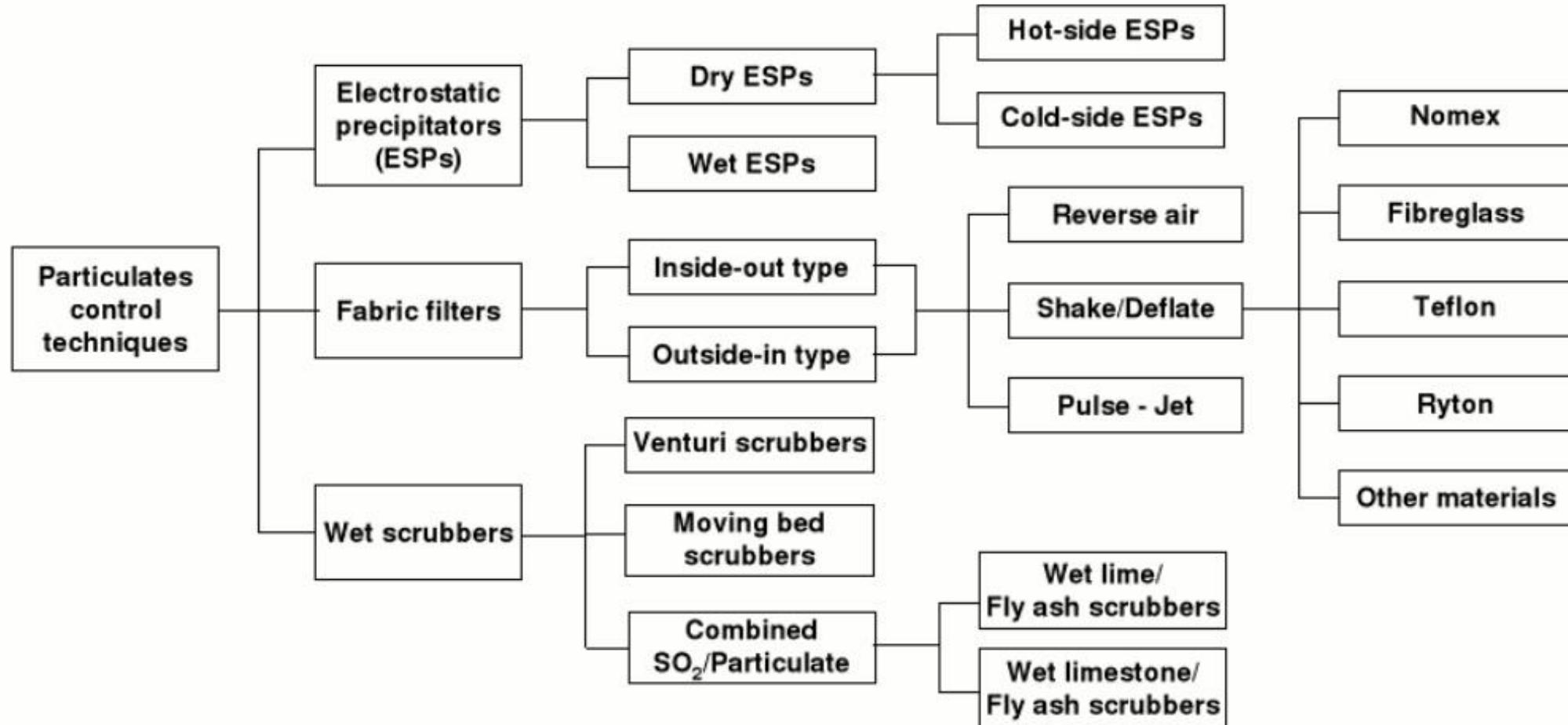
DeNOx TECHNOLOGY

SCR



SNCR

Püüdeseadmed – peenosakesed



PÜÜdeseadmed – peenosakesed

OVERVIEW DUST PRECIPITATION TECHNOLOGIES

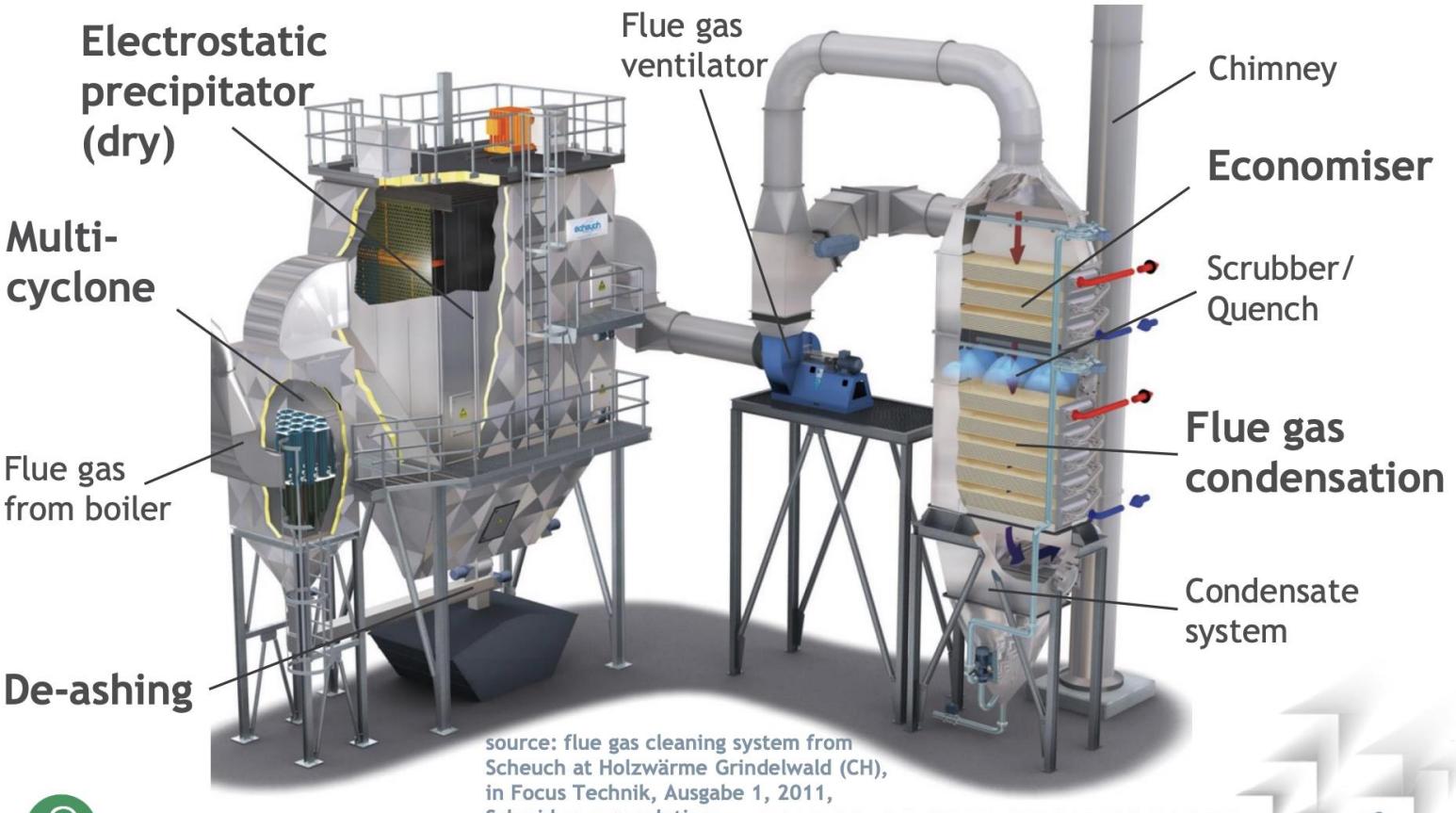


	Cyclones	ESP (dry)	Baghouse filter	Flue gas condensation
Particle size	> 5 µm	≥ 1 µm	all	≥ 1 µm
Dust content cleaned gas [mg/Nm ³ , 11% O ₂]	120 - 200	5 - 50	1 - 5	25 - 50
Operation temperature min (max) [°C]	(> 1000)	120 - 130 (300)	180 - 220 (280)	(40 - 60)
Pressure loss [mbar]	6 - 15	1.5 - 3	10 - 20	
Options	multi-cyclone	wet ESP	dry sorption (HCl, SOx, Hg, dioxins)	scrubber (quench)

Püüdeseadmed – peenosakesed

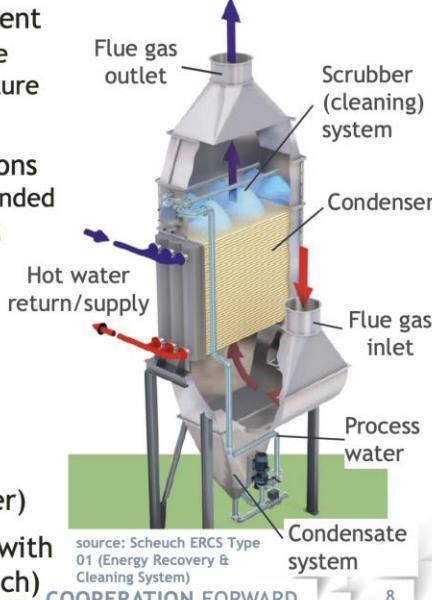
EXAMPLE FLUE GAS CLEANING SYSTEM WITH ESP AND FLUE GAS CONDENSATION

- Plant with 5 MW heat output (incl. condensation)



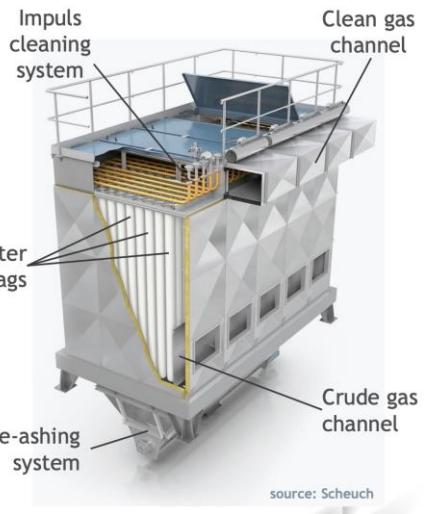
FLUE GAS CONDENSATION (SCRUBBERS)

- Primarily heat recovery (sensible and latent heat - feasibility mainly depends on moisture content of the fuel and return flow temperature from the district heating grid)
- Additional positive effect on dust emissions precipitation of fly ash upstream is recommended (dESP) in order to reduce problems regarding condenser corrosion and condensate composition
- Dust load gas outlet < 50 mg/Nm³ (without ESP upstream)
- Almost 100 % coarse fly ash removal (particle size > 1 µm)
- Stainless steel heat exchanger (condenser)
- Periodic cleaning of the heat exchanger with process water/option for scrubber (quench)



BAGHOUSE FILTER

- Fabric filter (adhesion separator)
- Almost 100 % dust removal efficiency (independent of particle size)
- Dust load cleaned gas < 5 mg/Nm³
- About 180 °C minimum operation temperature
- Dust removal from filter bags into de-ashing system by frequent back-pulsing with compressed air (impuls cleaning system)
- Beyond state of the art (applied for waste wood comb.)



Püüdeseadmete efektiivsusnäitajad

Pollutant	Alstom Process	References	Removal Performance
NO _x	Selective Catalytic Reduction	46GW	>95%
	Open Spray Tower	60GW	>99%
	Flowpac™ Absorber	1GW	>99%
SO _x	Dry Flue Gas Desulphurisation	30GW	>98%
	Seawater Desulphurisation	50GW	>98%
Particulates	Dry Electrostatic Precipitators	233GW	<10mg/Nm ³
	Wet Electrostatic Precipitators	2GW	<10mg/Nm ³
	Fabric Filters (standalone)	46GW	<5mg/Nm ³
SO _x /HCl/HF/Hg	NID & Spray Dryer Absorber	136 installations	≥98% for SO ₂
Mercury	Mer-Cure™/Filsorption™	8GW	>90%

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NO_x: Nitrogen Oxides SO_x: Sulphur Oxides HF: Hydrogen Fluoride HCl: Hydrogen Chloride Hg: Mercury

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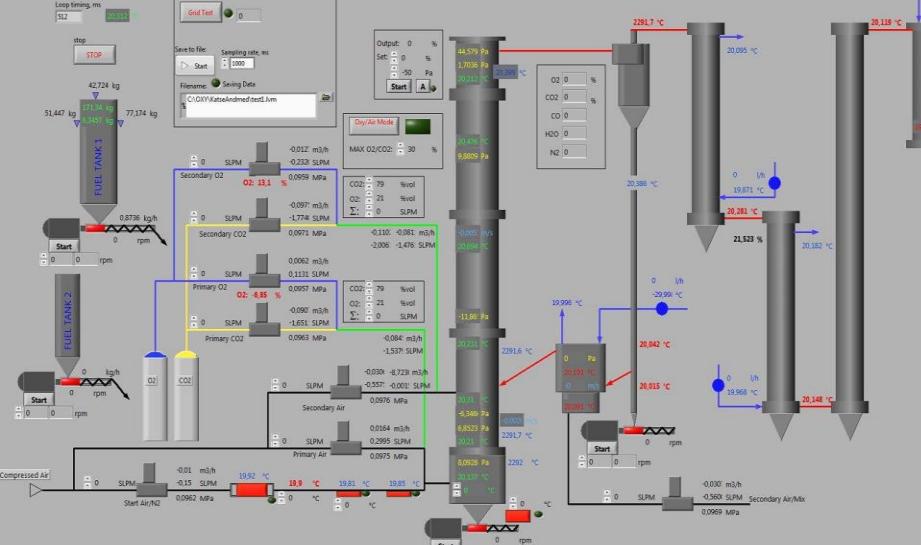
Particle Emission Reduction

Cost Analysis for Existing 1-20 MW_{fuel} Solid Biofuel Plants in Finland

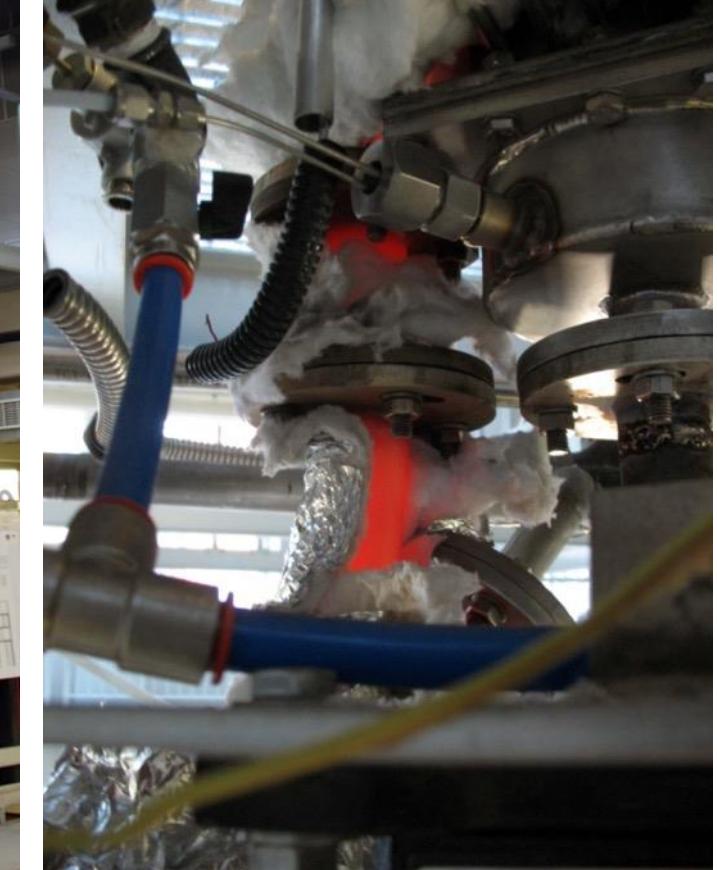
Technology	Achievable Emission Level
Multicyclone	Eelalandamiseks
ESP (two fields)	?
Fabric filter	Sobib!
Cyclone/Multicyclone + Scrubber	~45 mg/Nm ³
Multicyclone	~200 mg/Nm ³
ESP (two fields)	< 30 mg/Nm ³
Fabric filter	< 20 mg/Nm ³

Trace element	Conventional pollution abatement	
	ESP	Bag filter
Sb	96	97
As	98.5	98.5
Ba	99.5	98
Be	98.5	98.5
B	68	97
Cd	83	94
Cr	97.5	99.5
Co	98	99
Cu	89	99.5
Pb	98	98.5
Mn	97	99.5
Hg	30	60
Mo	96	100
Ni	96	99
Se	21	65
V	98	100

Source: [67, Nalbandian 2012]



CCUS - 60kW_{th} CFB Test Facility



Tänan tähelepanu
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