EGTEI – Expert Group on Techno Economic Issues

Results of EGTEI study on APATITY Power Plant

Nadine Allemand
Надин Альманд

EGTEI Technical Secretariat
(CITEPA)

30 November 2012

MURMANSK MEETING 2012

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Content of the presentation

- ✓ Characteristics of the power plant
- ✓ Available techniques to reduce emissions of SO2, NOx and TSP
- ✓ Costs assessement

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Apatity power plant

Apatity power plant: 10 boilers and 8 steam turbines for heat and electricity generation – 1700 hours/year full load

Boiler capacities : rated thermal input of 153 MWth

Total rated thermal input of the plant: **1 530 MWth**

Bituminous and sub bituminous coals used:

Type of fuels consumed	Low calorific value	Ash content in operating conditions	Fuel consumption 2010
	GJ/t	% w/w	kt
Intinskiy (Sub bituminous)	22.8	27.4	62.3
Vorkutinskiy (Sub bituminous)	22.6	21.4	167.4
Kuznetskiy (Bituminous)	17.8	16.8	171.3
Fuel oil	39.9		0.65

Sulphur content from 1.2 to 1.5 % w/w

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Apatity power plant

Apatity power plant: equipped with venturi scrubbers to limit TSP emissions

Total emissions	**2008**	**2010**
	kt	**kt**
Dust before venturi scrubber (anabated emissions)	91.3	84.6
Dust after venturi scrubber (abated emissions)	6.5	6.0
NOx	2.4	2.3
SO_2 (based on a sulphur content in coals of 1.5 %)	13.1	12.1

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Gothenburg Protocol Option considered for cost estimation of reduction techniques

	Anabated average concentrations observed			
	mg/m³ STP (Standard Temperature and Pressure) and 6 % O_2			
Dust	30 500			
NOx	815			
SO_2	4 370			

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Gothenburg Protocol ELVs considered for cost estimation of reduction techniques

	Average concentrations observed	Options for ELVs as suggested by EGTEI for Boilers > 500 MWth in technical Annexes IV, V and VII		
		Option 1	Option 2	Option 3
	mg/m³ STP and 6 % O_2			
Dust	30 500	10	20	50
NOx	815	100	200	200
SO_2	4 370	100	200	1 200

Abatement efficiency required for the Apatity plant:
TSP : 99.9 % ; NOx : 75.5 % and SO_2 : 95.4 %

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Available techniques

DeNOx:

Primary measures: not adapted for the reduction efficiency required

Selective Non Catalytic Reduction: not adapted for the reduction efficiency required

Selective Catalytic Reduction (SCR): adapted to the situation if installed in high dust configuration for temperature requirement

DeSOx (FGD: Flue Gas Desulphurisation):

Coals with very low sulphur content (less than 0.1 %) do not exist

LSFO: limestone with forced oxidation for gypsum production: largely used in the world.

LSNO: limestone with natural oxidation: not well suited

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Available techniques

Dedusting:

Both Electrostatic Precipitators (ESP) and Fabric Filters (FF) could be use.

Venturi scrubbers in place not sufficiently efficient

Selected techniques

Apatity plant:

A chain **SCR** (Selective Catalytic Reduction) to remove NOx, **ESP** (Electrostatic Precipitator) to remove dust and **wet FGD** (Flue Gas desulphurisation) by LSFO taken into account

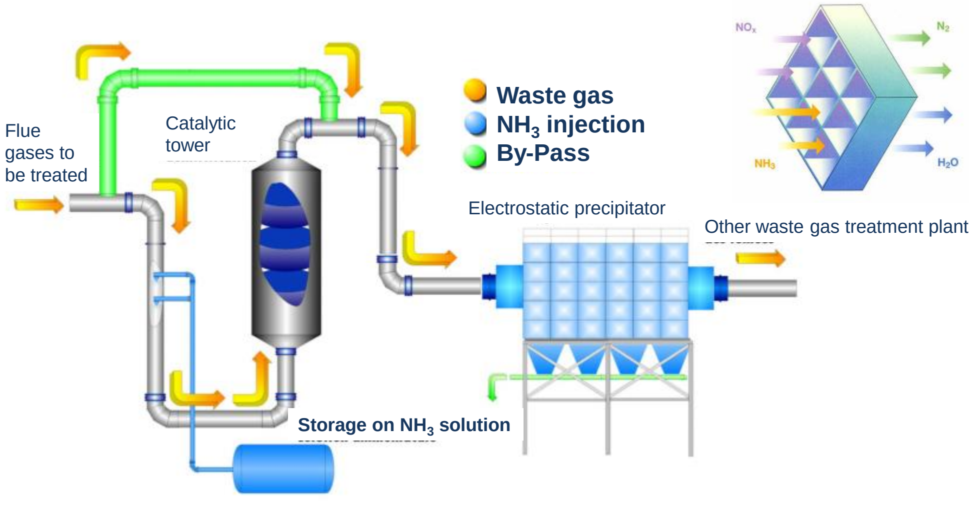
Due to too low outlet temperatures, venturi scrubbers (less than 70 °C) not kept in operation to avoid reheating of flue gases for the SCR

Cost assessment carried out for the following chain:

✓ Each boiler equipped with its own small SCR unit, followed by an ESP

✓ After the ESPs, waste gases collected and convoyed towards a unique FGD unit. FGD with forced oxidation. Gypsum recovered

Selective catalytic reduction (SCR)



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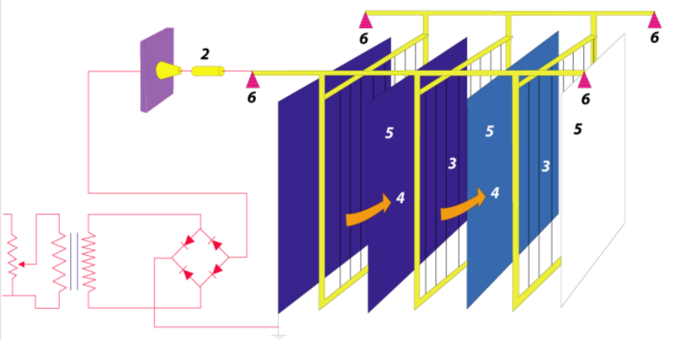
Electrostatic precipitator – ESP

Principle of an electrofilter



1. transformateur redresseur - 2. résistance d'amortissement - 3. électrodes émettrices - 4. sens de passage des gaz - 5. électrodes collectrices - 6. isolateur support

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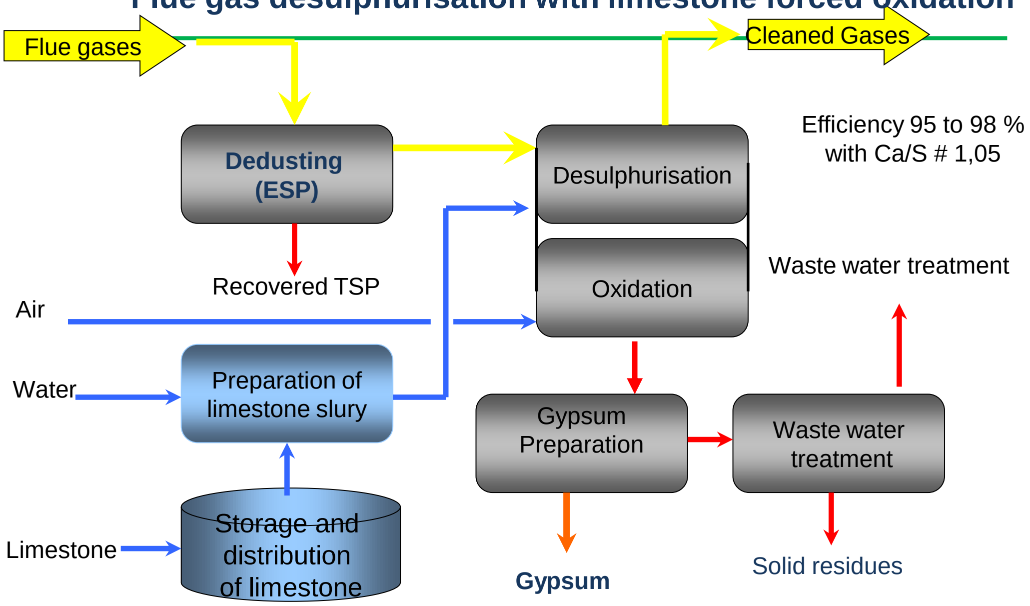
Flue gas desulphurisation with limestone forced oxidation



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Cost estimation

✓ **Investments (INV : k€ or M€):**

Amount paid for the reduction technique ready to be used – Retrofit factor for existing installations

✓ **Annualised capital costs (ACC : k€/y):**

Investments annualised taking into account the interest rate and the life time of the equipment

✓ **Fixed operating costs (OC$_{fix}$: k€/y):**

Costs of maintenance and repair, administrative overhead, etc.

✓ **Variable operating costs (OC$_{var}$: k€/y):**

Depending on the technique: costs of electricity, reagents ($CaCO_3$, NH_3), water, waste disposal...

✓ **Total annual costs: (C$_{tot}$: k€/y):**

$C_{tot} = ACC + OC_{fix} + Oc_{var}$

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Estimation of costs

✓ **Investments (INV : k€ or M€):**

Available EGTEI investment functions updated taking into account recent data on costs of the literature. Costs expressed in € of 2010

✓ **Annualised capital costs (ACC : k€/y):**

Investments annualised taking into account the interest rate of 4 % as in EGTEI

Life time of the equipment of 15 years

✓ **Fixed operating costs (OC$_{fix}$: k€/y):**

Costs estimated to 4 % of the investments

Estimation of costs

✓ **Variable operating costs (OC_{var} : k€/y):**

- labour demand,
- electricity consumption,
- water consumption,
- chemical consumption (reagent such as $CaCO_3$, NH_3…)
- byproduct cost (landfilled) / profit (when sold as gypsum…),
- …

Use of the cost functions developed by EGTEI with update for some criteria

Estimation of costs

✓**Prices used for definition of variable operating costs (country specific):**

The prices of utilities, wages, and reagents taken into account are as follows :
Electricity: 0.1 €/kWh
Wages: 6 k€/person/year
Waste disposal: 8.3 €/t
Limestone: 20 €/t $CaCO_3$.
NH_3: 400 €/t NH_3. Cost assumed to be similar to costs in the EU
SCR catalyst : 20 000 €/m^3

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Estimation of costs

	SO_2	NOx	TSP
Investments - M€ $_{2010}$	63.6	62.9	30.7
Operating costs - M€ $_{2010}$ / year	5.0	2.9	2.1
Total annual costs - M€ $_{2010}$/year	10.7	9.7	4.9
Initial annual average emissions tons/year	12 612	2 352	87 961
Emissions abated tons/year	12 034	1 764	87 903
Pollutants emitted after treatment tons/year	578	588	58
Cost € $_{2010}$/t pollutant abated	892	5 509	56

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Conclusions

- ✓ The EGTEI methodology for estimating costs in LCP successfully applied to estimate costs in a LCP in Russia
- ✓ Experience could be replicated with other sectors/plants
- ✓ Provide useful information for estimating the economical impact of a regulation
- ✓ Site specific engineering cost study would be necessary to define more accurately the costs. As example, complexity of the retrofit not known for the Apatity plant. Costs probably underestimated (place available, destruction of old equipment, control command...)

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Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique

Thank you for your attention
Спасибо

Nadine ALLEMAND
Deputy director
Nadine.allemand@citepa.org

30 November 2012