

CO₂ case: Calculation of energy savings in the Topsøe SNOXTM flue gas cleaning plants

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Background

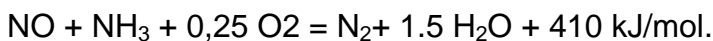
Accoat has for many years coated parts for the SNOXTM plants all over the world. These coatings withstand the high temperatures in the desulphurisation unit and make the process possible.

Accoat uses a substantial amount of energy to produce these coatings and it is the scope of this paper to compare the amount of energy used in the coating process to the possible savings in the SNOXTM units.

The SNOXTM process

SNOXTM stands for that Sulfur and NO_x gases, that effectively is removed from the flue gas.

In the removal of NO_x from the gases Ammonia NH₃ is mixed with the flue gas and the mixture led through a catalyst bed. The reaction is:



About 90% of the NO_x is removed in this process.

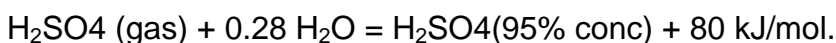
In the following SO₂ reactor the gas passes another catalyst bed, in which about 98% of the SO₂ in the gas is oxidized to SO₃:



The gas is led to the WSA condenser, a giant heat-exchanger 7 meter high, 1.5 meter wide and 2.5 meter long and equipped with 720 pcs. 7 meter long glastubes in which the gas is cooled to about 100°C. During the cooling in the tubes the SO₃ is first hydrated to concentrated sulphuric acid gas:



Later the sulphuric gas is cooled to under the de point and formation of 95% sulphuric acid is the result. This is collected in large fluoroplastic coated tanks until sold and shipped as pure concentrated sulphuric acid.



It can be calculated, that these 4 exothermic processes add so much energy to the processes, that about 0.8% of the total energy production of the SNOX™ plant.

Below is calculated the amount of energy and release of CO₂ for one unit.

Data for unit 2, the SNOX™ power plant at Nordjyllandsværket (NEFO)

For the NEFO plant in Northern Jutland (Nordjyllandsværket) in Denmark these savings are calculated using the following data from 2007:

Size of plant	225 MW electricity + 42 MJ/s heat for households.
42 MJ/s=	42x3600 = 151.200 MJ/h. 1 MJ = 0.27 kWh, so 151.200 x 0.27 = 40.824 kWh = 41 MW
Actual Production 2007 =	From (1): 269 + 41 = 310MW
Operation hours	4500
Coal consumption ton/h	105
Coal used for SNOX™ unit	4500 x 105 = 472.500 tons/year.
Total coal for both units	1.206.037 tons/year
Total emission CO ₂ for both units	2.759.949 t/year
CO ₂ emission for SNOX™	472.500/1.206.37 x 2.759.949 = 1.081.072 tons/year
Savings on SNOX™ unit	0.8% of 472.500 tons coal = 3780 t coal/year
Less CO ₂ on SNOX™ unit	0.8 % of 1.081.072 = 8649 ton CO ₂ /year
Coal savings per MW	3780/310 = 12.2 tons coal saved per MW
CO ₂ savings per MW	8649/310 = 15.0 tons CO ₂ not released in the air.

Accoat's emission of CO₂ producing the parts for the WSA unit

Normally the so called tubeplates in the WSA tower, one upper one and one lower one is coated with a fully fluorinated fluoroplastic coating of a minimum thickness of 550µ. In practice the film thickness is about 800µ. This coating protects the steel plate for corrosion from the corrosive sulphuric acid and from the high temperature of the flue gas.

In the coating process Accoat liberates CO₂ from the natural gas used for heating the plates up to about 400°C several times. For the calculations the following conversion factors are used:

For each 1000 kWh the power stations emits 494 kg CO₂ (NESA).
For each 1000 m³ natural gas is emitted 2253 kg CO₂(DGC).

Emission of CO₂ by coating of one tube plate with 8.5 m² fluoroplastic coating

Process	Electricity KWh	Natural gas m ³	Total amount CO ₂ in kg
Heat treatment		60	135
Sandblasting	165		82
Heating before priming		5	11
Heating when coating		120	270
Electricity to air pressure when spraying etc.	20		10
Total CO ₂ emitted			508

Normally 2 plates are coated per WSA unit, which makes the amount of CO₂ emitted per unit to 1016 kg or 1.016 tons. For the NEFO plant the emission will be about $72 \times 1.016 = 73,2$ tons of CO₂.

Conclusion

Calculations based on data from the Ohio demonstration plant and from NEFO, the first commercial plant SNOXTM plant has shown, that the exothermic reactions in the process saves a lot of energy, thus about 0.8% less coal is used and similarly 0.8% less CO₂ is emitted to the atmosphere.

Topsøe has installed about 70 WSA plants (some with NO_x cleaning also) all over the world and some larger than the NEFO unit. If it is assumed, that each plant contains 10 WSA units and that the coatings last for 10 ears (which is a low estimate). This amounts to totally 700 WSA units. NEFO has 72 units, which means that about 10 times the NEFO savings in coal and CO₂ emission is the result. As the plates last more than 10 years the savings amount to at least 100 time those at NEFO.

This means that 378.000 ton coal is saved from being used and the atmosphere is spared from 864.900 tons CO₂.

Compared to this Acccoat releases $700 \times 1.016 = 711$ ton of CO₂.

Acknowledgement

A thanks to Jens Hinke, R&D manager, SP Group, for calculating the savings of 0.8% using the SNOXTM process from the data in (3).

References

1. Green account for NEFO (Nordjyllandsværket) 2007
2. Optimization of power plants using WSA/SNOXTM technology, Peter Schoubye, Topsøe presentation, telephone: +45 4527 2468
3. SNOXTM flue gas cleaning demonstration project. Analysis of the 35 MW Ohio demonstration plant. U.S. Department of energy, June 2000.