

Cleaning of high SO₂ flue gases from boilers

Raffineria di Gela, Sicily, Italy

RESEARCH | TECHNOLOGY | CATALYSTS

1,200,000 Nm³/h SNOX™ plant

Background and considerations

The ENI owned refinery at Gela was started up in the 1960's. The steam and electricity used in the refinery was produced by burning of the petroleum coke produced in the refinery's delayed coker, containing 6–7% sulphur. In the 1980's it became clear that the SO₂ emission from the boilers had to be reduced. As the whole operation of the refinery was based on heavy crude, a change of crude or a change of boiler fuel were not relevant options.

A survey of available FGD technologies showed that only the Topsøe SNOX™ technology could offer an economically viable solution for cleaning of the flue gases which had a very high SO₂ content. Since no large-scale SNOX™ plant was in operation at the time, it was decided to construct a demonstration plant on scale 1:10. The demonstration plant was commissioned in 1991 and operated for a period, which made it clear that the technology was viable and could reach the targeted performance.

The decision to build a full scale SNOX™ plant followed in 1995. The SNOX™ plant was designed for treating the flue gases from three boilers. Later, a fourth boiler was connected to the SNOX™ plant, bringing the total flue gas flow rate up to more than 1,200,000 Nm³/h without significant changes in the SNOX™ plant. The total fired duty in the boilers equals approximately 900 MW.

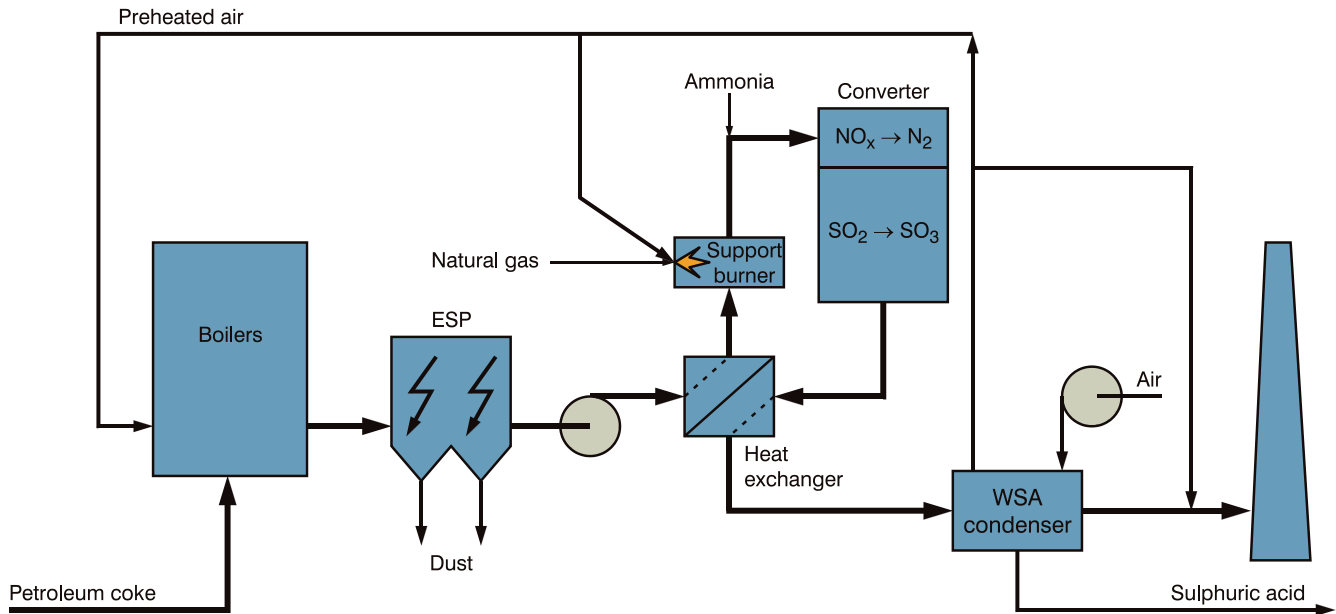
The Topsøe approach

The SNOX™ process is a catalytic process, which recovers sulphur from flue gases as concentrated sulphuric acid of commercial quality, reduces NO_x and removes all dust.

The process can be split up in six steps as follows:

- thorough de-dusting in electrostatic precipitators
- preheating of the flue gas in a rotating heat exchanger and in gas fired burners to about 400°C
- addition of ammonia for reaction with NO_x in a reactor with Topsøe DNX catalyst
- reaction of SO₂ with O₂ to SO₃ in a reactor with multiple parallel beds of Topsøe VK catalyst. Remaining dust in the gas is trapped in the catalyst.
- cooling in the rotating heat exchanger during which the SO₃ reacts with water vapour to form sulphuric acid vapour
- cooling of the flue gas to about 100°C and condensation of the sulphuric acid vapour in the WSA condenser. The cooling medium is atmospheric air. Most of the hot air is reused as preheated combustion air in the boilers thereby increasing their efficiency. The rest is added to the cleaned gas to increase the stack draft.





The Topsøe scope of supply for the Gela SNOX™ plant was know-how, basic engineering, catalysts, in-house developed proprietary equipment and materials as well as site supervision. The project was carried out in close collaboration between the client, the main contractor Snamprogetti S.p.A., Topsøe and local sub-contractors.

Summary

The SNOX™ plant has been in operation since September 1999. The client's requirements to emission limits have been met without problems throughout the operating period. The average reliability factor during the first ten calendar years of operation has been 99%.

Why choose SNOX™ for your flue gas cleaning?

- SNOX™ is the most economic technology for high SO₂ flue gases
- process accepts SO₃ in flue gas
- all dust in flue gas is removed
- no consumption of chemicals (except ammonia for the DeNO_x stage) and no production of waste materials
- no water consumption and no waste water
- the sulphur is recovered as concentrated sulphuric acid of commercial quality
- simple and flexible process with few moving parts

References

Currently, three SNOX™ plants are in operation for large flue gas applications. Fuels are coal, petroleum coke and heavy oil residue. Totally, more than 90 WSA plants (WSA is SNOX™ without the NO_x removal step) have been contracted for various applications.

Key data (test run)

Fuel used in boilers:	86-88% petroleum coke 12-14% other refinery fuel
Flue gas flow:	970,000 Nm ³ /h
SO ₂ concentration:	2900 vol.-ppm
NO _x concentration:	340 vol.-ppm
SO ₂ removal:	96.5%
NO _x removal:	90.5%
Dust emission:	not measurable
SO ₃ emission:	3 vol.-ppm
H ₂ SO ₄ production:	300 MTPD
H ₂ SO ₄ concentration:	95 wt.-%
Ammonia consumption:	240 kg/h
Natural gas consumption:	330 kg/h
Power consumption:	10.4 MWh/h