

Experience and Process Options with Topsøe's SCR DeNO_x Systems.

Søren S Enevoldsen
Environmental Technology Sales Manager,
Haldor Topsøe A/S
Nymøllevej 55
2800 Lyngby
Denmark
e-mail : sse@topsoe.dk
Phone : +45 45 272 000 (switchboard) or 45 272 045 (direct)
Fax : +45 45 272 999

Haldor Topsøe A/S is a private company founded in 1940 devoted to research and development in heterogeneous catalysis with the aim of serving the industry with catalysts, processes and specialised equipment based on in-house developments.

History

Haldor Topsøe A/S has been active in the SCR DeNO_x area since the early eighties, and the first demonstration units operating on coal fired boiler side stream were taken into operation in 1987. The experience and design of these units formed the basis for the design of large-scale plants where the first was taken into operation in 1990 on a 300 MWe coal fired boiler. Since then the company has supplied process know-how, equipment and catalysts for NO_x abatement in gas, oil and coal fired boilers, gas and diesel engines, gas turbines, incinerators and chemicals plants, totalling close to 100 installations, the largest being a 600 MWe coal fired boiler. Topsøe was the first company ever to design and install an SCR DeNO_x system on-board ships, and more than 10 of these installations are in operation today.

The Catalyst

A vital part in the SCR DeNO_x plant is the catalyst where Haldor Topsøe has pioneered the use of a fibre-reinforced corrugated catalyst which has shown remarkable performance characteristics. The shape combines the advantages of honeycomb-shape as to pitch and corresponding specific active area with the advantages of the plate-type as to dust tolerance. The catalyst is formulated on a ceramic fibre based TiO₂ carrier which is impregnated by vanadium and tungsten. These compounds are finely dispersed over the catalyst's surface. The special way of manufacturing the catalyst results in a very flexible, thermo-shock and erosion resistant catalyst with a high poisoning resistance resulting in low deactivation rates and high mechanical durability. In addition the catalyst has proven to have high DeNO_x activity and at the same time a negligible SO₂-oxidation. The low weight of the catalyst further yields a number of process options and eases the handling. The catalyst is manufactured with various pitches and compositions to cover the range from gas to high dust coal fired applications.

Ammonia Injection

Another vital part of the SCR DeNO_x system is the handling and injection of the reducing agent ammonia (anhydrous or aqueous) or urea. Topsøe has experience in applying static mixers for small- and large-scale plants as well as multiple nozzle systems for larger installations.

Reactor and Ducting Design (Vertical Flow)

The design of reactor, ducting, guide vanes and rectifiers is yet another key factor to good performance. Systems have been designed with various means of temperature control around the SCR DeNO_x reactor by use of economiser (low load) or reactor by-passes (start up). In several cases these have been omitted by use of special start up procedures and by dividing the economiser.

Case Story, Avedøre Power Station, Denmark

The 250 MWe coal fired boiler at Avedøre Power Station, Copenhagen, Denmark was retrofitted with a Topsøe SCR DeNO_x system in 1993. The design and supply of the SCR DeNO_x system was performed by Haldor Topsøe A/S. The system was tied-in in 5 weeks only.

Design

The system was designed for 80% NO_x removal from 400 ppm with an ammonia slip of less than 5 ppm and an SO₂ oxidation of less than 1%. Ammonia injection is carried out by multiple nozzles positioned across the inlet duct cross section. After the inlet duct the flue gas makes a 180° turn in a narrow area determined by the roof and walls of the existing building. At this point guide vanes are installed to ensure good flow and dust distribution. A rectifier grid is installed above the catalyst beds. Above each catalyst bed steam soot blowers are placed. There are 3 catalyst beds, out of which 2 were installed with catalyst initially. The catalyst beds are designed with bottom support gratings between the support beams which make the use and installation of rails and special designed catalyst loading wagons superfluous as the catalyst installation is carried out by use of a small forklift, thus improving safety during catalyst installation considerably. The catalyst is the Haldor Topsøe A/S corrugated type with a pitch of 7.4 mm. The system is designed without by-passes with the SCR DeNO_x unit placed down-stream the economiser whereby the temperature is high enough to operate the DeNO_x unit for loads above 70%. The reason being that the power plant is a base load unit operating an equivalent of 7900 full load hours per year.

Procedures

Preheating of the catalyst is done by preheating air in the economiser which passes through the boiler and catalyst. Steam soot blowing is carried out once per week.

Experience

Coal from North America, Australia, Poland, South Africa, Russia and Columbia has been used as fuel to the system. The sulphur of the coal has been 0.5-2.5% and the ash content has been 18-19% in average with a maximum of 25%. During the more than 35,000 hours of operation, the pressure drop has increased by less than 20% across the initial 2 layers of catalyst. Further DeNOx efficiencies between 80 and 92% with ammonia slips of less than 2 ppm (5 towards EOR) were achieved. No SO₂-oxidation has been detected which means that additional fouling by sulphates in the air preheater does not take place. The lifetime of the firstly installed two layers was extended from 16,000 hrs to 31,000 hours before the 3rd layer was added, partly due to the low deactivation of the catalyst, partly due to the installation of low NOx burners. The design of the catalyst beds has made installation of the catalyst fast and easy and installation of the spare layer could take place in just 2 days. The plant operation has demonstrated reliability, flexibility and easy operation of the system with an availability of more than 99.9%.

New Process Options

The weight of Haldor Topsøe's SCR DeNOX catalyst has made it possible to design a light weight compact system for in-duct installations which can be applied for both SCR DeNOx applications and for SNCR/hybrid solutions. The patented concept includes a frame on which the catalyst cassettes are mounted.

Conclusion

Topsøe offers optimised SCR DeNOx solutions for new and retrofit installations based on proprietary technology. The systems designed till this moment have all proven high reliability and easy, troublefree operation.