Steag's Long-term Catalyst Operating Experience and Cost

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Summary

Steag currently operates 24 SCR systems of these16 are bituminous coal-fired and 8 are refinery residue fired SCR systems. Numerous bituminous coal-fired units also use up to 10% supplemental fuels such as bone meal, sewage sludge, etc. Over its 18 years of experience, Steag has used various SCR arrangements including high dust (17 of the 24), low dust (1 of the 24), and tail-end (6 of the 24) systems. Most of these SCR systems have now been in continuous operation in excess of 100,000 operating hours. The SCR systems have used plate as well as honeycomb catalyst from various manufactures in a number of different configurations and mixes. Steag uses throughout is fleet of SCRs new catalyst from various suppliers as well as rejuvenated or regenerated catalyst treated by different reconditioning processes including Steag's own catalyst regeneration process.

Herne Cogeneration Plant Unit 3 is a 300 MW U-fired wet bottom boiler that burns pulverized coal. The tail-end SCR system was commissioned in 1989 and was designed for four layers of catalyst. It was initially filed with 1.5 layers of honeycomb catalyst and there are still 2.5 spare layers which are not likely to ever be filled due to the fact that no significant catalyst deactivation has been observed. Operation during the past 116,000 hours has been extremely uneventful and we do not expect to add any new catalyst before 2008. Due to the efficiency of the SCR and the fuel burned, we expect the catalyst replace cost to be less than 0.8% per 1,000 hours.

Herne Cogeneration Plant Unit 4 produces 385 MW of electricity and 550 MW of district heating. This pulverized coal unit burns waste bituminous coal as well as bone meal in its opposed wall-fired dry bottom boiler. The unit uses a high dust SCR system that was commissioned in 1988. It was designed as a four layer reactor and originally filled with two layers of honeycomb catalyst. However, the honeycomb catalyst encountered severe erosion problems due to the use of very high ash waste coal, and in 1991, all remaining honeycomb catalyst was replaced with plate catalyst. Instead of using two full layers of plate catalyst, four half layers were installed in order to better rotate the catalyst as it deactivated. Over the past 110,000 hours of operation, various deactivated half layers have been removed and replaced with new or regenerated catalyst. The removed catalyst was regenerated and reinstalled at a later date. The total catalyst replacement cost is estimated to be 337% or 3.06% of initial cost per 1,000 operating hours of SCR operation with the following cost breakdown:

- For catalyst replacement 9 (4 initial and 5 replacement) new half layers (= 225% of initial cost) plus 1 regenerated replacement layer (= 12% of initial cost).
- For field labor cost for the installation of 6 half layers and the removal of 5 half layers was found to be 11 x 10% of initial catalyst cost = 110%.

Voerde Power Station's Unit 4 is a 760 MW unit that burns pulverized world market bituminous coal. This high dust SCR was commissioned in 1989; designed as two four layer reactors, three layers were initially filled with honeycomb catalyst with one spare layer left empty. In 1996 Voerde experienced significant large particle ash (LPA) or popcorn ash pluggage problems. Steag developed a patented LPA screen design which prevented the LPA from reaching the SCR catalyst and since the installation of the screens Voerde has not experienced any further problems with the accumulation of LPA or popcorn ash. Steag now operates Voerde 4 with both new and regenerated honeycomb catalyst. Some of the regenerated catalyst used at Voerde 4 is from deactivated catalyst removed from the Herne 4 plant. This is typical for Steag as all catalyst, which is removed from a unit is regenerated and held in storage until needed at any of the Steag plants, unless the removed catalyst is mechanically and structurally destroyed or too eroded.

It should be noted that two catalyst exchanges were caused by LPA pluggage and not by normal catalyst deactivation. The total catalyst exchange cost during the last 107,000 SCR operating hours was found to be approximately 293% or 2.74% of initial cost per 1,000 operating hours with the following cost breakdown:

- For catalyst replacement 5 (3 initial, 2 half plate and 1 honeycomb replacement) new layers (= 167% of initial cost) plus 4 regenerated replacement layers (= 66% of initial cost).
- Field labor cost for the removal and installation of 6 layers was found to be 6 x 10% of initial catalyst cost = 60%.

Steag views and treats catalyst as a commodity; however, Steag also understands that not all catalyst types are suitable for all applications and each type of catalyst has its distinct advantages and disadvantages. The selection of the best catalyst type for a particular application and whether to use full or half layers requires an individual economic evaluation on a case by case basis. Steag's use of new versus regenerated catalyst depends solely on market conditions and prices. The price of regenerated catalyst can vary between 25% and 65% of new catalyst, depending on the price of the new catalyst and the type of regeneration process used and required. Steag has found no difference in longevity or deactivation rate between regenerated and new catalyst.