Recent Technology for IHI Denitrification (SCR) System

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1. Introduction

IHI has been conducting development of denitrification systems for stationary generators such as thermal power plants since the end of the 1960s. The world's first large-capacity SCR plant using a honeycomb catalyst for dirty exhaust gas from an oil fired utility boiler was delivered at the end of the 1970s by IHI, and up to now for a variety of exhaust gases, which are generated from gas turbines, diesel engines, and incinerators as well as boilers. The recent IHI technology is described for SCR systems including a newly-developed catalyst, and maintenance technology for SCR plants in operation.

2. Trends in gas-firing catalyst development

2.1 Small cell-pitch catalyst

Because denitrification reactions proceed near catalyst surfaces, reduction in the cell pitch of honeycomb catalysts enables an increase in contacted area to exhaust gas, leading to more efficient denitrification. Since clean gases like those in gas-firing do not contain dust and clogging and abrasion for catalysts need not be considered, a small cell pitch can be used with catalysts; therefore, the required amount of catalysts can be reduced. Though a reduction in cell pitches tends to increase the pressure loss, the loss can be reduced by means of a reduction in the catalyst amount (a reduction in catalyst lengths) due to high performance and catalyst wall thickness. In the beginning of catalyst development a 7.5-mm pitch (20 cells) form was adopted. With the development of recent catalyst manufacturing technology, high-performance honeycomb catalysts with a small cell pitch in 3 mm pitch level have been produced with a 30 to 50% reduction in the catalyst amount for the same denitrification performance as conventional catalysts.

2.2 The broadening of the applicable exhaust gas temperature

Because the optimal temperature range for denitrification catalyst performance is from 300 to 400°C, various catalysts for boilers have been developed for this range. Denitrification performance lowers as a gas treatment temperature deviates from the most appropriate active temperature range. In high temperature ranges in particular, catalyst lives decrease markedly due to hastening of catalyst sintering from heat. Recently, however, a high-temperature catalyst for denitrification equipment set at the gas turbine exit with a gas temperature above 500°C is available along with a low-temperature catalyst used in denitrification equipment for waste incinerators with an exhaust gas temperature near 200°C (when denitrification equipment is placed at a bag filter exit).

3 Trends in oil and coal-firing catalyst development

3.1 Small cell-pitch catalysts

The applicability of high-performance catalysts with reduced cell pitches in dirty gases such as those in oil or coal-firing has been confirmed by checking clogging and abrasion of catalysts by dust in exhaust gases during long exposure at actual plants. At this time, 6-mm pitch catalysts are commercially available as a result of ensuring proper gas flow and of several measures to prevent ash accumulation in coal-firing.

3.2 Low SO_3 conversion ratio catalysts

A recent trend is to produce high-efficiency denitrification equipment and the SO_3 conversion ratio tends to increase due to an increase in the amount of the catalyst. Therefore, low SO_3 conversion-ratio catalysts have been used in order to reduce the negative effects downstream in denitrification equipment.

4. The Maintenance technology for Denitrification Equipment

4.1 Performance recovery by catalyst replacement

A given denitrification performance can be maintained by increasing the ammonia injection amount (mole ratio) for the decline in denitrification performance in an actual plant. Because the amount of residual ammonia increases and reaches a control value when catalyst performance declines, the performance of denitrification equipment must be restored by a catalyst replacement or addition at the time. For IHI’s delivered long-term operation plants, long-term, stable plant operations have been accomplished by restoring denitrification performance through catalyst replacement or addition.

4.2 Performance recovery by catalyst regeneration

Regeneration by washing denitrification catalysts has received attention as a means of restoring the performance of denitrification equipment after long-term operation. For the establishment of this technology, an optimal washing method should be determined after ascertaining catalyst degradation conditions due to differences in operational situations (kinds of fuel, gas temperatures, etc.) by plant using long-term operational data as well as the resolution of the degradation and regeneration mechanisms of catalyst performance. It is also important to have used catalyst samples to carry out actual tests of catalyst washing. The technology is coming close to its practical phase.

Conditions for a decline in catalyst performance (denitrification performance) vary for the operational conditions (kinds of fuel, denitrification equipment operating temperatures, etc.) of plants. Decline of denitrification performance due to thermal degradation cannot be recovered by washing catalysts, so catalyst washing has little effect for gas-firing catalysts and oil and coal-firing catalysts with a large degree of thermal degradation after long-term use. In oil-firing catalysts, chemical degradation by catalyst harm of alkaline components (Na, K) in fuels is a main cause of a decline in denitrification performance. Consequently, a decline in performance except for thermal degradation can be recovered if alkalis adhering to catalysts are removed by washing.

In addition, high-sulfur oil-firing catalysts increase SO_3 conversion ratios due to the effect of V, which may cause problems for down-stream equipment. In such a case, although the SO_3 conversion ratio can be reduced by washing to remove the V that has adhered to catalysts, the effect of V removal on denitrification performance must be considered because V is also a factor in promoting denitrification performance. Even for coal-firing catalysts, a decline in denitrification performance due to coating components can be recovered by the removal of coating components from catalyst surfaces.

5. Conclusion

IHI has summarized the latest technology and maintenance technology for exhaust gas denitrification equipment including denitrification catalysts. An increase in demand in developing countries as well is expected with the requirement for environmental conservation on a global scale for problems such as global warming and acid rain. IHI, a top manufacturer of boiler plants that include denitrification equipment, will continue to develop new forms of technology in order to supply the world with optimal exhaust-gas denitrification equipment for various exhaust gas sources.