Effect of Optimal Urea Injection Rate on NO_X Conversion in a Steam Boiler with Zeolite-SCR Catalyst by Numerical Simulation

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The selective catalytic reduction (SCR) is well known as an effective and proven aftertreatment technology to reduce NO_X emissions in combustion devices. The aim of this study is to investigate the effect of urea injection rate on NO_X conversion in a LPG steam boiler with zeolite-SCR catalyst by using three dimensional modeling. When the optimal urea amount determined in experiment for the respective boiler load is injected, the NO_X conversion and NH_3 slip in a three dimensional modeling of zeolite-SCR catalyst by the SIMPLE algorithm are calculated and compared with the experimental results.

Fig. 1 shows the geometry of analytical domain for the model and mesh generation of urea-SCR system. Fig. 2 shows that the highest value of NO_X emissions before urea injection is at the boiler load of 80% while the lowest one is at the boiler load of 40%. In this case, 235 mg/min of urea is injected at the boiler load of 80% and the NO_X emissions are decreased from 71 ppm to 11.6 ppm. On the other hand, only small amount of NH_3 does not react with NO_X emissions, as the result, the NH_3 slip at the boiler load of 80% is below 7 ppm. As it is shown in Fig. 2, the NO_X emissions at the boiler load of 100% before urea injection is higher than one at the boiler load of 40%. However, the urea injection rate at the boiler load of 40% is higher than that of 100%. This is because the reaction temperature of zeolite-SCR catalyst at the boiler load of 40% is lower than that of 100%. The similar phenomenon also occurred at the boiler load of 60%. The lowest NO_X conversion rate is 76.2% at boiler load of 60% because the activation efficiency in the urea-SCR reactor is the worst among four conditions of boiler load. The final concentrations of NO_X emissions for the respective boiler load are less than 15 ppm and, on the other hand, the NH_3 slips at lower boiler loads are more than those of higher loads due to the low reaction temperature.

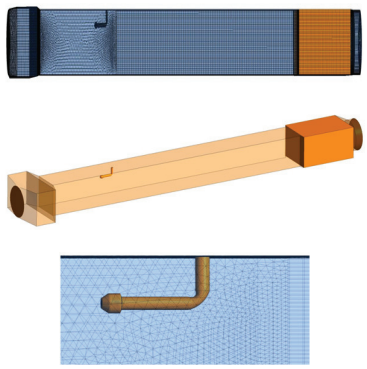

Fig. 1 Geometry and mesh generation of urea-SCR system

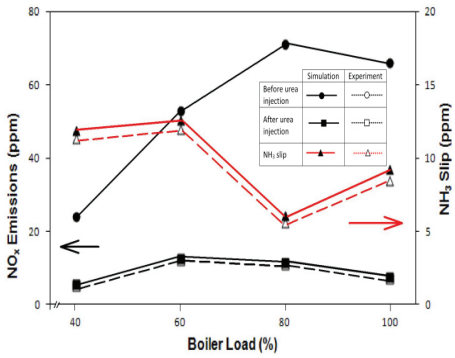

Fig. 2 Comparisons of NH_3 slip and NO_X emissions before and after urea injection relative to boiler load by the optimal urea injection rate between experiment and simulation

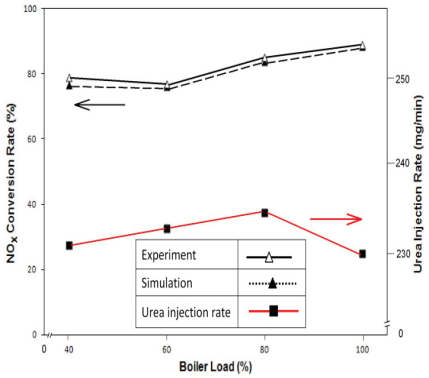

Fig. 3 Comparison of NO_X conversion with the optimal urea injection rate relative to boiler load between experiment and simulation

References

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