Injection of Urea through the Rotamix System to Obtain Improved NOx Reduction

Mobotec USA, Inc.

John Ralston, Presenter and Author
Mobotec USA, P.O. Box 3442, Kingsport, TN 37664, Tel: 423-288-6504, Fax: 423-288-8952, jralston@mobotecusa.com

Edwin Haddad, Co-Author
Mobotec USA, 8 McCarthy Circle, Framingham, MA 01702, Tel: 508-872-1610, Fax: 508-879-4216, ehaddad@mobotecusa.com

Summary

ROFA and ROTAMIX systems have been successfully installed in seventeen boilers in Sweden and five boilers in the USA. Mobotec USA is currently installing ROFA and ROTAMIX systems on fourteen additional boilers in the USA, eight of which will be started up in 2003. These boilers range in size from 44 MW to 570 MW and are t-fired, wall-fired, or opposed-fired. ROFA and ROTAMIX systems work with the majority of fuel types and firing conventions.

ROFA reduces NOx by improving the combustion in the boiler. The gas volume in the furnace is set in rotation via special asymmetrically placed air nozzles. The flue gases mix well with the added redirected air, creating increased turbulent mixing and rotation in the entire furnace. Turbulence improves temperature and species distributions and improves particle burnout in the upper furnace. Improved combustion and increased turbulence results in:

- Increased particle residence time
- More uniform temperature distribution
- Improved mixing of the fuel and oxygen
- Reduced CO and NOx
- Decrease in needed excess air

ROTAMIX is a second-generation SNCR and sorbent injection system. Depending on the design, sorbent, ammonia, or urea may be utilized in a Mobotec ROTAMIX System. ROFA prepares the way for the effective mixing of chemicals in the furnace. The result of rotating intermixing is that a more homogenous furnace temperature is obtained. The reducing chemicals can then be injected into the furnace, utilizing the ROFA air as a carrier, into areas where the temperature is most favourable for NOx reduction. The result is considerably reduced chemical consumption and lower chemical slippage. When coupled with ROFA and ROTAMIX, the efficiency of furnace sorbent injection improves.

Of the seventeen installations in Sweden ten of them included ROTAMIX. Of these ten units urea was injected to reduce NOx in two of them and ammonia was injected to reduce NOx in the remaining eight. The NOx reductions obtained ranged from 65 to 80% for the combination of ROFA and ROTAMIX. Very little difference was noticed between the NOx reductions obtained by

injecting ammonia compared to injecting urea. In the USA three of the five installations included ROTAMIX. In all of these installations we injected ammonia to reduce NOx. In all of these installations the NOx reductions ranged from 63 to 73%.

One thing we do during the design stage of a ROFA/ROTAMIX installation is model the temperature distribution in the boiler. It is important to locate the best level in the boiler to inject ammonia since there is a temperature window in which ammonia will be effective. As an added insurance measure, we take physical temperature measurements. However, after several ROTAMIX installations injecting ammonia, we started to suspect that the temperatures in the boilers were higher than what the CFD model showed and what we had physically measured.

It was at this point we decided to inject urea in the three units already in operation to determine what results could be obtained. It is known that urea has a higher temperature window to react with the NOx than ammonia. If the temperatures in the boilers were higher than measured, the urea should be more effective in reducing NOx.

On an experimental basis a 20% solution of urea was injected in all three of the ROTAMIX installations in operation in the USA. In the first unit the NOx level went from 0.17 lbs/MMBTU using ammonia to 0.10 lbs using urea for a total reduction of 84%. In the second unit the NOx level went from 0.18 lbs using ammonia to 0.13 lbs using urea for a total reduction of 79%. In the third unit the NOx level went from 0.23 lbs using ammonia to 0.15 lbs using urea for a total reduction of 77%. In all cases these numbers were obtained a full load. At less than full load much lower NOx levels were achieved. These results confirmed our suspicion that the temperatures in the boilers were much higher than measured.

We are currently in the process of evaluating urea injection in two additional ROTAMIX installations. At one of these installations where we knew the boiler was extremely hot, we obtained almost no NOx reduction when ammonia was injected; however, when urea was injected at 90% load, a NOx level of 0.15 was achieved for a total reduction of 74%. More work needs to be done at this installation to find the correct injection point to achieve the lowest NOx level.

We now believe we can achieve NOx levels of 0.15 lbs and lower using urea injection through the ROTAMIX system on a commercial utility boilers burning pulverized coal at about one-third the cost of a SCR.