Large Particle Ash (LPA) Screen Retrofits at Coal-fired Units in Indiana and Ohio

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Summary

The presence of LPA or popcorn ash poses a serious concern for many coal-fired utility boiler operators after retrofitting their units with high-dust SCR systems. LPA is formed in the boiler and can be easily carried over into the SCR reactor. As LPA is introduced to the SCR reactor it frequently causes:

- Catalyst pluggage, which leads to
  - Flue gas maldistribution
  - Loss of SCR performance through loss of available DeNOx potential
  - Unacceptable NH_3 slip
  - Excessive pressure drop
- Catalyst erosion damage

Many unsuccessful attempts were made in the industry experimenting with various types of LPA screens, i.e. hard framed, flat screens (straight or angled), and flexible curtain type screens (straight). None of them appear to perform satisfactorily in the long term.

However, a universally proven LPA screen design was developed in 1996 after LPA problems at both 760 MW units at Steag's Voerde Power Station in Germany plugged up the installed honeycomb catalyst and caused severe erosion damage. In an attempt to solve this problem, extensive CFD and physical modeling was performed to address the root cause of the LPA formation and carry over to the SCR reactor. The modeling activities addressed specific issues such as geometric scale and the relationship between the model and full-scale installation including pressure drop. As a result of the

modeling, modifications and/or additions to areas such as the boiler's economizer hopper, economizer outlet and the downstream ductwork were made to allow for continuous and reliable removal of the LPA and safe operation of the SCR system. Unfortunately, none of these efforts resulted in a reliable long-term solution. Flat screens either plugged up, eroded away very quickly or both.

After several failed attempts, an LPA screen design was developed, which reliably and continuously prevented the intrusion of LPA into the SCR reactor by effectively removing the LPA from the flue gas stream without the LPA screens plugging up or being eroded way. Typically, such LPA screens are installed at the boiler's economizer outlet utilizing the economizer hopper for the continuous extraction of the removed LPA. The special design features of these patented LPA screens are:

- A pleated design, which ensures a most advantageous angle of attack of the LPA onto the screen and a low flue gas flow velocity through the LPA screens resulting in a low pressure drop.

- A hinged design (typically at the top of the economizer outlet duct), which allows for the LPA screens to be rapped frequently in order to remove LPA that gets caught in the screens.

- A modular design, which allows for the use of numerous different types of screen materials depending on the flue gas velocity. Screen materials typically used include:
    - Uncoated or coated stainless steel wire mesh
    - Uncoated or coated stainless steel perforated plates
    - Uncoated or coated stainless steel wedge wire

Coating materials used include various commercially available types of metallic coatings such as flame spray and tungsten carbide coatings. The selection of the correct screen design and material must be made depending on the particular application and the actual flue gas velocity through the LPA screens.

Since installing the STEAG designed LPA screens in 1996, the Voerde Power Station has not had any problems with LPA intrusion into their SCR systems. Subsequently, numerous other coal-fired units equipped with SCR systems in Europe, as well as the United States, were supplied with STEAG LPA screens.

In spring 2005 prior to the 2005 ozone season, two bituminous coal-fired units, one in northern Indiana and Unit 3 of Dayton Power & Light's J. M. Stuart Generation Station in southern Ohio, were successfully equipped with this patented LPA screen design.

In the unit in Northern Indiana, uncoated stainless steel wire mesh screen inlays were used, since the average flue gas velocity in the economizer outlet duct was found to be no more than about 60 ft/sec. The unit has been in operation since May 2005 without any problems. During a recent inspection, no signs of erosion or screen damage could be detected. Thus, the same material was used for 2 coal-fired units in western Pennsylvania, which also have less than 60 ft/sec flue gas velocity and for which Steag's patented LPA screens were supplied in April 2006.

DP&L's Stuart Unit 3 has an average flue gas velocity in the economizer outlet duct of around 75 ft/sec. Therefore, wire mesh screen inlays with a highly erosion resistant metal spray coating were employed.

The LPA screens in DP&L's Stuart Unit 3 have also been in operation since May 2005 and have not experienced any significant pluggage or operational problems.

Even though this hinged and pleated LPA screen design is mostly self-cleaning, fully automated electric drive rapper systems were installed on these base loaded units, which ensure that no LPA remains on the LPA screens during operation.

Based on the successful operating experience of DP&L's Stuart Unit 3, DP&L decided to also equip Unit 1 with the same LPA screen design. However, rather than employing coated wire mesh as a screen inlay material, DP&L opted for uncoated stainless steel wedge wire. This material is much more erosion resistant than coated wire mesh but significantly less expensive. Tungsten carbide coated wedge wire screen inlays were also installed in some selected areas of particularly high flow velocities known to have caused erosion damage.

The same material was also used for the LPA screen inlays at a coal-fired power plant in northern Alabama. As in DP&L's Stuart Unit 3, tungsten carbide wedge wire was used in some selected areas while uncoated stainless steel wedge wire was used in most areas. In all three cases – Stuart 1 and 3 as well as the plant in Northern Alabama – the uncoated and/or coated wedge wire screen inlays will go into operation beginning with the 2006 ozone season.