Optimized Wet FGD Performance

by

Amy Evans, Director of Technology

Limestone based wet FGD (WFGD) technology has been the FGD technology most frequently selected for sulfur dioxide (SO_2) reduction from coal-fired utility boilers. Common FGD absorber designs include open-type spray towers and perforated-tray type towers. In the past, towers with wetted-film contactors (e.g., packing) were also common. Over the last several years advancements in the design of the limestone based WFGD have included:

- Operation at high flue gas velocities to improve mass transfer and reduce absorber capital investment costs.
- Reliability improvements enabling single module design (i.e., no standby spare(s)).
- Use of high capacity absorber recirculation (AR) pumps to reduce the number of spray levels and associated absorber tower materials.

The open spray tower absorber benefits the user with fewer internal components and much lower system pressure drop, as compared with the tray type absorber which carries with it more internal components and an inherently higher pressure drop.

One of the primary design criteria for achieving the desired level of SO_2 reduction is the liquid-to-gas (L/G) ratio or the quantity of liquid sprayed relative to the volume of flue gas. Increasing the L/G ratio improves SO_2 removal by exposing the gas to more absorbing liquor. Typically, however, this benefit comes at the expense of higher power consumption. A simple method of improving the gas/liquid contact and reducing the L/G requirements for an open spray tower is by the installation of Absorber Liquid Re-Distribution Devices (ALRD), either up-front in the OEM design or as a retrofitted upgrade to an existing system. The ALRD technology was developed and patented by General Electric Environmental Services, Inc. (GEESI, now Marsulex Environmental Technologies, or MET) in the 1990's and is reflected in MET's current OEM designs.

The ALRDs effectively offset the phenomena known as "sneakage" which represents the quantity of the flue gas that passes through the absorber partially untreated. Sneakage primarily occurs near the absorber wall due to the physical limitations in the arrangement of the spray headers and nozzles. This results in relatively low slurry liquor concentrations at the circumference of the absorber. In addition to the spray density mal-distribution, a flowing film of water/slurry running down the wall is created when the spray from the spray nozzles impacts the wall and cascades down the wall surface. The mass transfer efficiency at this gas liquid interface is very poor, thus the flowing film becomes a much less effective liquid contacting device. The effective surface area for gas-liquid contact is reduced by this phenomenon. The ALRDs offset sneakage without the imposition of excessive pressure drop (equating to additional energy consumption in terms of booster fans) that may be associated with a perforated tray approach.

Impact of Wall Sneakage

The impact of sneakage was quantified by measuring the SO_2 concentration directly above the upper spray header as a function of distance from the absorber wall for several operating units.

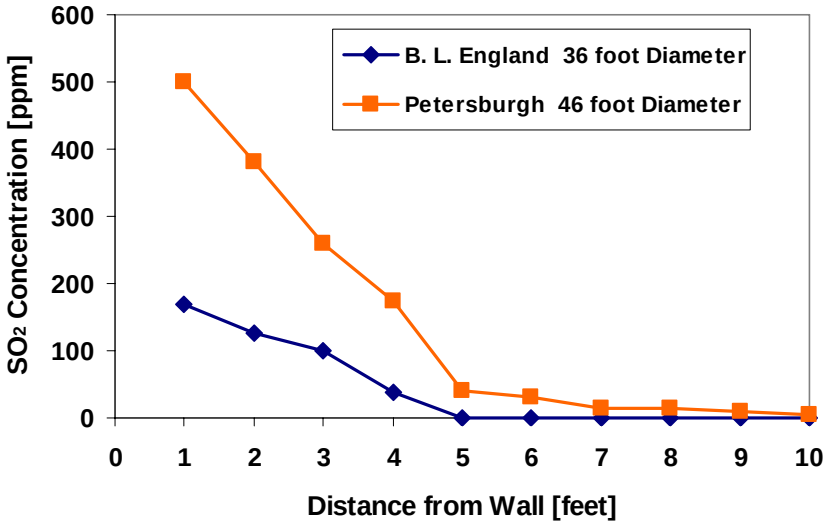

Figure 1 Impact of Wall Sneakage

The results of the field measurements summarized in Figure 1 illustrate that:

- The SO_2 concentration is the highest at or close to the wall.
- The SO_2 concentration decreases rapidly as the distance from the wall increases.
- Approximately 4 feet from the wall, the measured SO_2 concentration is at or less than the average SO_2 concentration in the stack.
- About 10 feet from the wall, the measured SO_2 concentration approaches zero (0) ppm.

The results described above clearly show that SO_2 penetration along the wall is significantly higher than away from the wall and a significant portion of the open tower cross section area operates at reduced SO_2 absorption performance. Therefore, re-directing the flow of the absorbent slurry away from the wall surface substantially improves the SO_2 capture efficiency.

ALRD Design

As a result of these findings, a concept was developed effectively re-introducing the liquid film back into the flue gas stream, maximizing the gas-liquid contact and improving the effective surface area for gas liquid contact and overall SO_2 reduction capability of the absorber. US Patent 6,550,751 B1 was assigned to Marsulex for the ALRDS which are located between the absorber spray levels as shown in Figure 2.

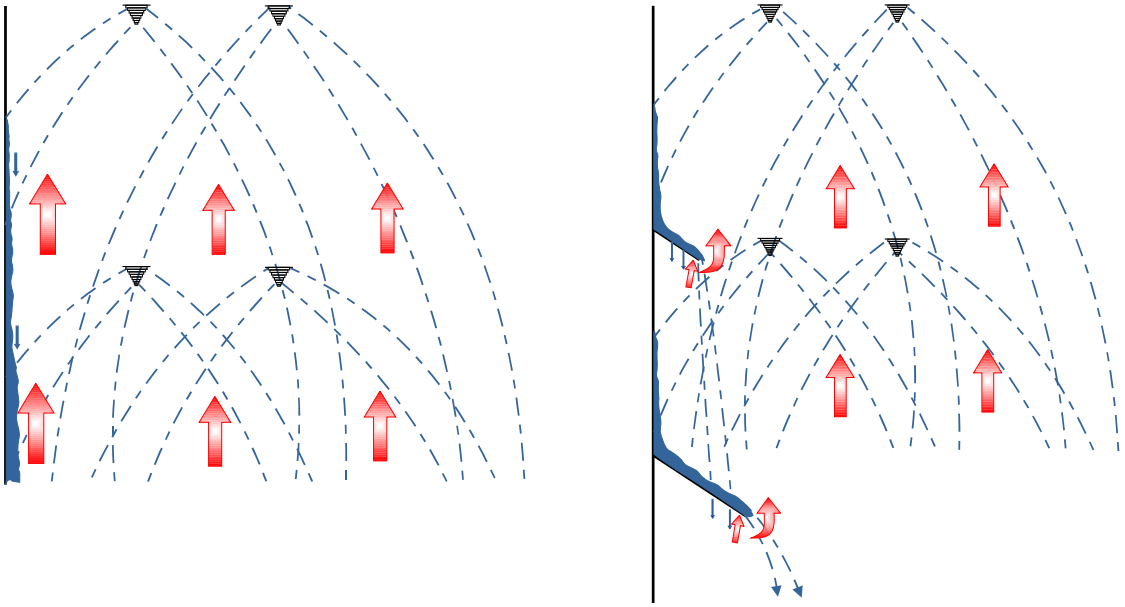

Figure 2 ALRD Improvement in Gas-Liquid Contact near Absorber Wall

The ALRD is a device designed to block an annular area of the absorber total cross-sectional area near the absorber wall and redirect the falling liquid film from the absorber wall back into the gas stream. This slight decrease in the cross-sectional area of the tower has a *minimal* effect on the flue gas pressure loss in the tower, but a major effect on gas-liquid contact.

ALRD Results

The improvement in the absorber performance due to the ALRDs is a function of the tower diameter and the number of ALRDs installed. The benefits of upgrading an existing system with the ALRDs include:

- Typically enables the removal of one AR pump from service while maintaining SO_2 removal efficiency
- Allows an increased level of SO_2 removal at no increase in power consumption
- Facilitates the burning of higher sulfur coals while maintaining SO_2 emission compliance

For an existing 40 foot diameter absorber, Figure 3 shows that the SO_2 removal efficiency can be increased from approximately 94% to 98% while maintaining three AR pumps in service. As an alternative, the ALRDs can improve the SO_2 removal efficiency relative to the baseline (95% versus 94%) when one of the three AR pumps/spray levels is taken out of service. The effective decrease in L/G will reduce the flue gas pressure drop across the absorber tower thereby reducing fan requirements as well as reducing the power required to operate the system AR pumps.

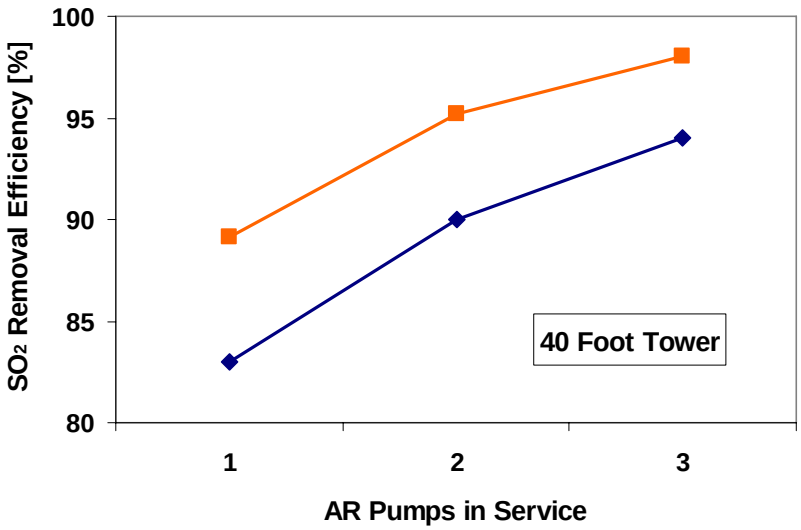

Figure 3 ALRD Impact on SO_2 Removal Efficiency

For new absorber tower designs, the ALRD enhancement allows for a decrease in the number of spray levels in service for a given sulfur loading when compared to a design without the ALRD. This translates to a savings in both power consumption and materials through the decrease in the overall tower height, elimination of a spray level and the associated AR pump.

Conclusions

The ALRD technology serves to provide a remedy for the past gas sneakage effects in an open WFGD spray tower, thus allowing the user to derive the full operational and maintenance benefits of an open spray tower while benefiting from optimized SO_2 capture in an energy-efficient way. This technology is available either up-front, incorporated in a new OEM design, or as a retrofitted backfit to existing FGDs of most any type.

For further information, please contact David Murphy, Chief Technology Principal of Marsulex Environmental Technologies, at dmurphy@marsulex.com or by telephone at 330-668-6205 or Amy Evans at aevans@marsulex.com or 717-274-7129.