Analysis of July 31, 2006 Report Prepared by Alvaro A. Linero, P.E. Titled "Trip Report on SCR Experiences at Solnhofer Portland Zementwerke, Cementeria di Monselice, and ASM Brescia Waste-to-Energy Plant"

Introduction

Schreiber Yonley & Associates (SYA) has reviewed the report titled "Trip Report on SCR Experiences at Solnhofer Portland Zementwerke, Cementeria di Monselice, and ASM Brescia Waste-to-Energy Plant" by Alvaro A. Linero (Linero Report), and has prepared the following comments. In general, the facts regarding SCR contained in the Linero Report are not significantly different than those reported by SYA in the report titled "The Experience of SCR at Solnhofen and its Applicability to US Cement Plants" (SYA Report). The differences in the reports primarily relate to the different conclusions that were drawn from these facts.

Comparison of Facts

Points of Agreement

- Both the Linero Report and the SYA Report state that the SCR system at the Solnhofen plant is not currently in operation and has not been operated since early 2006.

- The reports agree that the SCR catalyst needs replacement and that a cost comparison of SCR to SNCR is being conducted by the facility prior to making the capital investment in new catalyst.

- The reports also agree that the Solnhofen facility is currently utilizing SNCR for NOx control and that the NOx emission limit of 500 mg/Nm3 is being met.

- Both reports agree that the SNCR system utilizes more ammonia than SCR.

- The Linero Report indicates that the ammonia slip during operation of the SCR system is 1 mg/Nm3. The SYA Report stated that the ammonia slip during SCR operation was below 5 mg/Nm3.

- Both reports stated that the SCR system at Solnhofen was designed for 6 catalyst beds, and that only three catalyst beds were installed during its operation. Both also cite Solnhofen Plant management as stating that the

honeycomb catalyst that was installed in the SCR has about 40,000 hours of operation and needs replacement.

Points of Disagreement

- The Linero Report indicates that the SNCR system that is currently in operation at Solnhofen was recently installed at the request of the Bavarian government. The SYA report stated that the facility was permitted to install an SNCR system in 1995 and that the SNCR system has been utilized for a number of years as a backup to the SCR system when that system needed to be taken offline for cleaning.

- The Linero Report states that Solnhofen replaced one layer of the honeycomb catalyst with a plate catalyst after the honeycomb catalyst had been in use for 40,000 hours, but that it did not perform as well as the honeycomb catalyst. The Linero Report also states that the facility's catalyst supplier moved to China and that the facility is negotiating with catalyst suppliers to provide new satisfactory catalyst elements. The SYA Report agrees that the facility is trying to find a catalyst supplier to manufacture a plate catalyst with a specific formulation. When SYA visited the facility, SYA did not receive any information regarding the recent usage of a plate catalyst in the facility's full scale SCR system. SYA did report that Solnhofen plant management indicated that plate catalyst had been tried in the pilot test unit and that it eroded quickly from the dust in the gas stream and from the cleaning of the catalyst beds.

- The Linero Report states that the ammonia slip was "off-scale" in excess of 20 mg/Nm3 during SNCR operation. While the SYA Report did not specifically include a number for the ammonia slip, observations by SYA during its site visit in May 2006 were of ammonia slip below 5 mg/Nm3 while the SNCR system was in operation.

- The SYA Report stated that there are no regulatory limits on plume opacity in Germany. The Linero Report states that the parties present during Mr. Linero's visit were "amused at the notion that there is little concern about opacity given the prominent setting of the plant over the valley." Mr. Linero goes on to state that "they do not expect significant plumes and the direct control of the contributing pollutants and CEMS requirements promote low opacity." SYA agrees that the Solnhofen plant is unlikely to have plume problems. However, SYA believes that this is the result of the low alkali, chlorine and sulfur in the raw materials and fuels at the facility. Detached plumes generally result from reactions between ammonia and either chlorine or sulfates in the kiln gases to form ammonium chloride or ammonium sulfate salts in the atmosphere. However, whether or not there is a likelihood of an opacity problem at the plant, Solnhofen is not subject to a regulatory opacity standard and thus

does not face fines and other sanctions if a specific opacity limit is exceeded.

- The Linero Report includes information about reductions in the cost for compressed air resulting from optimization of the cleaning system. This is not addressed by the SYA Report nor was this discussed during the SYA visit to the Solnhofen plant.

Comparison of Conclusions

While the SYA Report did not discuss it, SYA agrees with the conclusion reached in the Linero Report that the Solnhofen SNCR system has not been optimized. According to the Linero Report, the Solnhofen SNCR system is achieving a 50 percent reduction in NOx, but has high ammonia slip and high ammonia usage. In contrast, Holcim's Midlothian SNCR systems are achieving NOx reductions of 40 to 50 percent at a molar ratio of 0.7, and negligible ammonia slip. Note that SYA did not observe a high ammonia slip during its visit to the Solnhofen plant in May 2006.

SYA disagrees with statements in the Linero Report that SCR is beneficial and perhaps preferable when there is high sulfur in raw materials. SYA is not aware of any evidence that supports this conclusion. In fact, there have been several reported instances where high sulfur in the inlet gas to SCR systems at utility boilers resulted, even with scrubbers in place, in damage from sulfuric acid mist in the stack gas. Special catalysts have been developed to reduce SO2 oxidation to SO3 in order to prevent the potential damage from acid mist.

SYA disagrees with the conclusion reached in the Linero Report that with only one more layer of catalyst in the SCR, Solnhofen will reduce NOx emissions to 200 mg/Nm3. SYA has seen no specific test data to support this conclusion. SYA agrees that theoretically, additional catalyst can lead to increased efficiency. However, additional catalyst will only improve efficiency if the stack gas can reach the additional catalyst. Plugging and fouling of the initial catalyst layer (a likely result on the Ellis County preheater/precalciner kilns) can prevent access to additional layers of catalyst. Actual testing would be required before reaching a conclusion that one additional catalyst bed would result in any specific NOx emission rate. During SYA's visit to Solnhofen, Mr. Sauter was asked if he could achieve and sustain an emission rate of 200 mg/Nm3 with the addition of catalyst layers. He stated at that time, as contained in the SYA Report, that he did not believe that 200 mg/Nm3 was achievable on a regular basis.

The Linero Report concludes that if SNCR ammonia usage were controlled through process optimization, SNCR would prove to be more cost effective than SCR. SYA did not speculate on this in its report, but agrees conceptually given the current catalyst setup.

The Linero Report also states that German cost studies indicate that SNCR is more economical at emission limits of 500 mg/Nm3, but that SCR is more economical at emissions limits of 200 mg/Nm3. This is speculative for a number of reasons. First, it is unclear what economic assumptions were used in such studies or whether there are operational data to support the conclusions. Solnhofen, the only cement kiln using SCR with any significant operating experience, has not operated the full scale system at 200 mg/Nm3 according to Mr. Sauter. Therefore, the Solnhofen experience cannot support the position. Furthermore, Solnhofen is currently studying and comparing the costs of SCR versus SNCR. If the "German cost studies" were definitive, as the Linero Report suggests, there would be no need for Solnhofen's efforts. Finally, regardless of any cost studies related to Solnhofen, the Solnhofen SCR operates on a different kiln type than found in Ellis County, and does not have high sulfur or alkali in raw materials or as high a dust loading to the SCR system. Costs estimates and comparisons developed for kilns in Germany are not transferable to kilns in Ellis County.

Based on these same German cost studies, the Linero Report concludes that SCR would be cost effective by US standards. As already stated, the German costs do not take into consideration the differences in kiln design and raw materials found in many US kilns. These differences may require the installation of sulfur scrubbers. They could also lead to the need for new ID fans due to the pressure drop across the SCR system and/or the total pressure drop across the SCR and scrubber. Moreover, the installation of additional catalyst layers in an effort to achieve lower levels of NOx emissions will increase the pressure drop across the SCR, and could result in the need for new ID fans. The German cost studies do not include this possibility. The German cost studies do not evaluate SCR systems for long wet or long dry kilns. Such systems would involve the significant costs and environmental impacts associated with reheating the exhaust gas prior to its entry into the SCR unit. Cost comparisons between SNCR and SCR must be site specific.

Finally, the Linero Report discusses the possibility of using SNCR with a smaller SCR reactor to polish NOx emissions and reduce ammonia slip, thereby reducing the cost and size of the SCR system. The use of SNCR, however, will not alter the volume of airflow or the dust loading. Both of these factors determine the area of the catalyst bed. Therefore, the size of an SCR system designed for polishing the gas stream following SNCR, may only be reduced by the number of catalyst layers required. The footprint of the unit may stay the same.

Conclusion

Factually, the Linero Report and SYA Report are similar. However, the conclusions drawn from those facts differ. The SYA Report did not speculate on costs or potential additional efficiencies. Both reports state that the SCR system at Solnhofen is offline and SNCR is currently being used to control NOx

emissions. The SNCR system is currently meeting the NOx emission limit. However, while the Linero Report intimates that the SCR system will be returned to service, SYA believes that conclusion to be premature. The cost comparison is ongoing to SYA's knowledge; decisions have not been made. Perhaps the most significant difference between the two reports is that the SYA Report was intended to draw comparisons between the Solnhofen kiln and the kilns in Ellis County, Texas, while the Linero Report is more generic in nature.

SYA has not been to the Monselice plant and therefore cannot comment on the information contained in the Linero Report. However, it is SYA's understanding that the Monselice kiln is very similar to Solnhofen which in turn means that it is very different from the Midlothian kilns in type and raw materials. Data regarding the Monselice plant must be reviewed before conclusions can be drawn.