Sulfuric Acid Dew Point for Gas Turbine Combined Cycle Power Plants

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With the increase in renewable energy power generation that fluctuates due to climate and other factors, the role of gas turbine combined cycle (GTCC) power plants, which is responsible for load fluctuations, will continue to increase. It will be important to ensure reliability while maintaining high-performance operation. Particularly, in order to increase the energy efficiency of GTCC, it is necessary to set the exhaust gas temperature to be as low as possible at the outlet of the heat recovery steam generator (HRSG) and the inlet temperature on the feedwater side. However, excessive reduction of the temperature may induce acid condensation on the surface of the heat transfer tube at the lowest temperature, which can lead to corrosion. If this corrosion severely progresses, it can affect the operation of the GTCC plant. Therefore, it is necessary to pay attention to the acid dew point to prevent condensation that causes corrosion. Among acid species, the dew point of sulfuric acid is particularly important because it is higher than that of other acids such as nitric and nitrous acids.

As a sulfuric acid dew point prediction formula, Otsuka's formula [1] has been adopted in Japan for a long time, and the Verhoff & Banchero formula [2] is famous overseas, but both formulas were developed and applied for boilers of conventional thermal power plants that contain a large amount of sulfur (several 100 ppmv) in exhaust gases such as heavy oil and coal fuel in the latter half of the 20th century, and are not for GTCC, which is a recent refined natural gas fuel with very low sulfur content. There is no sulfuric acid dew point prediction formula that covers the 1 ppb to 1 ppm level, partly because it is difficult to accurately measure the dew point of exhaust gas containing extremely low sulfur (SO3) content. In addition, extending the conventional equations to the extremely low SO3 range is risky because it underestimates the dew point.

For a method for predicting the sulfuric acid dew point that can cover existing relatively low SO3 (H2SO4) exhaust gases, such as Land's table (0.08 ppm or more) [3], Mueller's theoretical curve [4] and simulation calculations using models can be used, but the basis and scope of application are not clear. This time, the authors will propose a new highly accurate sulfuric acid dew point prediction method and/or prediction formula that covers a practical range from reliable data and theories while comparing and referring to these prediction methods.

References

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