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Water Interference of Pulsed Fluorescence SO_2 Monitor

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Our laboratory has been using a Thermo Electron Model 40 Pulsed Fluorescence SO_2 Monitor, Serial Number 40-19670-185, without sample conditioner to measure sulfur dioxide in synthetic flue gases. The flue gases are generated by mixing pure (greater than 99.98 percent purity) sulfur dioxide, air, nitrogen and carbon dioxide with a rotameter gas dilution system. By knowing the flow rates of the gases, the concentration of sulfur dioxide in the flue gas can be calculated. By performing an error analysis, this system should be able to generate a sulfur dioxide concentration within 2 percent. A typical calibration curve for this instrument shows a maximum difference between the calculated concentration and the measured concentration of approximately 5.0 percent.

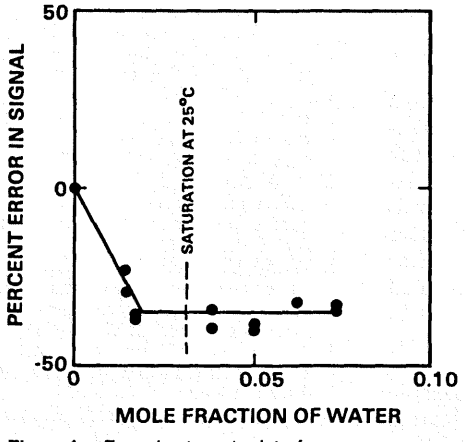

Figure 1. Error due to water interference.

After determining that the gas dilution system was functioning accurately, water was added. The water addition was performed by spraying deionized liquid water with a Meinhard nebulizer into the hot synthetic flue gas, approximately 205°C. The synthetic flue gas was hot enough for all the liquid water to be vaporized. The water concentration was varied between 0.0 and 8.0 percent mole fraction. The accuracy of the water mole fraction was determined to be 2 percent by error analysis. No condensate was observed within the instrument operated at room temperature; even though, the water concentration was sometimes greater than saturation at room temperature.

With the addition of water, the signal corresponding to sulfur dioxide changed significantly. The results are shown in Figure 1. The sulfur dioxide concentration was approximately 1200 ppm. Figure 1 shows an average error of approximately 35 percent occurs for water concentrations greater than 2 mole percent. This result indicates extreme care should be used when using pulsed fluorescence without a conditioner to measure sulfur dioxide in the presence of water. The exact mechanism of this interference is undetermined at this time.

Even though the mechanism of interference is unknown, two possible error sources can be eliminated. The first possible error source is a chemical specie in the deionized water reacting with the sulfur dioxide. This mechanism is unlikely because the impurity level of the deionized water is less than 10 ppm. A second possible candidate is sulfur dioxide being removed by dissolving in condensate within the instrument. This mechanism is also unlikely because the maximum error predicted is about 0.2 percent, whereas the observed signal reduction is about 35 percent.

Finally, the manufacturer of this instrument is aware that water causes a problem because they recommend using a conditioner for gas streams containing more than one mole percent water. The conditioner circumvents the water interference by diluting the stream being sampled with dry air in dilution ratios of 5:1, 20:1 and 100:1.

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