Summary

This document describes the general considerations to be made when applying acid dewpoint monitoring (ADM) technology. This relates to the burning of sulphur-based fuels in boiler systems, and the manufacture of sulphuric acid (as a primary or secondary process).

Introduction

The application of sulphuric acid dewpoint monitors falls in two categories:

- **Combustion Process Applications**
  - High Sulphur Fuel Oil
  - High Sulphur Coal (typically > 1% Sulphur)
  - Low Sulphur Coal (typically < 1% Sulphur)
  - Heat Recovery Steam Generators

- **Sulphuric Acid Production Processes**
  - Acid as an end product
  - Acid as part of another manufacturing process

Combustion Process Applications

Introduction

Acid Dewpoint Monitors can only measure sulphuric acid in its vapour-liquid equilibrium. They will not measure sulphuric acid which has been absorbed by ash in the process. This is critical in low sulphur coal applications. The simplest and most common uses for ADM is oil-fired boilers, however ADM also has applications in other processes.

- **High Sulphur Fuel Oil**

  When using high sulphur (>1%) fuel oil, the primary applications are:
  
  - Air Heater Fouling
  - Cold End Corrosion
  - Additives (Fuel and Process)
  - Acid Aerosol Emissions and Acid Smutting
**Air Heater Fouling and Cold End Corrosion**

In order to prevent cold end corrosion and air heater fouling it is important to ensure that the flue gas temperature is above the acid dewpoint temperature. However, if the temperature is too high then energy is wasted and plant efficiency is reduced. In order to operate at the optimum point, a fixed dewpoint meter installation can be employed. The output from the ADM can be used within the control loop, or by manual trim, for maintaining the optimum flue gas temperature.

**Additives (Fuel and Process)**

ADM can be used to control the rate at which chemical additives are injected into the combustion zone, to reduce corrosion and excess SO₃ production. This is a reasonably straightforward application wherever fuel oil is burned.

Fuel additives are used in fuel oil feed to increase burn efficiency. If excessive additive is used SO₃ is produced. Therefore an ADM can be used to control the injection of additives, saving money by preventing over injection and minimising the chance of corrosion and pollution due to the formation of acid.

**Acid Aerosol Emissions and Acid Smutting**

Traditionally SO₃ measurements have been made using wet chemistry methods. These techniques take into account the total available sulphuric acid (vapour, liquid and that absorbed in the ash). The calculated acid dewpoint temperature (ADT) will probably be higher than a true measured value. If emissions are measured with an acid dewpoint monitor, a true reading is obtained.

- **Low Sulphur Coal (Typically <1% Sulphur)**

**Corrosion Application**

Low sulphur coal applications are significantly affected by the absorption of SO₃ into the fly ash. These processes suffer from corrosion when the hot ash containing absorbed sulphuric acid sticks to a cold metal surface. The acid then corrodes the metal work. A fixed ADM system is not always useful under these conditions.

In such cases the dewpoint temperature measured in the application will be found to be very close to the water dewpoint. This is because the ash has absorbed all of the free SO₃. When all of the free SO₃ is in the ash, the ADM cannot condense any acid. The system can therefore only condense water, hence the reading of water dewpoint instead of acid dewpoint.

It is necessary to fully understand the measurement issues, as failure to do so may lead to lower flue gas exit temperatures. When this happens, ash will begin to stick to colder metal work and corrosion will start to occur.

A portable acid dewpoint monitor can be used for diagnostics or fuel blending control (high and low sulphur coal).

**Acid Aerosol Emissions**

Many countries are beginning to quantify Acid Aerosol Emissions. These are normally defined as sulphuric acid emissions in a vapour or liquid state, since the acid absorbed in the fly ash is assumed to be removed by the dust collectors. US EPA SARA Rule 313, Toxic Release Inventory (TRI), defines emissions as the qualitative or quantitative amount of sulphuric acid mist emitted from coal fired boilers over a one-year period.

If emissions are measured with an acid dewpoint monitor a true reading is obtained, whereas if a wet chemistry method is used the emissions reading will be overstated. This could cause public and legislative actions or restrictions in operation.
Acid dewpoint monitoring has been used in processes where the resistivity of the fly ash must be improved to ensure that the precipitator operates at optimum performance. Typically certain fuel additives and NH₃ injection (for NOₓ reduction) cause problems with ionisation of the ash particles, therefore reducing the particulate removal efficiency of the Electrostatic Precipitator (ESP). In order to achieve optimum ESP performance the process is fitted with an SO₃ injection system, which allows additional SO₃ to be added to the process to increase the resistivity of the fly ash. The ash then adheres to the precipitator electrodes better and the dust removal system performance is improved.

Typically in this application an opacity monitor is used to feedback on the precipitator performance. The problem with this is that if too much SO₃ is injected it is possible to cause a blue coloured plume, which shows as increased opacity. The control system will continue to feed in still more SO₃ as it will assume that the increased opacity is due to the ash not being collected in the dust removal system. This can then lead to a situation where the system will run out of control.

The best feedback method to save on SO₃ and to indicate when the ash is saturated with H₂SO₄ is an acid dewpoint monitor. The ADT will increase when there is excess SO₃ as it will combine with the water in the flue gas to form sulphuric acid.

**High Sulphur Coal (>1% Sulphur)**

In addition to the acid aerosol application above, ADM is used for cold end corrosion monitoring. This application is the most obvious and the instrument performs well.

The key consideration is the position where the monitor is installed.

The ADM should be installed at a point where the SO₃ and the water have completely combined (98% or better). This is typically in locations where the flue gas temperature is below 205°C /400°F (>98% combination) or below 175°C /350°F (>99% combination).

An additional consideration is that the ADT can be lower at the exit of the air heater since some acid is lost to the air heater itself. Because of this, many operators want to protect the air heater and therefore would benefit by installing an ADM prior to the air heater. The problem with this approach is that before the air heater the flue gas temperatures are higher and therefore all the acid may not be formed.

A solution to this issue is to pre-test using a portable ADM before and after the air heater, and at the precipitator, to establish the optimum installation point for a fixed ADM instrument. Photo: Air Heater

**Heat Recovery Steam Generators**

Heat Recovery Steam Generators (HRSG) offer a new opportunity for acid dewpoint monitors. HRSGs are added to plant in attempt to recover waste heat from the primary generator and produce steam to drive a further turbine, or for use in district heating, etc.

ADT monitoring is useful for plant where the primary fuel is high sulphur coal or oil (this includes Gas Turbines) and it allows control of HRSG preheating so as to prevent corrosion within the HRSG. In this application it is important to verify that sufficient acid is present to give a measurable acid dewpoint. This is best checked with a portable acid dewpoint monitor.
Sulphuric Acid Production Processes

In sulphuric acid processes it is essential that there is no moisture content in the process gas in order to avoid problems with internal corrosion at the heat exchangers and economisers.

A small amount of moisture in the process stream results in acid condensate build-up and is indicated by a rapid increase in cell output from the ADM. This feature allows an ADM to give a warning of plant leaks and allows repair before corrosion damage can occur.

Moisture occurs in the process via leaks, which are often difficult to detect, in the waste heat boilers, economisers, sulphur guns or drying towers. However the acid dewpoint temperature (ADT) is very sensitive to changes in water vapour concentration. Monitoring with an ADM will immediately detect any leaks in the process. Further investigations using a portable ADM at various positions can be used to isolate the leak.