CHEMTEX
INTERNATIONAL CHEMTEX CORPORATION

Technical Topics

Neutralizing Amine Regulation & Testing

TT-031-1098

Modern boiler plants produce steam for use in various applications, including electrical generation, manufacturing processes, sterilization of surgical instruments, space heating and humidification. In a number of these applications, the potential for contamination of the product or process from boiler water additives is a major issue. These applications include humidification, sterilization, and manufacturing processes where steam contacts food or food products.

Among the various chemicals used in boiler water treatment, of particular concern are amines, which are used to prevent carbonic acid corrosion in the steam condensate system. The most commonly used type, neutralizing amines, are volatile compounds that leave the boiler with the steam and are present to prevent corrosion in condensate receivers and return piping.

While neutralizing amines are safe to use, their use in certain processes is regulated. In systems in which treated steam contacts food or food packaging, the Food and Drug Administration (FDA) allows only the neutralizing amines morpholine, diethylaminoethanol (DEAE) or cyclohexylamine to be used. Further, the FDA limits the allowable level of each in treated steam to 10 parts per million (ppm) of morpholine, 15 ppm of DEAE, and 10 ppm of cyclohexylamine. In addition, FDA allows 25 ppm total amine when any or all are used in combination, provided that individual limits are not exceeded.

The United States Department of Agriculture (USDA) imposes the same amine limits in plants under its jurisdiction -- meat, poultry, egg and fish processing plants. In plants in which treated steam contacts dairy products, the FDA allows only ammonium hydroxide to be used.

The use of amines in systems in which treated steam is used for humidification became an issue as a result of an incident that occurred at Cornell University in New York in 1982. In that case, a number of employees at a campus library became ill with upper respiratory ailments. The cause of the ailments was determined to be exposure to high levels of DEAE, the amine used in the university's steam humidification system.

In late 1991 and early 1992, another case occurred in which workers in a New York state office building were reported to be suffering from symptoms similar to those experienced in the Cornell University incident. In this case, the causes of the ailments were many and varied, but DEAE exposure was again suspected to be a contributing factor.

In their investigations and reports covering both of these cases, the National Institute for Occupational Safety and Health (NIOSH) recommended that, if possible, DEAE not be used in direct steam humidification systems, or that its use at least be carefully controlled.

The NIOSH reports notwithstanding, no Federal government regulations exist governing the use of DEAE or other amines in direct steam humidification systems. It has been a convention in the water treatment industry to follow FDA limits for amine levels in steam used for this purpose.

Where steam is used for sterilization of surgical instruments, the American Society for Hospital Central Service Personnel (ASCHSP) has published guidelines for allowable amine concentrations. The ASCHSP guidelines also follow FDA limits for permissible amine levels in treated steam.

The feed rates of neutralizing amines are controlled in the field by in-plant testing for condensate pH. When maintained in a slightly alkaline range (7.5-9.0 pH), condensate will be relatively non-corrosive to system metals. However, maintaining pHs in this range is no guarantee that amine levels in the steam are within acceptable limits for a regulated application.

When it is necessary or desirable to determine if amine levels are in compliance with government regulations or published guidelines, laboratory analysis of the steam is required. To assure accurate results from a laboratory amine analysis, care must be taken to follow very specific procedures for collection and shipment of steam samples.

Procedures for Collection and Shipment of Steam Samples for Laboratory Analysis by HPLC Method

1. Sample must be collected directly from the steam line immediately upstream from the point of use in question, utilizing an ASTM steam sampling nozzle. A sample cooler or cooling coil must be used to completely condense the sample to the liquid phase. Let sample run to drain for 15 minutes prior to collection.
2. Using a four or eight ounce plastic sample bottle, fill bottle to top, allowing a slight overflow. Immediately cap tightly, taking care to assure that there is no head space above the liquid.
3. Pack the sample on ice in a styrofoam cooler and ship by next-day air to the Chemtex laboratory for analysis. Laboratory personnel must be notified at least three days in advance that an amine analysis will be required.

The precise determination of amine concentrations in steam used for critical applications can be a valuable service tool when used properly. Amine analysis using the High Performance Liquid Chromatography (HPLC) method is highly accurate and reliable. However, it is also a complex, complicated and time-consuming procedure that should not be used for routine analyses. Because of the complexity and time involved, a cost is normally associated with this procedure.