

# Engineering Humidification

F O R A B E T T E R E N V I R O N M E N T

from DRI-STEEM Humidifier Company

Education Series

## Growing concern over boiler treatment chemicals used in direct steam humidification

Humidifier users are finding that chemically-treated boiler-generated steam is unsuitable for direct injection into the air as humidification. This is because the boiler water has been treated with anticorrosive chemicals and these chemicals are being dispersed along with steam humidification, becoming part of the air in the humidified space.

The pioneering study, done by NIOSH (National Institute of Occupational Safety and Health) at the Johnson Museum of Art at Cornell University, found that the commonly used anticorrosion chemical, DEAE, may have been causing eye irritation and dermatitis symptoms in workers and recommended that human exposure to DEAE be eliminated.<sup>1</sup>

***“Steam humidifiers should utilize clean steam rather than steam created from chemically treated boiler water, so occupants will not be exposed to chemicals.”***

***— U.S. Environmental Protection Agency***

Even though there remains no conclusive evidence to prove that boiler chemicals in humidification steam are a health hazard, study after study recommends the discontinuation of chemical use in direct steam injection humidification because that potential exists.

The significant concerns that have grown since the NIOSH findings have prompted research into the safety of such practices, and prompted action by various institutions across America.

Chemical companies are taking precautions and becoming more explicit about the use of their chemicals. Union Carbide Corporation, a manufacturer of DEAE, includes a Material Safety Data Sheet with their DEAE distribution that outlines warnings about the use of DEAE in direct steam injection applications.<sup>2</sup>

The EPA (Environmental Protection Agency) has issued these warnings regarding boiler chemicals:

“Heating system steam should not be used in the HVAC humidification system, as it may contain potentially harmful chemicals such as corrosion inhibitors.”<sup>3</sup>

“Steam humidifiers should utilize clean steam rather than steam created from chemically treated boiler water, so occupants will not be exposed to chemicals.”<sup>4</sup>



In March of 1994, the California Office of Statewide Health Planning and Development released a Code Application Notice that stated: "If steam from a central boiler plant will be injected into the airstream, the design professional should verify that the boiler water will not be treated with chemicals or contain minerals which are known to be hazardous to health, or which might contribute to an indoor air quality problem."

While the wait continues for conclusive evidence that proves the specific hazards of boiler chemicals used in direct steam humidification, preventative measures are already being taken among HVAC engineers and building owners, in institutions as varied as hospitals, office buildings and museums.

## How boiler treatment chemicals work

To ensure an acceptable service life for steam boilers, condensate piping and all associated components, protection from corrosion is provided through the use of boiler water treatment chemicals. Heat transfer surfaces, such as boiler tubes, are also protected against buildups of oxides and minerals that could cause overheating and heat transfer failures.

### How corrosion occurs

Corrosion occurs in a condensate system as a result of carbon dioxide and oxygen dissolving in condensate.

Dissolved carbon dioxide forms carbonic acid. The carbon dioxide in the system results primarily from carbon compounds in the feed water being thermally broken down in the boiler.

Oxygen enters the system through vents, steam traps, or air leaks. Dissolved oxygen usually causes localized pitting, while carbonic acid continually erodes and causes ruts or troughs to form at the bottom of condensate pipes.

Ammonia is a third contributor to corrosion. By combining with oxygen, it forms ammonium hydroxide, which attacks copper and brass parts in the system.

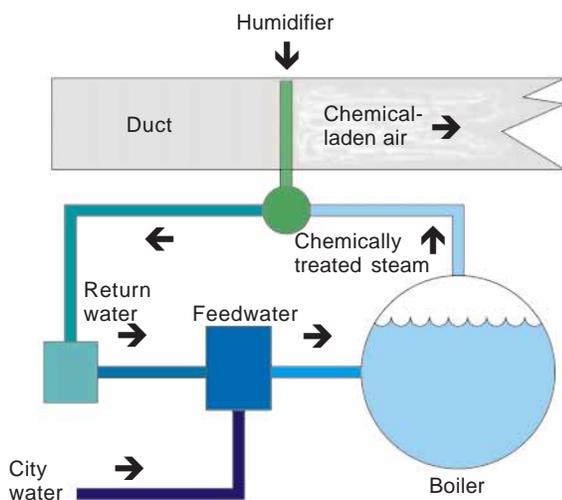
### Boiler chemicals reduce corrosion

Amines are alkaline compounds added to boiler feed water to neutralize the effects of carbonic acid. Amines are vaporized in the boiler and are carried as a gas along with the steam. To ensure that all parts of the piping system receive protection, several different amines (each having different condensing rates) are often blended together.

Cyclohexylamine is slow to condense and therefore protects the far ends of the system. Diethylaminoethanol (DEAE) works on the mid-length runs, while morpholine takes care of the short runs because it condenses earliest.

Sometimes carbon dioxide concentrations are so high that neutralization is impractical. In those cases a filming amine, such as octadecylamine, is added. This amine provides a protective film on the vulnerable metal surfaces to prevent oxygen and acid corrosion.

### How boiler chemicals enter the airstream



### Chemicals in air cause irritation

When used in conjunction with direct steam injection humidifiers, boiler chemicals come in contact with humans. Amines irritate eyes and skin, and aggravate respiratory ailments. Some may also combine with other substances to form carcinogenic compounds. In addition, amines can negatively affect the preservation of certain organic materials. As a result, institutions like museums and art galleries, as well as hospitals and office buildings, are replacing direct boiler steam injection with an alternative method of humidification.

## Alternatives: Use boiler steam, but keep chemicals out of the air

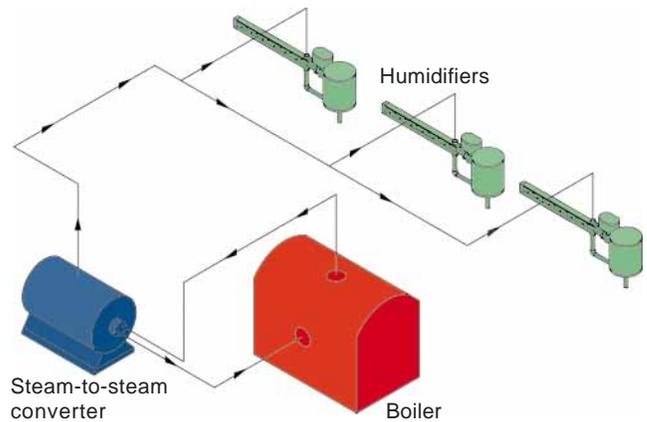
### Steam-to-steam converter system

A steam-to-steam converter system (drawing, right) is one way to take advantage of on-site steam while creating very pure humidification steam. Instead of injecting boiler-generated steam directly into the airstream, boiler steam is used as an energy source to heat a second pressurized vessel filled with deionized water, creating ultra-pure steam for humidification. This system offers flexible design, easy installation and superior control capability, and the use of individual, compact, duct-type steam injection humidifiers that allow individual room or zone control. Although this method is highly successful, the use of deionized water requires that the humidifier and valves be fabricated completely in stainless steel. Therefore, this system is used in applications where superior control, high-purity steam, and maintenance-free humidification take high priority to justify the higher cost.

### Steam-to-steam evaporative humidifier

Another way to take advantage of on-site steam is to run boiler steam through the heat exchanger of an evaporative humidifier tank (see drawing below). This steam-to-steam system is a cost-effective way to provide humidification free of boiler chemicals while using on-site boiler steam as the energy source.

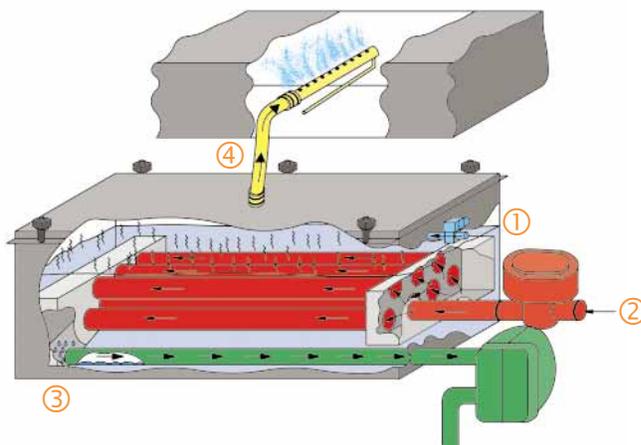
### Steam-to-steam converter system



*In this system, boiler steam is sent to a steam-to-steam converter where secondary, pressurized steam is generated and then delivered to steam injection humidifiers.*

Evaporative steam-to-steam systems can use tap, softened or DI/RO (deionized/reverse osmosis) makeup water, offering a range of solutions to meet almost any humidification need. Systems using DI/RO makeup water provide the tightest control, the cleanest humidification steam and require almost no maintenance, but also require higher quality equipment. Standard water systems use either hard tap or softened water, with water level control systems designed to skim or flush precipitated minerals. Systems using softened water can operate for several seasons without a need for cleaning.

### Steam-to-steam evaporative humidifier



#### Principle of operation:

1. Makeup water enters the evaporating chamber through the automatic water makeup valve.
2. Pressurized steam passes through the modulating steam valve to the heat exchanger. Here it causes water in the chamber to boil creating secondary, evaporative steam for humidification.
3. Condensate from the heat exchanger passes through a steam trap and is returned to the boiler.
4. Humidification steam is dispersed into the airstream.

## Chemical-free steam with DRI-STEEM's STS®



### No direct injection of boiler chemicals!

Consider the benefits of an evaporative steam-to-steam humidification system:

- Economical
- VAPOR-LOGIC<sup>3</sup> state-of-the-art control
- Redesigned cover and cleanout plate ease maintenance
- RH control to  $\pm 3\%$
- Maximum capacity to 6400 lbs/hr
- Designed for use with all types of makeup water: tap, softened or DI/RO
- Disperse steam through ductwork or directly into a space
- ***CLEAN humidification steam!***

## Visit the on-line humidification resource center

Check out our web site to learn more about designing humidification systems, types of humidifiers and current humidification issues. You'll find our newest tool, the Design Guide manual to help you design and specify a humidification system. Also available on our web site is DRI-CALC® — our exclusive software that sizes loads, selects equipment, writes specifications, and creates equipment schedules for DRI-STEEM products.

[www.dristeem.com](http://www.dristeem.com)

#### Notes:

1. NIOSH Health Hazard Evaluation Report, HETA Publication No. 83 020-1351, Cornell University, Ithaca, NY, August, 1983.
2. Material Safety Data Sheet: MORLEX Corrosion Inhibitor DEEA, Union Carbide Chemicals and Plastics Company, Inc., August, 1993.
3. EPA/400/1-91/033, December, 1991.
4. EPA SN-005-000-00390, September, 1992.

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# DRI-STEEM®



14949 Technology Drive • Eden Prairie, MN 55344  
Phone: (952) 949-2415 • Fax: (952) 229-3200  
E-Mail: [sales@dristeem.com](mailto:sales@dristeem.com) • Web: [www.dristeem.com](http://www.dristeem.com)

**1-800-328-4447**

#### Europe Office:

Bell Place, Bell Lane • Syresham, Brackley • NN13 5HP, U.K.  
Phone: +44 1280 850122  
Fax: +44 1280 850124  
E-Mail: [106277.1443@compuserve.com](mailto:106277.1443@compuserve.com)

The DRI-STEEM representative in your area is: