ImproChem

Technobrief

Steam Contamination - Causes & Cures

ImproChem

A business of AECI Water & Process™

A basic objective in boiler operation is to keep the steam clean and dry. Contamination with boiler water impurities can cause a wide variety of problems including deposits in superheaters, turbines and engines; and process contamination. To produce pure steam, boiler water must be kept from "carrying over". There must be good separation of water and steam inside the boiler.

Mechanical separators in the boiler drum will do this effectively when the water boils smoothly. However, when the boiling water surges, splashes, foams or mists, the steam is apt to be contaminated. Boiler water composition is not the only factor influencing carryover; mechanical and operational conditions play a big role. Proper water treatment and chemical control, however, are important in keeping the steam clean and dry.

Types of Carry-over

Carryover into steam lines occurs when boiler water primes, mists or foams.

Priming

Priming is like the surge of charged water in a bottle that has just been uncapped. In priming, the water is mechanically lifted by the steam as it surges through the water surface. This may be caused by a number of conditions. Sudden steam load increases may "siphon" water out of the boiler. High water levels in the boiler drum can cause priming by decreasing the surface area for steam release. Falling away of slag from the boiler tubes causes sudden, localized increases in heat input and can disrupt water circulation. Broken or loose baffling causes priming when the hot gas flow is erratic and upsets the boiler water circulation. Sudden and severe contamination in the boiler water will also cause it to prime. Very often, a combination of several of these conditions contributes to priming.

Misting

Boiler water may also carry over in the form of a fog-like mist (like bubbles on champagne). This mist is difficult to separate from the steam. It is a sudden release in pressure under steam bubbles as they burst on the water surface. This phenomenon is called "aquaglobejection", which describes how misting occurs. Misting is not caused by boiler water solids or chemical conditions. (It rarely occurs when there is foaming.) When misting is a problem, effective mechanical steam separating equipment is needed to keep the mist from going off with the steam.

Foaming

Boiler water foaming causes carryover by forming a stable froth (like foam on beer) that becomes entrained in steam. In addition, many tiny steam bubbles build up in the water itself, causing it to expand into the steam space. Foaming is related to the type and amount of impurities in the boiler water. These impurities affect the nature of the steam bubble film. With pure water, relatively large, tender steam bubbles form and break easily to release the steam. Water impurities make the bubble film tough; the bubbles are small and resist breaking. As these bubbles come through the water surface, the bubbles form froth. To prevent carryover from foaming, the type and amount of dissolved solids in the boiler water must be controlled. Chemical antifoams are very effective in preventing foaming.

Preventing Carry-over Mechanically

Mechanical devices for preventing carryover fall into three categories: steam separators, steam washers and steam dryers (purifiers). Some steam separation equipment is always needed to prevent carryover.

Steam separators are devices that radically change the steam flow, causing the heavier water and impurities to separate out. The equipment might consist of baffling, or might involve more elaborate centrifugal separation equipment.

Steam washers operate on the principle of an open deaerating feedwater heater. Relatively pure Feedwater is sprayed into the steam space to "dilute"any entrained impurities. Washers are not always necessary and their use is dictated by the amount of space available in the steam drum and the steam purity requirements.

Steam dryers operate like filters. Steam dryers slow down the steam velocity and provide maximum surface area over which the steam may pass before leaving the boiler.

The various boiler manufacturers have developed several types and combinations of separators, washers and dryers. It is important to keep these devices in good condition.

Preventing Carry-over Chemically

Of the three types of carryover, foaming is most frequently caused by chemical conditions in the boiler water. Foaming may be prevented in two ways:

- By controlling the amount of dissolved and suspended matter in the boiler water and
- By the use of chemical antifoams

The American Boiler Manufacturers Association (ABMA) has set certain limits for boiler water solids, above which they will not guarantee steam quality. These limits are shown in Table 1.

Table 1 - ABMA boiler water solids limits

Boiler Pressure	**Total Dissolved Solids**	**Total Alkalinity**	**Suspended Solids**
(bar)	(ppm)	(ppm)	(ppm)
0 - 20	3500	700	300
20 - 30	3000	600	250
30 - 40	2500	500	150
40 - 50	2000	400	100
50 - 60	1500	300	60
60 - 70	1250	250	40
70 - 100	1000	200	20

The amount of dissolved and suspended matter in boiler water is controlled by blowdown. In preventing foaming, the average boiler water composition is not as important as the consistency of the composition. Radical or sudden changes in boiler water solids content, even if brief, can cause carryover due to foaming.

One of the most significant advances made in feedwater treatment in past decades has been the development of temperature-stable chemical antifoams. Antifoams have two basic properties:

1. Insolubility in water and
2. Surface activity

When properly dispersed in boiler water, they are present in the steam bubble skin. Their presence there weakens the film, causing it to rupture easily. Figure 1 A,B & C shows the effect of antifoams on steam bubble formation.

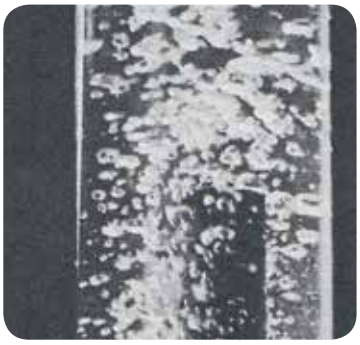
To be effective, antifoams must be well dispersed and distributed throughout the boiler water. For this reason, they are commonly incorporated in organic sludge conditioning treatments that act as antifoam "carrier". Several modern polymer formulations exhibit antifoam properties and will in most cases cater for small deviations in boiler water solids content.

Testing Steam Purity

The major problem in testing steam for purity is getting a good sample. Special sampling procedures are needed, as outlined in the ASME Power Test Code (ASTM Method D 1066-66T) and ImproChem Technobrief (Boiler System Sampling: TB-2-1).

Figure 1 A,B,C

A. Distilled Water
- No Antifoam



B. Boiler Water
- No Antifoam

C. Boiler Water
- With Antifoam

ImproChem

A business of AECI Water & Process ™

Head Office
1 Pinelands Hill Business Park • Maxwell Drive
Founders Hill • Johannesburg
P.O.Box 2954 • Kempton Park • 1620 • South Africa
Telephone: +27 11 971-0400
Facsimile: +27 11 394-3436
Email
improchem@improchem.co.za
Website
www.improchem.co.za

TB 7-2