**Tech Sheet #ST 103**

# Steam: Yesterday, Today and Tomorrow
# The Use of Steam as an Efficient Heat Source

The mention of steam conjures up the thought of days gone by when steam was used to power engines, to pump water for mines and replace the muscle power of men and animals. In reality, steam, which powered the industrial revolution of yesterday, is still the most popular heat transfer medium in many industries. Steam continues to be an efficient heat source for industry throughout the world.

## AN EFFICIENT HEATING MEDIUM

Steam is an excellent heat transfer medium. Plant engineers depend on steam systems for a wide range of applications. Steam is often chosen over other energy sources (i.e., natural gas and fuel oil) because of its unique advantages. Examination of Table 1 shows the properties of steam as a heat carrier and suggests the following points which describe the advantages of steam as an efficient heat source:

- **High Heat Content**

Steam has a high latent heat content, which is given up during the process of condensing to provide heat. If we compare this to the usable heat available from hot water (sensible heat), steam can provide over five times the heat by mass (see Table 1). Large amounts of heat energy can be distributed economically through a given pipe size using steam instead of water.

- **Heat Transfer – Advantage Of Steam**

Steam offers significant advantages at the point of use. For example, if we compare the heat transfer rate for steam as compared to hot water, we find that steam can provide significantly higher heat than water. For a submerged coil heating application supplied with steam, the coils would only be a fraction of the length of coils fed with hot water. This is because the heat transfer rate from steam to water is about six times that of the rate of heat transfer from water to water. A steam coil can reduce the heating surface by up to 50% as compared to a hot water coil with cost savings on initial purchase price of up to 35%.

- **Pumping**

Steam flows in response to pressure drop along the distribution line and, therefore, eliminates large and expensive circulating pumps. The steam system requires only a boiler feed pump and sometimes a condensate return pump, but these are insignificant compared to circulating pumps, which are required in hot water systems.

- **Control And Flexibility**

The pressure-temperature relationship of steam, as shown in Table 1 provides for simple control. Lower temperatures can be obtained readily by using a pressure reducing valve to lower the steam pressure. The pressure reducing valve allows the end user to customize the steam pressure for each application. Another characteristic of steam is that it maintains a constant temperature as it condenses and gives up heat. This can be valuable for certain process applications.

- **Highly Responsive**

Steam is a gas and is highly responsive as a heat transfer medium. It can respond more quickly to changes in demand than a liquid because a vapor flows far more rapidly in a pipe than a liquid does.

- **Ease Of Distribution**

Steam's unique features allow steam lines to be relatively lightweight. Steam is a gaseous form and contains high heat content that can be delivered through distribution lines to points of use far more efficiently than any other medium. At the point of use steam gives up its heat when it condenses. Approximately 900 Btu's per pound of steam is released when condensation occurs with heat transfer coefficients ten to one hundred times higher than those of hot water when heating air. In hot water systems, for example, pipe sizes may need to be two times larger than steam systems to deliver the same amount of heat. Steam lines can also be readily shut down when steam is not required.

## STEAM: YESTERDAY, TODAY, and TOMORROW

Steam was harnessed to drive the steam engines which triggered the industrial revolution. Engineers and designers realized that steam could be used not only to power engines, but also to provide an efficient heat transfer medium. While electricity eliminated the need for steam engines, it did not eliminate steam's other advantages . Ironically, today, most electricity is still generated using steam turbines for driving power.

Today, steam remains an excellent heat transfer medium, as indicated by all the advantages that we have discussed, e.g., high heat content, heat transfer advantages, ability to be circulated without pumps, flexibility, and ease of control and distribution. In many industries, including, for example, the chemical processing industry, it is the most popular heat transfer medium.

Due to all of its advantages, steam will continue to be the most effective and convenient way to convey heat. This superior heat transfer medium powered the industrial revolution of yesterday, continues to work for us today, and will always be an efficient heat source

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TABLE 1.0

**Properties of Saturated Steam**
(Abstracted from Keenan and Keyes, THERMODYNAMIC PROPERTIES OF STEAM, by permission of John Wiley & Sons, Inc.)

| Gauge Pressure (psig) | Absolute Pressure (psia) | Steam Temp. (°F) | Heat of Saturated Liquid (Btu/lb) | Latent Heat (Btu/lb) | Total Heat of Steam (Btu/lb) | Specific Volume of Saturated Liquid (cu ft/lb) | Specific Volume of Saturated Steam (cu ft/lb) |
|---|---|---|---|---|---|---|---|
| 0.0 | 14.696 | 212.00 | 180.07 | 970.3 | 1150.4 | 0.016715 | 26.80 |
| 15.3 | 30.0 | 250.33 | 218.82 | 945.3 | 1164.1 | 0.017004 | 13.75 |
| 50.3 | 65.0 | 297.97 | 267.50 | 911.6 | 1179.1 | 0.017429 | 6.66 |
| 125.3 | 140.0 | 353.02 | 324.82 | 868.2 | 1193.0 | 0.018024 | 3.22 |