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A frank discussion on heating air with steam

This discussion is to approach the heating of air as with unit heaters or a similar devise using steam as the heat source. In view of the fact that the normal use is for space heating the air temperature is to be room temperature or about 70 degrees Fahrenheit. From experience low pressure steam, 15 psig to 30 psig, is usually the medium used for this application. There are exceptions and reasons for other pressures to be used in specific cases. Our discussion will focus on why low pressure is usually used.

Using low pressure steam tends to allow for airflows to be heated in the range of 90 to 140 degrees Fahrenheit and mixing with the room air to have a blend temperature of approximately 70 degrees Fahrenheit. This combination works and very little stratification is noticed of the air within the space. The lower temperature air tends to spread out more evenly in the heating space. Using higher temperature steam can and usually does tend to cause stratification to occur since the hotter air tends to rise and go to the top of the room in lieu of mixing immediately. The high temperature air can create concentrated hot spots that may be uncomfortable to the personnel in the room.

Some folks are concerned about efficiency and enthalpy in systems and want to understand the process of heating with steam at various pressures. This discussion requires a basic understanding of the properties of steam and using steam tables. Should the reader be unfamiliar with steam tables a thorough study of the table and the information available about steam tables is recommended to comprehend the following discussion.

Saturated steam has sensible heat and latent heat that is available to use for heating. For all practical purposes the latent heat is the heat source we are talking about in utilizing steam for heating. The sensible heat is not used in the discussion since the condensed steam or condensate is at the same temperature and pressure as the steam, in vapor form, up stream (prior to) of the steam trap. This condensate once it passes through the trap immediately goes to the corresponding temperature and pressure down stream of the trap.

For example 175 psig steam and condensate prior to the trap, immediately after the trap and the downstream pressure being atmospheric pressure, the 377 degree Fahrenheit condensate would have 17% re-evaporation to create steam at 212 degrees Fahrenheit and condensate at 212 degrees Fahrenheit. The steam would typically be lost energy in the form of vented steam vapor. There are methods to utilize this waste energy but we are not going to approach this in the discussion. Using lower pressure steam would reduce the amount of flash loss. Using 15 psig steam, the 250 degree Fahrenheit condensate on the up-stream side of the trap would have 4% re-evaporation to create steam at 212 degrees Fahrenheit and condensate at 212 degrees Fahrenheit. The flash loss is significantly lowered using the lower pressure steam!

Another phenomenon that takes a little thought to comprehend is the lower pressure steam in the example above has more BTU's per pound of steam available for the work of heating the air. This is due to the fact that up stream of the trap the steam and condensate are at the same corresponding temperature and pressure. Therefore; the 175 psig steam has 848 BTU/LB available for heating – the 15 psig steam has 946 BTU/LB available for heating. This is in direct relationship to the re-evaporation discussion prior.

The enthalpy of reducing the pressure is for all practical purposes equal. The energy in is equal to the energy out. For practical purposes we are going to limit our discussion to steam at pressures below 400 psig. This will allow us to make the statement that the down stream steam is going to be dryer steam. Since the steam entering the regulator is normally "wet" you usually wind up with dry or not so wet steam. If there is any superheat it is quickly dissipated before it reaches any equipment. I mention this because if the superheated steam reaches the equipment the heat transfer area of the equipment would have to be increased because the "U" factor is lower. This would mean that using 175 psig steam and reducing the pressure to 15 psig would allow us to have the BTU's available remain a constant and even increase the useable BTU's as in the discussion prior based upon the re-evaporation and vent loss.

The reader is cautioned to make sure that confusion is not intended with the entropy change and thermodynamic availability that takes place when reducing steam pressure. This is another topic of discussion.