Solution Note

Honeywell

Heat Transfer B.T.U. Measurement
Energy Management

Problem

The increasing cost of energy has led to the need for measurement of heat transfer in heating and cooling applications for the purpose of allocating cost and to serve as a basis for measuring conservation programs. When individual operating units are charged for the energy consumption in their departments they become more energy conscious.

Heat exchanger efficiency deteriorates with time due to fouling or scaling of the heat exchanger surface. Monitoring the long time trend of B.T.U. (British Thermal Unit) transfer in a heat exchanger can be used as a method of determining exchanger efficiency and can serve as a guide in determining when to clean the exchanger heating surface.

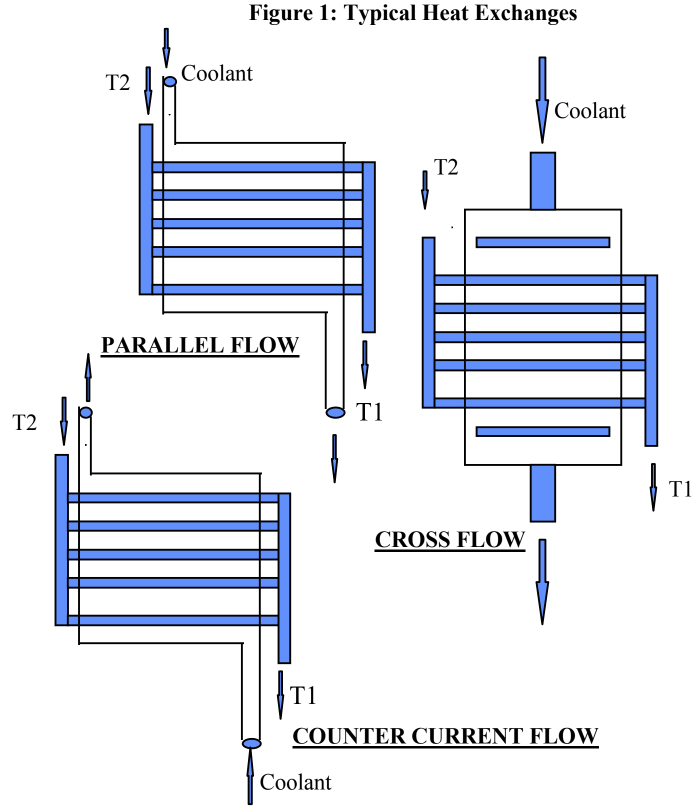
The above problem and other requirements can justify the monitoring of B.T.U. heat transfers for:

1. Allocation of cost.
2. Basis for energy conservation programs.
3. Testing of new equipment.
4. Monitoring energy conservation programs.
5. Scheduling maintenance on equipment.
6. Research. Engine testing.
7. Energy production of solar installations.

Solution

Honeywell offers a B.T.U. monitoring solution to help solve the problem of rising energy cost. The solution includes flow measurement, temperature measurement, computation, totalizing plus flow recording.

Figure 1: Typical Heat Exchanges



Note: Heat Exchangers shown are for a cooling process. In a heating process the coolant would be replaced by a heating medium and the temperatures T2 and T1 would be reversed.

Heat Transfer Theory

A heat exchanger is a device in which one or both materials that are exchanging heat are fluids which flow continuously through the equipment and give up or acquire heat. One fluid is inside a pipe or tube, or on one side of a plate. The other fluid flows around the pipe or tube, or on the opposite sides of the plate. The two fluids can flow parallel, counter current, or cross flow to each other.

There are many different types of heat exchangers. A few types are shows schematically in Figure 1. The same basic instrument package can be used to measure the heat transfer rates.

Heat transfer takes place when a mass undergoes a temperature change. In a flowing system, the quantity of heat transferred can be determined by measuring the flow rate of the heat transfer fluid and the temperature difference of the fluid. The product of these two measurements and a scaling factor will provide the heat transfer in the desired units.

The fluid temperature can increase or decrease as it passes through the exchanger. Referencing to Figure 2, the □T (i.e. T_2-T_1) between outlet and inlet temperature is measured, as well as the fluid flow rate.

The B.T.U. (British Thermal Unit) is universally accepted as the unit of heat transfer measurement. One B.T.U. is defined as the quality of heat required to raise one pound of water 1^{o}F, assuming that during the process no change of state of the fluid takes place. The equation for heat transfer to a fluid is:

$Q = W (T_2 - T_1) Cp$

where Q = heat transfer per unit time (B.T.U./hr.)

W = mass rate of fluid (lb/hr)

T_2 = higher heat exchanger fluid temperature (^{o}F)

T_1 = lower heat exchanger fluid temperature (^{o}F)

Cp = specific heat capacity of fluid.

The flow rate in the above equation must be expressed in lbs/hr or whatever other units of time are desired. The temperature must be in ^{o}F. Specific heat is the heat in B.T.U.'s required to change the temperature of 1 lb of a substance by 1^{o}F. Since the specific heat of the water is 1 B.T.U./lb the Cp factor in the above equation becomes 1. If the fluid being measured is not water, the specific heat for that fluid must be used for Cp.

Measurement Description

The basic B.T.U. measurement package is shown in Figure 2. The heat exchanger discharge temperature (T_2) and inlet temperature (T_1) are measured by resistance temperature detectors.

The temperature differential (T = T_2-T_1) is calculated in the DR4500 Recorder which is multiplied by flow rate signal that is sent to the recorder from the flow transmitter (FT). This product represents the B.T.U.'s of heat transfer in units of time corresponding to the flow rate time base. If the specific heat value is entered in the multiplier equation as a constant, the output from the equation represents the rate of heat transfer in B.T.U.'s per unit time.

The BTU result can be recorded to provide a record of the B.T.U. transfer rate or it can be totalized by the internal DR4500 Software Totalizer function to provide total B.T.U.'s, which the DR4500 Truline Recorder can print at each major time line.

Equipment Description

The Honeywell package for B.T.U. measurement includes two RTD's, a flow transmitter, the DR4500 Truline Recorder with Math and Totalization options.

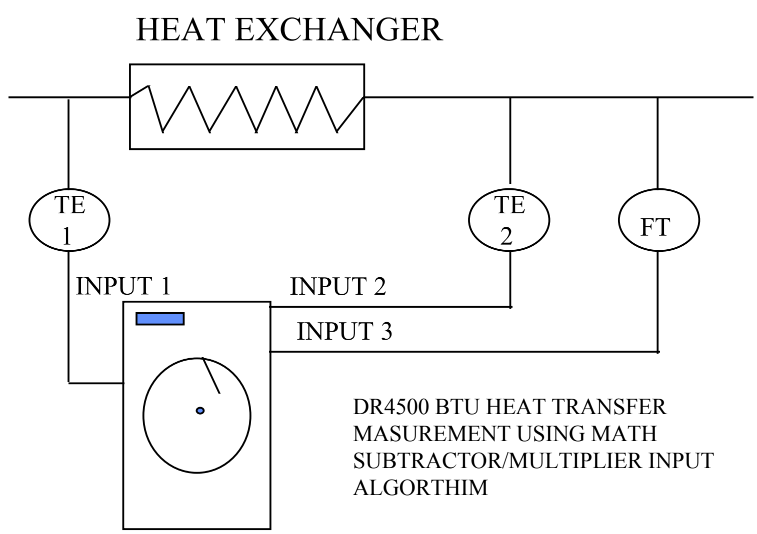


Figure 2

Resistance Temperature Detectors

The 100 ohm platinum RTD's are used to accurately measure the incoming and outgoing temperatures to the heat exchanger.

The advantage of the 100 ohm pt. RTD is that they can accurately measure temperatures over narrow spans.

Flow Transmitter

The flow transmitter measures the flow through the heat exchanger. The flow element is usually an orifice, and the Honeywell ST3000 Differential Pressure Transmitter is recommended for measuring this pressure drop across the orifice plate.

The transmitter should be installed with a three-way manifold to provide the ability to purge the pressure lines, to check instrument zero, and to ease installation and start-up.

DR4500 Truline Recorder

The Honeywell DR4500 Truline Recorder with the Math and Totalization Software options provides the key that ties this solution together. Three inputs are required, Input 1 and 2 are used for the RTD temperature inputs and Input 3 is the flow input from the Honeywell ST3000 Differential Pressure Transmitter. The math equation used in the DR4500 Truline Recorder is PV=K[Input 1 x Ratio A + Bias A)-(Input 2 x Ratio B + Bias B)] x (Input 3 x Ratio C + Bias C). Each input can have a separate Ratio and Bias applied to the incoming signal and the entire calculation can be multiplied by the K constant, which is typically the specific heat value of the fluid. This calculated PV can then be assigned to one of the pens of the DR4500 and traced. The totalizer can also be enabled to totalize this same PV to provide total B.T.U.'s consumed.

Benefits

The B.T.U. data can be used for:

1. Billing of each department for actual B.T.U.'s used in their area. This will provide an incentive to each department to conserve energy usage. The actual usage charge provides a fair method of allocation of cost rather than on a square footage or other basis.
2. The initial data can be used as a bench mark for energy conservation programs.
3. In many cases a decrease in B.T.U. transfer rate is an indication of a heat exchanger surface that is "fouling". The B.T.U. record can be used as a guideline to determine when to clean a heat exchanger.
4. The continuous monitoring and reporting of B.T.U. usage can promote energy awareness and lead to energy conservation.
5. Areas of misuse or energy loss can be detected and corrective action taken to minimize energy usage.

More Information

For more information on Truline Recorders, visit www.honeywellprocess.com, or contact your Honeywell account manager.

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