Processing Costs Due to Inaccurate Temperature Sensors

Let's assume that water, the processing fluid, flows at a rate of 100 gallons per minute (GPM) all year long. This water is to be controlled at 100 °F, but the monitoring temperature sensor is off and the water is really being controlled at 101 °F. How much will this cost the company?

Basically, we are asking how much heat is used to raise the temperature of a year's worth of water by one °F and how much does that heat cost?

$Q=c_p m\Delta T$

Where:
Q = heat transferred (BTU)
c_p = specific heat at constant pressure (BTU/lbm-°F)
m = mass (lbm)
ΔT = temperature change (°F)

In this example, the only unknown is Q.

Q = unknown
c_p = 1 BTU/lbm-°F
m = (8.33 lbm/gal)(100gal/min)(525600min/yr) = 437,824,800 lbm/yr
ΔT = 1 °F

substituting

Q = (1 BTU/lbm-°F)(437,824,800 lbm)(1 °F)

solving

Q = 437,824,800 BTU

converting

1 KW-hour = 3413 BTU therefore

Q = 128,282 KW-hour

Cost using electricity

Assuming the cost of electricity is 7 cents per KW-hour.

Cost = (128,282 KW-hour)(.07 dollars/KW-hour)

= $8,980 (using electricity)

Cost using natural gas

1 cubic ft of natural gas = 1031 BTU = $.01176

Cost = (437,824,800 BTU)($.01176/1031 BTU)

= $4,994 (using natural gas)

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