Recommendation #: Increase insulation thickness. (AR No. 2.2512)

Est heat saved = ***169 MMBTU/yr***
*Est cost of Natural gas reduced = $****920 /yr***
Est. Implementation Cost = ***$950***
Simple Payback = ***1.03yr***

<u>Recommended Action</u>

Retrofit the GT bath water tanks with rigid foam boards.

<u>Background</u>

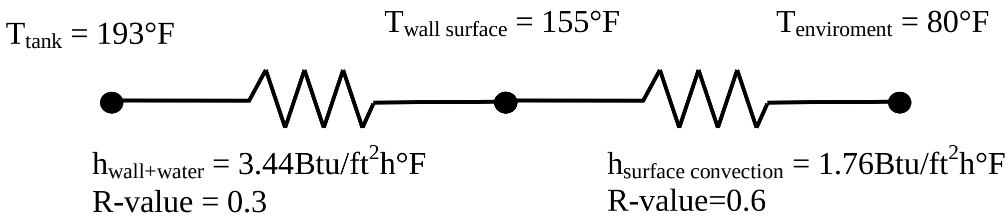
Currently, the GT Bath water tanks #1 and #2 have little insulation. The tanks are insulated by a steel plate and coated with a thin insulating ceramic paint. The water within the tanks are kept at 193°F(89°C), and have a average surface temperature of 155°F(68°C). The environment in the plant is 80°F(26°C). The drop of 38 degrees through the tanks wall is small compared to the drop of 74 degrees between the tanks surface and the ambient temperature. This indicates that the wall of the tank is offering little resistance to the loss of heat.

The tanks surfaces are flat, and are ideal for a retrofit using polyisocyanurate (polyiso) insulation. It is important to note that many materials exist for insulation. In this report, cost savings are calculated based on polyiso. Polyiso is recommended because of its low cost, moisture resistance, robustness to heat and corrosion, and its ease of installation. Polyiso boards are primarily utilized for roofing insulation, and can easily be purchased though any business specialized in insulation. Additionally, depending on the brand, Polyiso boards are rated for operating conditions up to 250°F and are inherently resistant to moisture. Rigid boards of polyiso insulation are widely available on the market and are easy to hand cut for installation.

<u>Anticipated Savings</u>

The anticipated savings are based on the reduced consumption of natural gas. An insulated tank requires less steam, reducing the work load of the boiler. The reduced consumption of natural gas corresponds to the reduced rate of heat loss in the storage tank.

The rate of heat loss is calculated for the tanks with, and without insulation. Based on the laws of thermodynamics, the rate of heat conducting though the wall is equal to the rate of heat convecting and radiating from the tanks surface to the plant environment. For calculating anticipated savings, it is assumed that the surface of the water bath has an overall natural convection rate of 1.76Btu/ft^{2}h°F (10.0W/m^2°K) and that radiation loss is insignificant. This assumption is made considering that typical natural convection rates for surfaces range between 5 & 25 (W/m^2°K).

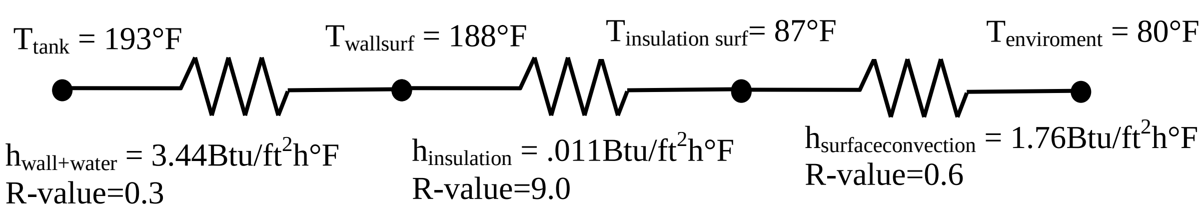


[Figure above shows the overall heat transfer resistance of a non-insulated water tank]

$q_{overall}$ = SA*$h_{overall}$* ΔT=22,000Btu/h (6.44kW)
=$h_{surface}$*SA($T_{wall\ surface}$-$T_{enviroment}$)
=$h_{wall+water}$*SA(T_{tank}-$T_{wall\ surface}$)

Where:
SA=Exposed Surface Area (of both tanks)=169ft^2 (15.7m^2)
$h_{surface\ convection}$=Convection Rate=1.76Btu/ft^2h°F (10.0W/m^2°K)
ΔT=change in temperature($T_{surface}$-$T_{enviroment}$)=74°F (41°C)
$h_{overall}$=1.164 Btu/ft^2h°F

The overall transfer of heat to the environment is estimated to be 22,000Btu/h (6.44kW). This high number can be explained by observing the low temperature difference between the inside and outside of the tank.



[Figure above shows the overall heat transfer resistance of an insulated water tank]

insulation

Polyiso insulation had an R-Value of approximately 6.0 per inch. A 1.5” thick board commonly has an R-Value of 9.0. As a note, R-Values are the inverse of the heat transfer coefficient ‘h’. (R-Value of 9.0 = 1/$h_{insulation}$=0.11Btu/ft^2h°F=0.63 W/m^2°K). This gives us the new insulated model.

$q_{overall}$ = SA*$h_{overall}$* ΔT=1,900Btu(0.56Kw)
= $h_{surfaceconvection}$*SA($T_{insulation\ surface}$-$T_{enviroment}$)
= $h_{insulation}$*SA($T_{tankwall}$-$T_{surface}$)
= $h_{wall+water}$*SA*(T_{tank}-$T_{surface}$)
$h_{overall}$=0.101 Btu/ft^2h°F

The amount of thermal energy saved due to insulation is the difference between the two calculated values for overall heat transfer ‘q’ with and without insulation.

Annual natural gas savings = (q_{saved}*)(annual operating hours)=168.7 MMBTU*$_{annually}$

*Annual Cost Savings = (annual natural gas savings)(cost of natural gas)=$920*$_{annually}$

Where:
$q_{saved} = q_{uninsulated} - q_{insulated}$ = 22,000 Btu/h – 1,900Btu/h =20,100Btu/h (5.88Kw)
Cost of Natural Gas=$5.446/MMBTU
Annual operating hours = 8,400hrs (50 weeks annually, 7 days a week)

Implementation Cost

Polyiso insulation is commonly available in 4’x8’x1.5” pieces at a purchase price of $30.00 a board. It is estimated that the two GT Bath water units would require 15 4’x8’ pieces.

Implementation cost = Material cost + Labor cost + Miscellaneous cost = $950

Where:
Material cost = (number of boards)(cost of board)=$450
Labor cost= $300(estimated two days of labor)
Miscellaneous cost = $ 200

SimplePayback = Project cost/Annual Cost Savings/

Simple Payback =$920/$950=1.03years = 12.4months

Additional Commentary

Polyiso insulation is resistant to moisture; However, it will deteriorate when wet. The insulation should be weather sealed along the edges to reduce the damage due to steam escaping from the water tank.

The existing storage tanks have been coated with an insulating paint. The insulating paint is a special ceramic composite that has a low thermal conductivity ‘K’. However, because the ceramic coating is paint thin, there is little added effective insulation. An effective insulating layer must be both a material of low thermal conductivity conductivity ‘K’ and thick ‘X’.

$$h_{thermal\ conductivity} = K_{thermal\ conductivity} * A_{surface\ area} \frac{\Delta T}{X_{thickness}}$$