David Sellers

From:	David Sellers
Sent:	Saturday, June 1, 2019 11:53 AM
To:	Hunt, David
Subject:	RE: Follow-up
Attachments:	Reset Savings Calc v2.xlsx

Hi David,

I just figured out the problem with the video and it is rending as I type this. I will upload it to Hightail once it is done. That may happen later today depending on how long it takes to process because we have to drive down to Salem in a bit, so if its not done by then I will have to do it this evening.

I also realized I forgot to attach the example of a reset calculations, so I have attached that. Most reset schedules as well as the losses through pipe insulation relative to temperature difference are linear. So you can use the equation of a straight line to develop a relationship between outdoor temperature and hot water supply temperature and then hot water supply temperature and losses through the insulation for doing the spreadsheet calculations.

So, for instance, if you use 3EPlus to come up with the losses through a given pipe size with a given insulation thickness for two different temperatures - for instance, your maximum and minimum temperatures - then you can develop an equation for loss as a function of hot water temperature. This page of the web site …

http://www.av8rdas.com/y--m--x--b-spreadsheet.html

… has a spreadsheet tool that has the equation of a straight line built into it an also a bit of discussion about the topic for an number of building system applications.

The other way to come up with the relationships you need is to plot them in Excel and then use the trend line function to do a curve fit to your data. That is the approach I used in the example I have attached.

The example is in the form of a bin data calculation but you would use the same basic procedure for an hour by hour calculation using one of the psych chart weather data files. The basic steps are:

1. Establish the base case by:

    a. Using 3EPlus to calculate the loss for each line size\insulation thickness you need to assess.

    b. Total up the feet of pipe in your system. As I mentioned yesterday, this does not have to be exact, just a reasonable estimate based on the piping geometry, number of risers, etc. As you play with 3EPlus, you will probably notices that the losses for similar sized

lines are not that different. So you can probably expedite your process by combining line sizes that have similar loss characteristics.

c. For a system that operates at a fixed temperature the loss will always be the same for all hours the system is up to temperature. So, once you know the Btu/hr/ft loss for each line size and how many feet of that size there are, you just multiply the hourly loss per foot by the number of feet and the number of hours the system is hot (24/7 for you, right?) and total it all up.

d. That number represents the energy that left the system. To come up with the fuel that went into the boiler, you have to divide the losses by the boiler efficiency.   If you don't know it for sure, there are some things you can do to estimate it, which I discuss in this blog post.

https://av8rdas.wordpress.com/2016/03/20/retrocommissioning-findings-reducing-boiler-purge-cycle-losses/#FlueGasTemp

e. Once you adjust for boiler efficiency, you multiply that by your fuel cost and that is about what you are spending for losses from the pipe with out a reset schedule.

f. Note that technically, since the return temperature is different from the supply temperature, you will need to do this calculation twice, once for the feet of pipe on the supply side at the supply temperature and then again for the return.   But if your temperatures are not that different, you may be able to use the average temperature times the total (supply plus return) feet of pipe.

Basically, its an engineering judgment call. But truth be told, once you get the formulas built into the spreadsheet, changing a couple of numbers and doing the two calculations is not that big of a deal time wise.

2. Establish the losses that will occur with a reset schedule in place. The process for estimating what the losses are with a reset schedule is similar but, since the supply temperature varies with outdoor temperature and the losses vary with the water temperature, you have to do the calculation for each condition.

In the olden days, when we were doing this all by hand (a spreadsheet was made out of paper and you had a 4 function calculator and a slide rule), or even in the early computer days, doing 8,760 rows of calculations was not practical, so we used bin data, which is what the example does. But now, with a spreadsheet, once you write the formulas for the first row in an hour by hour weather data file, you can just copy and paste them down the sheet and doing 8.760 calculations is not a big deal.

In fact, I could quickly change my bin example to an hour by hour example simply by loading up the hour by hour file, and using the same formulas I used for a given row/bin in the bin calculation. I just have not taken the time to do that yet.

Anyway, the steps are:

    a. Figure out what the upper and lower limits of your reset schedule are and develop the equation for calculating supply temperature based on outdoor air temperature as I discuss above.

    b. For the upper and lower limits, for each line size you are dealing with:

        i. Use 3EPlus to come up with the losses associated with the upper and lower temperatures and then

        ii. Develop the equation for losses as a function of water temperature for each line size.

    c. Calculate the hot water temperature associated with the outdoor air temperature for a given hour.

    d. Use the hot water temperature you came up to calculate the losses from each line size for the hour you are dealing with.

    e. Add all of those losses up to get the total losses for the hour.

    f. Copy and paste those formulas all the way down the spreadsheet.

    g. Total up the losses for the year and divide them by boiler efficiency and the multiply by your fuel cost.

    h. The difference between this number and what you came up with for the base case is what you will save.

You will have to make an assumption about what the return water temperature will do when you do the reset schedule. And while it is true that the lower water temperatures will change the heat transfer characteristics of the coils, and other loads, it is reasonable to assume that the delta t you are seeing will persist and simply occur at lower temperatures. In other words if your system is currently going out at 170°F and coming back at 155°F (a 15°F delta t) then for each hour or bin in the calculation, it is reasonable to assume that the return temperature will be 15°F lower than the supply temperature.

Note that you may need to use some logic in your water temperature calculation to cap it at a certain temperature. For instance, you probably don't want to reset to the point where you would condense in your boilers (the O&M manuals tell you how low you can safely go usually, but if you can't find that, probably don't go below 130-140 °F on the return side). So, when you calculated the reset temperature, you would do some logic to see if the calculated temperature was below your limit. If it was not, then you would use the calculation result, otherwise, you use your limit temperature.

Hope this helps,

Kathy and I had a pleasant late afternoon and evening that included several glasses of wine; thanks for asking.

Take care,

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From: Hunt, David <David.Hunt@marriott.com>
Sent: Saturday, June 1, 2019 5:51 AM
To: David Sellers <dsellers@facilitydynamics.com>
Subject: RE: Follow-up

David, thanks again for all you help and calming nature, I hope I didn't cut into too much of your time yesterday and you and Kathy got to do your walk and wine outing.

If you are able to get the recording working I would enjoy watching it a few more times as a refresher and help me absorb more.

Thanks again!

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Please consider our environment before printing this e-mail

From: David Sellers <dsellers@facilitydynamics.com>
Sent: Friday, May 31, 2019 10:29 PM
To: Hunt, David <David.Hunt@marriott.com>
Subject: Follow-up

Hi David,

Outlook in its wisdom has decided that it is in fact O.K. for me to connect to my account again.

For some reason, the video has not rendered; I suspect I bored the crap out of the application and it fell asleep.

But, I have uploaded the spreadsheet to Hightail so you can reverse engineer it (it was too big to attach; you should get a notification that you have a file to download in the next little bit).

I hope you are taking some time to relax. You are doing great and I really enjoy working with you on this stuff.

Take care,

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