Tuning GateCycle Models to Match HRSG Vendor Data for Fired Cases

When the HRSG temperatures are high (> 1100F) as a result of supplemental firing, the default correlations in GateCycle can have difficulty matching HRSG vendor predicted performance. GateCycle and most other commercial heat balance software packages) use the Effectiveness – NTU method to model HRSG heat exchangers. Most HRSG vendors use a much more detailed modeling method that requires tube level geometric data rather than the overall surface areas required by GateCycle. There are a couple of problems with the Effectiveness – NTU method when it is used to model heavy supplemental firing cases. The Effectiveness – NTU method does not account for radiative heat transfer that is present under heavy supplemental firing conditions. Furthermore, the underlying assumption in GateCycle is that the gas side limits the overall heat transfer coefficient. With heavy supplemental firing, this may not be the case as the steam side could be the limiting factor. We are aware of these issues and we are working to add tube level calculations to GateCycle. Unfortunately, the first release of this capability is targeted for internal GE use only. There are some proprietary pieces that must be stripped out and made more generic before we can release the feature commercially.

In the meantime, there are a couple of ways to account for these shortcomings and better match HRSG Vendor data.

1. One can tune the off design correlation that is used for calculating the overall heat transfer coefficient (U) when GateCycle is run off design. The default off design correlation for U is as follows:

$$U_{OD} = U_D \left(\frac{\dot{m}_{OD}}{\dot{m}_D} \right)^x \left(\frac{T_{OD}}{T_D} \right)^y \left(\frac{P_{OD}}{P_D} \right)^z$$

where:

$x = 0.8$

$y = 0.0$

$z = 0.0$

To tune the off design correlation to match vendor data for high gas path temperature cases, we recommend introducing a temperature effect by specifying a non zero value for y, the exponent of the off design correlation's temperature term. y can be specified by pressing the Correlations button on the input form for any heat exchanger icon. Good results have been obtained by using a temperature term exponent between 1.2 and 4.0. A good starting value is 1.8. Use higher exponents (2.0 – 4.0) for hotter gas path temperatures (> 1100 F) and lower exponents (1.2 – 2) for lower (approximately 1100F) gas path temperatures.

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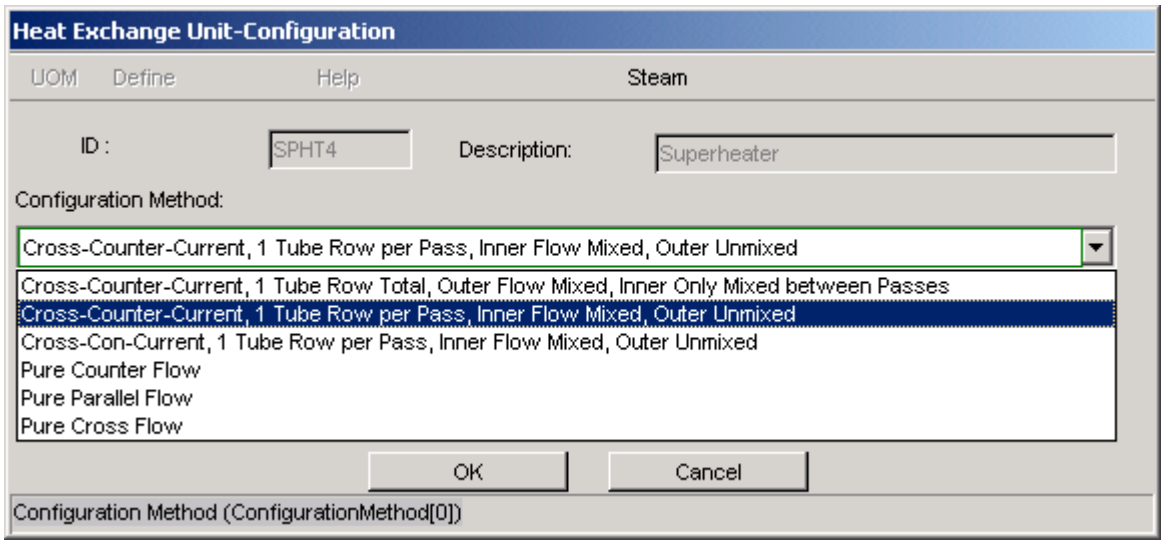
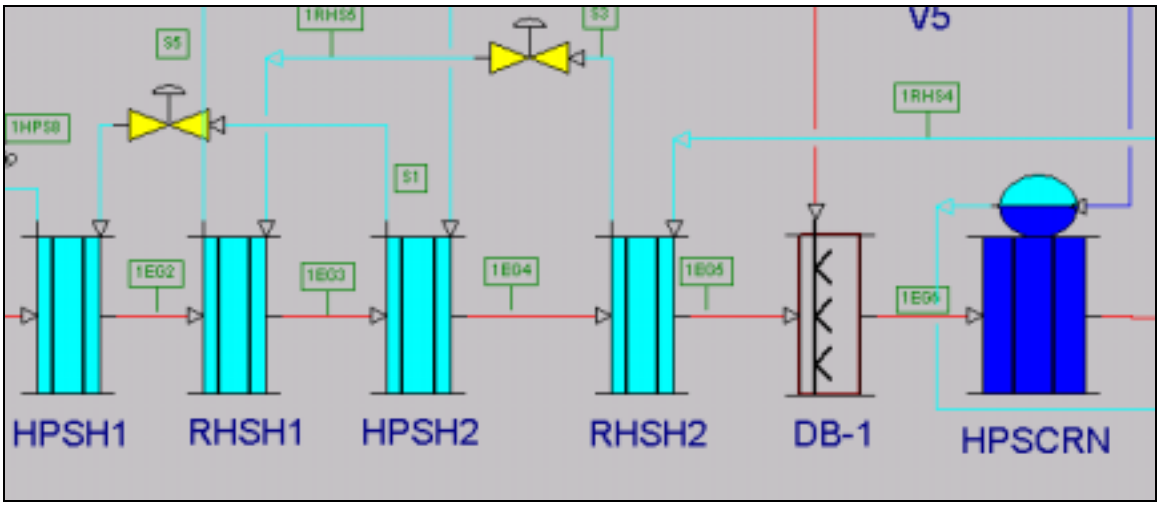
2. Use the new configuration methods found in the Superheater and Economizer icons to change the underlying Effectiveness – NTU relationship used by GateCycle. This can be helpful for modeling HRSGs where colder steam is heated by the hottest gas to allow the use of cheaper tube materials. The configuration screen is shown below and is displayed by pressing the ***Configuration*** button found on the main data entry form for superheater and economizer icons running in design mode.



3. Place some surface that the vendor says is upstream of the Duct burner down stream of it. GE Enter has had success putting a portion (~10%) of the superheater section that the vendor shows upstream of the duct burner, right downstream of the duct burner. We use the vendor's gas path temperatures in the design case to guide how we apportion the area. The model diagram excerpts below illustrate this technique graphically:



Vendor's Layout of HRSG

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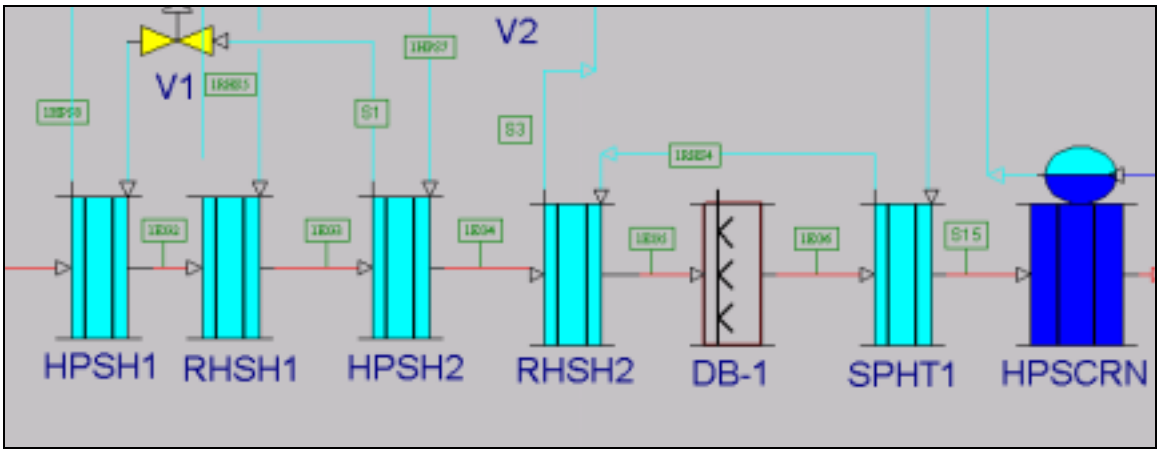

Modified Layout using Fictitious SPHT1 that has 10% of RHSH2's surface area

4. Use macro's to modify GateCycle's overall heat transfer coefficient so that it includes tube level effects. This approach will require detailed information on the geometry of your particular HRSG.

In general, using options 1 and 3 together usually gives the best results with the least amount of effort. It is usually best to use the max fired case for your design point and then tune the model to match an unfired case. Once this is done, it is desirable to use another fired case (different from the design case) to validate the tuned model. Ideally, you will simply copy the tuned unfired off design case, change the appropriate inputs and see a decent match between the calculated steam flows and temperatures and those quoted by the vendor.

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