

Exploring Sigmafine Energy Balance Application

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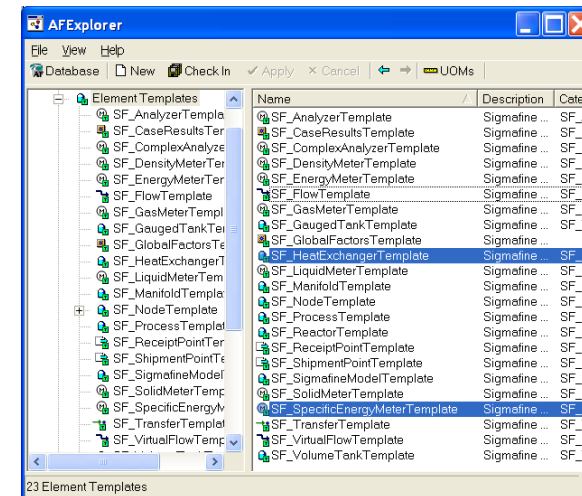
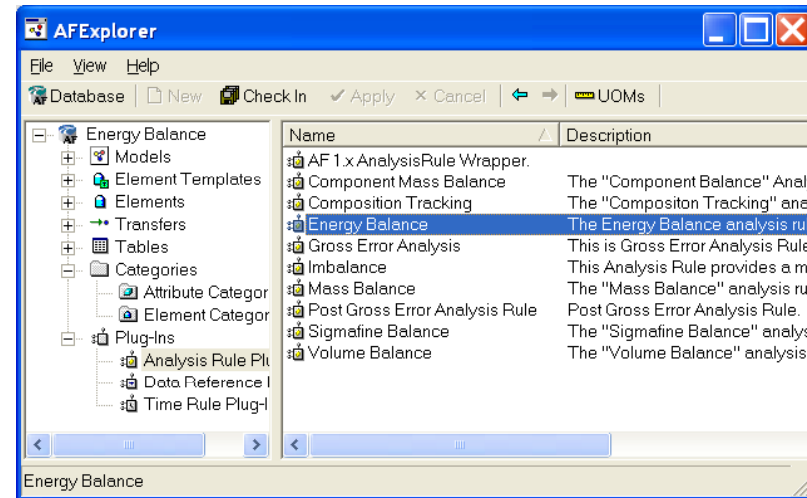
Agenda

- What do we have to begin with?
- What do we need?
- What have we done so far?
 - The Steam Table DR
 - The Flue Gas DR
- Putting the pieces together
- What can we do next?

What do we have to begin with?

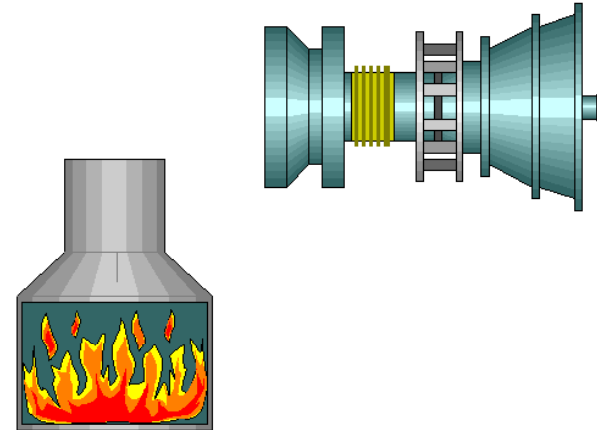


- Sigmafine Energy Balance Analysis Rule
 - Sigmafine Reference Manual – Appendix L
 - Heat Exchanger Templates
 - Specific Energy Templates
 - Other essentials like Process, Nodes, Flow, Meters Templates



What do we need?

- More Heat/Energy Transfer Equipments Types
 - Boilers, Turbines, etc
- Energy Calculations
 - Performing Energy Balance requires sufficient energy measurements so that the model is at least solvable
 - Besides power plants MW measurement, production plants do not measure energy directly

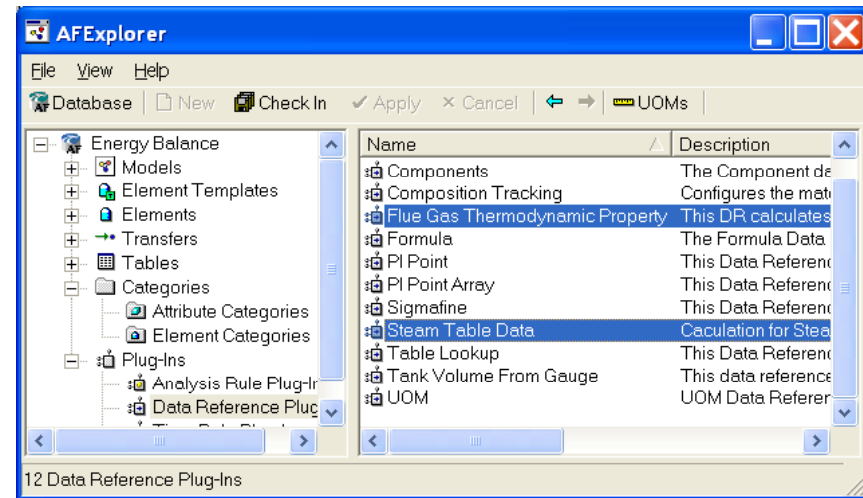


$$P_r = P_t \int \frac{\lambda^2 g_t g_r}{(4\pi)^2 r_1^2 r_2^2} \sigma dV$$

What have we done so far?



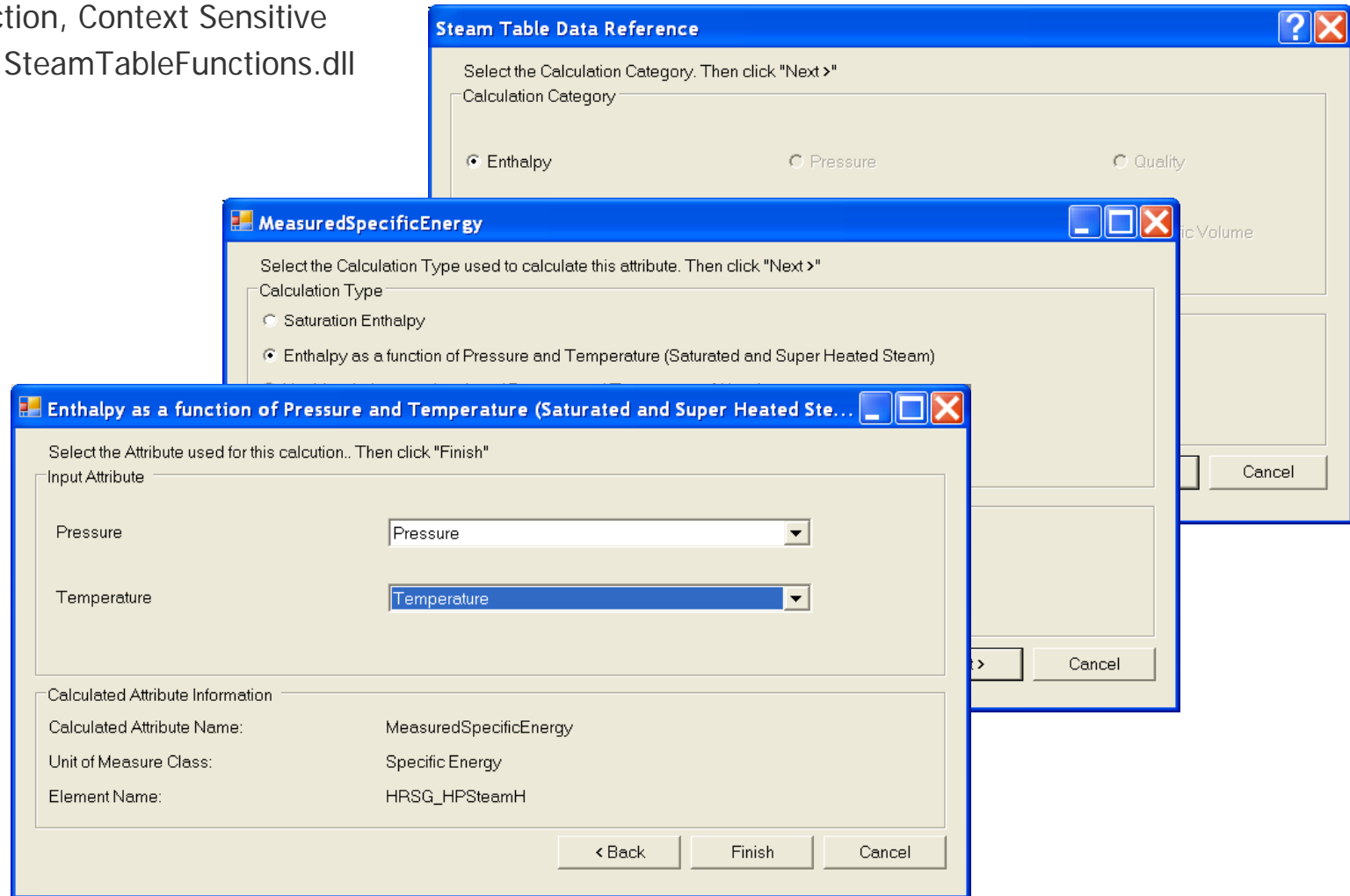
- Created a Steam Table Data Reference
 - Most common medium in the industry for heat transfer
 - To be used in Specific Energy calculation
- Created a Flue Gas Property Data Reference
 - Useful to model the process side of heat transfer equipments
 - To be used in Specific Energy calculation



The Steam Table DR



- Full Function, Context Sensitive
 - Uses PISteamTableFunctions.dll



The Flue Gas Properties DR



- Full Function, Context Sensitive
 - Thermodynamics and transport properties
 - Base on flue gas components such as N2, CO2, H2O, O2 and Ar
 - Mainly used to calculate enthalpy of flue gas

The image shows two overlapping software dialog boxes. The background dialog is titled "Flue Gas Thermodynamic Properties Data" and contains a "Calculation Category" section with radio buttons for "Specific Enthalpy" (selected), "Saturated Enthalpy", "Specific Entropy", and "Saturated Entropy". Below this is a "Calculated Attribute Information" section showing "Calculated Attribute Name: ReconciledSpecificEnergyCorrection", "Unit of Measure Class: Specific Energy", and "Element Name: GT_GasSpecificEnergy1". The foreground dialog is titled "Specific Enthalpy" and prompts the user to "Select the Attribute used for this calculation.. Then click 'Finish'". It features an "Input Attribute" section with a "Composition (in Mol Fraction)" group containing dropdown menus for N2, O2, Ar, CO2, and H2O, and "Pressure" and "Temperature" dropdown menus. The "Calculated Attribute Information" section in this dialog shows "Calculated Attribute Name: ReconciledSpecificEnergyCorrection", "Unit of Measure Class: Specific Energy", and "Element Name: GT_GasSpecificEnergy1". Buttons for "< Back", "Finish", "Cancel", "Next >", and "Cancel" are visible at the bottom of the dialog.

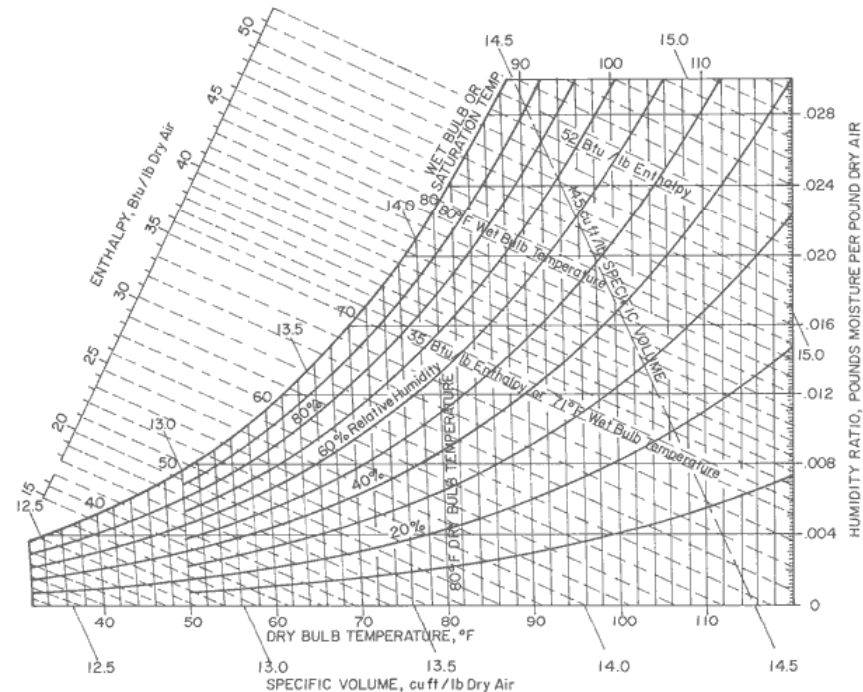
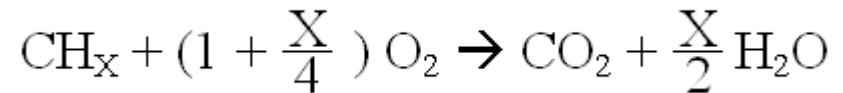
What can we do next?

- Develop combustion calculations
 - Consider using Formula DR; or a custom DR
 - Calculate mass and energy balance around combustion process

- Develop air properties DR
 - Support combustion calculations
 - Enable ambient conditions to feature in the model

- Build more details for each piece of equipment to reflect actual plant configurations

- Build KPI calculations
 - Heat rate, equipment efficiency, etc



$$\text{Efficiency (in \%)} = \frac{P_{\text{out}}}{P_{\text{in}}} \times 100$$

Thank you

