March 15, 2009

Dear Customer,

We are pleased to enclose a major upgrade to our software suite, Version 19, with the following highlights:

(1) Post-combustion capture of CO2 from flue gas in combined cycles, and pre-combustion CO2 capture in IGCC plants are available in GT PRO/MASTER.

(2) Post-combustion CO2 capture from flue gas is available in STEAM PRO/MASTER.

(3) CO2 capture using physical or chemical absorption is available in THERMOFLEX to extract CO2 from flue gas or syngas streams.

(4) GT PRO and GT MASTER include a large-format comprehensive heat balance diagram to display detailed heat and mass balance results for the entire plant model on a single flowsheet. A 4ft x 3ft (1220mm x 914mm) comprehensive heat balance printout for an IGCC plant is included to demonstrate this new feature.

(5) STEAM PRO and STEAM MASTER include a grate-fired boiler option for modeling plants burning low grade fuels like municipal solid waste.

(6) THERMOFLEX/PEACE includes additional shell-tube heat exchangers for use with a variety of fluids in liquid, two-phase, and vapor states.

(7) THERMOFLEX Solar Field now includes linear Fresnel collector configuration, direct steam generation (DSG) capability, and cost estimation.

These developments along with other smaller improvements are described in more detail below.

GT PRO / GT MASTER / PEACE

Post-combustion CO2 capture using an amine-based chemical absorption process is available. The model includes auxiliary power estimate and thermal interaction between the power plant and the separation process, so the computed result represents overall integrated plant performance. This feature facilitates analysis of the impact that post-combustion carbon capture and sequestration (CCS) has on combined cycle gross/net electric capacity and efficiency, installed plant capital cost, and plant economics.

Pre-combustion CO2 capture from high pressure syngas using a physical absorption process is available for IGCC plants. The high pressure, low temperature syngas is treated in a physical absorption process using solvents such as Selexol, or others. The model adds heating and cooling loads to the plant, and consumes electricity to power CO2 compressors that deliver relatively pure CO2 at high, often supercritical, pressures. As with post-combustion capture, this model permits analysis of the impact that pre-combustion carbon capture and sequestration (CCS) has on IGCC gross / net electric capacity and efficiency, installed plant capital cost, and plant economics.

The Acid Gas Removal (AGR) model used for syngas cleanup in IGCC plants has been improved. The prior black-box model was replaced by a gray-box model that captures the interactions between the power island and the gas cleanup process in more detail. The heat required to drive the process can be delivered from the steam cycle to the AGR reboiler. The amount of CO2 removed along with the H2S is more easily modeled. The cost function is more sensitive to the AGR configuration.

Historically, GT PRO and GT MASTER relied on the Cycle Flow Schematic together with a number of sub-system graphics to present the overall plant heat balance and sub-system details. TFLOW19 introduces a Comprehensive Heat Balance Diagram to collectively display data from all these diagrams, plus some additional information previously shown only in text reports. Using the mouse, the user can zoom in/out and pan around the diagram to review results for all plant subsystems. The diagram uses AutoDesk DWF format and may be saved in PDF format, or printed on large format printers. A sample printout is included with these update materials to demonstrate the capability.

GT PRO now evaluates tube stress for user-defined boiler tubes to ensure the tube wall is sufficient to withstand design stress. GT MASTER tests wall stress for all cases at current pressure and temperature. Additional inter-HX pressure drops are available in GT PRO and MASTER. The auxiliary power reported by GT PRO is now the same regardless of whether PEACE is used, or not.

Gas Turbine Data Base

The gas turbine data base, used by various Thermoflow products was updated, as shown below.

Engines added to the database			
355	MHI 701F(4)[1]	358	RR TRENT 60 DLE (50 Hz)
		359	RR TRENT 60 DLE (60 Hz)
356	Siemens SGT 5-3000E	360	RR TRENT 60 WLE (50 Hz)
357	Siemens SGT 6-5000F	361	RR TRENT 60 WLE (60 Hz)
365	Siemens SGT 6-2000E (33 MAC)		
366	Siemens SGT 6-2000E (41 MAC)	362	GE LM6000 PG SAC (60 Hz)
		363	GE LM6000 PG SAC (50 Hz)
367	Ansaldo V64.3A		
368	Ansaldo V94.2	372	Hitachi H-25
369	Ansaldo V94.3A		
		370	Kawasaki GPB 80D

364	Solar Titan 250	371	Kawasaki GPB 180D
Existing engines with modified performance			
324	Siemens SGT 5-4000F	304	Siemens SGT5-3000E

Anyone using the GE APPS program to compute GT performance in GT PRO or GT MASTER should download APPS 3.7.6 from the GE website.

THERMOFLEX / PEACE

The following new components were introduced in this version.

An Intercooled Compressor component (General tab) was introduced to make it easier to model multi-stage compressors with intercooling. Previously, an intercooled compressor model would be built using a number of compressor + heat exchanger + moisture separator components. This is still possible, but in many cases the Intercooled Compressor will be easier to use.

The CO2 capture features used in GT PRO/MASTER and STEAM PRO/MASTER use a number of new THERMOFLEX components, described below.

CO2 capture from low pressure flue gases with moderate to small CO2 concentrations is accomplished using the Chemical Absorption CO2 Capture component (Flue Gas tab). This is a model of an amine-based chemical absorption process, typically using MEA or other similar solvents. Heat and cooling is supplied to the process from the network. The component estimates auxiliary power to run pumps, and computes heating and cooling flows based on CO2 capture rate and other inputs. Captured CO2 can be connected to a compressor and piping system for further processing. The model includes cost estimation.

CO2 capture from high pressure syngas with high CO2 concentrations is accomplished using the Physical Absorption CO2 Capture component (Gasification tab). This component models a physical absorption process using solvents such as Selexol, etc. Captured CO2 from flashtanks at several pressure levels may be connected to compressors in the network. Heat and cooling is supplied to the process from the network. The component estimates auxiliary power to run pumps, and computes heating and cooling flowrates based on CO2 capture rate and other inputs. The model includes cost estimation.

An Acid Gas Removal (AGR) component (Gasification tab) using either chemical or physical absorption, is available for removing H2S from fuel streams. Typically used to treat cooled syngas in IGCC plants, this component connects to heating and cooling streams in the THERMOFLEX network. It delivers a fuel stream with reduced H2S and somewhat less CO2. This component includes cost estimation.

A combined AGR/CO2 Capture component (Gasification tab) using either chemical or physical absorption is available, primarily for use in IGCC plants with pre-combustion CO2 capture. It removes sulphur and carbon dioxide from CO2-rich, cooled syngas downstream of a shift reactor. This component gets connected to heating and cooling streams in the THERMOFLEX network. It computes auxiliary power consumption, and heating and cooling flows. This component includes cost estimation. The Gas Cleanup System component (Gasification tab) has been modified to include this combined AGR/CO2 Capture component.

A Shell-Tube Condensing HX component (PEACE tab) was included to provide a physical-model counterpart to the virtual-model General Condenser introduced in TFLOW18. This new component can condense steam or NIST refrigerant vapors in the shell. Tube-side coolants can be water/steam (blue), brine (brown), heat transfer fluid (pink), liquid or vapor refrigerant (purple), liquid or gaseous fuel (orange), or even gas/air (red fluid). This component provides size, weight, and cost outputs.

A Shell-Tube General HX component (PEACE tab) was included to provide a physical-model counterpart to the virtual-model General HX component that has been part of THERMOFLEX since its inception. Like its virtual counterpart, it processes all fluid types, however, this component does not support phase change. This component provides size, weight, and cost outputs.

The following summarizes improvements to existing features, introduced in this version.

The Shell-Tube Economizer and Superheater models were modified so the heating fluid can flow on either the tube or shell-side. Both components provide additional flexibility in how the flows are established on both sides.

The Shell-Tube Evaporator model was modified to enable evaporation of NIST (REFPROP) refrigerants. Additional flow-control modes are available that let the component establish vapor flowrate, or accept the network-determined vapor flowrate.

The Solar Field component (General tab) now includes ability to model Linear Fresnel collectors in addition to its existing capability to model parabolic troughs. Collector type is chosen in Thermodynamic Design (TD) mode. The Solar Field now supports direct steam generation (DSG) in the receiver tubes for both the parabolic trough and linear Fresnel configurations. A new option for modeling general linear collectors is available for those users with access to Incident Angle Modifier (IAM) data for a known collector. The solar field output now includes estimated cost.

Thermodynamic property functions for red fluids (gas/air) were modified for high pressure conditions where simplified treatment of compressibility breaks down. THERMOFLEX provides an option on the **Others**tab of the **Current Settings** menu to use NIST properties in these cases, or to issue a warning for states in a computed model where the low pressure / high temperature assumption breaks down.

THERMOFLEX files can now link to STEAM MASTER models at the stack inlet "node"; that is after any flue gas treatment in the STM model. The Natural Draft Cooling tower (PEACE tab) now includes size, weight, and cost. Transport properties for gaseous and liquid fuels were added, thereby enabling physical equipment sizing based on pressure drop conditions for this fluid. Virtual models of the Electric and Absorption chillers can now be connected to heat transfer fluid on the coolant and chilled liquid nodes. Additional outputs are available including the flow and pressure matrices, useful for debugging model behavior.

ST PRO / STEAM MASTER / PEACE

Post-combustion CO2 capture using an amine-based chemical absorption process is available. The model includes auxiliary power estimate and thermal interaction between the power plant and the separation process, so the computed result represents overall integrated plant performance. This feature facilitates analysis of the impact that post-combustion carbon capture and sequestration (CCS) has on combined plant gross / net electric capacity and efficiency, installed plant capital cost, and plant economics.

A grate-fired boiler option is available from the **New Session** topic to model plants burning low grade fuels like municipal solid waste. Grate cooling may be accomplished by heating feedwater, or by preheating air. The air handling system was modified to include configurations used by grate fired boilers.

A second steam air heater was introduced so a unique SAH is now available for both primary and secondary air streams. For plants including a natural draft cooling tower, the tower's size, weight, and cost estimate are provided. An option to use the NDCT as the plant stack is also available.

Water balance and water accounting features were added, similar to features in GT PRO/MASTER. A new Environment topic was introduced. It includes the Emissions & Instrumentation inputs previously on the Other PEACE topic, along with Water Accounting and CO2 Capture inputs.

Superheater and reheater tube wall thicknesses were increased to prevent under sizing in high pressure/temperature situations such as in ultrasupercritcal plants. This will increase estimated cost of supercritical boilers.

DOCUMENTATION

Keeping with tradition, the context-sensitive online help available from within each program is the primary source of documentation. The online help is up-to-date. Printed documentation has been updated with the most significant changes. The following describes how to update your manuals.

· GT PRO Chapter 15 – Use the enclosed pages, from 15-13 through 15-48, to replace pages 15-13 to the end of your present Chapter 15.

· GT PRO Chapter 23 – Add this Chapter 23 after the existing Chapter 22, replacing any existing pages of an earlier Chapter 23.

· STEAM PRO Chapter 19 – Insert this new chapter after Chapter 18.

· THERMOFLEX Chapter 16 – Use the enclosed pages, 16-57 through 16-118, to replace the page 16-57.

· THERMOFLEX Chapter 22 – Use the enclosed pages, 22-49 through 22-79, to replace all pages after 22-48 in your Chapter 22.

GENERAL

Currency conversion factors and regional cost multipliers were updated based on currency data from the first quarter of 2009. Overall PEACE cost estimates, which had been revised significantly upwards in TFLOW18, were not adjusted for TFLOW19. Uncertainty in the global economic picture is likely to cause significant variability in project costs for the rest of 2009, and likely into 2010.

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[1] ID 355 was included in web revisions to the March 2008 TFLOW18 release.