



Welcome!

Webinar #2: SCRIPTS in Thermoflow Programs

- Introduction: Why Scripts?
- Scripts in GT PRO, GT MASTER and THERMOFLEX
- Script Definition
- Managing Script Variables
- Examples
- * Q & A Session

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Support: Meritt Elmasri (U.S. HQ)

Thermoflow Training and Support

- Standard Training
- On-site Training course
- Advanced Workshop
- Webinars when new version is released
- Help, Tutorials, PPT, Videos, ...
- Technical Support

→ Feature Awareness Webinars

Feature Awareness Webinars

1- Assemblies in THERMOFLEX

2- Scripts in Thermoflow Programs

INTRODUCTION: Why Scripts?

- Philosophy of Thermoflow software
- How to interact with Thermoflow programs
 - ELINK
 - ULINK
 - User Defined Components in TFX
 - Adjustment methods, Correction factors,...
 - **Scripts**

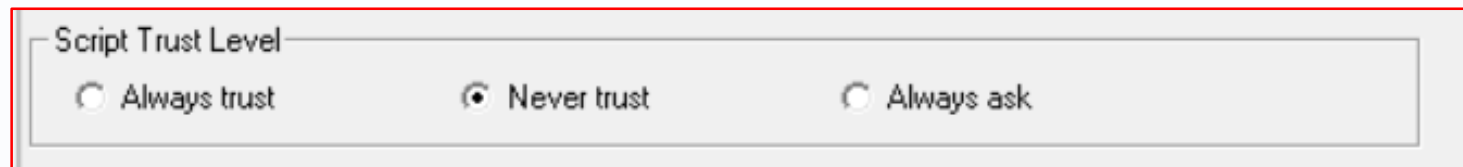
SCRIPTS in:

- THERMOFLEX, Version 23, since 2013
- GT MASTER, Version 24, since 2014
- GT PRO, Version 26, since 2016

SCRIPTS:

Scripting functionality allows users to create and compute custom outputs or to set certain inputs using code written in the scripting language Lua

Special Note: Scripts can be dangerous. They can link to and run code and other programs that are not immediately visible from the script editing. Do not run a script that you think may contain malicious or harmful code.

A screenshot of a software dialog box titled 'Script Trust Level'. It contains three radio button options: 'Always trust', 'Never trust', and 'Always ask'. The 'Never trust' option is currently selected, indicated by a filled radio button.

Basic Lua Documentation

THERMOFLEX uses the scripting language Lua, version 5.1.4.

Documentation in → <http://www.lua.org/>

Compiled Windows binaries, libraries, and a code editor

→ <https://github.com/rjpcomputing/luaforwindows>

Lua and Lua for Windows available under the terms of the MIT license

→ <http://opensource.org/licenses/mit-license.php>.

Full online documentation for version 5.1:

→ <http://www.lua.org/manual/5.1/manual.html>

SCRIPT Activation:

GT PRO

File View Edit Options Window Excel Link Compare Files **Scripts** Custom Variable List Help

System | Gas Turbine | HRSG | Steam Turbine | Cooling System | Energy Charts | Exergy Charts | Gasification | Desalination | Miscellaneous

Plant Summary

GT Selection	43197 kW	Ambient	15 C
GT Inputs	42207 kW	Ambient pressure	1.013 bar
ST-HRSG	989.7 kW	Ambient relative humidity	60 %
HRSG Inputs	6979 kJ/kWh	Ambient wet bulb temperature	10.82 C
Water Circuits	7143 kJ/kWh	Site cooling water temperature	15 C
HRSG Layout	51.58 %		
Cooling System	50.4 %		
ST Inputs	83741 kWh		
Environment	92920 kWh		
Other PEACE	0 kWh		
Economics			
Gasification			
Desalination			

13197 kW

35.78 T
49.97 M

1,013 p
98.5 T
324 M

50 p
471 T
41.86 M

Stop Valve

4.8 p
205.1 T
8,058 M

0.0586 p
35.73 T
49.69 M
0.89 x

0.013 M

to HRSG

CH4
8.024 M
83741 kWh LHV

1,003 p
15 T
318 M

1,003 p
15 T
318 M

30000 kW

User Def GT

LP IP HP

35.78 T
49.97 M

1,013 p
98.5 T
324 M

1,209 p
105 T
0.9393 M

5,216 p
164.2 T
8.058 M

53.43 p
268.1 T
41.86 M

1,037 p
340 T
324 M

141.1 T
135 T

218.7 T
109.2 T

472.9 T
283.1 T

p [bar] T [C] M [Mh]. Steam Properties: IAPWS-IF97

Click to view Plant Summary Table

GT MASTER

File View Options Tools Window New Session Control Loops Excel List Compare Files **Scripts** Custom Variable List Help

Main Inputs | Plant Criteria | GT Inputs | ST Inputs | HRSG Process | HRSG Inputs | Water Circuits | Control System | Insert | Customization | Detail Editor | Simulation | Design in GT PRO | COMPUTE

Did you know you can estimate project cashflow using a series of cases to represent operation throughout the year?
Click here to jump to 'Economics' tab to set Cashflow Method = 'Annual Model'.

Mode
 GT MASTER only
 GT MASTER & PEACE

Number operating GT/HRSG
 (1 in plant)
 (1 in plant)

Number operating ST
 (1 in plant)
 (1 in plant)

Simple cycle operation

User Def GT

THERMOFLEX

File Edit Options Define View Help

Scripts | Components | Test | Graphics | PEACE | Assemblies | Messages | Design | Multiple Runs... | Run from Excel

Control Loops
 Searcher
 Classic Macro Inputs
 Classic Macro Outputs
 Fix a Flow
 Fix a Pressure
 Shaft Power
 Energy Accounting
 Refrigeration COP
 Water Accounting
 ST Assembly
 HRSG Assembly
 Boiler Assembly
 Output Variable Message Thresholds
 Multi-HX TQ Diagram
 ST Moller Chart
 Custom Output Table
 Custom Efficiency
 User-Defined Component
 Title Block

97780 kW
96376 kW
47.13 %
43.53 kW

21 26 27 28 29 30 31 32 33

204497 kW

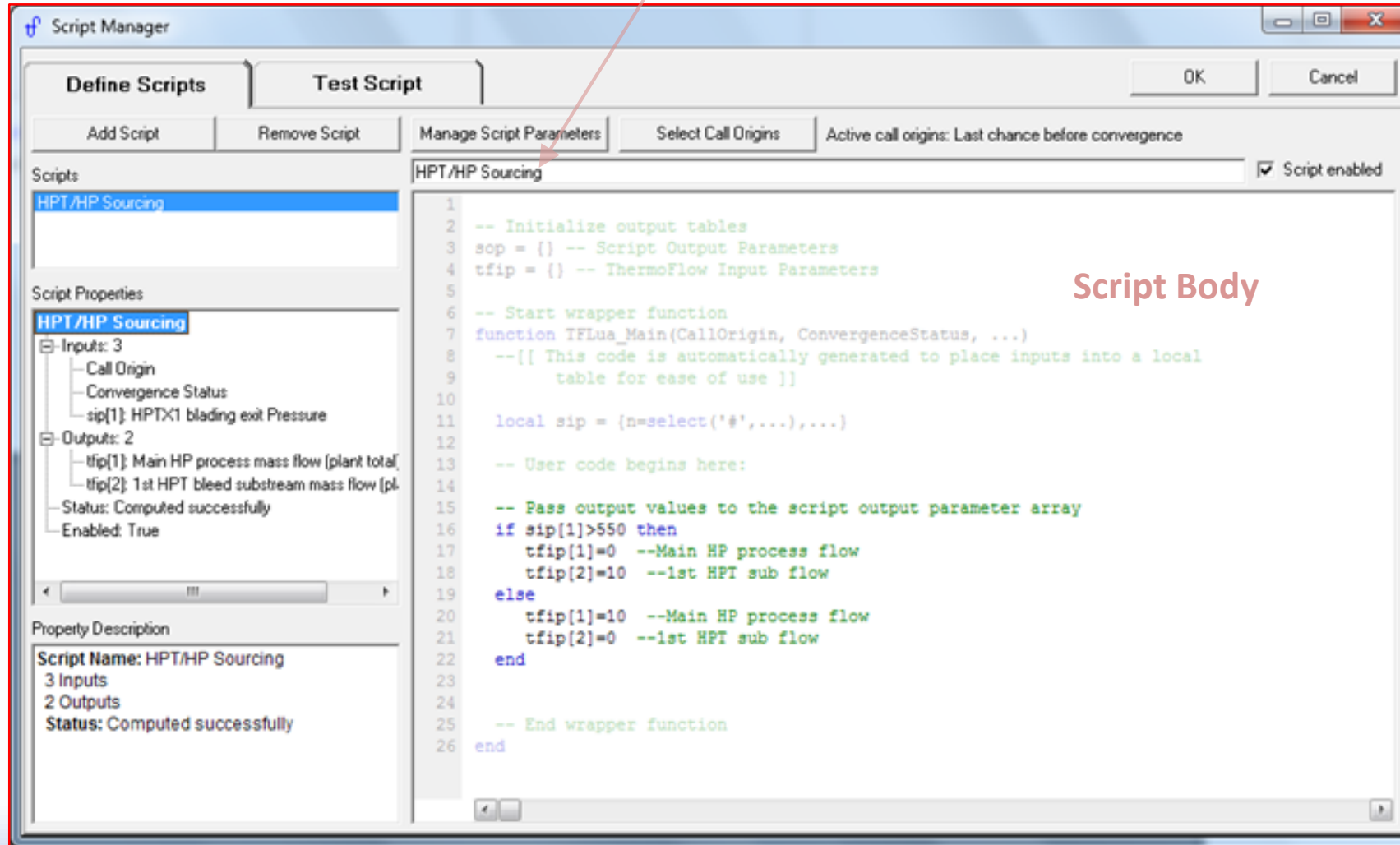
10292 kW

302.5 kW

9.017 kW

SCRIPT Definition:

Script Name



The screenshot shows the 'Script Manager' window with the 'Define Scripts' tab selected. The 'HPT/HP Sourcing' script is highlighted in the 'Scripts' list. The 'Script Properties' section shows 3 inputs and 2 outputs. The 'Script Body' section contains the following Lua code:

```
1 -- Initialize output tables
2 sop = {} -- Script Output Parameters
3 tfip = {} -- ThermoFlow Input Parameters
4
5
6 -- Start wrapper function
7 function TFLua_Main(CallOrigin, ConvergenceStatus, ...)
8   --[[ This code is automatically generated to place inputs into a local
9     table for ease of use ]]
10
11   local sip = {n=select('#',...),...}
12
13   -- User code begins here:
14
15   -- Pass output values to the script output parameter array
16   if sip[1]>550 then
17     tfip[1]=0 --Main HP process flow
18     tfip[2]=10 --1st HPT sub flow
19   else
20     tfip[1]=10 --Main HP process flow
21     tfip[2]=0 --1st HPT sub flow
22   end
23
24
25   -- End wrapper function
26 end
```

Script Body

SCRIPT Parameters:

Custom Script Inputs: name, description and Units (TFIP)

Script Inputs from program (GTP-GTM-TFX) : input parameters to be determined by the Script (TFIP)

Script Outputs: custom output parameters to be computed by the Script (SOP)

Script Inputs: inputs and outputs from the program required by the Script (SIP)
(Custom Script Inputs must be added here)

→ Caution: notice the difference on Units: “Current display” and “Native”

Unit conversion within the script is left to the user

SCRIPT Parameters:

Custom Input Parameters

Define custom input parameters for this model. The values of these parameters can be edited from the TFX Edit Inputs menu. The custom script inputs defined here are made available to any and all scripts in this file.

Number of Engines in operation	Number of Engines in operation
	New custom input

Unit
Unit label: None

Current display: Native:

Add [Up] [Down] Remove Select

Script Output Parameters (SOP)

Define custom script output parameters to be computed by this script.

	Name
	Description
	Unit

Current display: Native:

Add [Up] [Down] Remove Select

TFX Input Parameters (TFIP)

Select THERMOFLEX input parameters to be determined by this script.

Fuel Specification [14] : Flow divider value	Fuel Specification [14] : Flow divider value
Gas/Air Specification [7] : Flow multiplier value	TFX variable
Gas/Air Specification [13] : Flow divider value	
Water Specification [11] : Flow divider value	
Water Specification [12] : Flow multiplier value	
Water Specification [27] : Flow multiplier value	
Water Specification [28] : Flow divider value	
Power Device: Multiplier of Reciprocating Engine S	
Auxiliary Device: Multiplier of HRSGAssembly[1]; Ec	

Unit
Unit label: None

Current display: Native:

Add [Up] [Down] Remove Select

OK Cancel

Script Input Parameters (SIP)

Select the parameters required by this script. The call origin flag and the convergence status are always passed into the script and cannot be removed from this list.

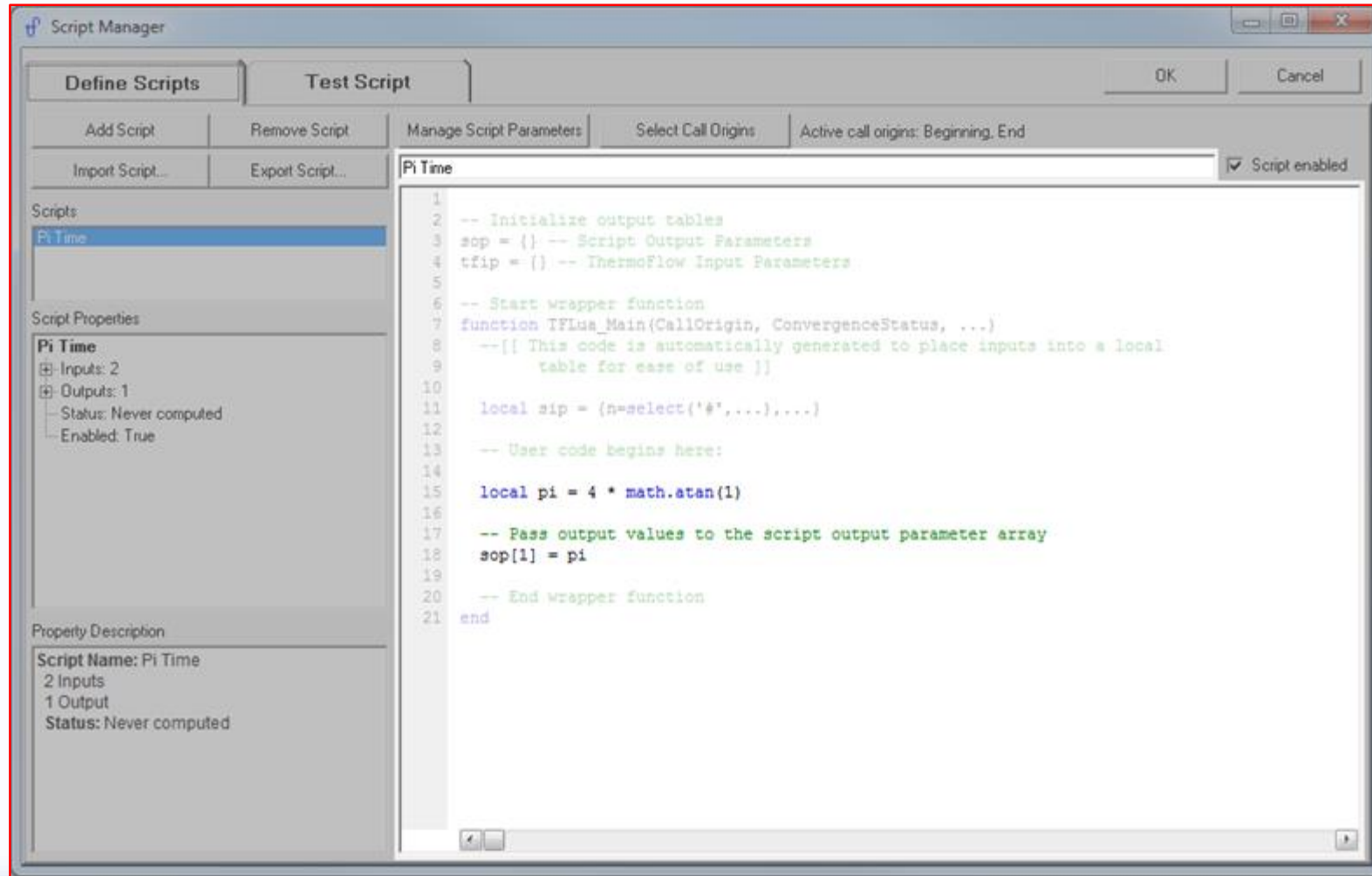
Call Origin	Call Origin
Convergence Status	
Custom Inputs: Number of Engines in operation	This value identifies the origin of this call to the script computation routine. See the scripting documentation for a more-detailed description.

Unit
Unit label: None

Current display: Native:

Add [Up] [Down] Remove Select

SCRIPT “Code”:



SCRIPT “Call Origin”

1. **At the beginning of computation** before anything else has been computed

Allows a script to set THERMOFLEX input parameters before beginning the computation.

2. **During the main computation loop**

Allows a script to set inputs during the computation instead of waiting for convergence. This can give a result faster, but is also more likely to make the model unstable.

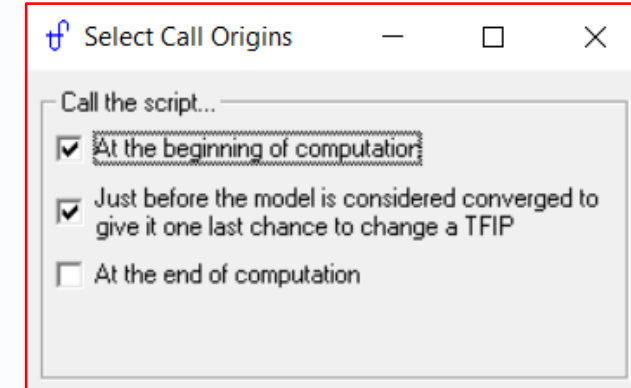
3. **Just before the model is deemed converged** to give the script one last chance to change THERMOFLEX input parameters (TFIPs)

Allows a script to set inputs that change the flow or pressure relational matrices

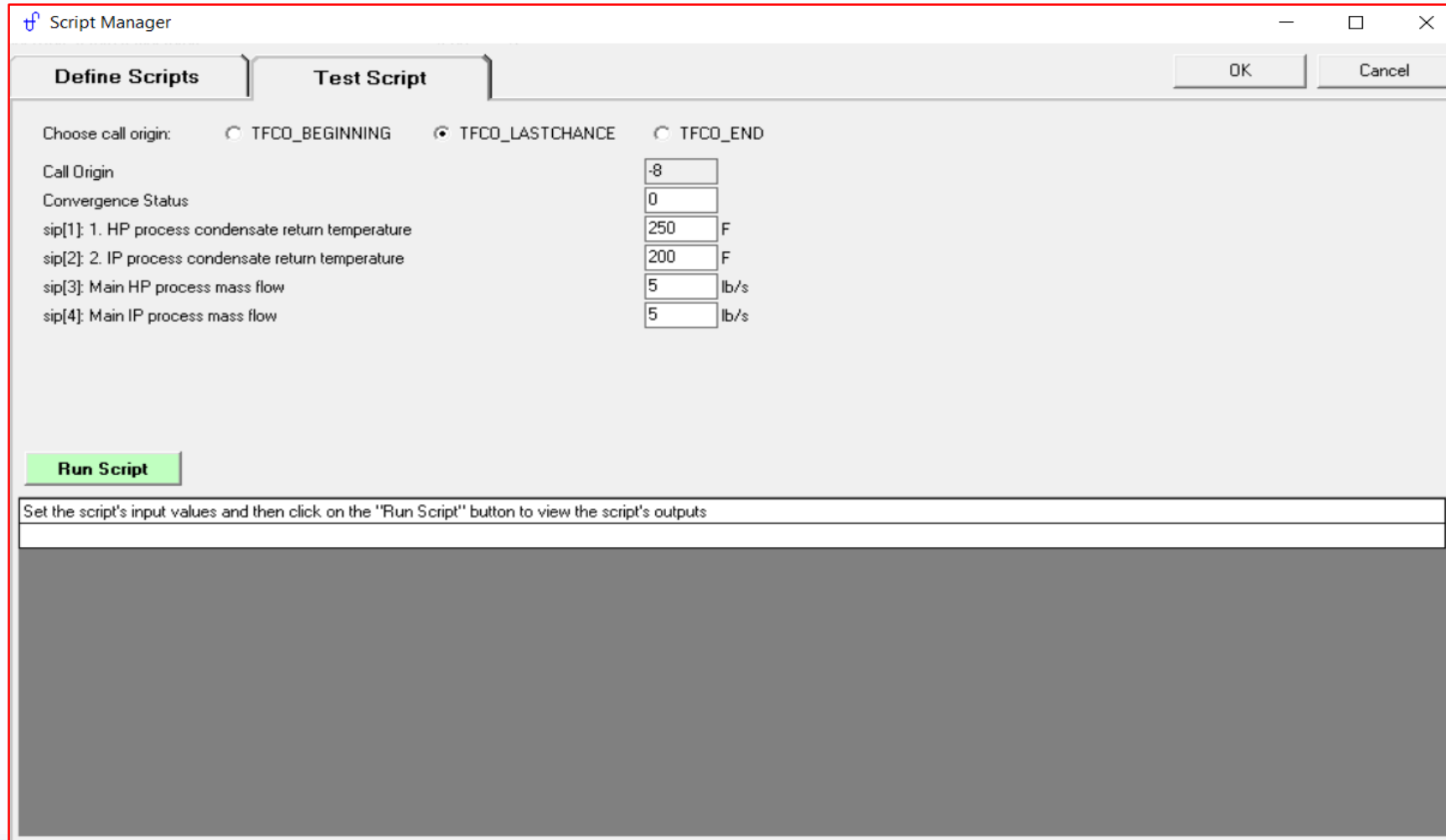
4. **At the end of computation** after all other outputs have been computed

Allows a script to compute custom outputs using the final results of the computation.

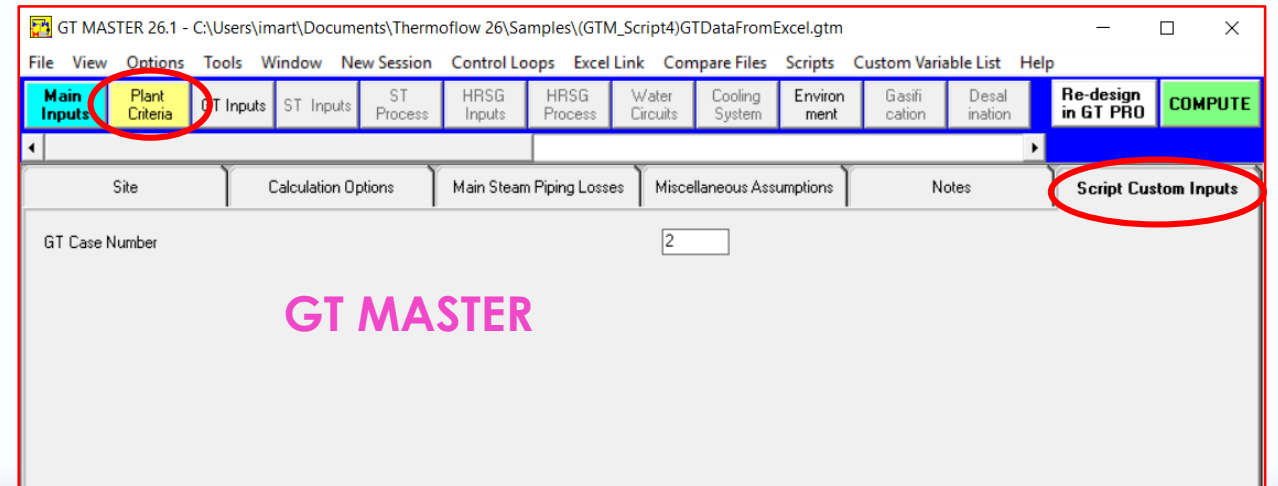
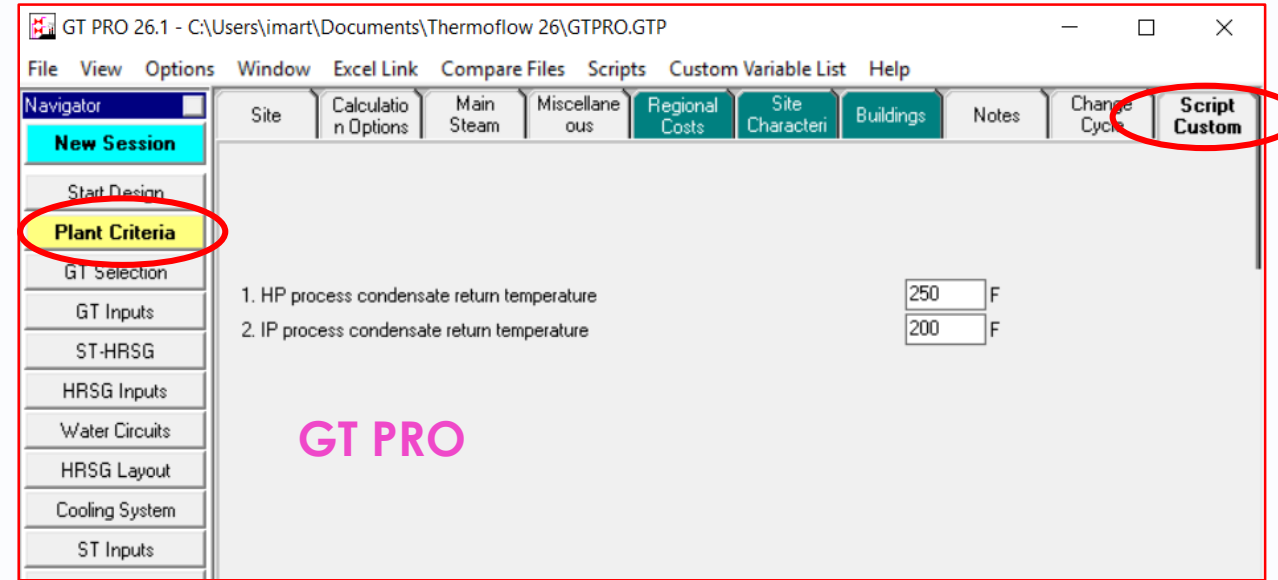
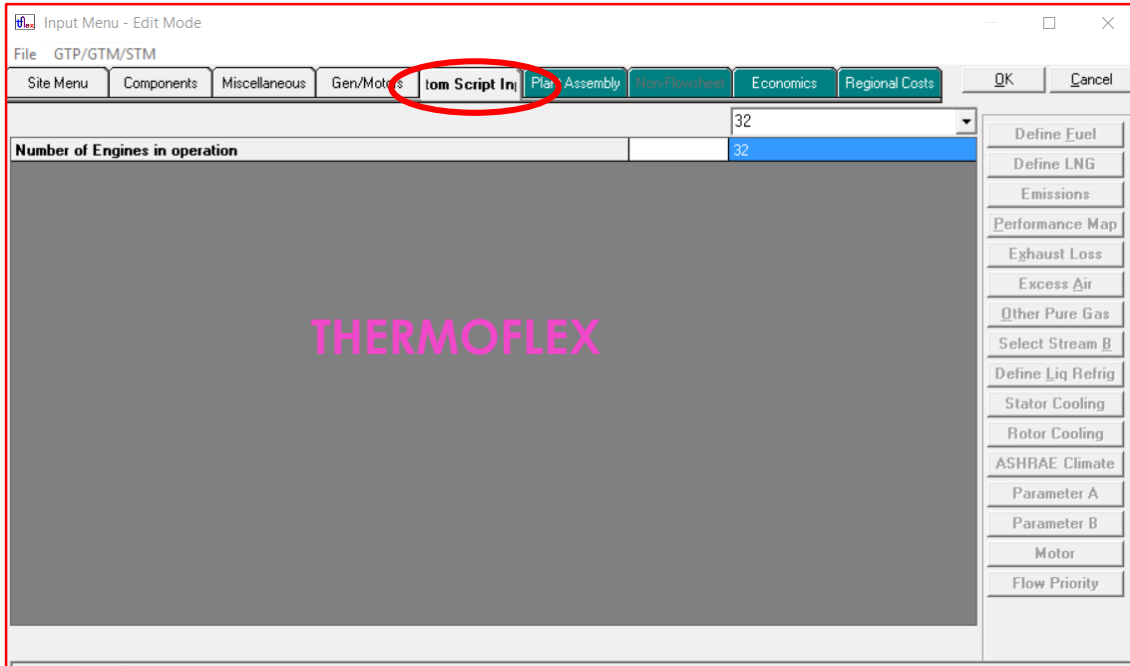
THERMOFLEX input parameters are not set at this time. Computation is over, so setting TFIPs to new values at this point would have no effect on the results.



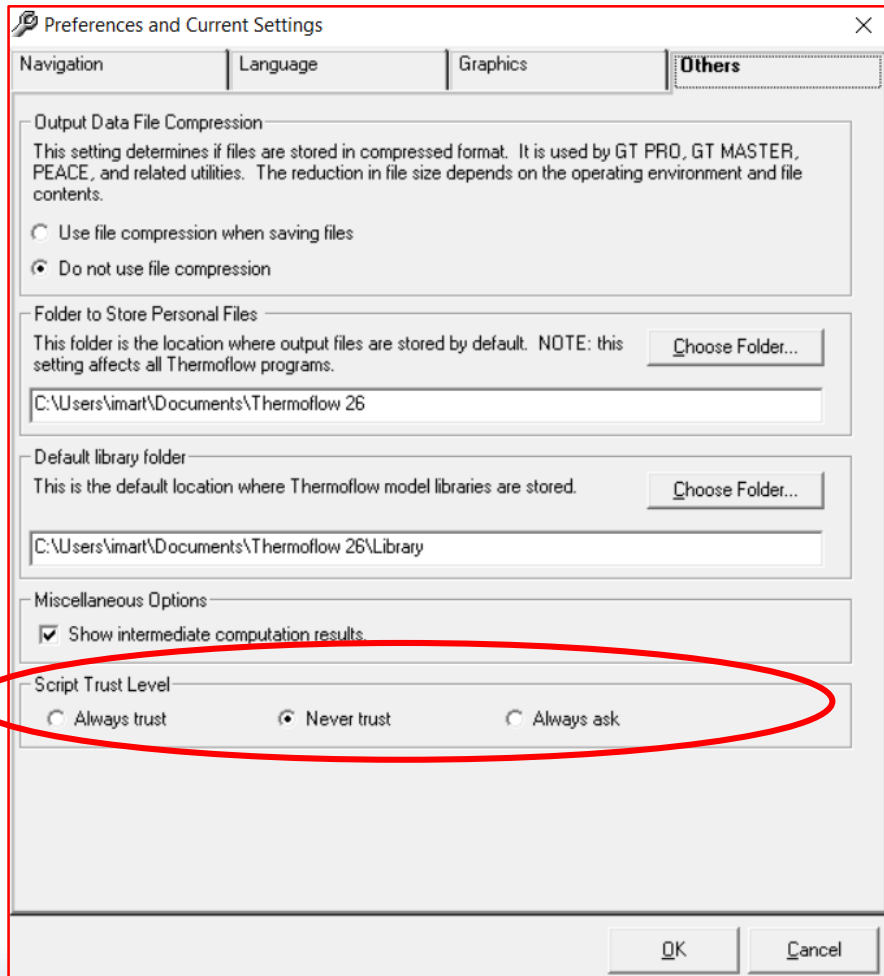
Test SCRIPTS



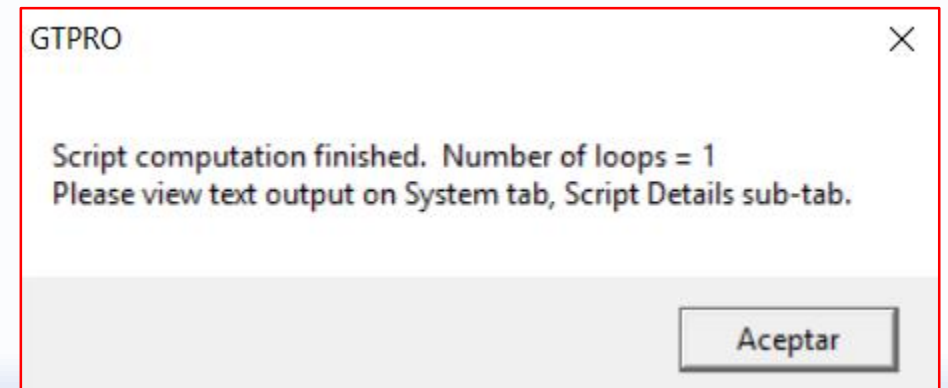
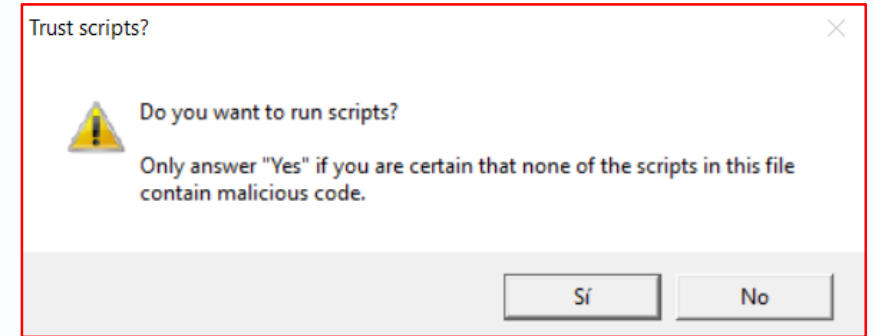
Edit SCRIPT Inputs



Run SCRIPT

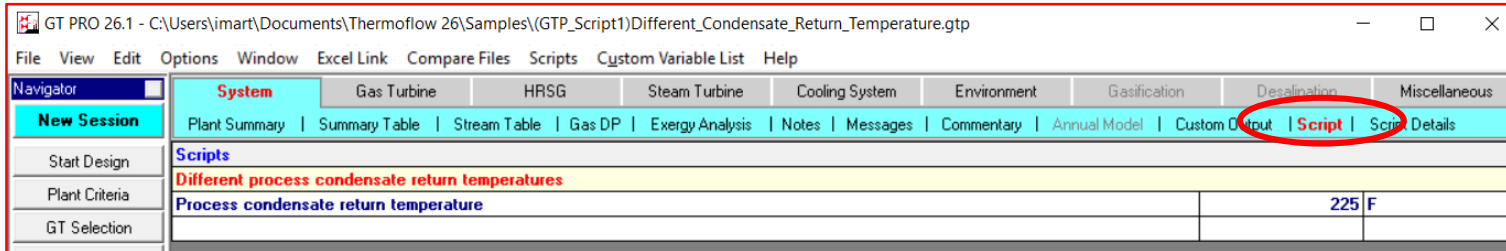


Compute



SCRIPT Outputs

GT PRO – GT MASTER



GT PRO 26.1 - C:\Users\imart\Documents\Thermoflow 26\Samples\GTP_Script1\Different_Condensate_Return_Temperature.gtp

File View Edit Options Window Excel Link Compare Files Scripts Custom Variable List Help

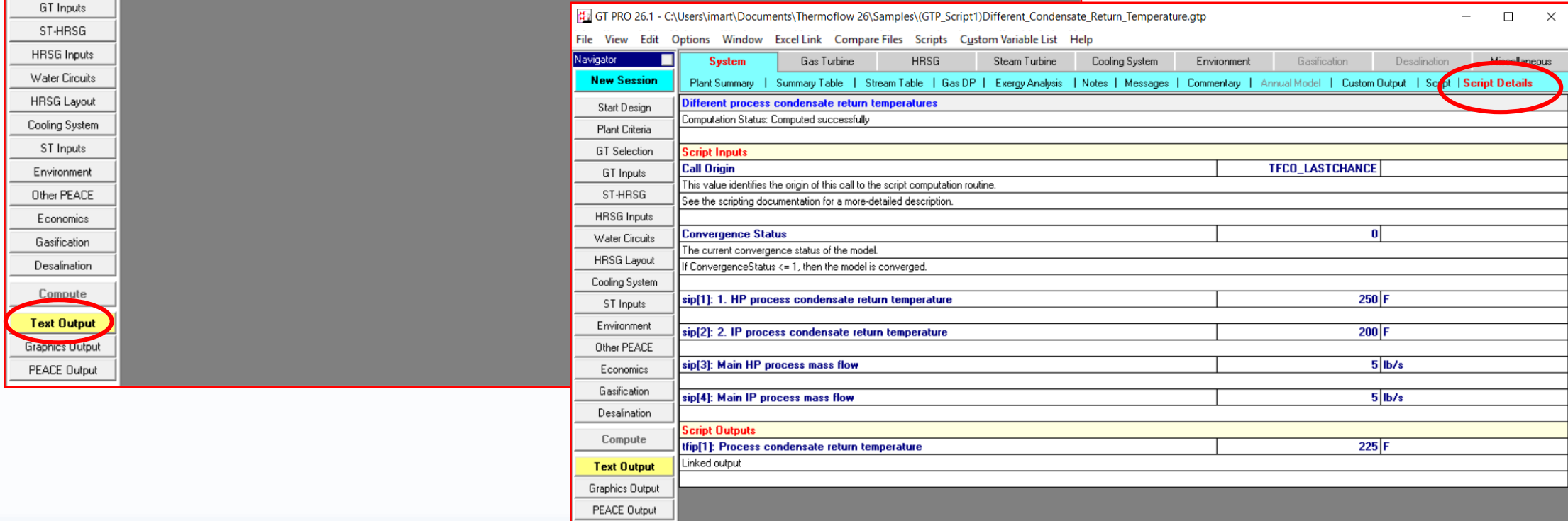
System Gas Turbine HRSG Steam Turbine Cooling System Environment Gasification Desalination Miscellaneous

New Session Plant Summary Summary Table Stream Table Gas DP Exergy Analysis Notes Messages Commentary Annual Model Custom Output **Script** Script Details

Scripts

Different process condensate return temperatures

Process condensate return temperature	225 F
---------------------------------------	-------



GT PRO 26.1 - C:\Users\imart\Documents\Thermoflow 26\Samples\GTP_Script1\Different_Condensate_Return_Temperature.gtp

File View Edit Options Window Excel Link Compare Files Scripts Custom Variable List Help

System Gas Turbine HRSG Steam Turbine Cooling System Environment Gasification Desalination Miscellaneous

New Session Plant Summary Summary Table Stream Table Gas DP Exergy Analysis Notes Messages Commentary Annual Model Custom Output Script **Script Details**

Different process condensate return temperatures

Computation Status: Computed successfully

Script Inputs

Call Origin

This value identifies the origin of this call to the script computation routine. See the scripting documentation for a more-detailed description.

TFCO_LASTCHANCE	
-----------------	--

Convergence Status

The current convergence status of the model. If ConvergenceStatus <= 1, then the model is converged.

0	
---	--

Script Inputs

sip[1]: 1. HP process condensate return temperature	250 F
sip[2]: 2. IP process condensate return temperature	200 F
sip[3]: Main HP process mass flow	5 lb/s
sip[4]: Main IP process mass flow	5 lb/s

Script Outputs

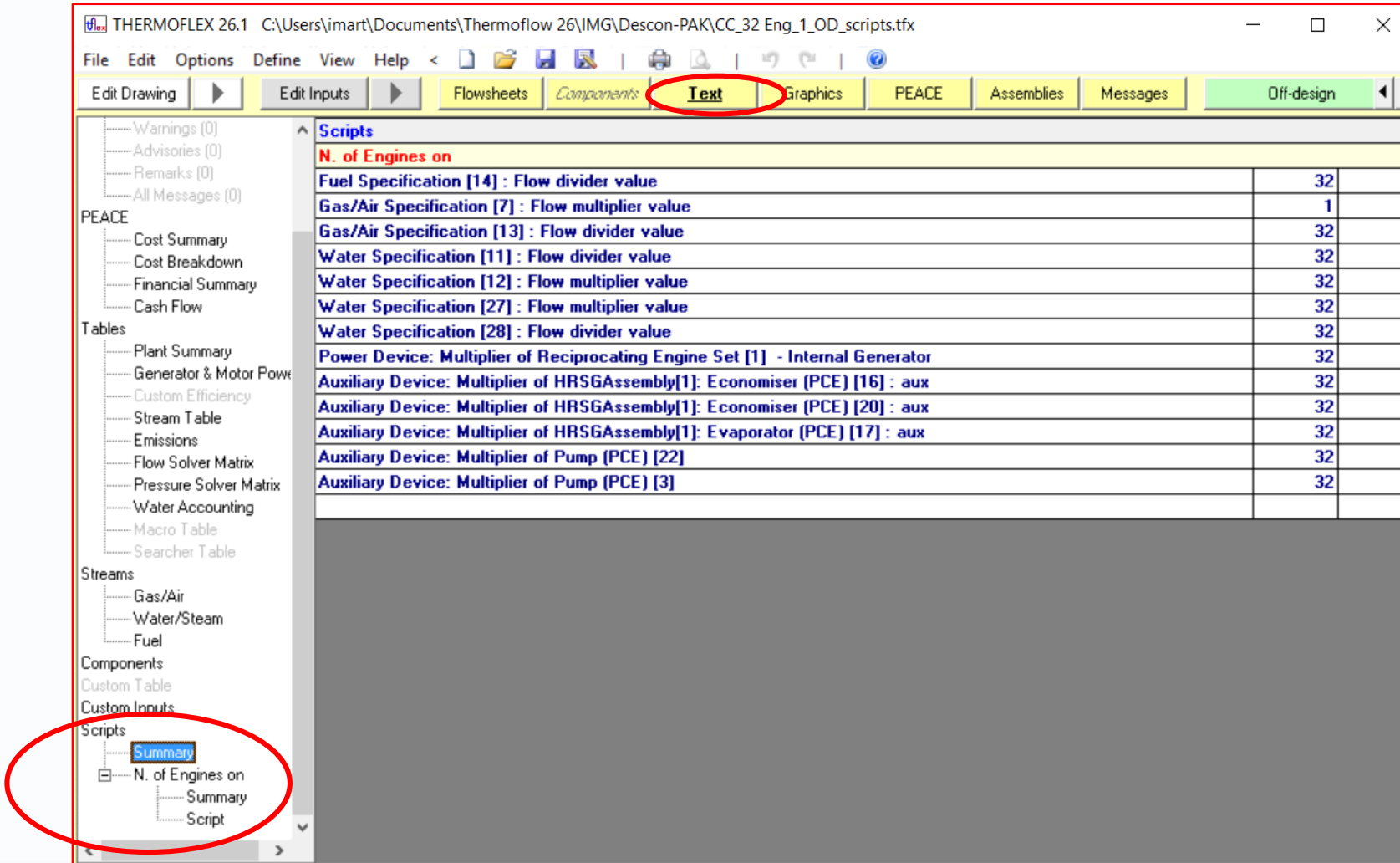
!fip[1]: Process condensate return temperature	225 F
--	-------

Text Output

Linked output

SCRIPT Outputs

THERMOFLEX



The screenshot shows the THERMOFLEX 26.1 software interface. The 'Text' tab is selected in the top navigation bar. The left sidebar shows a tree view with 'Scripts' expanded and 'Summary' selected. The main window displays a table of script outputs under the heading 'Scripts'.

Scripts	
N. of Engines on	
Fuel Specification [14] : Flow divider value	32
Gas/Air Specification [7] : Flow multiplier value	1
Gas/Air Specification [13] : Flow divider value	32
Water Specification [11] : Flow divider value	32
Water Specification [12] : Flow multiplier value	32
Water Specification [27] : Flow multiplier value	32
Water Specification [28] : Flow divider value	32
Power Device: Multiplier of Reciprocating Engine Set [1] - Internal Generator	32
Auxiliary Device: Multiplier of HRSGAssembly[1]: Economiser (PCE) [16] : aux	32
Auxiliary Device: Multiplier of HRSGAssembly[1]: Economiser (PCE) [20] : aux	32
Auxiliary Device: Multiplier of HRSGAssembly[1]: Evaporator (PCE) [17] : aux	32
Auxiliary Device: Multiplier of Pump (PCE) [22]	32
Auxiliary Device: Multiplier of Pump (PCE) [3]	32

SCRIPTS Compatible with

- Multiple Runs
- ELINK
- TFX: “Classic” Macros, Searcher

Import and Export SCRIPTS

Importing: Things that are always preserved

The following properties of an imported script are always preserved:

- Name and body
- Call origins
- Script Output Parameters

Importing: Things that are never preserved

The following properties of an imported script are never preserved:

- Script Input Parameters (sips) that refer to custom inputs
- Custom inputs, file-specific.

Importing: Things that may be preserved

Script Input Parameters (sips) and Thermoflow Input Parameters (tfips) are links to variables in the main program hosting the script. When a script is imported, the script will ask the main program (e.g. THERMOFLEX, GT PRO, or GT MASTER) if its sip and tfip variables are still available in the current file. If they are, the variables will be preserved. If they are not, then the variables will be cleared and the script itself will also be disabled.

This process may not be perfect. It is up to the user to ensure that all of an imported script's sips and tfips have been properly assigned, and to reassign them if necessary.

When importing a script exported from a different program (i.e. importing a script exported from THERMOFLEX into a GT PRO file, or a script made in GT PRO into a THERMOFLEX file, etc.), all sips and tfips will be cleared.

SCRIPTS Samples

GT PRO:

- (GTP_Script1)Different_Condensate_Return_Temperature
- (GTP_Script2)Different_Steam_Export_Prices
- (GTP_Script3)Script_DB_STkW

GT MASTER:

- (GTM_Script1)ExtractionSelector
- (GTM_Script2)ACC_Scheduling
- (GTM_Script3)CustomOutputs
- (GTM_Script4)GTDataFromExcel & (GTM_Script4)GTDataFromExcel.xls

THERMOFLEX:

- (S2-36)Load Scheduling 6-on-1 CC Plant
- (S2-37)Modeling M-on-N Plant Using Scripts
- (S5-22) SolarPV with Gas Turbine Backup using Scripting
- (S5-23) WindFarm with Gas Turbine Backup using Scripting

SCRIPTS Help:

GT PRO: Chapter 24

GT MASTER: Chapter 24

THERMOFLEX: Chapter 3.3

Contact THERMOFLOW Support at info@thermoflow.com