



Welcome!

Webinar #1: ASSEMBLIES in THERMOFLEX

13 JUNE 2017

Agenda:

- * Introduction
- * HRSG Assembly
- * Boiler Assembly
- * Steam Turbine Assembly
- * Plant Assembly
- * Q & A Session

Presenter: IGNACIO MARTIN (SPAIN)

Support: Meritt Elmasri (U.S. HQ)

1. Introduction

- Welcome and purpose of the FAW. TF Education options
- Thermoflow Background
- Programs: Application Specific vs Fully Flexible Approach
- Assemblies in THERMOFLEX/PEACE: Why

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

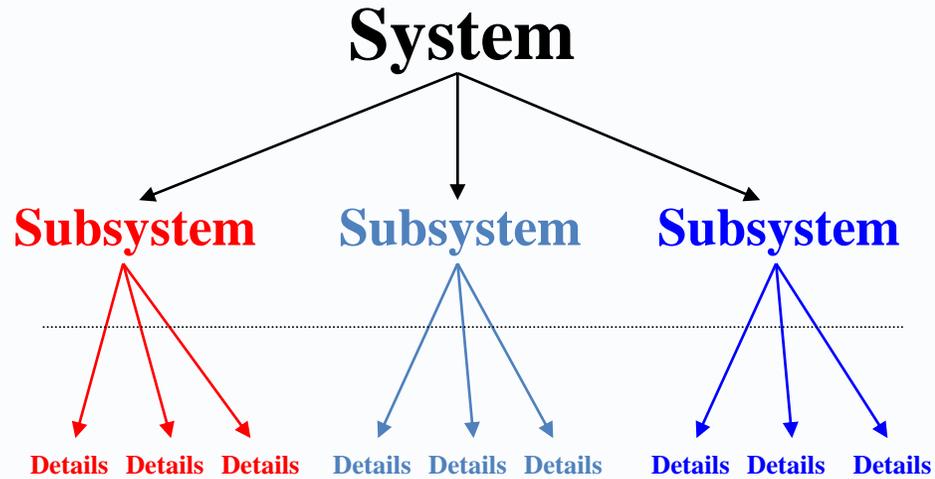
Thermoflow Background

- Consulting company 1981-1987 while founder was professor at MIT.
- Since 1987, full-time focus on power plant modeling software. **First copy of GT PRO sold in 1988.**
- Thermoflow provides the world's most complete and mature heat balance software product line, with over 330,000 man-hours of advanced talent invested during 28 years of steady evolution.
- We believe that the Thermoflow heat balance software suite is the most widely used in the world.
- Developed and maintained by a stable group of experienced mechanical engineers, mostly top MIT graduates and Ph.D.'s, no 'programmers' or external subcontractors ever used.
- Thermoflow has always been independent, stable, profitable and conservative. Ample financial resources for stability, derived from excellence of its products, not from sponsors.

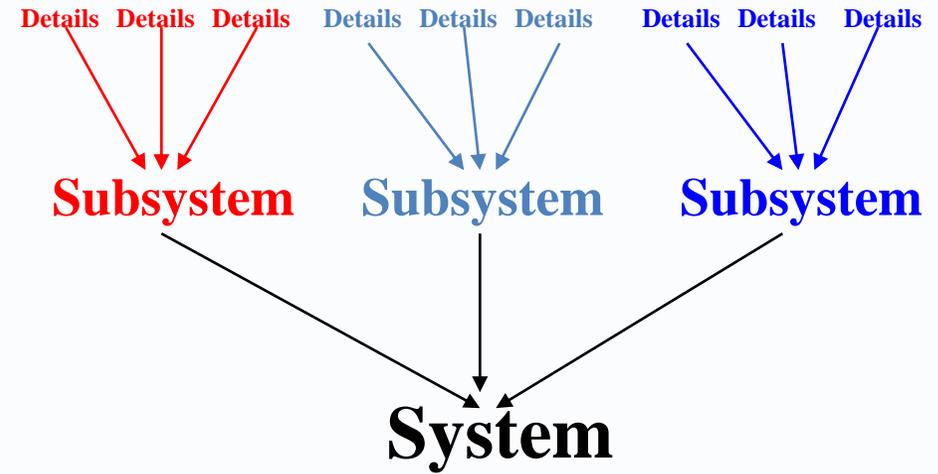
Thermoflow Programs

| Program | Year First Copy Licensed | Aprx Total Licenses/Seats Sold (end 2015) |
|--------------|--------------------------|---|
| GT PRO | 1988 | 2400 |
| GT MASTER | 1988 | 1840 |
| STEAM PRO | 1990 | 1020 |
| STEAM MASTER | 1991 | 850 |
| RE-MASTER | 1992 | 400 |
| THERMOFLEX | 1995 | 1370 |
| PDE | 1995 | 800 |
| PEACE | 1998 | 1640 |

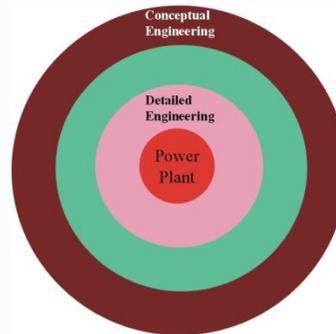
...built from the outside in



...built from the inside out

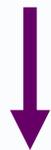
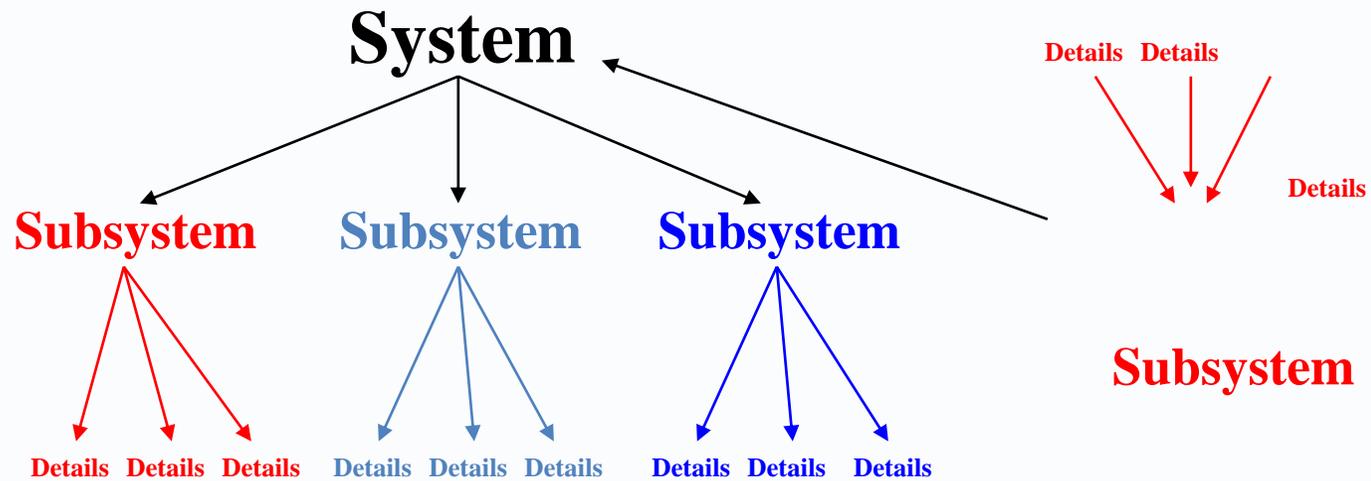


Application-Specific Program



Fully-Flexible Program

...you can even get the best of both worlds



Application-Specific + Fully-Flexible

GT Template
- User-Defined GT

Plant Design Expert (PDE)
- Executive level of GT PRO

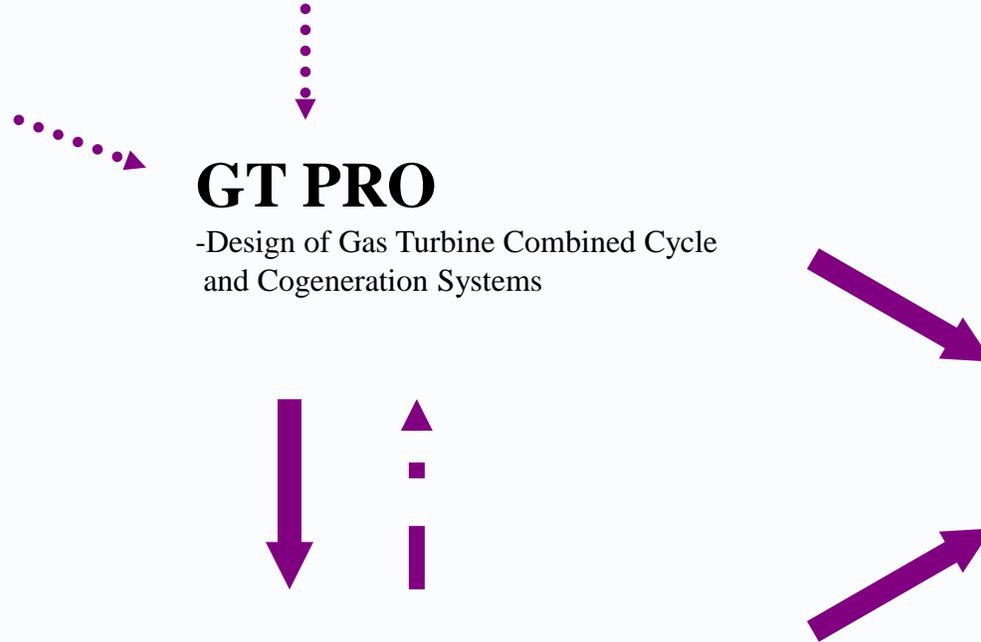
GT PRO
-Design of Gas Turbine Combined Cycle
and Cogeneration Systems

GT MASTER
- Simulation
- OFF-Design

PEACE*
-Preliminary Engineering
-Cost Estimation
-Detailed Hardware Specifications

* Plant Engineering and Construction Estimator

Elink
DRS
TOPS



STEAM PRO

- Design of conventional steam power plants



STEAM MASTER

- Simulation
- OFF-Design



PEACE*

- Preliminary Engineering
- Cost Estimation
- Detailed Hardware Specifications

* Plant Engineering and Construction Estimator

RE-MASTER

- Design and Simulation of conventional Steam power plants with gas turbines

Elink
DRS
TOPS

User def. Component

- External *.exe file
or EXCEL workbook
- Your developments
- Own database



THERMOFLEX

- Modular program with graphical interface
- More than 100 components
- All types of power plants
- Thermal power systems and networks



PEACE



Load

File:

- GT PRO
- STEAM PRO
- GT MASTER



Link

File:

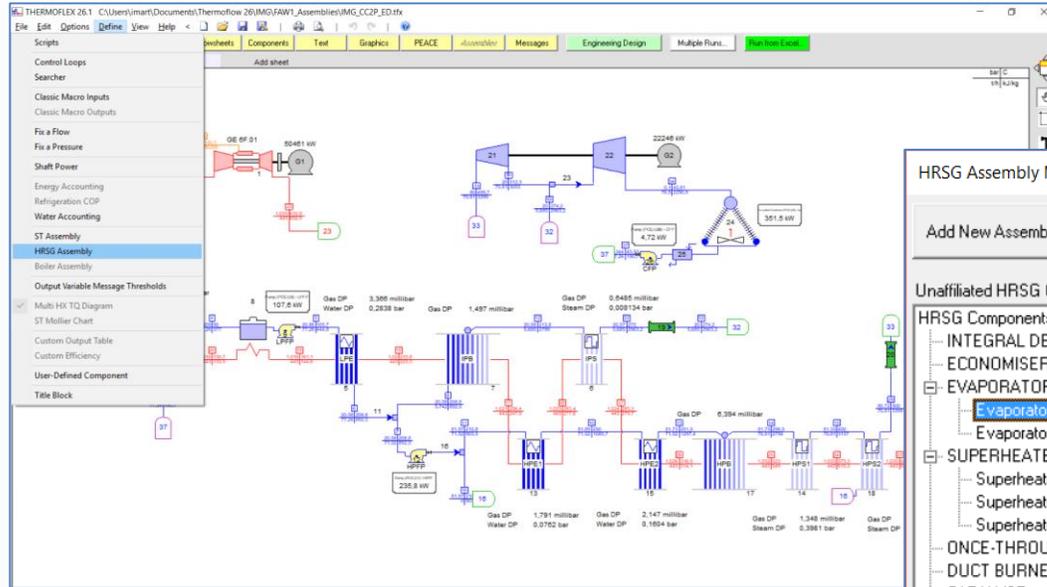
- GT PRO
- GT MASTER
- STEAM MASTER

Elink
DRS
TOPS

2. HRSG Assembly

- HRSG Design in TFX. TD and ED
- HRSG Assembly Definition and Requisites
- HRSG Assembly Outputs
- Managing the HRSG Assembly
- HRSG Assembly in OD Mode
- HRSG Assembly in files imported from GTP-GTM

2. HRSG Assembly: Definition and Requisites



HRSG Assembly Manager

Add New Assembly Remove Selected Assembly

HRSG Assembly
HRSGAssembly[1]

OK
Cancel

Unaffiliated HRSG Components in Plant

- HRSG Components
- INTEGRAL DEAEATOR
- ECONOMISER
- EVAPORATOR
 - Evaporator (PCE) [7] - IPB
 - Evaporator (PCE) [17] - HPB
- SUPERHEATER/REHEATER
 - Superheater (PCE) [6] - IPS
 - Superheater (PCE) [14] - HPS1
 - Superheater (PCE) [18] - HPS2
- ONCE-THROUGH BOILER ELEMENT
- DUCT BURNER
- CATALYST
- STACK
- DUCT

Components Affiliated with HRSG Assembly

- HRSGAssembly[1]
 - INTEGRAL DEAEATOR
 - ECONOMISER
 - Economiser (PCE) [4] - LTE
 - Economiser (PCE) [5] - LPE
 - Economiser (PCE) [15] - HPE2
 - Economiser (PCE) [13] - HPE1
 - EVAPORATOR
 - SUPERHEATER/REHEATER
 - ONCE-THROUGH BOILER ELEMENT
 - DUCT BURNER
 - CATALYST
 - STACK
 - DUCT

Arrange Assembly Display

Did you know that ...
Each assembly must hold a main stack.
All members of an assembly must be part of the same type of boiler (either horizontal or vertical)

Input Menu - Edit Mode

File: GTP/GTM/STM

Site Menu Components Miscellaneous Gen/Motors Plant Assembly HRSG Assembly Economics Regional Costs OK Cancel

Economiser (PCE) [4] - LTE Engineering Design

TD Main Inputs

Water-side Recirculation

None

Specify min inlet temperature

Specify flow percent

Specify outlet water temperature 30 C

Specify outlet subcooling 5 C

Miscellaneous Heat Transfer

01 [0] %

02 [0] %

03 [0] %

Click a button to select the heat adder to receive water side heat

Allow condensation from gas

Min. temp difference allowed in economiser 5 C

Treat as a Typical Element of a

Horizontal HRSG

Vertical HRSG

Conventional boiler

Smoke tube boiler

Heat loss [0.75] %

Economiser

2. HRSG Assembly: Definition and Requisites

Input Menu - Edit Mode

File GTP/GTM/STM

Site Menu Components Miscellaneous Gen/Motors Plant Assembly Non-Flowsheet Economics Regional Costs

HRSGAssembly[1]: Economiser (PCE) [13] - HPE1 Engineering Design

TD Main Inputs ED Main Inputs ED Hardware ED Other Inputs

Water-side Mass Flux
 Min. allowable 2109,2 t/h-m² 0,7044 m/s
 Max. allowable 8788 t/h-m² 2,935 m/s

Water-side Pressure Drop
 Water/steam dP by program
 User-defined water-side dP/P 1 %
 Max allowable water-side dP/P 12,69 %

Flow Arrangement
 Counter flow
 Parallel flow

Hardware Design
 Automatic
 Tube Selection
 Min. design water P 85,75 bar
 Min. design gas T 283,7 C
 User-defined (integer no. of rows)
 User-defined (standard fin geometry)

Heat Exchanger Orientation
 Common practice
 Turned 90°

Heat Exchanger Placement
 Main HRSG
 Transition, stack, other

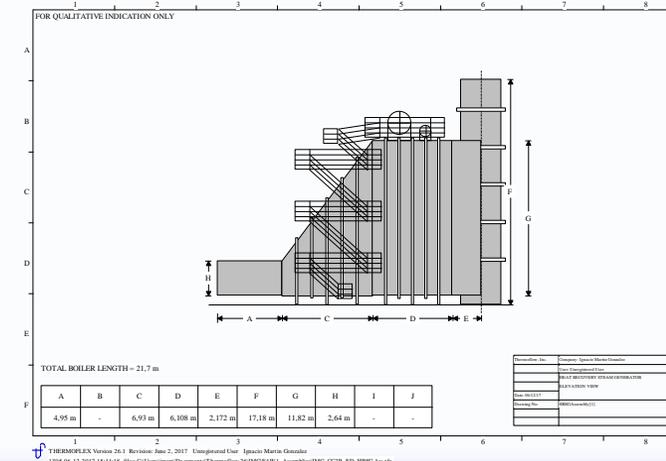
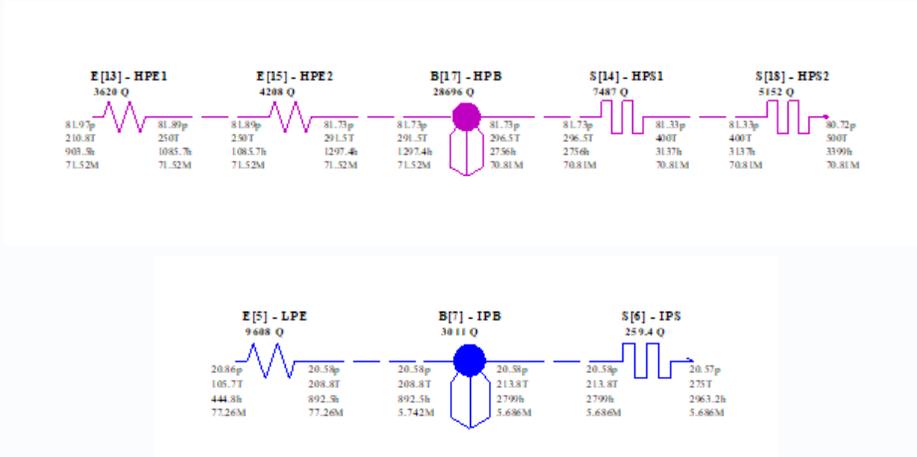
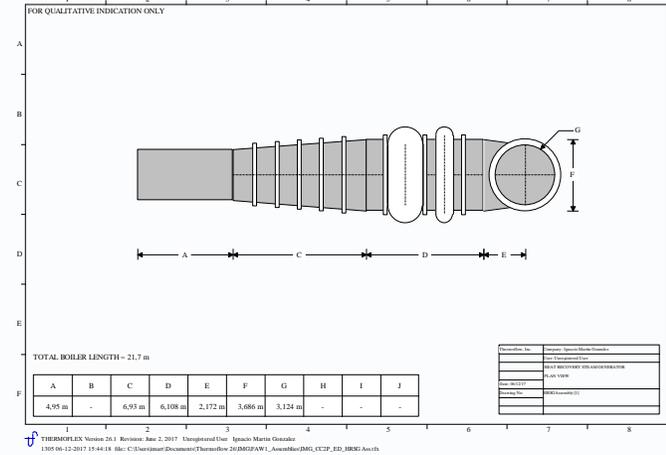
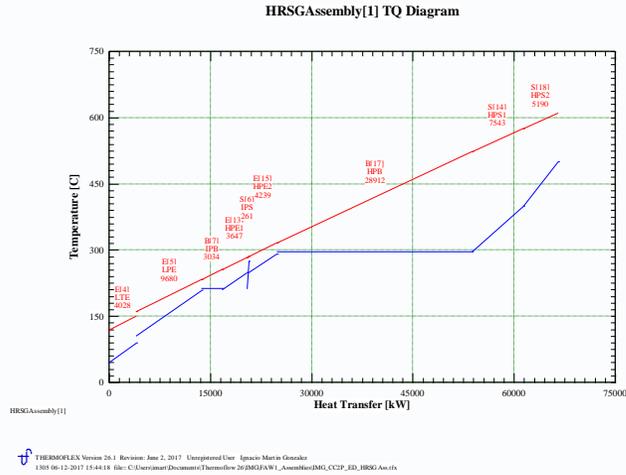
Design gas-side mass flux 30 t/h-m²

Integer No. of Rows by Modifying
 Fin height
 Fin spacing
 Transverse pitch

Economiser

Notes

2. HRSG Assembly: Outputs



2. HRSG Assembly: Outputs

HRSGAssembly[1]

File Edit

HRSGAssembly[1]

HRSGAssembly[1]

- Specification
- Overall
- Thermodynamics
- Hardware**
- Heat Transfer
- Plan View
- Elevation View
- TQ Diagram
- Water Paths
 - Water Path 1
 - Water Path 2
 - Water Path 3
 - Water Path 4
 - Water Path 5

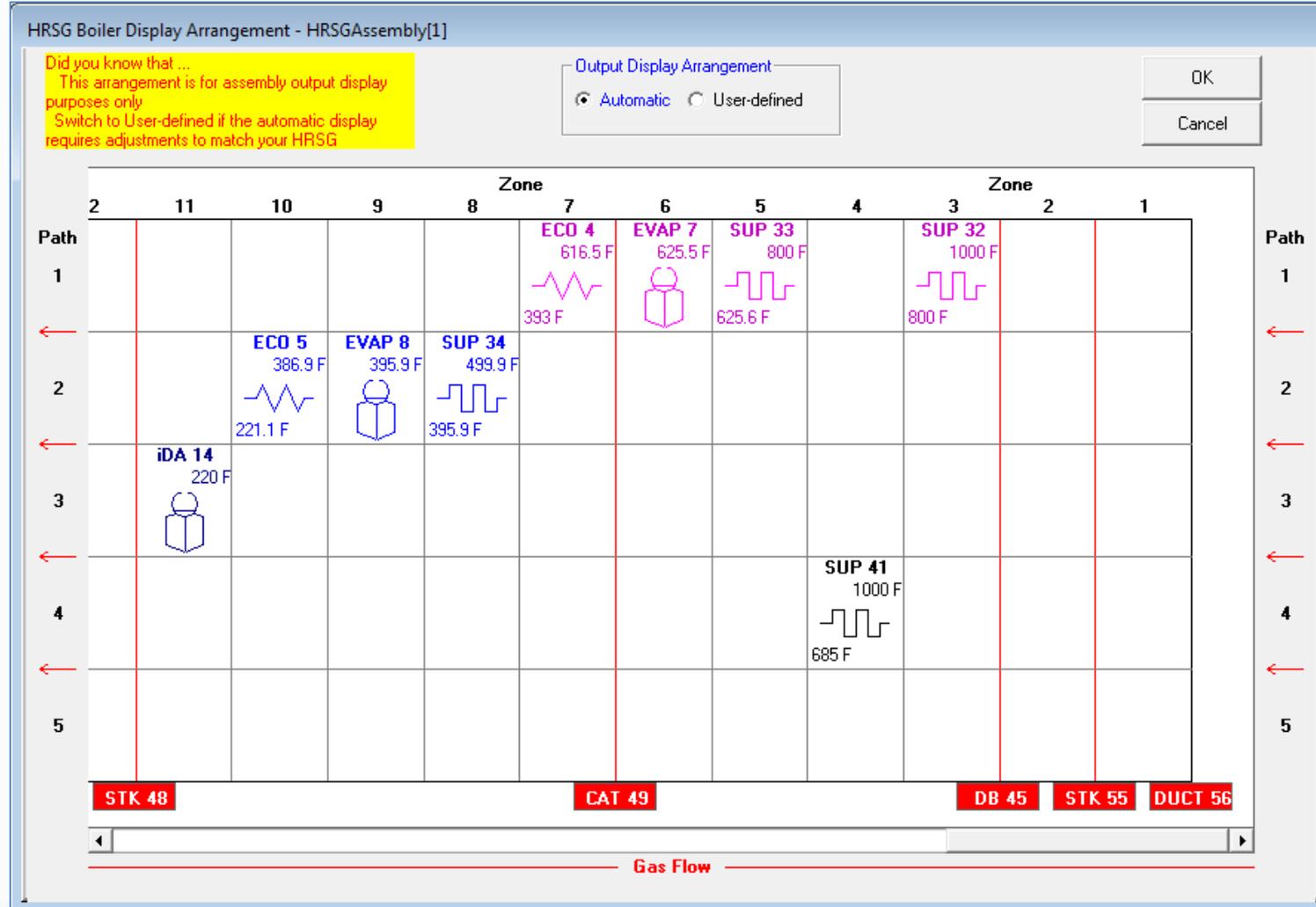
| HRSGAssembly[1] | B[17] - HPB | E[15] - HPE2 | S[6] - IPS | E[13] - HPE1 | B[7] - IPB | E[5] - LPE | E[4] - LTE |
|---|--------------|--------------|--------------|--------------|--------------|--------------|------------|
| Estimated Heat Exchanger Hardware Data | | | | | | | |
| Tube material | Carbon Steel | T409 |
| Number of tube rows (longitudinal) | 12 | 6 | 2 | 3 | 4 | 10 | 3 |
| Number of tubes per row (transverse) | 44 | 44 | 58 | 44 | 40 | 44 | 44 |
| Number of rows per waterside flow pass | 12 | 1 | 1 | 1 | 4 | 1 | 1 |
| Longitudinal row pitch [mm] | 92,52 | 92,52 | 69,85 | 92,52 | 104,1 | 92,52 | 92,52 |
| Gas path transverse width [m] | 3,413 | 3,413 | 3,413 | 3,413 | 3,413 | 3,413 | 3,413 |
| Tube length [m] | 9,847 | 9,847 | 9,847 | 9,847 | 9,847 | 9,847 | 9,847 |
| Tube outer diameter [mm] | 38,1 | 31,75 | 37,73 | 31,75 | 38,1 | 31,75 | 31,75 |
| Tube wall thickness [mm] | 2,108 | 1,905 | 2,108 | 1,905 | 2,108 | 1,905 | 3,048 |
| Transverse tube pitch [mm] | 76,7 | 76,7 | 58,34 | 76,7 | 84,27 | 76,7 | 76,7 |
| Tube metal conductivity @ 500F (260C) [W/m-C] | 46,73 | 46,73 | 46,73 | 46,73 | 46,73 | 46,73 | 26,13 |
| Tube metal conductivity slope [W/m-C ²] | -0,0249 | -0,0249 | -0,0249 | -0,0249 | -0,0249 | -0,0249 | 0,0075 |
| Fins | | | | | | | |
| Fin material | Carbon Steel | Carbon Steel | N/A | Carbon Steel | Carbon Steel | Carbon Steel | T409 |
| Fin height [mm] | 12,7 | 15,88 | N/A | 15,88 | 15,88 | 15,88 | 15,88 |
| Fin spacing [mm] | 3,776 | 4,059 | N/A | 2,06 | 3,737 | 3,145 | 2,652 |
| Fin thickness [mm] | 0,9906 | 0,9906 | N/A | 0,9906 | 0,9906 | 0,9906 | 0,9906 |
| Number of fins per meter | 209,8 | 198 | N/A | 327,8 | 211,5 | 241,8 | 274,5 |
| Serrated fin segment width [mm] | 3,97 | 3,97 | N/A | 3,97 | 3,97 | 3,97 | 3,97 |
| Number of serrated fin segments | 34,17 | 30,15 | N/A | 30,15 | 35,17 | 30,15 | 30,15 |
| Un-serrated height / fin height | 0,2 | 0,2 | N/A | 0,2 | 0,2 | 0,2 | 0,2 |
| Fin metal conductivity @ 500F (260C) [W/m-C] | 46,73 | 46,73 | N/A | 46,73 | 46,73 | 46,73 | 26,13 |
| Fin metal conductivity slope [W/m-C ²] | -0,0249 | -0,0249 | N/A | -0,0249 | -0,0249 | -0,0249 | 0,0075 |
| Overall Data | | | | | | | |
| Gas path frontal area [m ²] | 33,61 | 33,61 | 33,61 | 33,61 | 33,61 | 33,61 | 33,61 |
| Min. gas free flow cross section / frontal area | 0,4295 | 0,4991 | 0,3503 | 0,4465 | 0,4631 | 0,4814 | 0,4681 |
| H.T. surface area / min. free flow cross section | 29,46 | 25,67 | 5,75 | 45,62 | 31,27 | 31,91 | 36,89 |

2. HRSG Assembly: Outputs

| HRSGAssembly[1] | | |
|-------------------------------------|-----------|----------------|
| Estimated HRSG Data | | |
| 1. HRSG System Summary | | |
| Size | | |
| Overall Length (horizontal) | 21,72 | m |
| Overall Width | 3,686 | m |
| Overall Height (HRSG) | 11,82 | m |
| Overall Height (Main stack height) | 17,18 | m |
| Weight | | |
| Overall Weight (dry) | 220.400 | kg |
| Round to Square | 7.400 | kg |
| Transition Duct | 25.150 | kg |
| Main HRSG Section | 187.850 | kg |
| Overall Weight (wet) | 234.650 | kg |
| Heat Transfer Surface Area | | |
| Overall surface area | 20309 | m ² |
| Economiser | 11542 | m ² |
| Evaporator | 7051 | m ² |
| Superheater | 1716 | m ² |
| Miscellaneous | | |
| Total number of tubes | 1948 | |
| Equipment | | |
| Overall HRSG Unit Cost - including: | 5.352.000 | € |
| Main Stack | 257.450 | € |
| Mechanical | | |
| Mechanical Labor | 12.280 | hours |
| Mechanical Labor Cost | 453.150 | € |
| Transportation & Rigging | | |
| On-site Transportation & Rigging | 239.000 | € |
| Civil | | |
| Foundation Concrete Volume | 272 | m ³ |
| Civil Labor | 5.200 | hours |

| HRSGAssembly[1] | | |
|---|-------|----------|
| Overall HRSG Thermodynamic Data | | |
| 1. HRSG Summary | | |
| HRSG efficiency | 81,58 | % |
| Heat recovered | 66040 | kW |
| Heat loss | 495,3 | kW |
| Heat available in exhaust gas (cooled to ambient) | 80954 | kW |
| HRSG gas inlet temperature | 610,9 | C |
| Stack gas exit temperature | 120,1 | C |
| HRSG gas inlet mass flow | 443 | t/h |
| Stack gas exit mass flow | 443 | t/h |
| HRSG gas inlet pressure | 1,035 | bar |
| Stack gas exit pressure | 1,011 | bar |
| Ambient pressure | 1,013 | bar |
| HRSG total gas-side pressure drop to top of stack | 24,52 | millibar |
| HRSG total gas-side pressure drop to ambient | 21,96 | millibar |
| 2. Water/Steam Paths | | |
| Path 1 | | |
| Total heat transfer | 49162 | kW |
| Steam/water exit | | |
| Pressure | 80,72 | bar |
| Temperature | 500 | C |
| Mass flow | 70,81 | t/h |
| Steam/water inlet | | |
| Pressure | 81,97 | bar |
| Temperature | 210,8 | C |
| Mass flow | 71,52 | t/h |
| Path 2 | | |
| Total heat transfer | 12879 | kW |
| Steam/water exit | | |
| Pressure | 20,57 | bar |
| Temperature | 275 | C |
| Mass flow | 5,686 | t/h |
| Steam/water inlet | | |
| Pressure | 20,86 | bar |
| Temperature | 105,7 | C |

2. HRSG Assembly: Managing



3. Boiler Assembly

- Boiler Design in TFX. TD and ED
- Boiler Assembly Definition and Requisites
- Boiler Assembly Outputs
- Managing the Boiler Assembly
- Boiler Assembly in OD Mode
- Boiler Assembly in files imported from STP

3. Boiler Assembly Definition

Input Menu - Edit Mode

File GTP/GTM/STM

Site Menu Components Miscellaneous Gen/Motors Plant Assembly Non-Flowsheet Economics Regional Costs OK Cancel

Superheater (PCE) [5] - CS1 Engineering Design

TD Main Inputs

Desuperheating

Inlet Specify steam DT

Exit Specify steam DT

Min. superheat after desuperheating 15 C

Water Wall Heat Transfer

Q1 0 %

Q2 0 %

Q3 0 %

Click a button to select the heat adder to receive water wall heat

Treat as a Typical Element of a

Horizontal HRSG

Vertical HRSG

Conventional boiler

Smoke tube boiler

Specify outlet steam temperature 451.8 C

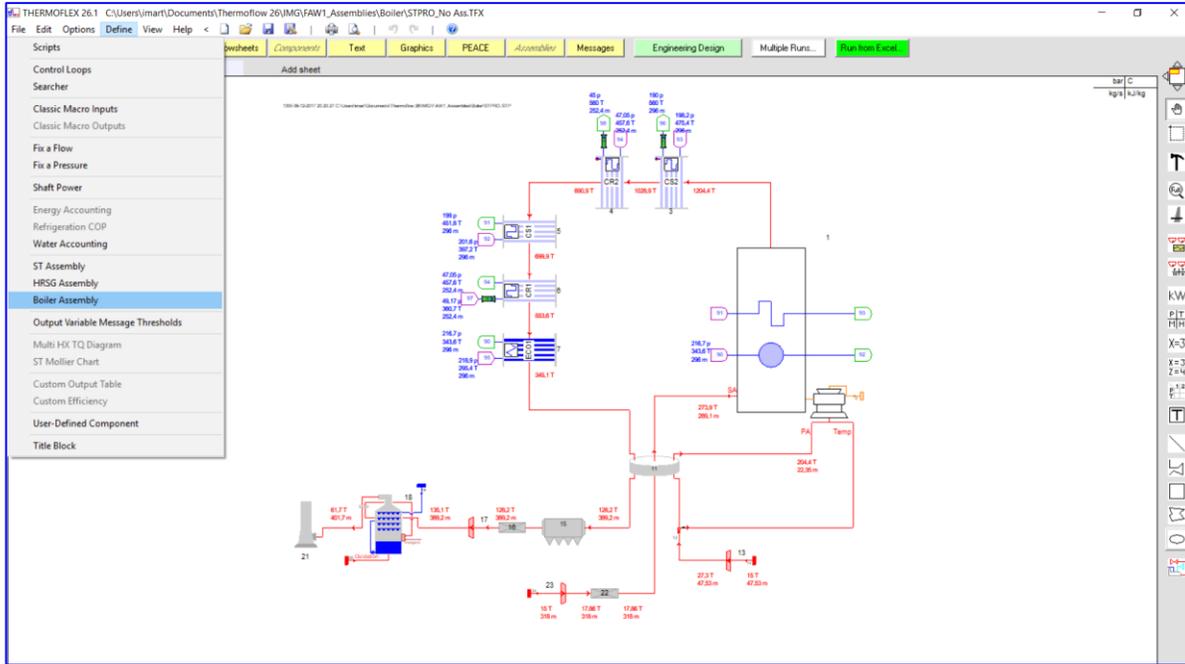
Specify outlet steam temperature as an approach to hot gas temperature 20 C

Min. temp difference allowed in superheater 5 C

Heat loss 2 %

Superheater

3. Boiler Assembly Definition



Boiler Assembly Manager

Add New Assembly Remove Selected Assembly Boiler Assembly [] OK Cancel

Unaffiliated Boiler Components in Plant Components Affiliated with Boiler Assembly

Components

- Radiant Furnace
- Economiser
 - Convective Evaporator
- Superheater/Reheater
- Air Heater
- Fan
- Emission Control
- Duct
- Stack
- Miscellaneous

Boiler Cycle Type

Non-Reheat
 Single Reheat
 Double Reheat

OK Cancel Reheat/Non-Reheat

Boiler Assembly Manager

Add New Assembly Remove Selected Assembly Boiler Assembly Boiler Assembly[1] OK Cancel

Unaffiliated Boiler Components in Plant Components Affiliated with Boiler Assembly

Components

- Radiant Furnace
- Economiser
 - Economiser (PCE) [7] - ECO1
- Convective Evaporator
- Superheater/Reheater
 - Superheater (PCE) [5] - CS1
 - Superheater (PCE) [6] - CR1
- Air Heater
- Fan
- Emission Control
- Duct
- Stack
- Miscellaneous
 - Pipe (PCE) [8]
 - Pipe (PCE) [9]
 - Pipe (PCE) [10]
 - Pipe (PCE) [46]
 - Pipe (PCE) [57]
 - Pipe (PCE) [59]
 - Pipe (PCE) [61]
 - Pipe (PCE) [63]
 - Pipe (PCE) [67]
 - Pipe (PCE) [69]

Boiler Assembly[1]

- Radiant Furnace
 - Furnace w/ Pulverizer [1]
- Economiser
 - Convective Evaporator
- Superheater/Reheater
 - Superheater (PCE) - Parallel Flow [3] - CS2
 - Superheater (PCE) - Parallel Flow [4] - CR2
- Air Heater
- Fan
- Emission Control
- Duct
- Stack
- Miscellaneous

Reheat/Non-Reheat Edit Assembly

3. Boiler Assembly Arrangement

Boiler Assembly Display Arrangement - Boiler Assembly[1]

Boiler Configuration | Flow Sequences | Equipment Options | Energy Accounting

Boiler Assembly[1] - Conventional, Two Pass

Gas Path Configuration: Two Pass Tower Type

Check convective pass HX size: Yes No

Convective Heat Exchanger Placement

| Component | Zone | Path | In Tunnel | Down Pass | External |
|---|------|------|-----------|-----------|----------|
| Superheater (PCE) - Parallel Flow [3] - CS2 | 5 | 0 | X | | |
| Superheater (PCE) - Parallel Flow [4] - CR2 | 6 | 0 | X | | |
| Superheater (PCE) [5] - CS1 | 7 | 0 | | X | |
| Superheater (PCE) [6] - CR1 | 8 | 0 | | X | |
| Economiser (PCE) [7] - ECO1 | 9 | 0 | | X | |

OK Cancel

Boiler Assembly Display Arrangement - Boiler Assembly[1]

Boiler Configuration | **Flow Sequences** | Equipment Options | Energy Accounting

View Flow Sequence: Air/Gas flow HP Water/Steam flow RH Steam flow LP RH Steam flow

Arrange Component Locations: Automatic User-defined

| Zone | | | | | | | | | Path 1 |
|------|------|------|------|------|------|--------|---------|----------|---------|
| 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | |
| G | E(7) | S(6) | S(5) | S(4) | S(3) | FRN(1) | AH(11A) | Duct(22) | Fan(23) |

Gas Flow ←

HP Flow ←

Boiler Assembly Display Arrangement - Boiler Assembly[1]

Boiler Configuration | **Flow Sequences** | Equipment Options | Energy Accounting

View Flow Sequence: Air/Gas flow HP Water/Steam flow RH Steam flow LP RH Steam flow

Arrange Component Locations: Automatic User-defined

| Zone | | | | | Path 1 |
|------|---|------|------------|------|-------------|
| 7 | 6 | 5 | 4 | 3 | |
| | | S(5) | FRN(1)-HX1 | S(6) | FRN(1)-Evap |
| | | | | | E(7) |

OK Cancel

Boiler Assembly Display Arrangement - Boiler Assembly[1]

Boiler Configuration | Flow Sequences | **Equipment Options** | Energy Accounting

Boiler Cost Model

Always use field-erected boiler cost estimate

Use package boiler cost estimate for oil or gas fired non-reheat boilers with flows below: kg/s

Sootblower

Include Exclude

Parallel HX Configuration

HX tube length equal to convective pass depth

HX bundle width equal to convective pass width

Storage Capacity

On-site solid fuel storage capacity: days

On-site combustion waste storage capacity: days

OK Cancel

Boiler Assembly Display Arrangement - Boiler Assembly[1]

Boiler Configuration | Flow Sequences | Equipment Options | Energy Accounting

Heat to Steam Cycle Include or Exclude from Efficiency

| Component | Include | Exclude |
|---|---------|---------|
| Furnace w/ Pulverizer [1] | X | |
| Furnace w/ Pulverizer [1] | X | |
| Superheater (PCE) - Parallel Flow [3] - CS2 | X | |
| Superheater (PCE) - Parallel Flow [4] - CR2 | X | |
| Economiser (PCE) [7] - ECO1 | X | |
| Superheater (PCE) [5] - CS1 | X | |
| Superheater (PCE) [6] - CR1 | X | |

Air Heating (NA) t

OK Cancel

3. Boiler Assembly

Messages

File

Errors (0) Warnings (1) Advisories (0) Remarks (2) All Messages (3)

Double-click any Icon- or Stream-related message in the list to locate that item on the flowsheet

| Message Source | Message # |
|-------------------------------------|-----------|
| Boiler Assembly: Boiler Assembly[1] | 21 |

Boiler Assembly: Boiler Assembly[1]
 [21] - Tube lengths for heat exchangers in convective pass, do not match within 25%. Assembly cannot be completely computed. You may relocate the hot end HX from the convective pass to the Tunnel or the cold end HX to External. Convective heat exchanger may be relocated from the Edit Assembly menu. Or you may remove the convective pass HX size checking from the Edit Assembly menu.

Boiler Assembly Display Arrangement - Boiler Assembly[1]

Boiler Configuration | Flow Sequences | Equipment Options | Energy Accounting

Boiler Assembly[1] - Conventional, Two Pass

Gas Path Configuration: Two Pass Tower Type

Check convective pass HX size: Yes No

Convective Heat Exchanger Placement

| Component | Zone | Path | In Tunnel | Down Pass | External |
|---|------|------|-----------|-----------|----------|
| Superheater (PCE) - Parallel Flow [3] - CS2 | 5 | 0 | X | | |
| Superheater (PCE) - Parallel Flow [4] - CR2 | 6 | 0 | X | | |
| Superheater (PCE) [5] - CS1 | 7 | 0 | | X | |
| Superheater (PCE) [6] - CR1 | 8 | 0 | | X | |
| Economiser (PCE) [7] - EC01 | 9 | 0 | | | X |

Boiler Assembly Display Arrangement - Boiler Assembly[1]

Boiler Configuration | Flow Sequences | Equipment Options | Energy Accounting

Boiler Assembly[1] - Conventional, Two Pass

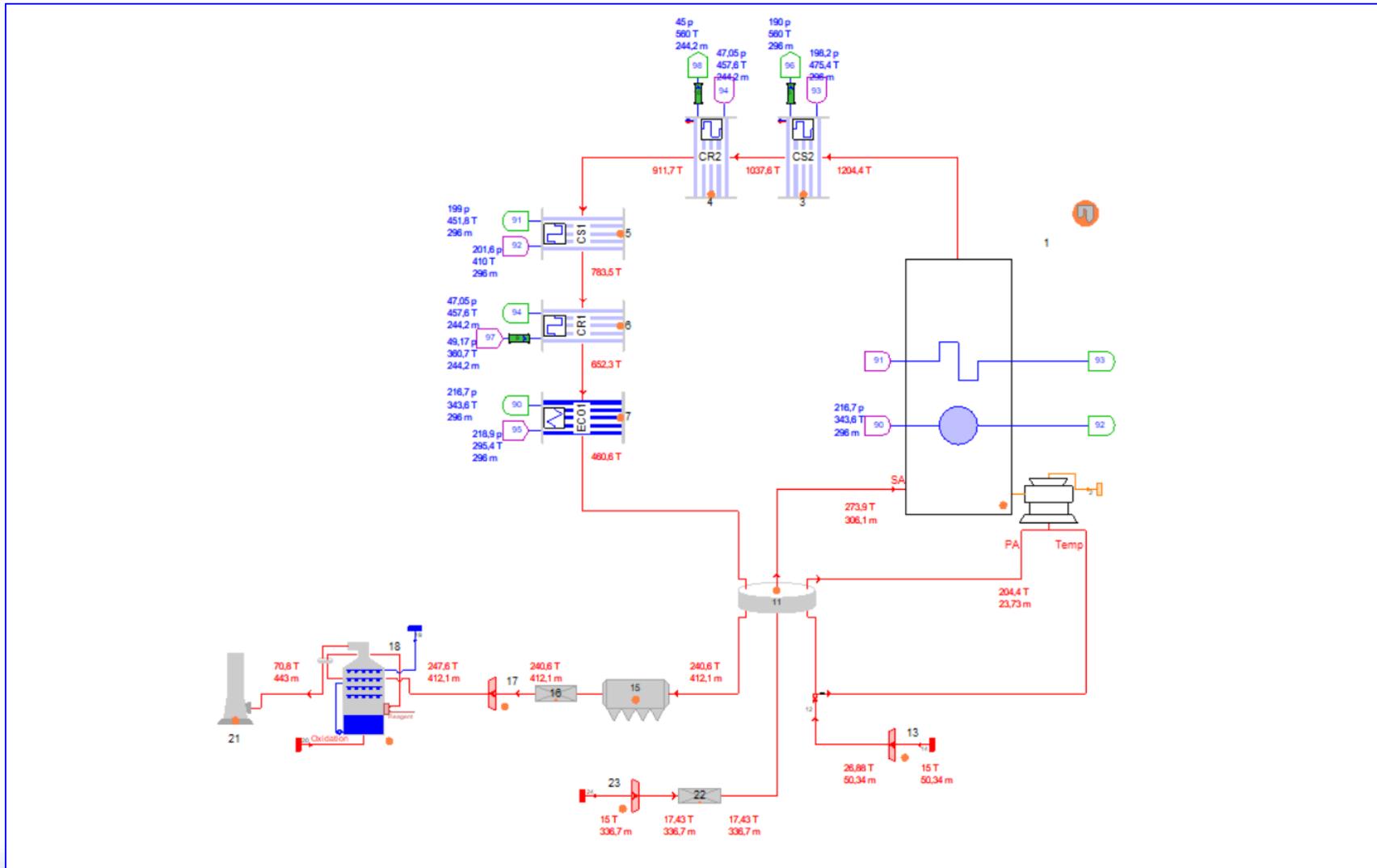
Gas Path Configuration: Two Pass Tower Type

Check convective pass HX size: Yes No

Convective Heat Exchanger Placement

| Component | Zone | Path | In Tunnel | Down Pass | External |
|---|------|------|-----------|-----------|----------|
| Superheater (PCE) - Parallel Flow [3] - CS2 | 5 | 0 | X | | |
| Superheater (PCE) - Parallel Flow [4] - CR2 | 6 | 0 | X | | |
| Superheater (PCE) [5] - CS1 | 7 | 0 | | X | |
| Superheater (PCE) [6] - CR1 | 8 | 0 | | X | |
| Economiser (PCE) [7] - EC01 | 9 | 0 | | X | |

3. Boiler Assembly



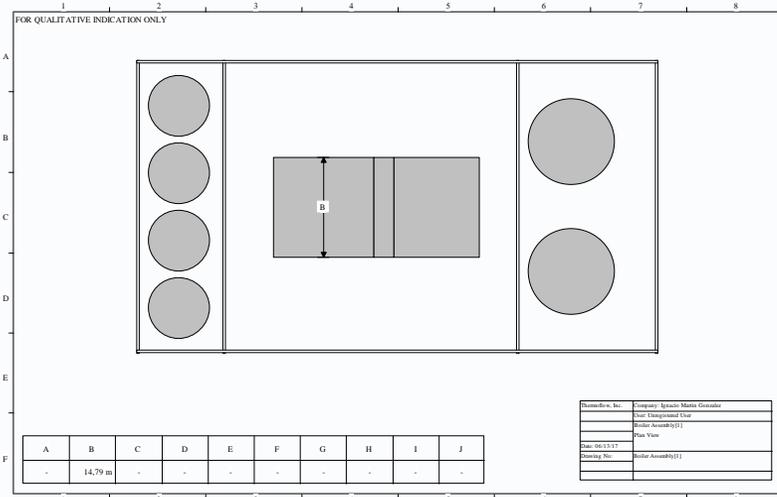
3. Boiler Assembly, Outputs

| Boiler Assembly[1] | | | | |
|---|--|--|---|--|
| Boiler Assembly[1] Specification Overall ASME Boiler Energy Balance Air/Gas Zone Summary Water/Steam Zone Summary Plan View Elevation View TQ Diagram Components Heat Balance Furnace w/ Pulverizer [1] Economiser (PCE) [7] - ECO1 Superheater (PCE) - Parallel Flow [3] - CS1 Superheater (PCE) - Parallel Flow [4] - CS1 Superheater (PCE) [5] - CS1 Superheater (PCE) [6] - CR1 Rotary Air Heater [11] Wet FGD [18] Electrostatic Precipitator [15] Concrete Stack [21] Fan [13] Fan [17] Fan [23] Hardware Furnace w/ Pulverizer [1] Economiser (PCE) [7] - ECO1 Superheater (PCE) - Parallel Flow [3] - CS1 Superheater (PCE) - Parallel Flow [4] - CS1 Superheater (PCE) [5] - CS1 Superheater (PCE) [6] - CR1 Rotary Air Heater [11] Wet FGD [18] Electrostatic Precipitator [15] Concrete Stack [21] Heat Transfer Furnace w/ Pulverizer [1] Economiser (PCE) [7] - ECO1 Superheater (PCE) - Parallel Flow [3] - CS1 Superheater (PCE) - Parallel Flow [4] - CS1 Superheater (PCE) [5] - CS1 Superheater (PCE) [6] - CR1 | | Boiler Assembly[1] Estimated Boiler Data Boiler Specification and Estimated Dimensions Boiler Type Size Overall Length Overall Width Overall Height Furnace Furnace height (including hopper height if it exists) Furnace width Furnace depth Aperture height Hopper height Furnace volume Furnace effective projected radiant surface Water wall effective projected surface Horizontal Pass Height (tube length) Width (boiler width) Depth (duct length) Gas flow frontal area Second Vertical Downward Pass Height (duct length) Width (boiler width) Depth (tube length) Gas flow frontal area Weight Boiler Total Weight (wet) Boiler Total Weight (dry) Includes: - Furnace incl. burners & waterwall - Pulverizers & feeders - Boiler casing & refractory - Convective HX incl. waterwall - Desuperheaters and controls - Air & flue gas ducts - Burner piping & fittings - Soot blowers - Structural steel incl. walkways & ladders - Rotary air heater - Fans - Miscellaneous | Conventional, Two Pass 29,45 m 14,35 m 49,94 m 49,94 m 14,35 m 14,35 m 9,327 m 8,61 m 9,400 m ³ 3,290 m ² 3,000 m ² 9,327 m 14,35 m 3,764 m 134 m ² 6,208 m 14,35 m 12,23 m 175 m ² 5,857,000 kg 5,747,000 kg | |

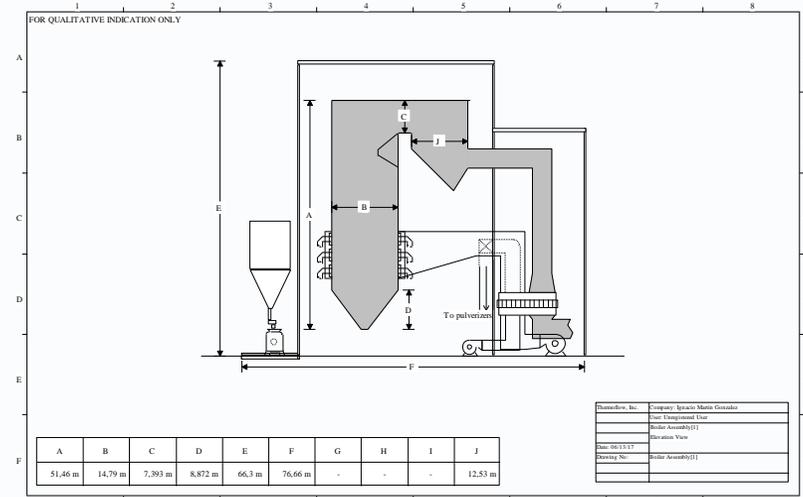
3. Boiler Assembly, Outputs

| ASME Boiler Energy Balance | | | |
|--|---------------|---------------|----|
| | HHV Based | LHV Based | |
| Energy input from fuel | 889736 | 860359 | kW |
| Credit due to entering dry air | -2458 | -2458 | kW |
| Credit due to moisture in entering air | -28,74 | -28,74 | kW |
| Credit due to sensible heat in fuel | 0 | 0 | kW |
| Credit due to sulfation | 0 | 0 | kW |
| Credit due to sensible heat in sorbent | 0 | 0 | kW |
| Credit due to auxiliary equipment power | 1122 | 1122 | kW |
| Total credits | -1364,8 | -1364,8 | kW |
| Total Energy in | 888372 | 858994 | kW |
| Energy to steam and water | 748599 | 748599 | kW |
| Loss due to sensible heat in dry gas | 86917 | 86917 | kW |
| Loss due to moisture in fuel | 1602,4 | 231,1 | kW |
| Loss due to moisture from burning hydrogen | 32732 | 4720 | kW |
| Loss due to moisture in air | 1003,7 | 1003,7 | kW |
| Loss due to unburned carbon | 1839,2 | 1839,2 | kW |
| Loss due to calcination of sorbent | 0 | 0 | kW |
| Loss due to radiation and unmeasured losses | 15679 | 15679 | kW |
| Total losses | 139774 | 110391 | kW |
| Total Energy out | 888373 | 858990 | kW |
| ASME fuel efficiency (Output/Input) | 84,14 | 87,01 | % |
| ASME gross efficiency (Output/(Input+Credits)) | 84,27 | 87,15 | % |
| Energy input from fuel is based upon fuel heating value at 25 C. | | | |
| Zero enthalpy: dry gases & liquid water at 25 C. | | | |
| The entering air enthalpy is calculated based on air temperature before air heater. | | | |
| The leaving gas enthalpy is calculated based on flue gas temperature after the last heat exchanger at 240,6 C. | | | |
| Evaluation of this table per ASME PTC-4 | | | |

3. Boiler Assembly, Outputs

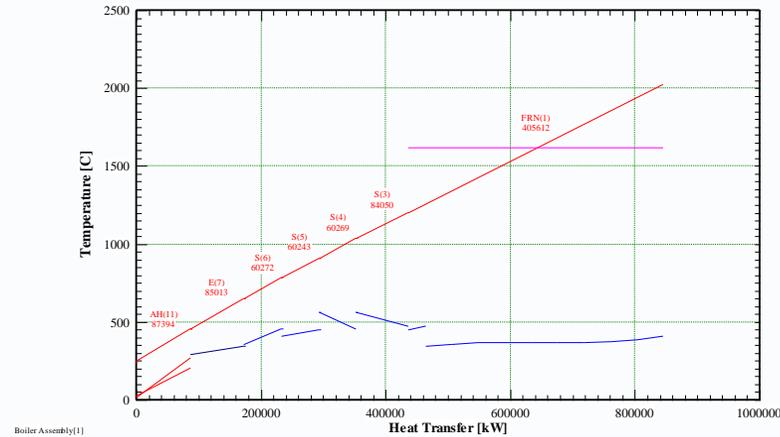


THERMOFLEX Version 26.1 Revision: June 2, 2017 Unregistered User Ignacio Martin Gonzalez
 1305 06-13-2017 14:14:12 file=C:\Users\ignat\Documents\Thermodflow 26\IMGa_FAW1_Asemblies\BoilerSTPRO_No Ass_ED_Ass.TFX



THERMOFLEX Version 26.1 Revision: June 2, 2017 Unregistered User Ignacio Martin Gonzalez
 1305 06-13-2017 14:14:12 file=C:\Users\ignat\Documents\Thermodflow 26\IMGa_FAW1_Asemblies\BoilerSTPRO_No Ass_ED_Ass.TFX

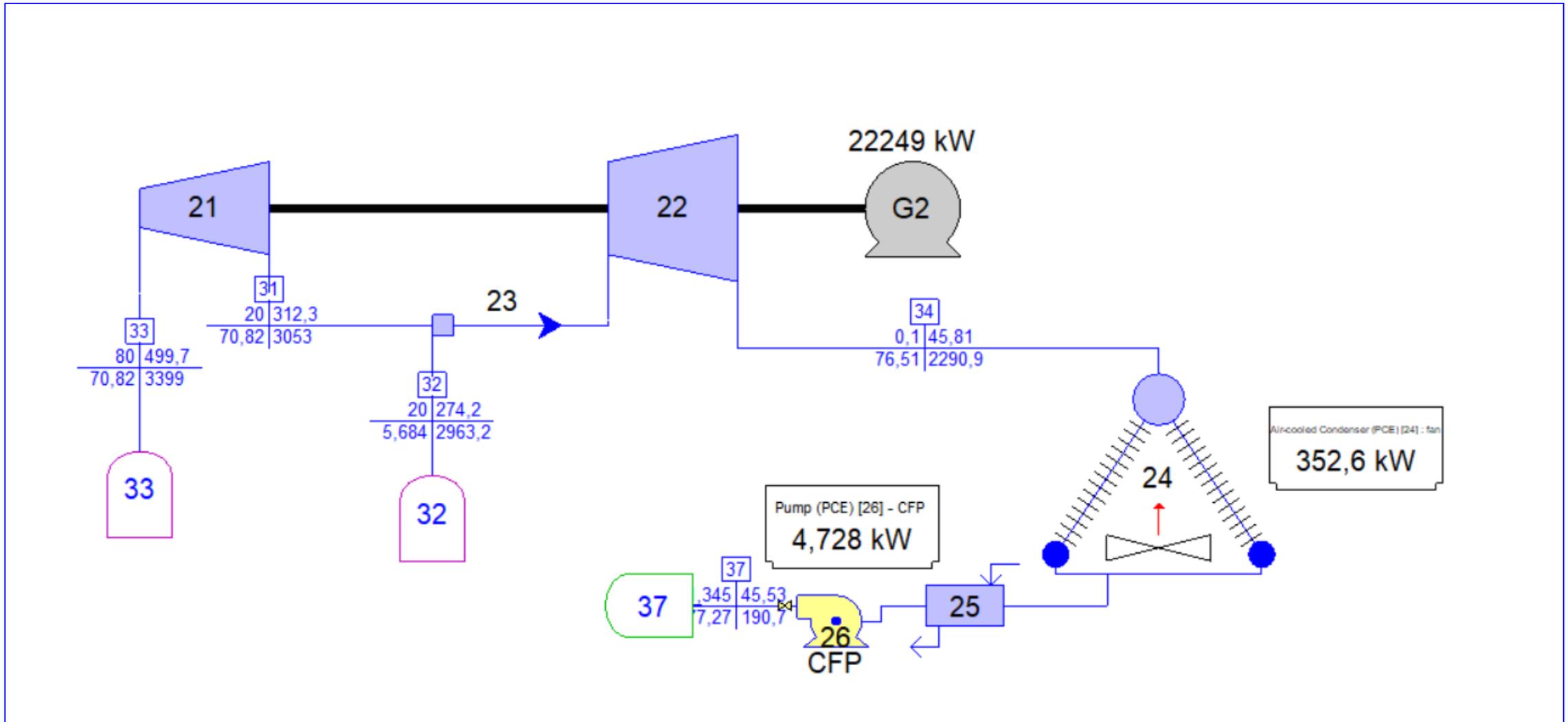
Boiler Assembly - Boiler Assembly[1] T-Q Diagram



THERMOFLEX Version 26.1 Revision: June 2, 2017 Unregistered User Ignacio Martin Gonzalez
 1305 06-13-2017 14:14:12 file=C:\Users\ignat\Documents\Thermodflow 26\IMGa_FAW1_Asemblies\BoilerSTPRO_No Ass_ED_Ass.TFX

4. Steam Turbine Assembly

- ST Design in TFX
- ST Assembly Definition and Requisites
- ST Assembly Outputs
- Differences ST Assembly / No Assembly
- Managing the ST Assembly
- Leakage Flows to a TFX Source
- ST Assembly in OD Mode
- ST Assembly in files imported from GTP-GTM-STP



Input Menu - Edit Mode
File: GTP/GTM/STM

Site Menu | Components | Miscellaneous | Gen/Motors | Plant Assembly | **Thermodynamic Design** | Economics | Regional Costs | OK | Cancel

ST Group [21] | Thermodynamic Design | Exhaust Loss & Miscellaneous

Main Inputs

Efficiency Definitions:

- Specify dry step efficiency: 85 %
- Specify exit enthalpy (before exhaust loss): 2325.9 kJ/kg
- Reference pressure ratio for ST expansion step: 1.35
- Condensation quality (Wilson line): 0.97
- Moisture efficiency penalty (Baumann coefficient): 0.72
- Moisture efficiency penalty method: 0=Old, 1=New: 1

Inlet pressure control: Uncontrolled (sliding pressure)

Control pressure drop: 2.5 %

Sizing flow / design point flow: 1

Design point pressure: 80 bar

Inlet pressure drop: 0 %

Mechanical Definitions:

- Shaft number: 2
- Shaft speed: 3000 RPM
- Mechanical efficiency: 99.75 %

(33)
P = 80.00
T = 499.7
Sup = 204.6
H = 3398.51
H* = 851.02
M = 70.82

(31)
P = 20.00
T = 312.3
Sup = 99.9
H = 3052.51
H* = 505.02
M = 70.82

P[bar] T[C] H[kJ/kg] H*[kJ/kg] M[t/h]
ST Group [21]
Mode: Thermodynamic Design; Type of inlet control: Sliding
Expansion power = 6807 kW Mechanical loss = 17.02 kW Shaft power = 6790 kW Current RPM = 3000
Dry step efficiency = 85 % Group overall eff. = 86.76 % Group blading eff. = 86.76 %
Inlet pressure = 80 bar
Exit pressure = 20 bar enthalpy = 3053 kJ/kg steam superheat = 99.88 C

Input Menu - Edit Mode
File: GTP/GTM/STM

Site Menu | Components | Miscellaneous | Gen/Motors | Plant Assembly | **Thermodynamic Design** | Economics | Regional Costs | OK | Cancel

ST Group [22] | Thermodynamic Design | Exhaust Loss & Miscellaneous

Main Inputs

Efficiency Definitions:

- Specify dry step efficiency: 85 %
- Specify exit enthalpy (before exhaust loss): 2325.9 kJ/kg
- Reference pressure ratio for ST expansion step: 1.35
- Condensation quality (Wilson line): 0.97
- Moisture efficiency penalty (Baumann coefficient): 0.72
- Moisture efficiency penalty method: 0=Old, 1=New: 1

Inlet pressure control: Uncontrolled (sliding pressure)

Control pressure drop: 2.5 %

Sizing flow / design point flow: 1

Design point pressure: 20 bar

Inlet pressure drop: 0 %

Mechanical Definitions:

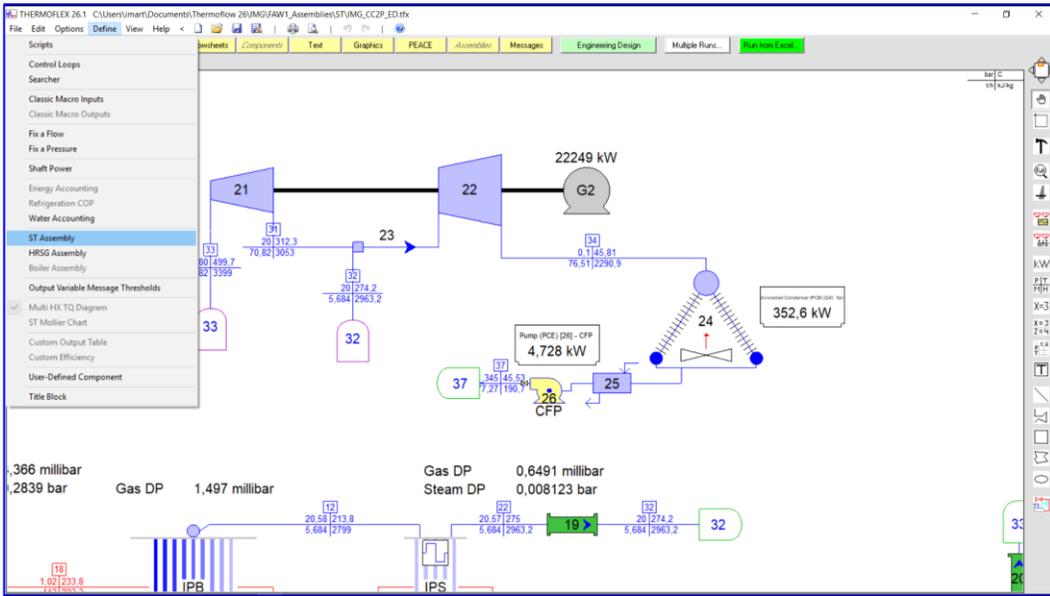
- Shaft number: 3
- Shaft speed: 3000 RPM
- Mechanical efficiency: 99.75 %

(30)
P = 20.00
T = 309.4
Sup = 97.0
H = 3045.89
H* = 498.39
M = 76.51

(34)
P = 0.1000
T = 45.81
x = 0.878
H = 2290.91
H* = -256.58
M = 76.51

P[bar] T[C] H[kJ/kg] H*[kJ/kg] M[t/h]
ST Group [22]
Mode: Thermodynamic Design; Type of inlet control: Sliding
Expansion power = 16045 kW Mechanical loss = 40.11 kW Shaft power = 16005 kW Current RPM = 3000
Dry step efficiency = 85 % Group overall eff. = 84.8 % Group blading eff. = 84.8 %
Inlet pressure = 20 bar
Exit pressure = 0.1 bar enthalpy = 2290.9 kJ/kg steam quality = 0.8775

4. Steam Turbine Assembly Definition



ST Assembly Initialization - STAssembly[1]

Main

Turbine Classification

- Non-Condensing Non-Reheat
- Condensing, Non-Reheat**
- Condensing, Single-Reheat
- Condensing, Double-Reheat
- Non-Condensing, Single-Reheat
- Non-Condensing, Double-Reheat
- Nuclear Steam Turbine

Overall Casing Arrangement

HPT (1 casing)

HPT/LPT (1 casing)

HPT (1 casing)
HPT/LPT (1 casing)
HPT + LPT (2 or more casings)

HPT/PIPT + IPT + LPT (3 or more casings)

HPT/PT/LPT (1 casing)

HPT/PIPT + IPT + LPT (3 or more casings)

HPT + LPT 3600 RPM (2 or more casings)

The casing configuration uses / and + symbols.
 / means two parts of the turbine are in the same casing.
 + indicates two parts are in separate casings.

HPT/LPT

HPT | IPT | LPT

ST Assembly Manager

Add New Assembly | Remove Selected Assembly

ST Assembly: STAssembly[1]

Unaffiliated ST Components in Plant

- ST Components
- ST Group [22]

Components Affiliated with ST Assembly

STAssembly[1]

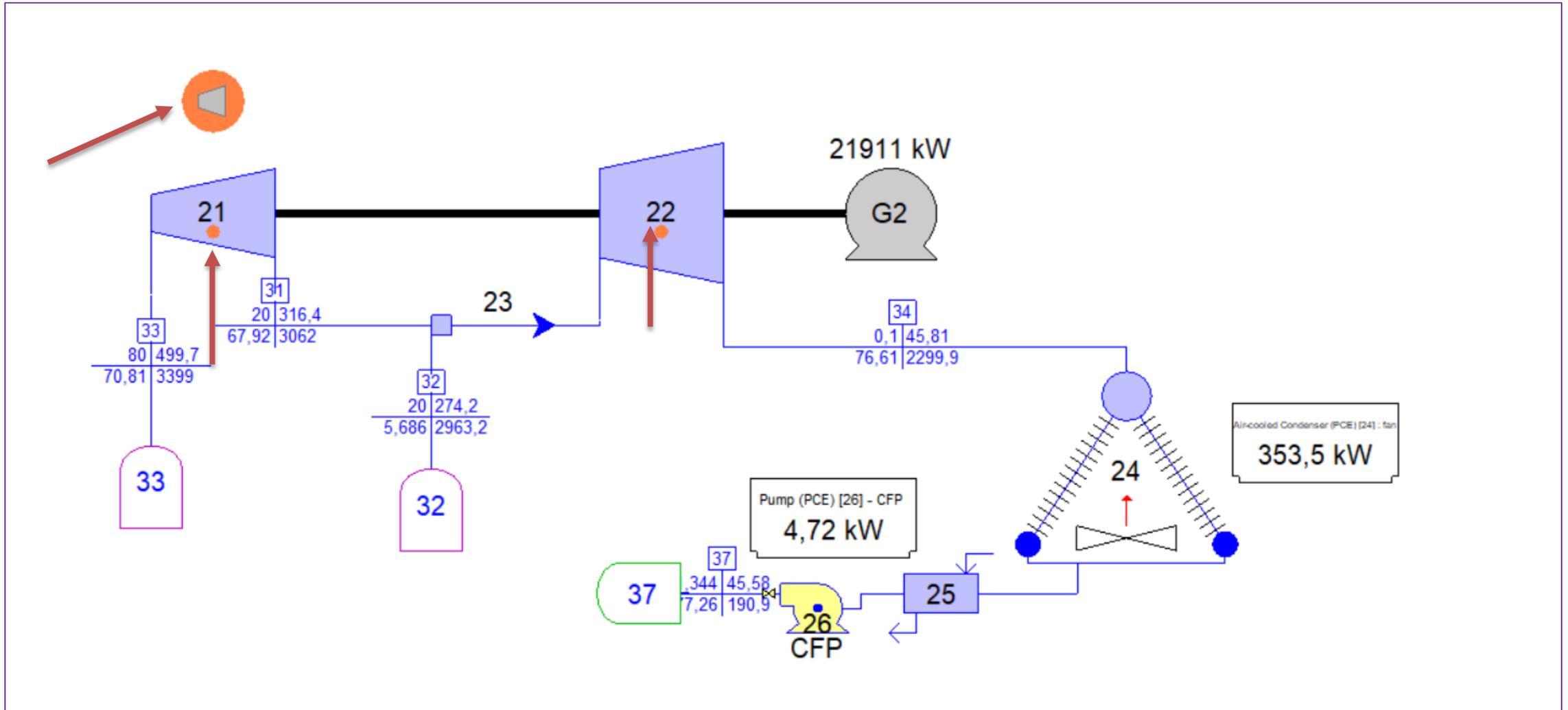
- HPT/LPT - HPT
- ST Group [21]
- HPT/LPT - LPT

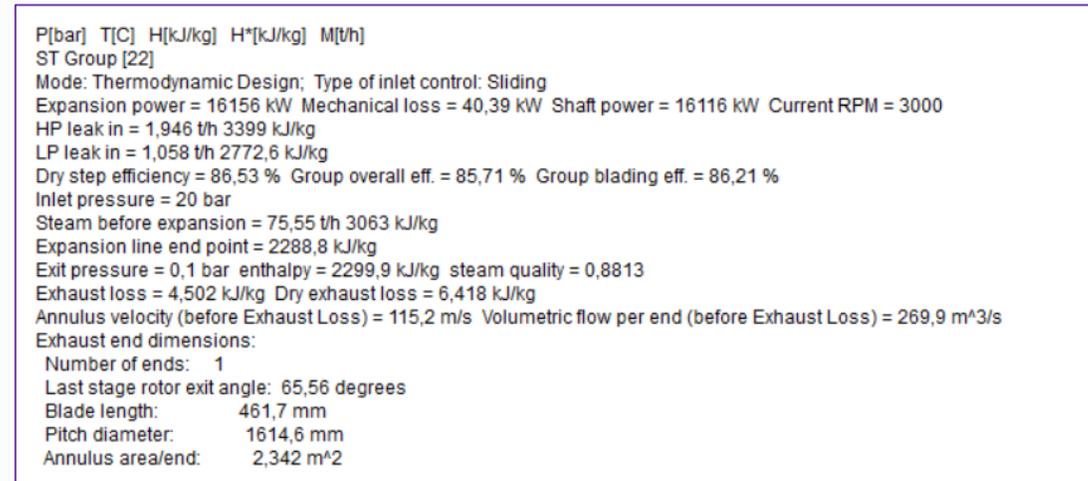
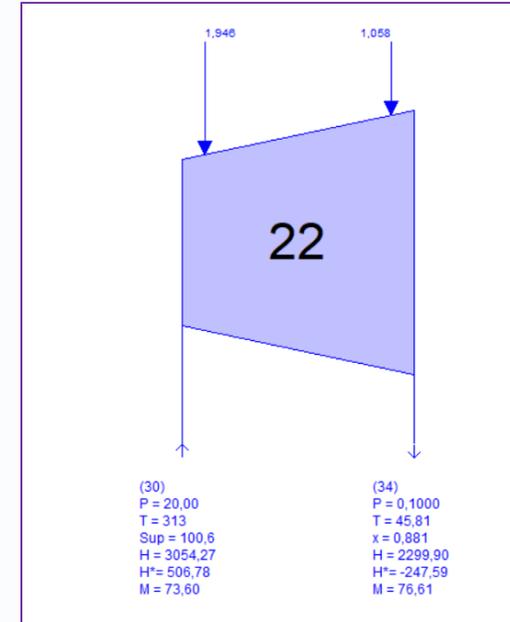
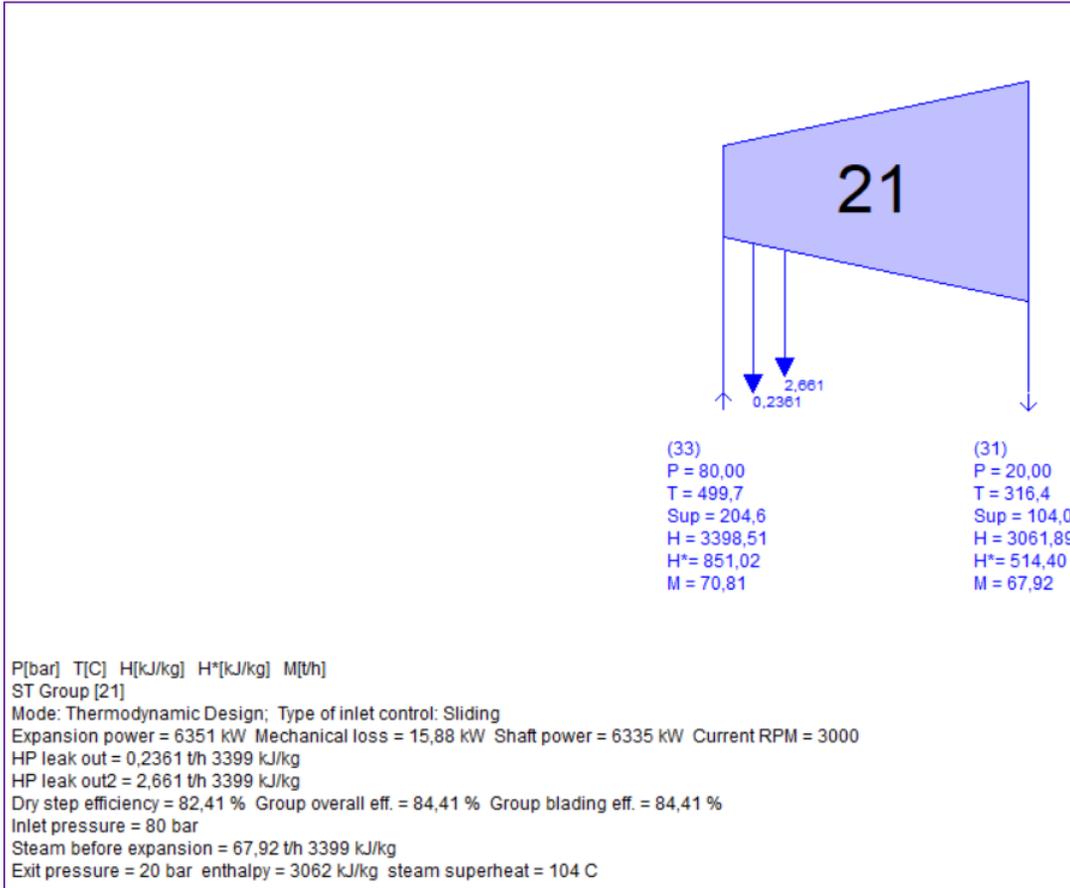
ST Casing Selection

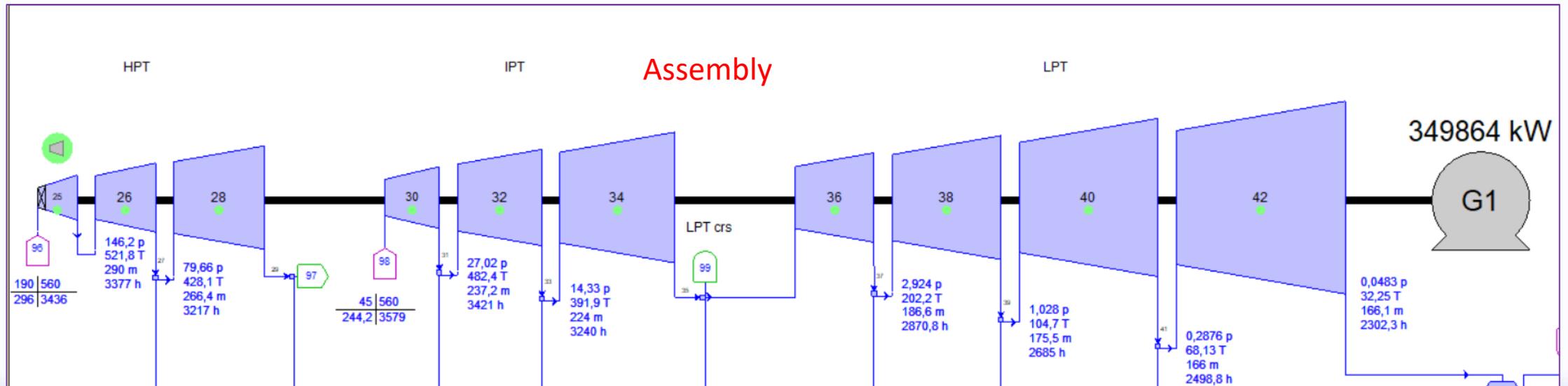
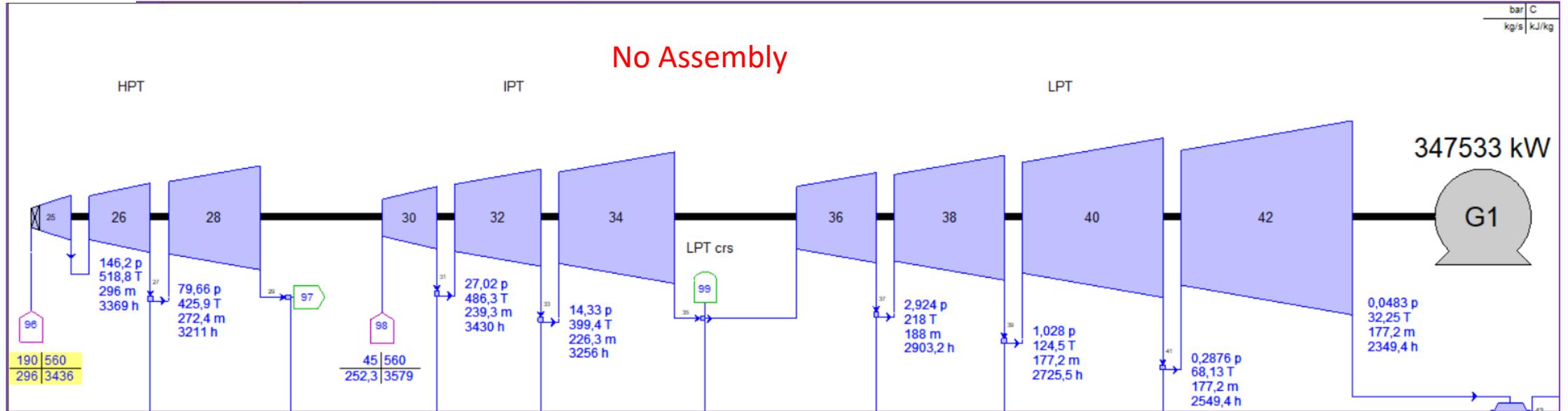
HPT/LPT - HPT
HPT/LPT - LPT

Remember to select "ST Casing" when filling the ST assembly.

Did you know that ...
 Clicking "OK" in "Re-define ST Casing Configuration" will re-initialize the assembly input.
 Activating "Edit Assembly Input" will let the user edit inputs for governing stage, ST efficiency, design conditions, leakages, SSR system, and exhaust end.





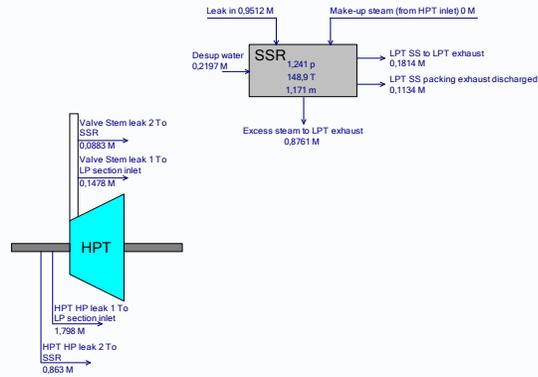


4. Steam Turbine Assembly Outputs

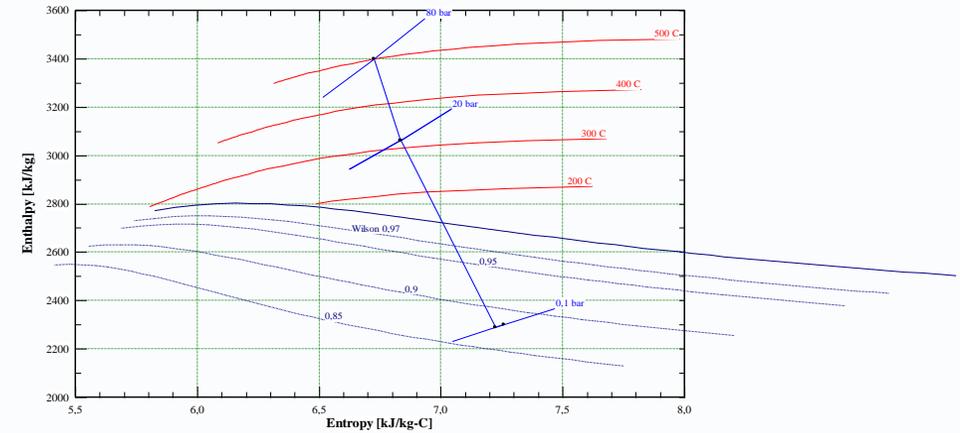
| STAssembly[1] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|-----|--------------------|-------|-----|-------------------------------------|-----|--|-----------------------------------|-------|---|--------------------|-------------------------|--|-----------------------------|----|-----|--------------------------------|-------|---|-----------------------------|-------|-----|------------------|------------|--|------------------------------|---|--|--------------------------------------|---|--|--|---|--|----------------------|-----|---|---------------------|-------|---|----------------------|--------|----|--------------------------------------|-------|---|-----------------|-------|---|------------------|--------|----|---------------------------------|-------|---|--------------------------------|-------|---|---------------------------------|--------|----|-------------------|-------|---|------------------|-------|---|------------------|--|--|----------------------------|-----------|---|------------|--|--|-----------|--|--|-------------|--|--|------------------|--|--|--|--|--|--|--|--|--------------------------|--|--|-------------------|--|--|--------------------------|--------|---|
| File Edit | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| STAssembly[1] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> STAssembly[1] <ul style="list-style-type: none"> Specification Overall Groups Leakages ST Schematic Leak Schematic ST Expansion <ul style="list-style-type: none"> Display All Plan View Elevation View | STAssembly[1] Estimated Steam Turbine Data 1. Steam Turbine Description <table border="1"> <tr><td>Nameplate Capacity</td><td>25.56</td><td>MVA</td></tr> <tr><td>Design Point Generator Power Factor</td><td>0.9</td><td></td></tr> <tr><td>Design Point Generator Efficiency</td><td>97.63</td><td>%</td></tr> <tr><td>Steam Turbine Type</td><td>Condensing, Non-Preheat</td><td></td></tr> <tr><td>Nameplate Throttle Pressure</td><td>84</td><td>bar</td></tr> <tr><td>Nameplate Throttle Temperature</td><td>499.7</td><td>C</td></tr> <tr><td>Nameplate Throttle Massflow</td><td>70.81</td><td>t/h</td></tr> <tr><td>Exhaust End Type</td><td>Down Draft</td><td></td></tr> <tr><td>Number of LPT Exhaust Annuli</td><td>1</td><td></td></tr> <tr><td>Number of Extraction/Admission Ports</td><td>1</td><td></td></tr> <tr><td>Number of Auto-Extraction/Auto-Admission Ports</td><td>0</td><td></td></tr> </table> 2. Estimated Weights & Dimensions <table border="1"> <tr><td>Steam Turbine Length</td><td>4.9</td><td>m</td></tr> <tr><td>Steam Turbine Width</td><td>3.322</td><td>m</td></tr> <tr><td>Steam Turbine Weight</td><td>42.780</td><td>kg</td></tr> <tr><td>Generator Length (Including Exciter)</td><td>6.916</td><td>m</td></tr> <tr><td>Generator Width</td><td>2.723</td><td>m</td></tr> <tr><td>Generator Weight</td><td>54.100</td><td>kg</td></tr> <tr><td>Overall ST and Generator Length</td><td>11.82</td><td>m</td></tr> <tr><td>Overall ST and Generator Width</td><td>3.322</td><td>m</td></tr> <tr><td>Overall ST and Generator Weight</td><td>96.850</td><td>kg</td></tr> <tr><td>Foundation Length</td><td>13.41</td><td>m</td></tr> <tr><td>Foundation Width</td><td>3.987</td><td>m</td></tr> </table> 3. Reference Material, Equipment, and Installation Costs <table border="1"> <tr><td colspan="3">Equipment</td></tr> <tr><td>Steam Turbine Package Cost</td><td>5.738.000</td><td>€</td></tr> <tr><td colspan="3">Including:</td></tr> <tr><td>- Turbine</td><td></td><td></td></tr> <tr><td>- Generator</td><td></td><td></td></tr> <tr><td>- Exhaust System</td><td></td><td></td></tr> <tr><td>- Electrical/Control/Instrumentation Package</td><td></td><td></td></tr> <tr><td>- Lube Oil Package w/ main, auxiliary & emergency pump</td><td></td><td></td></tr> <tr><td>- Transportation to Site</td><td></td><td></td></tr> <tr><td colspan="3">Mechanical</td></tr> <tr><td>Mechanical material cost</td><td>40.670</td><td>€</td></tr> </table> | | Nameplate Capacity | 25.56 | MVA | Design Point Generator Power Factor | 0.9 | | Design Point Generator Efficiency | 97.63 | % | Steam Turbine Type | Condensing, Non-Preheat | | Nameplate Throttle Pressure | 84 | bar | Nameplate Throttle Temperature | 499.7 | C | Nameplate Throttle Massflow | 70.81 | t/h | Exhaust End Type | Down Draft | | Number of LPT Exhaust Annuli | 1 | | Number of Extraction/Admission Ports | 1 | | Number of Auto-Extraction/Auto-Admission Ports | 0 | | Steam Turbine Length | 4.9 | m | Steam Turbine Width | 3.322 | m | Steam Turbine Weight | 42.780 | kg | Generator Length (Including Exciter) | 6.916 | m | Generator Width | 2.723 | m | Generator Weight | 54.100 | kg | Overall ST and Generator Length | 11.82 | m | Overall ST and Generator Width | 3.322 | m | Overall ST and Generator Weight | 96.850 | kg | Foundation Length | 13.41 | m | Foundation Width | 3.987 | m | Equipment | | | Steam Turbine Package Cost | 5.738.000 | € | Including: | | | - Turbine | | | - Generator | | | - Exhaust System | | | - Electrical/Control/Instrumentation Package | | | - Lube Oil Package w/ main, auxiliary & emergency pump | | | - Transportation to Site | | | Mechanical | | | Mechanical material cost | 40.670 | € |
| Nameplate Capacity | 25.56 | MVA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design Point Generator Power Factor | 0.9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design Point Generator Efficiency | 97.63 | % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Steam Turbine Type | Condensing, Non-Preheat | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nameplate Throttle Pressure | 84 | bar | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nameplate Throttle Temperature | 499.7 | C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nameplate Throttle Massflow | 70.81 | t/h | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Exhaust End Type | Down Draft | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Number of LPT Exhaust Annuli | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Number of Extraction/Admission Ports | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Number of Auto-Extraction/Auto-Admission Ports | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Steam Turbine Length | 4.9 | m | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Steam Turbine Width | 3.322 | m | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Steam Turbine Weight | 42.780 | kg | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Generator Length (Including Exciter) | 6.916 | m | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Generator Width | 2.723 | m | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Generator Weight | 54.100 | kg | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Overall ST and Generator Length | 11.82 | m | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Overall ST and Generator Width | 3.322 | m | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Overall ST and Generator Weight | 96.850 | kg | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Foundation Length | 13.41 | m | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Foundation Width | 3.987 | m | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Equipment | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Steam Turbine Package Cost | 5.738.000 | € | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Including: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Turbine | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Generator | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Exhaust System | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Electrical/Control/Instrumentation Package | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Lube Oil Package w/ main, auxiliary & emergency pump | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Transportation to Site | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mechanical | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mechanical material cost | 40.670 | € | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

4. Steam Turbine Assembly Outputs

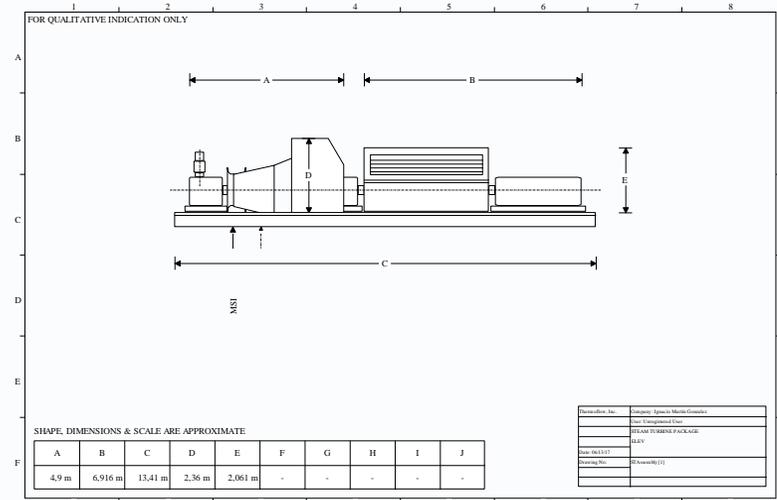
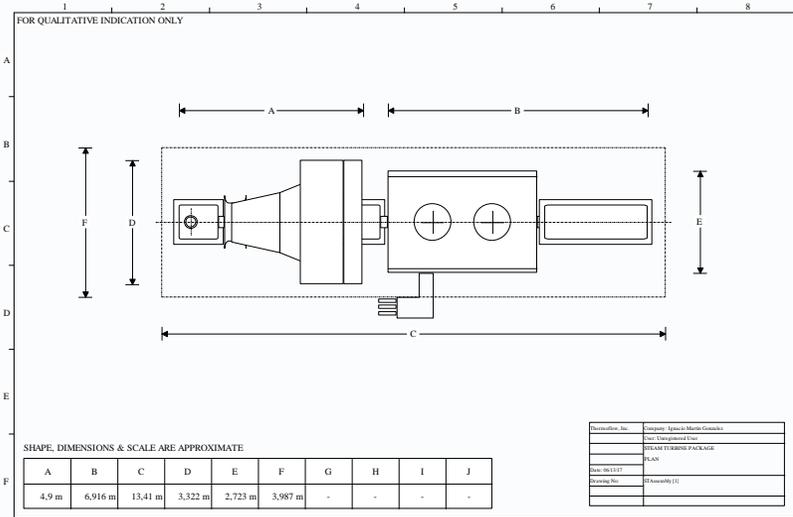
STAssembly[1]



STAssembly[1]: Steam Turbine Expansion Path



p[bar], T[C], h[kJ/kg], M[t/h]



Thermodflow Inc. | Ignacio Martin Gonzalez
 THERMOFLEX Version 26.1 | Revision: June 2, 2017 | Unregistered User: Ignacio Martin Gonzalez
 1305 06-13-2017 08:42:05 file: C:\user\martin\Documents\Thermodflow 26\IMG\FAW1_Assemblies\ST\IMG_CC2P_ED_ST_Asa.tfx

Thermodflow Inc. | Ignacio Martin Gonzalez
 THERMOFLEX Version 26.1 | Revision: June 2, 2017 | Unregistered User: Ignacio Martin Gonzalez
 1305 06-13-2017 08:42:05 file: C:\user\martin\Documents\Thermodflow 26\IMG\FAW1_Assemblies\ST\IMG_CC2P_ED_ST_Asa.tfx

4. ST Assembly, Efficiency Definition

ST Assembly: Edit Inputs (Design) - STAssembly[1]

Did you know...
The inputs edited on this menu depend on whether the assembly is in 'Design' or 'Off-design' mode.

ST Main Inputs | ST Leakages | Steam Seal System | Exhaust End Design | Miscellaneous | Model Adjustments

HPT Governing Stage

1st ST group in HPT is governing stage

Number of governing stage rows: 0

Throttle pressure / First stage exit pressure: 1

Selection of Governing Stage Pitch Diameter

Auto

User-defined

Governing stage pitch diameter: 609,6 mm

Estimated governing stage pitch diameter: 609,6 mm

Desired Exhaust Duct Type

Downdraft Axial

Volumetric Flow Threshold for Increasing Number of Paths

Lower Intermediate Higher

Back Pressure Steam Turbine

Use single stage steam turbine

Nameplate Conditions

Nameplate throttle pressure / current value: 1,05

Nameplate throttle temperature / current value: 1

ST Group Efficiency Estimate

Automatic - Version 21 method (2011 to date)

Control Point for Automatic Estimate of Dry Step Efficiency

ST Group [21] (HPT/LPT - HPT): 1

Pressure Drop Assumptions for Automatic Estimate of Dry Step Efficiency

HPT stop valve pressure drop (DP/P): 2,5 %

Hot reheat stop valve pressure drop (DP/P): 2 %

Apply modified method for governing stage efficiency adjustment

Input Menu - Edit Mode

File GTP/GTM/STM

Site Menu | Components | Miscellaneous | Gen/Motors | Plant Assembly | Non-Flowheat | Economics | Regional Costs

STAssembly[1]: ST Group [21] | Thermodynamic Design

Efficiency Definitions

Specify dry step efficiency: 82,41 %

Specify exit enthalpy (before exhaust loss): 2325,9 kJ/kg

Reference pressure ratio for ST expansion step: 1,35

Condensation quality (Wilson line): 0,97

Moisture efficiency penalty (Baumann coefficient): 0,72

Moisture efficiency penalty method, 0=Old, 1=New: 1

Dry step efficiency will be calculated by the ST assembly holding this steam turbine group.

Inlet pressure control: Uncontrolled (sliding pressure)

Control pressure drop: 2,5 %

Sizing flow / design point flow: 1

Design point pressure: 80 bar

Inlet pressure drop: 0 %

Mechanical Definitions

Shaft number: 2

Shaft speed: 3000 RPM

Mechanical efficiency: 99,75 %

4. ST Assembly: Leakage to TFX Source

ST Assembly: Edit Inputs (Design) - STAssembly[1]

Did you know...
The inputs edited on this menu depend on whether the assembly is in 'Design' or 'Off-design' mode.

ST Main Inputs | **ST Leakages** | Steam Seal System | Exhaust End Design | Miscellaneous | Model Adjustments

Automatic Procedure Options

Thermostat-modified SCC method Spencer, Cotton & Cannon (SCC) method

Valve Stem Leaks

HPT HP leak 2

Leak destination: SSR (1,241 bar)

Leak flow modeled by: Automatic Procedure

HPT HP End Leaks

- HP end leak 1
- HP end leak 2
- HP end leak 3

Click the appropriate button to define the leak model and destination. In each group of leaks, the leak number and destination pressure should be in order, with leak 1 connected to highest pressure destination.

4. ST Assembly: Exhaust End

The screenshot shows the 'ST Assembly: Edit Inputs (Design) - STAssembly[1]' window with the 'Exhaust End Design' tab selected. A yellow callout box at the top states: 'Did you know... The inputs edited on this menu depend on whether the assembly is in 'Design' or 'Off-design' mode.' The dialog box in the foreground is titled 'Steam Turbine User-defined Exhaust End Geometry and Leaving Loss' and has two tabs: 'ST Exhaust End' and 'Exhaust Loss Curve'. The 'ST Exhaust End' tab contains the following fields and options:

- Exhaust end description (up to 10 characters only):** [Empty text box]
- Pitch diameter:** 1614.6 mm
- Annulus area:** 2,342 m²
- Blade length (computed):** 461.7 mm
- Nominal RPM:** 3000 RPM
- Exhaust loss correction factor:** 1

The 'Exhaust Loss Curve' tab contains the following options:

- Specify exhaust loss curve using:**
 - Axial steam velocity
 - Steam volume flow

Buttons on the right side of the dialog include 'OK', 'Cancel', 'Save Exhaust End File...', and 'Load Exhaust End File...'. The background software interface shows the 'Exhaust End Design' tab with options for 'Automatic' or 'User-defined' calculation methods and 'Automatic' or 'User-defined' exhaust end size and leaving loss curves. A yellow callout box in the background says: 'Did you know that... The "Calculation Method" during "ST Casing" is the option for automatic "Total Number of LPT Exhaust Moisture Correction Options'.

4. ST Assembly: Miscellaneous

ST Assembly: Edit Inputs (Design) - STAssembly[1]

Did you know...
The inputs edited on this menu depend on whether the assembly is in 'Design' or 'Off-design' mode.

OK Cancel

ST Main Inputs | ST Leakages | Steam Seal System | Exhaust End Design | **Miscellaneous** | Model Adjustments

ST Miscellaneous Auxiliary Load

- % of ST generator rated power: 0,05 %
- Fixed value: 0 kW

ST Lube Oil Auxiliary Load

- Auxiliary load correction factor: 1

HPT inlet leak

- Throttle pressure/HPT inlet leak pressure: 1,3
- Throttle enthalpy - HPT inlet leak enthalpy: 0 kJ/kg

HPT - High Speed with Reducing Gear

- Reducing gear efficiency: 98,5 %

Generator Coolant and Oil-Cooler Heat Recovery

- All Heat Rejections to Single Heat Adder: [] Single Heat Adder
- Connect to Heat Adder: Generator elec+windage heat rejection (coolant) 0 % Not connected Heat Adder
- Connect to Heat Adder: Generator mechanical loss (lube oil) 0 % Not connected Heat Adder
- Connect to Heat Adder: ST mechanical loss (lube oil) 0 % Not connected Heat Adder
- Connect to Heat Adder: Gear box heat rejection (lube oil) 0 % Not connected Heat Adder

Click a button to select the heat adder to receive the recovered heat

4. Steam Turbine Assembly at Off Design

ST Assembly: Edit Inputs (Off-design) - STAssembly[1]

Did you know...
The inputs edited on this menu depend on whether the assembly is in 'Design' or 'Off-design' mode.

ST Leakages | Steam Seal System | Exhaust End Design | Miscellaneous | Model Adjustments

Valve Stem leak 1

Leak destination: LP section inlet (20 bar)

Leak flow modeled by: C Factor

C Factor: 1,161 m²

Valve Stem Leaks

- VS leak 1
- VS leak 2
- VS leak 3

HPT HP End Leaks

- HP end leak 1
- HP end leak 2
- HP end leak 3

ST Assembly: Edit Inputs (Off-design) - STAssembly[1]

Did you know...
The inputs edited on this menu depend on whether the assembly is in 'Design' or 'Off-design' mode.

ST Leakages | Steam Seal System | Exhaust End Design | Miscellaneous

Sealing Steam (SS)

Destination of SS packing exhaust: Discharge

Sealing steam condenser pressure: 0,8274 bar

SS flow to LPT exhaust per LPT path: 0,1814 t/h

SS flow to packing exhaust per LPT path: 0,1134 t/h

Sealing Steam Regulator (SSR)

Destination of excess flow from SSR: LPT exhaust

SSR makeup steam source: HPT inlet

Sealing steam regulator pressure: 1,241 bar

Maximum sealing steam regulator temperature: 148,9 C

Desuperheating water temperature: 15 C

ST Assembly: Edit Inputs (Off-design) - STAssembly[1]

Click the appropriate to the leak number and its pressure destination.

Did you know...
The inputs edited on this menu depend on whether the assembly is in 'Design' or 'Off-design' mode.

ST Leakages | Steam Seal System | Exhaust End Design | Miscellaneous | Model Adjustments

Exhaust End for ST Group: ST Group [22] (HPT/LPT - LPT)

Exhaust End Dimensions and Leaving Loss

Apply exhaust curve

Use these options to modify or replace the current exhaust end definition.

Select from exhaust end database

Load from exhaust end datafile

Edit current or create new exhaust end

Edit Thermoflow exhaust loss model parameters

Apply constant exhaust loss

Exhaust loss: 9,303 kJ/kg

LPT Exhaust Moisture Correction Options

- Method 1: $CEL = ELdy \cdot 0,87 \cdot (1-y) \cdot (1-0,65y)$
- Method 2: $CEL = ELdy \cdot (1-y)$
- No moisture correction: $CEL = ELdy$

CEL = corrected exhaust loss, ELdy = dry exhaust loss, y = exhaust moisture fraction

ST Assembly: Edit Inputs (Off-design) - STAssembly[1]

Did you know...
The inputs edited on this menu depend on whether the assembly is in 'Design' or 'Off-design' mode.

ST Leakages | Steam Seal System | Exhaust End Design | Miscellaneous | Model Adjustments

Model Adjustments

Enabled Disabled

Tune ST Model

ST Group [21] - Group Adjustment Factors

ST Group: ST Group [21]

Nozzle Area Adjustment Factors

| | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 |
|---|--------------------------|---------|---------|---------|---------|
| Group inlet volume flow / Design value | 40 % | 60 % | 80 % | 100 % | 120 % |
| Group inlet nozzle area adjustment factor | 1 | 1 | 1 | 1 | 1 |
| Design point group inlet volume flow = | 0,7875 m ³ /s | | | | |

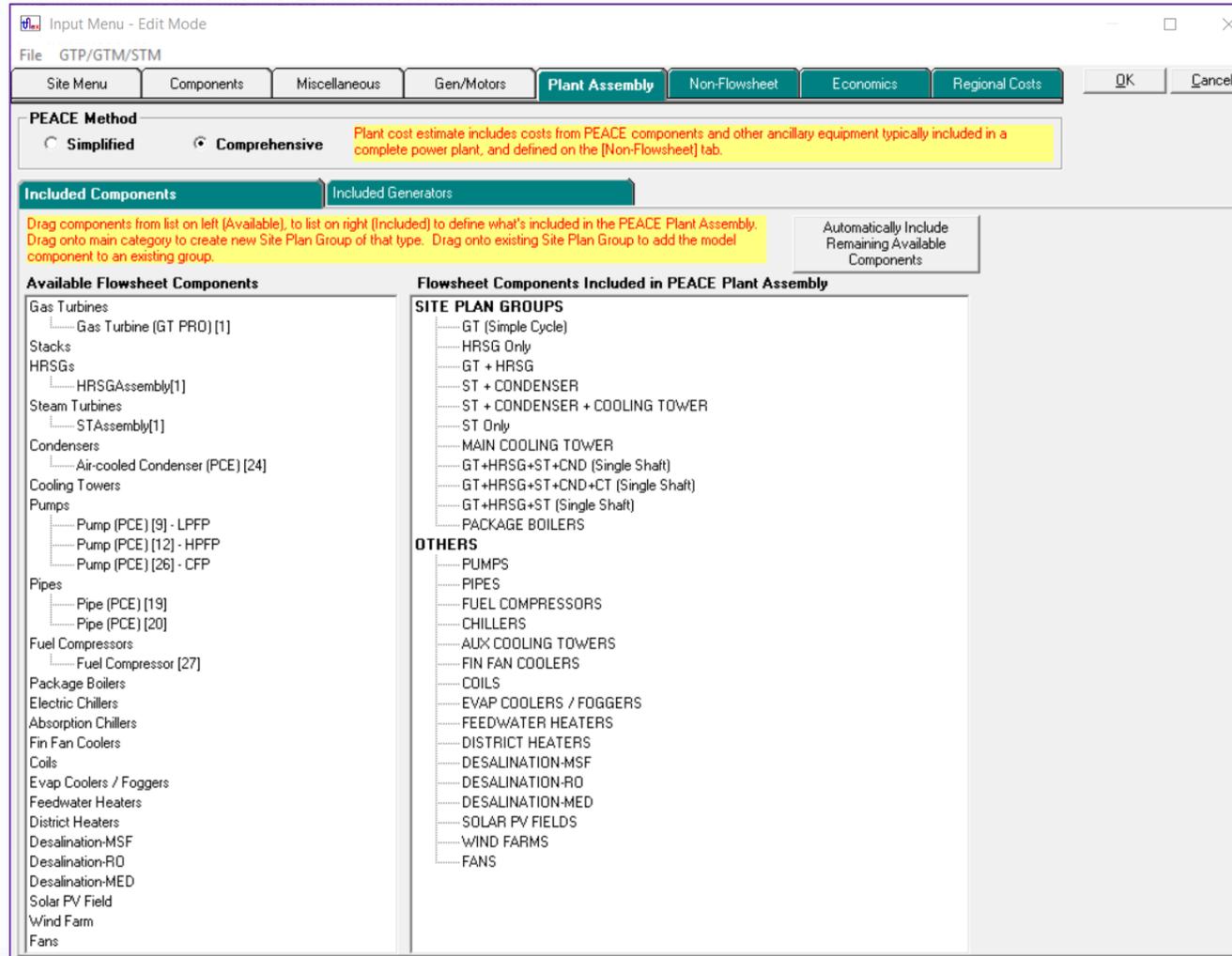
Dry Stage Efficiency Adjustment Factors

| | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 |
|---|------------------------|---------|---------|---------|---------|
| Group exit volume flow / Design value | 40 % | 60 % | 80 % | 100 % | 120 % |
| Group design dry stage efficiency adjustment factor | 1 | 1 | 1 | 1 | 1 |
| Design point group exit volume flow = | 2,45 m ³ /s | | | | |

5. Plant Assembly

- PEACE Cost Estimation Difference:
 - App. SP.: Total Plant Cost
 - TFX-PCE: Sum of cost of Equipment (included Ass.)
- Plant Assembly Definition (GT Plants)
 - Main Components, configuration
 - Miscellaneous
 - Economic Assumptions
- Plant Assembly Outputs
- Plant Assembly in files imported from GTP-GTM

5. Plant Assembly: Definition and Inputs



The screenshot shows the 'Input Menu - Edit Mode' window with the 'Plant Assembly' tab selected. The interface is divided into several sections:

- PEACE Method:** Two radio buttons are present: 'Simplified' (unselected) and 'Comprehensive' (selected). A yellow tooltip explains: "Plant cost estimate includes costs from PEACE components and other ancillary equipment typically included in a complete power plant, and defined on the [Non-Flowsheet] tab."
- Included Components / Included Generators:** Two tabs are visible at the top of the main workspace.
- Drag-and-Drop Instructions:** A yellow tooltip states: "Drag components from list on left (Available), to list on right (Included) to define what's included in the PEACE Plant Assembly. Drag onto main category to create new Site Plan Group of that type. Drag onto existing Site Plan Group to add the model component to an existing group."
- Available Flowsheet Components (Left Panel):**
 - Gas Turbines
 - Gas Turbine (GT PRD) [1]
 - Stacks
 - HRSGs
 - HRSGAssembly[1]
 - Steam Turbines
 - STAssembly[1]
 - Condensers
 - Air-cooled Condenser (PCE) [24]
 - Cooling Towers
 - Pumps
 - Pump (PCE) [9] - LPFP
 - Pump (PCE) [12] - HPFP
 - Pump (PCE) [26] - CFP
 - Pipes
 - Pipe (PCE) [19]
 - Pipe (PCE) [20]
 - Fuel Compressors
 - Fuel Compressor [27]
 - Package Boilers
 - Electric Chillers
 - Absorption Chillers
 - Fin Fan Coolers
 - Coils
 - Evap Coolers / Foggers
 - Feedwater Heaters
 - District Heaters
 - Desalination-MSF
 - Desalination-RO
 - Desalination-MED
 - Solar PV Field
 - Wind Farm
 - Fans
- Flowsheet Components Included in PEACE Plant Assembly (Right Panel):**
 - SITE PLAN GROUPS**
 - GT (Simple Cycle)
 - HRSG Only
 - GT + HRSG
 - ST + CONDENSER
 - ST + CONDENSER + COOLING TOWER
 - ST Only
 - MAIN COOLING TOWER
 - GT+HRSG+ST+CND (Single Shaft)
 - GT+HRSG+ST+CND+CT (Single Shaft)
 - GT+HRSG+ST (Single Shaft)
 - PACKAGE BOILERS
 - OTHERS**
 - PUMPS
 - PIPES
 - FUEL COMPRESSORS
 - CHILLERS
 - AUX COOLING TOWERS
 - FIN FAN COOLERS
 - COILS
 - EVAP COOLERS / FOGGERS
 - FEEDWATER HEATERS
 - DISTRICT HEATERS
 - DESALINATION-MSF
 - DESALINATION-RO
 - DESALINATION-MED
 - SOLAR PV FIELDS
 - WIND FARMS
 - FANS
- Buttons:** 'OK' and 'Cancel' buttons are located in the top right corner.

5. Plant Assembly: Definition and Inputs

The screenshot shows the 'Input Menu - Edit Mode' window with the 'Plant Assembly' tab selected. The interface includes a menu bar with options like 'Site Menu', 'Components', 'Miscellaneous', 'Gen/Motors', 'Plant Assembly', 'Non-Flowsheet', 'Economics', and 'Regional Costs'. Below the menu, there are radio buttons for 'Simplified' and 'Comprehensive' PEACE Method, with a yellow callout box explaining that the 'Comprehensive' method includes costs for ancillary equipment. The main area is divided into 'Included Components' and 'Included Generators' tabs. A yellow callout box provides instructions on how to connect generators to drivers and GSUs. A button labeled 'Assign Remaining Generators to Two-Winding GSUs' is also visible. The 'Available Generators' list is currently empty, while the 'Generators Assigned to GSUs' list shows a tree structure for a 'Two-winding GSU for one Generator' with sub-items for 'GSU [1]' and 'GSU [2]', each linked to a 'Generator'.

5. Plant Assembly, Non-Flowsheet Equipment

Input Menu - Edit Mode

File GTP/GTM/STM

Site Menu Components Miscellaneous Gen/Motors Plant Assembly **Non-Flowsheet** Economics Regional Costs OK Cancel

Site Characteristics Buildings Electrical **Tanks** Other Piping Other Pumps Cooling Others

Specify tank volume Specify tank height & diameter

1. Number of tanks in plant

2. Individual tank volume l

3. Tank diameter m

4. Tank height m

Fuel Oil
 Hydrous Ammonia
 Demineralized Water
 Raw Water
 Neutralized Water
 Acid
 Caustic
 Waste Water
 Fire Protection
 Chilled Water
 Process Water
 District Heating Water

5. Plant Assembly, Economics

Input Menu - Edit Mode

File GTP/GTM/STM

Site Menu Components Miscellaneous Gen/Motors **Plant Assembly** Non-Flowsheet **Economics** Regional Costs OK Cancel

Main Inputs Escalation Rates Contractor's Soft Costs Owner's Soft Costs Yearly O&M Costs User-defined Costs

My Plant

| | | |
|---------------------------|--------|------------------|
| Fuel LHV price | 5,118 | €/GJ |
| Imported water price | 0 | €/m ³ |
| Limestone price | 19,84 | €/tonne |
| Lime price | 79,37 | €/tonne |
| CO2 capture solvent price | 1984,2 | €/tonne |
| Activated carbon price | 1984,2 | €/tonne |

| | |
|---|--------------|
| First year of plant operation | 2018 |
| Project life in years | 20 |
| Operating hours per year (full-load equivalent) | 8100 |
| Straight line depreciation life in years (enter 0 for variable depreciation) | 15 |
| Depreciable percentage of total investment | 90 % |
| Debt term in years | 15 |
| Debt percentage of total investment | 70 % |
| Debt interest rate | 9 % |
| Overall tax rate | 35 % |
| Negative taxes treated as tax credits: 0=yes, 1=no | 0 |
| Amount of interest payment that is NOT tax deductible | 0 % |
| Discount rate for NPV calculation | 15 % |
| Fixed O&M costs | 18 €/kW |
| Variable O&M costs | 0,0018 €/kWh |

| | | |
|---|-------|---------|
| Electricity price | 0,045 | €/kWh |
| Heat export price | 4,265 | €/GJ |
| Capacity income | 0 | € |
| Captured CO2 export price or avoided cost | 0 | €/tonne |
| Syngas export price | 0 | €/GJ |
| Hydrogen export price | 6,825 | €/GJ |
| Desalinated water price | 3,6 | €/kG |
| CO2 emission penalty | 0 | €/tonne |
| Annual CO2 emission allowance | 0 | ktonne |
| Combustion waste disposal cost | 0 | €/tonne |
| FGD waste/byproducts disposal cost | 0 | €/tonne |

All prices are for the first year only. Price adjustments for subsequent years are computed using the factors on the 'Escalation Rates' tab.

5. Plant Assembly, Regional Costs

Input Menu - Edit Mode
File GTP/GTM/STM

Site Menu Components Miscellaneous Gen/Motors **Plant Assembly** Non-Flowsheet Economics **Regional Costs**

Method
 Simplified Detailed

Select region most representative of the project site

- Within United States
- Outside United States
 - Algeria
 - Argentina
 - Australia
 - Austria
 - Belgium
 - Brazil
 - Canada
 - China
 - Colombia
 - Czech Republic
 - Egypt
 - France
 - Germany
 - Hungary
 - India
 - Indonesia
 - Israel
 - Italy
 - Japan
 - Malaysia
 - Mexico
 - The Netherlands
 - Poland
 - Russia
 - Saudi Arabia
 - Singapore
 - South Africa
 - Spain

Cost Multipliers

| | Actual | Suggested |
|------------------------------|-----------------------------------|-----------------------------------|
| Specialized equipment | <input type="text" value="1,05"/> | <input type="text" value="1,05"/> |
| Other equipment | <input type="text" value="1,05"/> | <input type="text" value="0,7"/> |
| Commodity | <input type="text" value="1,05"/> | <input type="text" value="0,65"/> |
| Labor | <input type="text" value="1,25"/> | <input type="text" value="0,54"/> |

Union rates Non-union rates

Reference Exchange Rate: 62 INR/USD

CAUTION:
 (1) International cost estimates have greater uncertainty than US cost estimates.
 (2) Exchange rate fluctuations increase cost estimate uncertainties.
 (3) Should the current exchange rate differ from the Reference Exchange Rate shown, the user must exercise greater discretion.

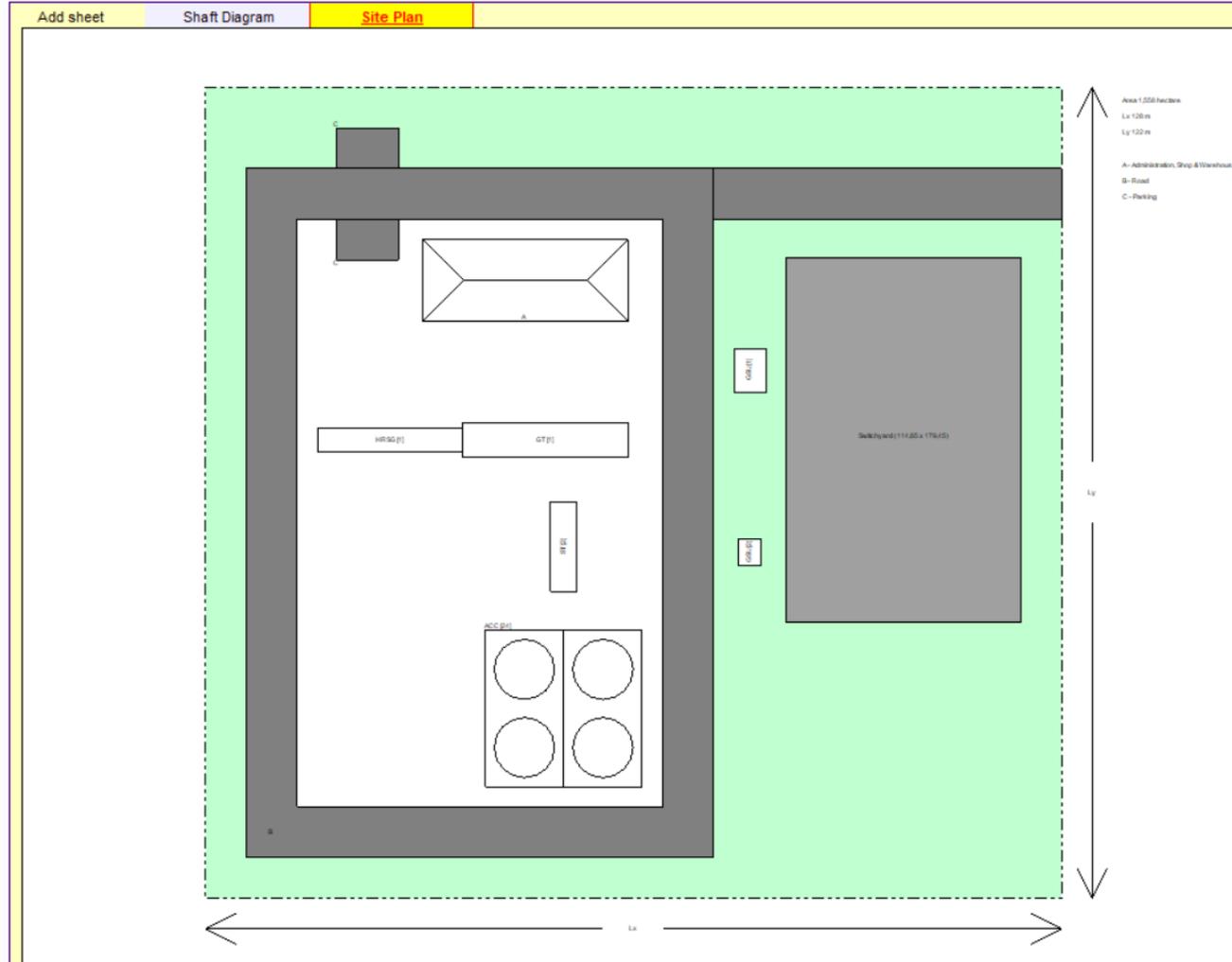
Currency

Currency symbol

Number of currency units per USD

CAUTION:
 (1) It is insufficient to simply enter the current exchange rate, and expect the PEACE cost estimate to accurately reflect project costs!

5. Plant Assembly: Outputs



5. Plant Assembly: Outputs

PEACE Output

File Edit Cost Modifiers

Preliminary Engineering **Financial**

Equipment Data **Cost Report** Cash Flow

Soft & Miscellaneous Costs Engineering & Plant Startup Linked Files & Other Systems

Buildings Mechanical Electrical Assembly & Wiring

Civil Specialized Equipment Other Equipment

Project Cost Summary

| Project Cost Summary (€) | Ref Cost | Est Cost | |
|--|-------------------|-------------------|-------------|
| Power Plant | | | |
| I. Specialized Equipment | 37.562.000 | 39.440.000 | € |
| II. Other Equipment | 1.084.000 | 1.138.000 | € |
| III. Civil | 3.842.000 | 4.343.000 | € |
| IV. Mechanical | 3.800.000 | 4.574.000 | € |
| V. Electrical Assembly & Wiring | 1.607.000 | 1.904.000 | € |
| VI. Buildings & Structures | 2.527.000 | 2.906.000 | € |
| VII. Engineering & Startup | 5.671.000 | 5.678.000 | € |
| VIII. Linked Files & Other Systems | 0 | 0 | € |
| Subtotal - Contractor's Internal Cost | 56.093.000 | 59.983.000 | € |
| IX. Contractor's Soft & Miscellaneous Costs | 7.395.000 | 8.212.000 | € |
| Contractor's Price | 63.488.000 | 68.196.000 | € |
| X. Owner's Soft & Miscellaneous Costs | 5.714.000 | 6.138.000 | € |
| Total - Owner's Cost | 69.202.000 | 74.333.000 | € |
| Nameplate Net Plant Output | 69,66 | 69,66 | MWe |
| Price per kW - Contractor's | 911,4 | 979 | €/kW |
| Cost per kW - Owner's | 993,4 | 1067,1 | €/kW |
| * Cost estimates as of August 2016. | | | |

5. Plant Assembly: Outputs

PEACE Output

File Edit Cost Modifiers

Preliminary Engineering Financial

Equipment Data Cost Report Cash Flow

Site Piping Pumps **Motors** Electrical Tanks Water Treatment Miscellaneous

| Estimated Electric Loads | Count | Nominal Operating kWe | Nominal Standby kWe | Voltage volts |
|--|-----------|--------------------------|------------------------|------------------|
| | 66 | 2.320 | 1.780 | |
| 1. Pump Motors | 3 | 422 | | |
| Pump (PCE) [9] - LPFP | 1 | 140 | 0 | 480 |
| Pump (PCE) [12] - HPFP | 1 | 275 | 0 | 4.160 |
| Pump (PCE) [26] - CFP | 1 | 7 | 0 | 480 |
| 2. Air Cooled Condenser Fans | 4 | 400 | | |
| Air-cooled Condenser (PCE) [24] - Air Cooled Condenser Fan | 4 | 400 | 0 | 480 |
| 3. Fuel Compressor Motors | 2 | 1.100 | 1.100 | |
| Fuel Compressor [27] - Motor | 2 | 1.100 | 1.100 | 4.160 |
| 4. Air Compressor Motors | 2 | 13 | 13 | |
| Station Air Compressor | 2 | 13 | 13 | 480 |
| 5. Water Treatment System Motors | 18 | 10.5 | 21 | |
| Misc. Makeup Water Auxiliary Loads | 18 | 10.5 | 21 | 480 |
| 6. GT Auxiliary Loads | 25 | 266 | 612 | |
| Gas Turbine (GT PRO) [1] - GT Frame Blower Motor | 2 | 70 | 0 | 480 |
| Gas Turbine (GT PRO) [1] - GT Starter Motor | 1 | 0 | 550 | 4.160 |
| Gas Turbine (GT PRO) [1] - GT Lube Oil Pumps | 2 | 40 | 40 | 480 |
| Gas Turbine (GT PRO) [1] - GT HVAC | 6 | 44 | 22 | 480 |
| Gas Turbine (GT PRO) [1] - Misc. GT Aux Loads | 14 | 112 | 0 | 480 |
| 7. ST Auxiliary Loads | 5 | 47 | 35 | |
| STAssembly[1] - ST Lube Oil Pumps | 2 | 35 | 35 | 480 |
| STAssembly[1] - Misc. ST Aux Loads | 3 | 12 | 0 | 480 |
| 8. Miscellaneous Plant Loads | 7 | 63 | | |
| Plant HVAC Loads | 1 | 23 | 0 | 480 |
| Plant Lighting Loads | 1 | 40 | 0 | 480 |
| Misc. Plant Aux Loads | 5 | 0 | 0 | 480 |
| 9. Total Plant Motors & Loads | | | | |
| Total 4160V Motors & Loads | | 1.380 | 1.650 | |

5. Plant Assembly: Outputs

PEACE Output

File Edit Cost Modifiers

Preliminary Engineering Financial

Equipment Data Cost Report Cash Flow

Financial Summary Cash Flow

| Cash Flow EUR | 2018 (1) | 2019 (2) | 2020 (3) | 2021 (4) | 2022 (5) | 2023 (6) | 2024 (7) | 2025 (8) | 2026 (9) | 2027 (10) | 2028 (11) | 2029 (12) | 2 |
|--|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|---|
| Escalators | | | | | | | | | | | | | |
| Inflation | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | |
| Fuel | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | |
| Steam | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | |
| Electricity | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | |
| Imported Water | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | |
| CO2 Emission Penalty | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Desal water | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | |
| H2 from syngas | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 | |
| Reagent | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Activated carbon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Prices | | | | | | | | | | | | | |
| Electricity, EUR per kWh | 0,0585 | 0,0611 | 0,0639 | 0,0668 | 0,0698 | 0,0729 | 0,0762 | 0,0796 | 0,0832 | 0,0869 | 0,0908 | 0,0949 | |
| Fuel, EUR/GJ | 5,118 | 5,349 | 5,589 | 5,841 | 6,104 | 6,379 | 6,666 | 6,966 | 7,279 | 7,607 | 7,949 | 8,306 | |
| Steam, EUR/GJ | 4,265 | 4,457 | 4,658 | 4,868 | 5,087 | 5,315 | 5,555 | 5,805 | 6,066 | 6,339 | 6,624 | 6,922 | |
| Imported Water, EUR/m ³ | 0,2378 | 0,2485 | 0,2596 | 0,2713 | 0,2835 | 0,2963 | 0,3096 | 0,3236 | 0,3381 | 0,3533 | 0,3692 | 0,3858 | |
| CO2 Emission Penalty, EUR/tonne | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Desal water, EUR per 1000 imperial gallons | 3,6 | 3,762 | 3,931 | 4,108 | 4,293 | 4,486 | 4,688 | 4,899 | 5,12 | 5,35 | 5,591 | 5,842 | |
| H2 from syngas, EUR/GJ | 6,825 | 7,132 | 7,453 | 7,788 | 8,138 | 8,505 | 8,887 | 9,287 | 9,705 | 10,14 | 10,6 | 11,08 | |
| Syngas, EUR/GJ | 2,559 | 2,674 | 2,795 | 2,921 | 3,052 | 3,189 | 3,333 | 3,483 | 3,639 | 3,803 | 3,974 | 4,153 | |
| Limestone, EUR/tonne | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Lime, EUR/tonne | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Captured CO2, EUR/tonne | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| CO2 capture solvent, EUR/tonne | 1984,2 | 2073,4 | 2166,8 | 2264,3 | 2366,1 | 2472,6 | 2583,9 | 2700,2 | 2821,7 | 2948,6 | 3081 | 3220 | |
| Activated carbon, EUR/tonne | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Revenues | | | | | | | | | | | | | |
| Electricity | 27.757.640 | 29.006.740 | 30.312.040 | 31.676.080 | 33.101.500 | 34.591.070 | 36.147.670 | 37.774.310 | 39.474.160 | 41.250.490 | 43.106.760 | 45.046.570 | |
| Capacity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |