

A brief introduction to Aspen plus

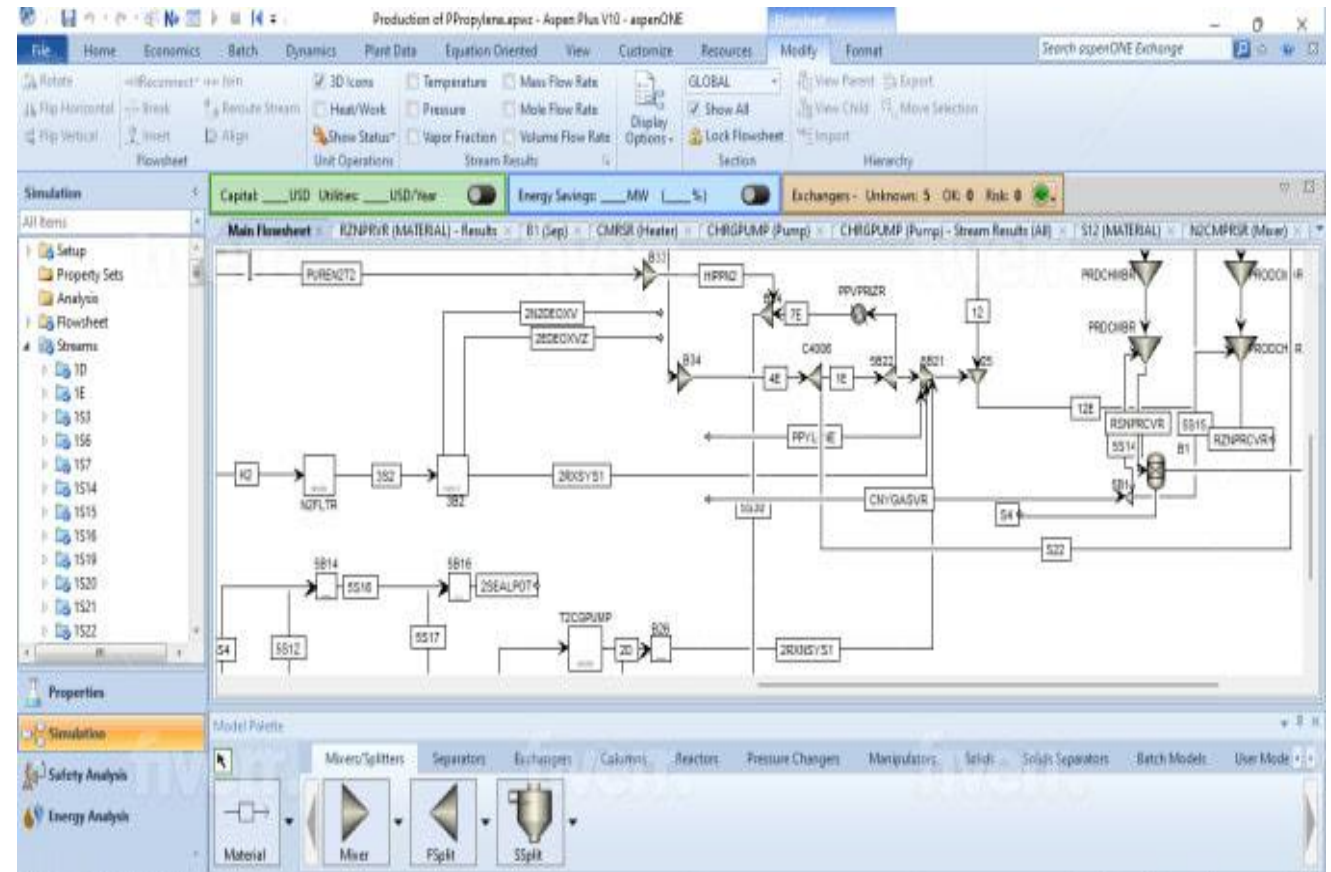
N.Zuliani

Content

- What Aspen Plus is?
- Installing Aspen Plus
- Basic steps to simulate a process plant with Aspen Plus
- Simulation example: simple process configuration and simulation
- Rankine cycle exercise

Aspen Plus

Aspen Plus is **one** of the leading Chemical Process Simulator in the market. It is based on a database of **component properties** and different **property methods** to compute the thermodynamic and transport properties.



Graphic User Interface

The screenshot displays the Aspen Plus V11 software interface, specifically the Flowsheet tab. The window title is "Simulation 1 - Aspen Plus V11 - aspenONE". The interface is organized into several key areas:

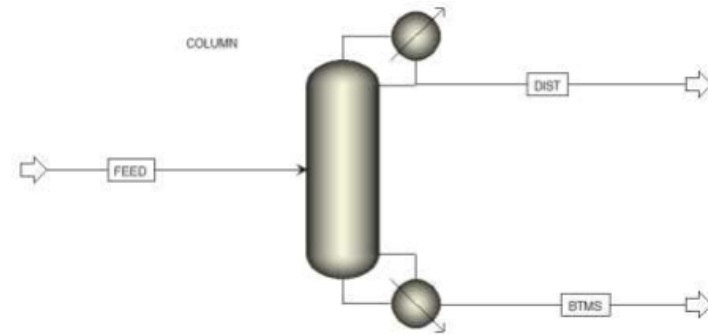
- Menu Bar:** Includes File, Home, Economics, Batch, Dynamics, Plant Data, Equation Oriented, View, Customize, Resources, Modify, and Format.
- Simulation Properties:** A horizontal bar at the top of the main workspace contains simulation parameters: Capital: ___ USD, Utilities: ___ USD/Year, Energy Savings: ___ MW (___%), and Exchangers - Unknown: 0 OK: 0 Risk: 0.
- Left Panel:** A tree view titled "All Items" lists the project structure, including folders for Setup, Property Sets, Analysis, Flowsheet, Streams, Blocks, Utilities, Reactions, Convergence, Flowsheeting Options, Model Analysis Tools, EO Configuration, Results Summary, Datasheets, Dynamic Configuration, and Plant Data.
- Main Workspace:** A large empty area labeled "Main Flowsheet" where the process flow diagram is typically drawn.
- Bottom Panel:** A "Model Palette" containing icons for various unit operations: MATERIAL, Mixer, FSplit, and SSplit.
- Status Bar:** At the bottom left, a red box indicates "Flowsheet Not Complete" with a "Check Status" button. The bottom right shows a zoom level of 132%.

Basic steps to simulate a process plant with Aspen Plus

- 1. Components definition:** in every simulation, you must define the components that will make up the simulation. In other words, you must specify which chemicals Aspen Plus should take from its large database of chemicals and use in the simulation.
- 2. Property method choice:** A property method is a collection of methods and models (equation of states, advanced equation of states etc ..) that Aspen Plus uses to compute thermodynamic (Enthalpy, Entropy, Gibbs free energy..etc..) and transport properties (Viscosity, Thermal conductivity...etc).

Property method

Ooops... the results are different!



Specification:

- 30 stages
- Distillate rate 500 kmol/hr
- Reflux ratio 1.3

IDEAL

NRTL

PENG-ROBINSON

	Units	FEED	BTMS	DIST	BTMS	DIST	BTMS	DIST
- Mole Flows	kmol/hr	2328.31	1828.31	500	1828.31	500	1828.31	500
WATER	kmol/hr	1754.07	1691.96	62.1051	1753.92	0.147487	1754.05	0.0143418
METHANOL	kmol/hr	574.243	136.349	437.895	74.3909	499.853	74.2578	499.986
- Mole Fractions								
WATER		0.753365	0.925424	0.12421	0.959312	0.000294974	0.959384	2.86836e-05
METHANOL		0.246635	0.0745763	0.87579	0.0406884	0.999705	0.0406155	0.999971

Image from <https://t.ly/2D4no>

Basic steps to simulate a process plant with Aspen Plus

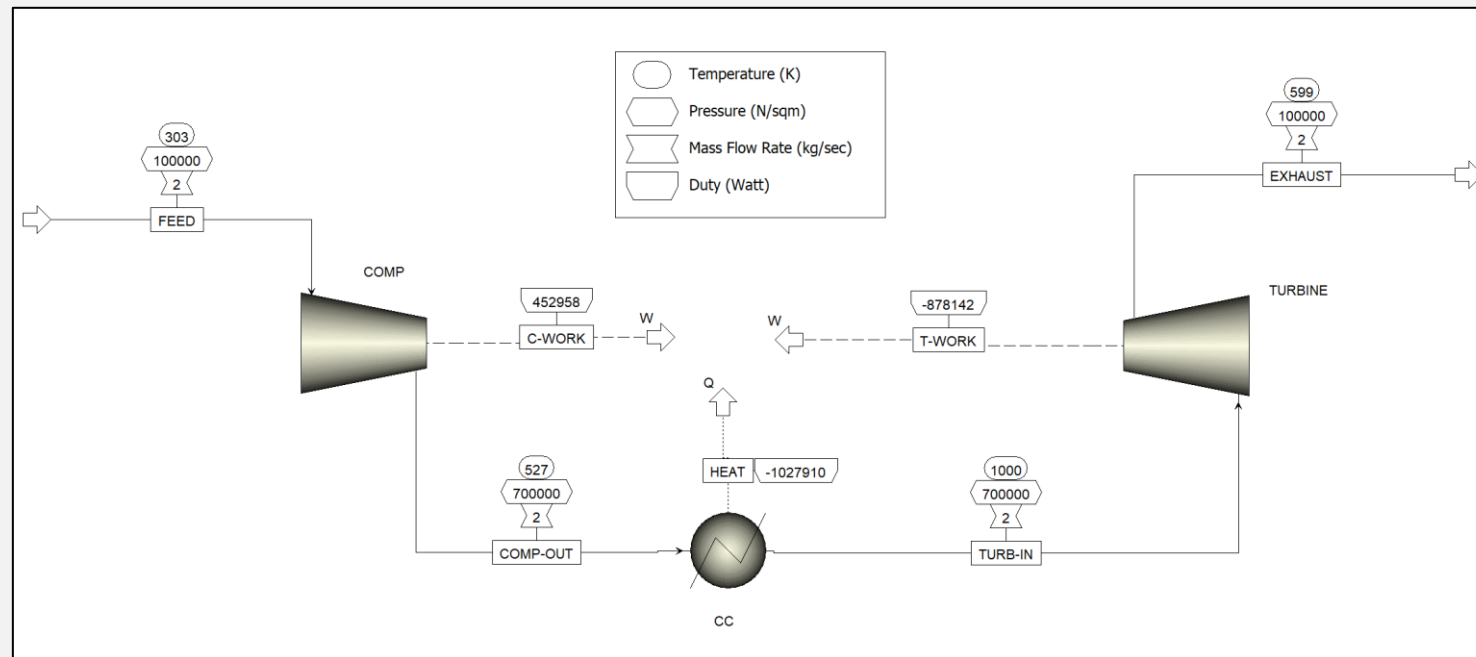
Property method choice: You must select one (or more) Property Methods to model the properties of specific systems (chemicals) in your flowsheet. Choosing the appropriate property method is often the key decision in determining the accuracy of your simulation results. Aspen Plus includes a large number of built-in property methods that are sufficient for most applications.

How to choose the correct property method ?

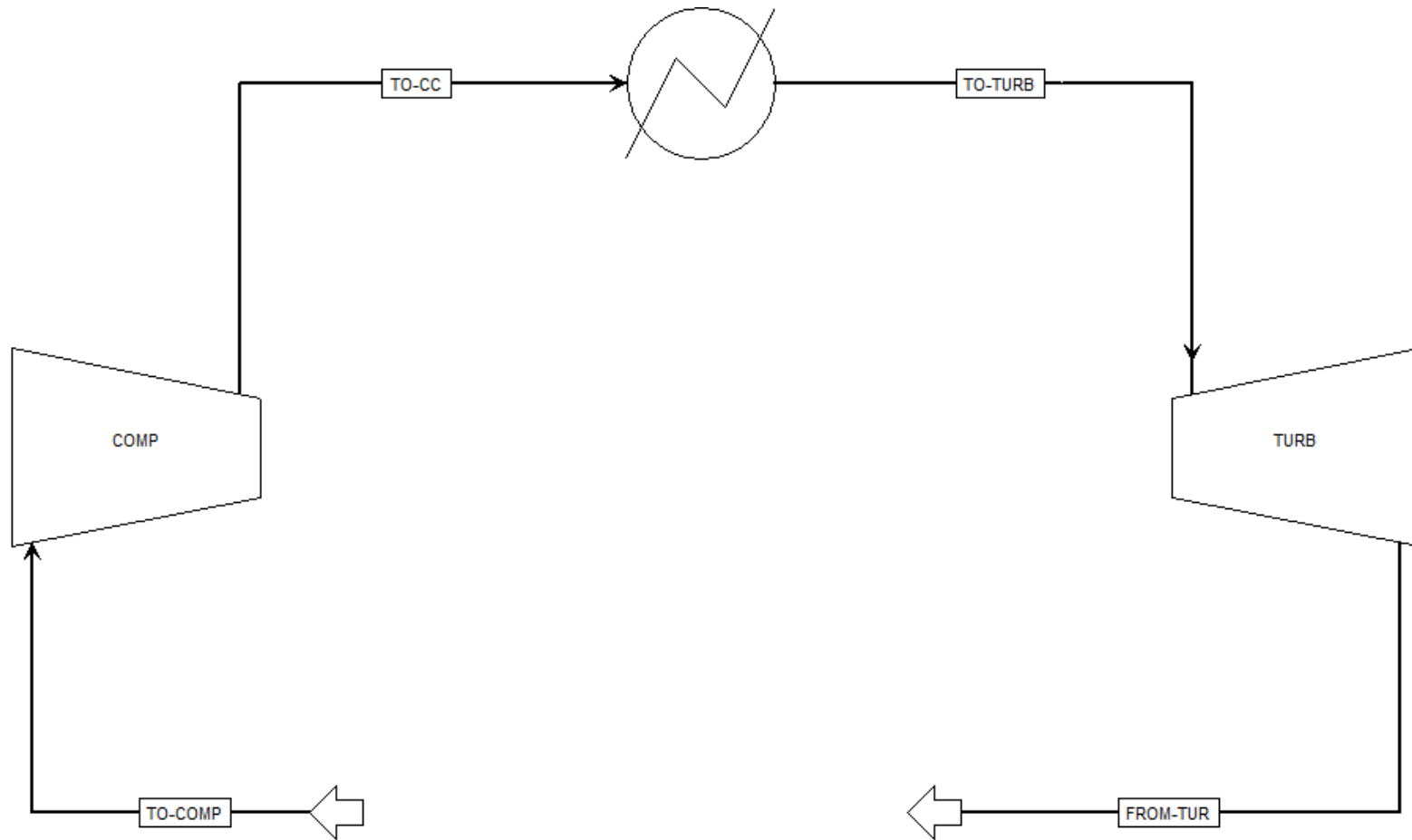
- Aspen Plus recommended methods for different plant (oil and gas production, gas processing, Petrochemicals et...)
- Literature analysis on similar works
- Experience (experimental data comparison)

Basic steps to simulate a process plant with Aspen Plus

3. **Process flowsheet definition:** “drawing” of the process plant by means of choosing the *unit operations model*, *materials* and *energy streams*.



Example



Specification

- Fluid: air
- Feed air mass flow: 500 kg/h
- Feed air pressure and temperature: 1 bar, 30° C
- Compressor pressure ratio: 10
- Turbine inlet temperature: 1.000 °C
- Turbine outlet pressure: 1 bar

Calculate

- Streams temperature and pressure
- Compressor work
- Turbine work

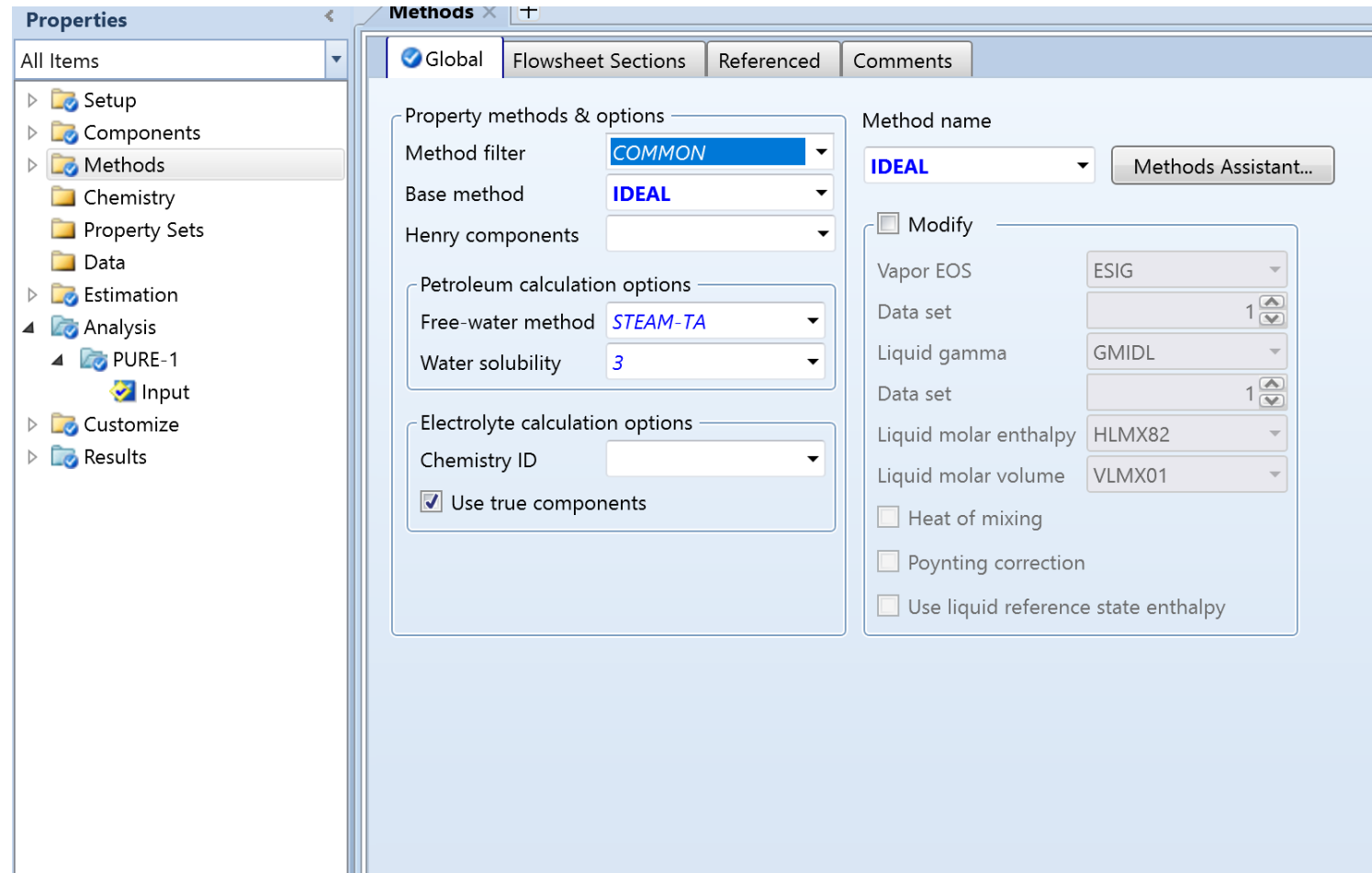
Component definition

The screenshot displays a software interface for defining components. On the left, a tree view under 'Properties' shows the 'Components' folder expanded. The right pane, titled 'Components', has tabs for 'Selection', 'Petroleum', 'Nonconventional', 'Enterprise Database', and 'Comments'. The 'Selection' tab is active, showing a table with the following data:

Component ID	Type	Component
AIR	Conventional	AIR

Below the table are buttons for 'Find', 'Elec Wizard', 'SFE Assistant', 'User Defined', 'Reorder', and 'R'.

Method choice



Properties

All Items

- Setup
- Components
- Methods
- Chemistry
- Property Sets
- Data
- Estimation
- Analysis
 - PURE-1
 - Input
- Customize
- Results

Methods

Global | Flowsheet Sections | Referenced | Comments

Property methods & options

Method filter: COMMON

Base method: IDEAL

Henry components: [empty]

Petroleum calculation options

Free-water method: STEAM-TA

Water solubility: 3

Electrolyte calculation options

Chemistry ID: [empty]

Use true components

Method name: IDEAL [Methods Assistant...]

Modify

Vapor EOS: ESIG

Data set: 1

Liquid gamma: GMIDL

Data set: 1

Liquid molar enthalpy: HLMX82

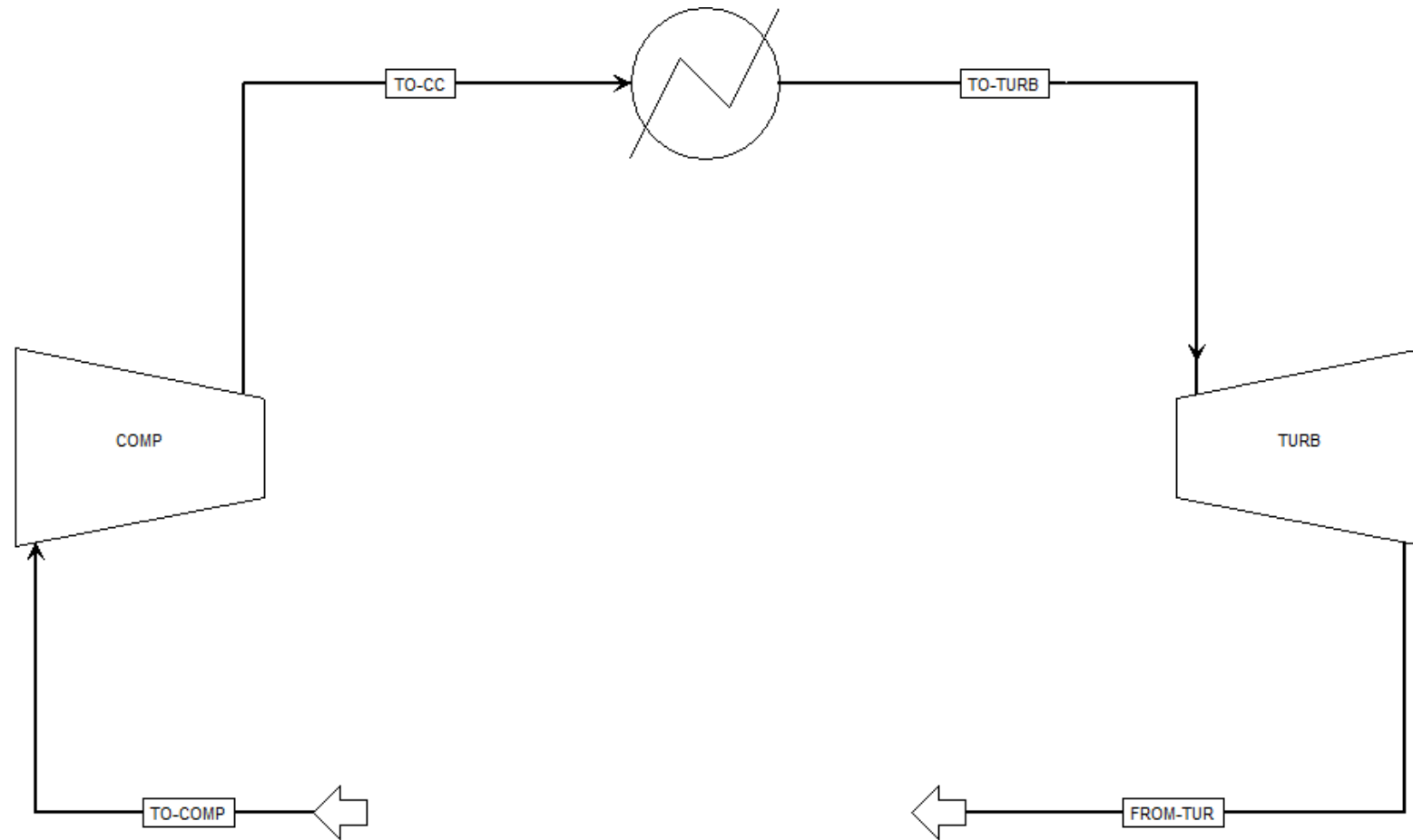
Liquid molar volume: VLMX01

Heat of mixing

Poynting correction

Use liquid reference state enthalpy

Blocks, materials and streams



Feed flow rate and composition

Specifications

Flash Type: Temperature Pressure

State variables

Temperature: 30 C

Pressure: 1 bar

Vapor fraction: []

Total flow basis: Mass

Total flow rate: 500 kg/hr

Solvent: []

Reference Temperature

Volume flow reference temperature: [] C

Component concentration reference temperature: [] C

Composition

Mole-Frac

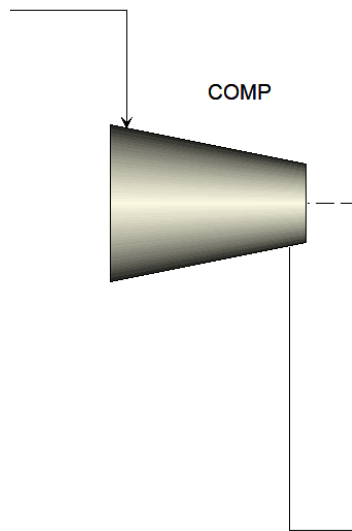
Component	Value
AIR	1

Total: 1

Component Attributes

Particle Size Distribution

Compressor block



Main Flowsheet x COMP (Compr) x +

Specifications Calculation Options Power Loss Convergence Integration Parameters Utility Comments

Model and type

Model Compressor Turbine

Type **Isentropic**

Outlet specification

Discharge pressure [] bar

Pressure increase [] bar

Pressure ratio [10]

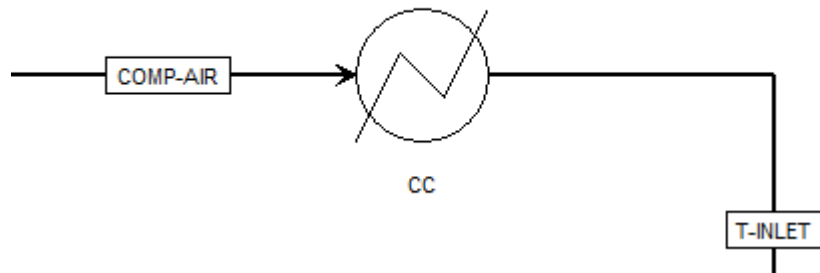
Power required [] kW

Use performance curves to determine discharge conditions

Efficiencies

Isentropic [] Polytropic [] Mechanical []

Heater block



Run Summary

Main Flowsheet x CC (Heater) x +

Specifications Flash Options Utility Comments

Flash specifications

Flash Type Temperature

Pressure

Temperature 1200 C

Temperature change C

Degrees of superheating C

Degrees of subcooling C

Pressure 0 bar

Duty cal/sec

Vapor fraction

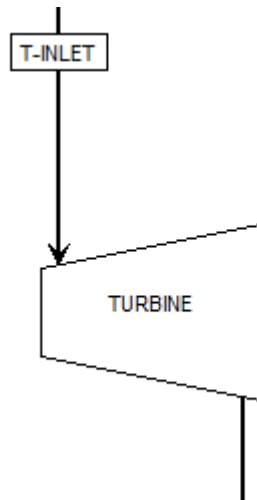
Pressure drop correlation parameter

Always calculate pressure drop correlation parameter

Valid phases

Vapor-Liquid

Turbine block



Main Flowsheet x TURBINE (Compr) x +

Specifications Calculation Options Power Loss Convergence Integration Parameters Utility Comments

Model and type

Model Compressor Turbine

Type **Isentropic**

Outlet specification

Discharge pressure **bar**

Pressure increase bar

Pressure ratio

Power required kW

Use performance curves to determine discharge conditions

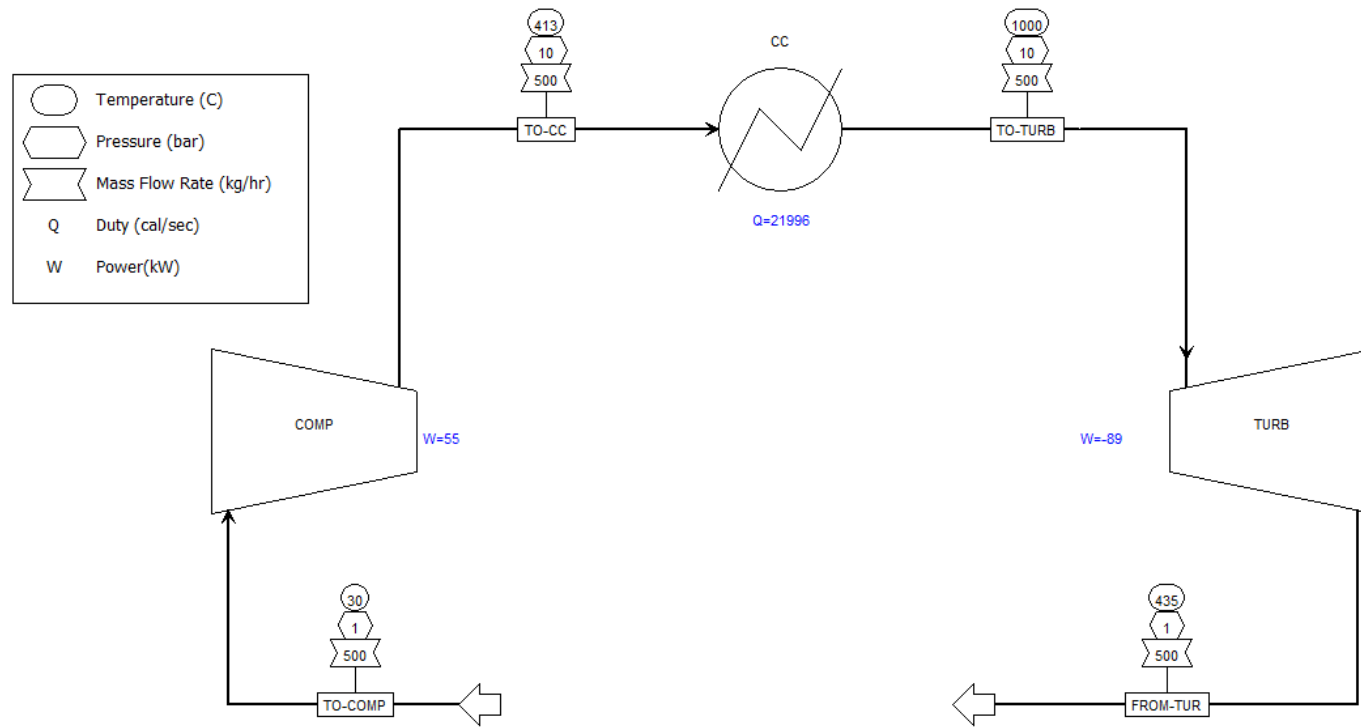
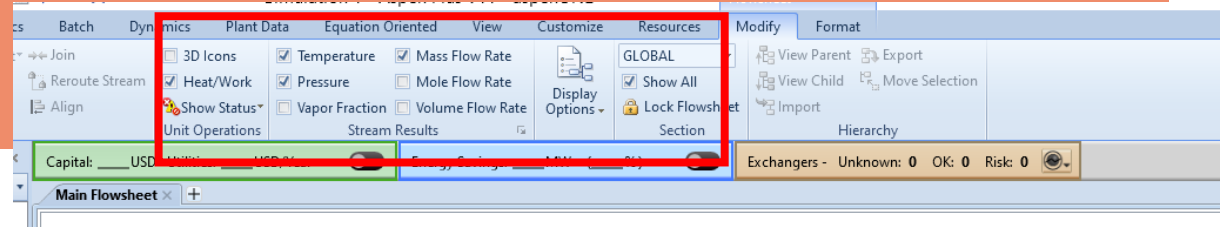
Efficiencies

Isentropic Polytropic Mechanical

Run the simulation, showing results, change units of measure

- Streams data (temperature, pressure etc..)
- Compressor and turbine work
- Combustion chamber heat
- How to change units of measure
- How to change unit visualization

Show results



Stream stream results table

- Streams table



Material	Heat	Load	Work	Vol.% Curves	Wt.% Curves	Petroleum	Polymers	Solids	
	Units					COMP-AIR	FEEDAIR	T-INLET	T-OUTLET
Description									
From						COMP	COOLER	CC	TURBINE
To						CC	COMP	TURBINE	COOLER
Stream Class						CONVEN	CONVEN	CONVEN	CONVEN
Maximum Relative Error									
Cost Flow	\$/sec								
- MIXED Substream									
Phase						Vapor Phase	Vapor Phase	Vapor Phase	Vapor Phase
Temperature	C					412.845	30	1200	743.591
Pressure	bar					10	1	10	1
Molar Vapor Fraction						1	1	1	1
Molar Liquid Fraction						0	0	0	0
Molar Solid Fraction						0	0	0	0
Mass Vapor Fraction						1	1	1	1
Mass Liquid Fraction						0	0	0	0
Mass Solid Fraction						0	0	0	0
Molar Enthalpy	J/kmol					1.15322e+07	144981	3.76355e+07	2.21117e+07
Mass Enthalpy	J/kg					398337	5007.81	1.29998e+06	763765
Molar Entropy	J/kmol-K					5632.27	591.677	30781.9	37336
Mass Entropy	J/kg-K					194.545	20.4372	1063.25	1289.63
Molar Density	kmol/cum					0.175328	0.0396748	0.0816443	0.0118294
Mass Density	kg/cum					5.07591	1.14862	2.36368	0.342472
Enthalpy Flow	kW					55.3246	0.695529	180.552	106.078
Average MW						28.9509	28.9509	28.9509	28.9509
+ Mole Flows	kmol/sec					0.00479739	0.00479739	0.00479739	0.00479739

Copy paste to excel

File Home Insert Page Layout Formulas Data Review View Automate Add-ins

Paste Font Alignment Number Conditional Formatting Format as Table Cell Styles Cells Editing Add

Clipboard Styles Add

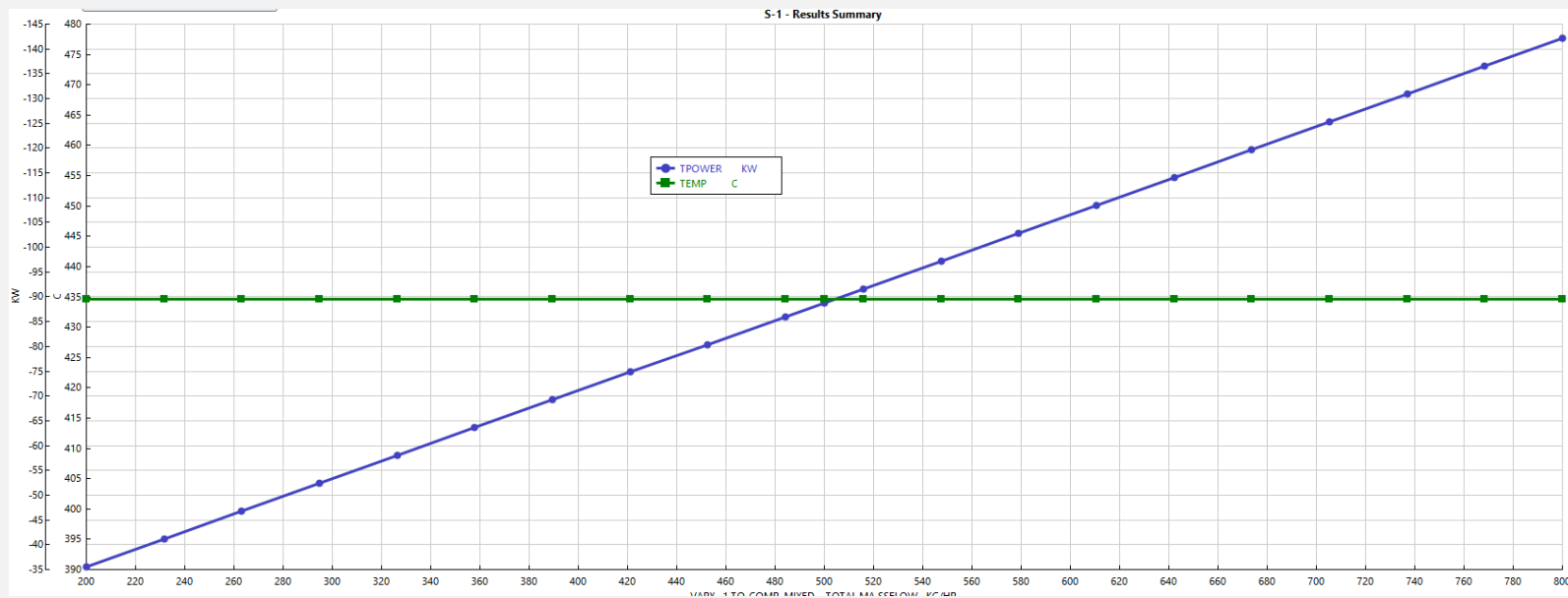
G7 : X ✓ fx

	A	B	C	D	E	F	G	H	I	J	K	L
1		Units	FROM-TURB	TO-COMP	TO-TURB							
2		Description										
3		From	TURB	COMP	CC							
4		To	CC	COMP	TURB							
5		Stream Class	CONVEN	CONVEN	CONVEN	CONVEN						
6		Maximum Relative Error										
7		Cost Flow \$/hr										
8		MIXED Substream										
9		Phase	Vapor Pha	Vapor Pha	Vapor Pha	Vapor Phase						
10		Temperat C	434.6128	412.8452	30	1000						
11		Pressure bar	1	10	1	10						
12		Molar Vapor Fractior	1	1	1	1						
13		Molar Liquid Fractior	0	0	0	0						
14		Molar Solid Fraction	0	0	0	0						
15		Mass Vapor Fraction	1	1	1	1						
16		Mass Liquid Fraction	0	0	0	0						
17		Mass Solid Fraction	0	0	0	0						
18		Molar Entl cal/mol	2915.447	2754.423	34.62805	7339.374						
19		Mass Enth cal/gm	100.7031	95.14118	1.196095	253.511						
20		Molar Entl cal/mol-K	6.148897	1.345244	0.14132	6.148896						
21		Mass Entri cal/gm-K	0.21239	0.046466	0.004881	0.21239						
22		Molar Der mol/cc	1.70E-05	0.000175	3.97E-05	9.45E-05						
23		Mass Den: gm/cc	0.000492	0.005076	0.001149	0.002735						
24		Enthalpy f cal/sec	13986.55	13214.05	166.1244	35209.86						
25		Average MW	28.95091	28.95091	28.95091	28.95091						
26		Mole Flow kmol/hr	17.27062	17.27062	17.27062	17.27062						

Ready Sheet 1 of 1 Accessibility: Good to go

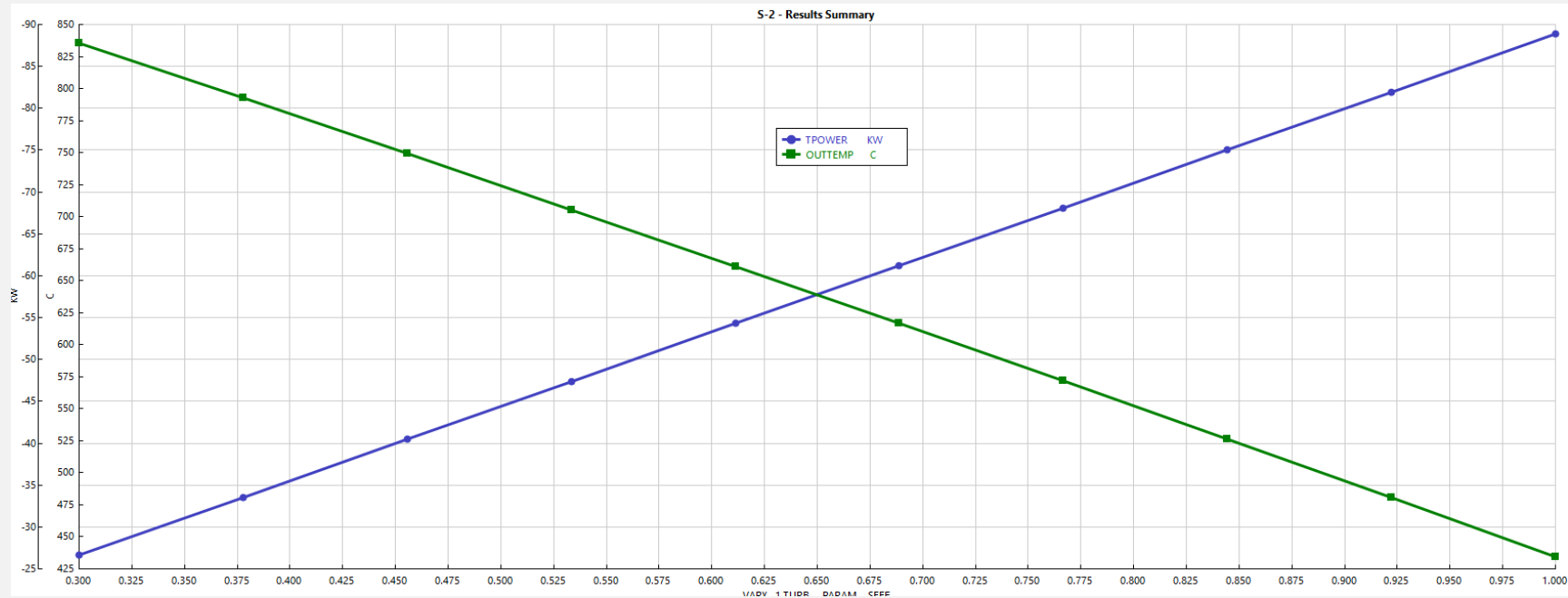
Model analysis tool: sensitivity analysis

Aim: evaluate the turbine power and output temperature change with air flow rate change



Model analysis tool: sensitivity analysis

Aim: evaluate the turbine power and output temperature change with turbine isentropic efficiency change



Model analysis tool: sensitivity analysis

The screenshot shows the 'Vary' tab interface. At the top, there are tabs for 'Main Flowsheet', 'S-1 - Results', 'S-1 - Results Summary - Plot', 'Results Summary - Run Status', and 'S-2'. Below the tabs are buttons for 'Vary', 'Define', 'Tabulate', 'Options', 'Cases', 'Fortran', 'Declarations', and 'Comments'. The 'Vary' button is selected. There are checkboxes for 'Active' and 'Case study'. A section titled 'Manipulated variables (drag and drop variables from form to the grid below)' contains a table with one row:

Variable	Active	Manipulated variable	Units
1	<input checked="" type="checkbox"/>	Block-Var Block=TURB Variable=SEFF Sentence=PA...	

Below the table are buttons for 'New', 'Delete', 'Copy', and 'Paste'. A section titled 'Edit selected variable' is expanded, showing two sub-sections:

- Manipulated variable:** Variable: 1, Type: Block-Var, Block: TURB, Variable: SEFF, Sentence: PARAM.
- Manipulated variable limits:** Equidistant (selected), Logarithmic, List of values. Start point: 0.3, End point: 1, Number of points: 10, Increment: 0.077778.

A 'Report labels' section is also visible at the bottom.

The screenshot shows the 'Vary' tab interface with a different view. At the top, there are tabs for 'Vary', 'Define', 'Tabulate', 'Options', 'Cases', 'Fortran', 'Declarations', and 'Comments'. The 'Vary' button is selected. A section titled 'Sampled variables (drag and drop variables from form to the grid below)' contains a table with two rows:

Variable	Definition
TPOWER	Block-Var Block=TURB Variable=BRAKE-POWER Sentence=RESULTS Units=kW
OUTTEMP	Stream-Var Stream=FROM-TUR Substream=MIXED Variable=TEMP Units=C

Below the table are buttons for 'New', 'Delete', 'Copy', 'Paste', 'Move Up', 'Move Down', and 'View Variables'. A section titled 'Edit selected variable' is expanded, showing:

- Variable:** TPOWER
- Category:** All, Blocks (selected), Streams, Model Utility, Property Parameters, Reactions.
- Reference:** Type: Block-Var, Block: TURB, Variable: BRAKE-POWER, Sentence: RESULTS, Units: kW.

Flowsheet options: design specifications

Aim: find the air flow rate to produce 200 kW from turbine

Main Flowsheet x DS-1 x +

Define Spec Vary Fortran Declarations EO Options Comments

Active

Sampled variables (drag and drop variables from form to the grid below)

Variable	Definition
TPOWER	Block-Var Block=TURB Variable=BRAKE-POWER Sentence=RESULTS Units=kW

New Delete Copy Paste Move Up Move Down View Variables

Edit selected variable

Variable: TPOWER

Category:

- All
- Blocks
- Streams
- Model Utility
- Property Parameters
- Reactions

Reference:

Type: Block-Var

Block: TURB

Variable: BRAKE-POWER

Sentence: RESULTS

Units: kW

EO input

Open variable:

Description:

Capital: ___ USD Utilities: ___ USD/Year Energy Savings: ___ MW (___%) Exchanger

Main Flowsheet x DS-1 x +

Define Spec Vary Fortran Declarations EO Options Comments

Design specification expressions

Spec	TPOWER
Target	-200
Tolerance	0.1

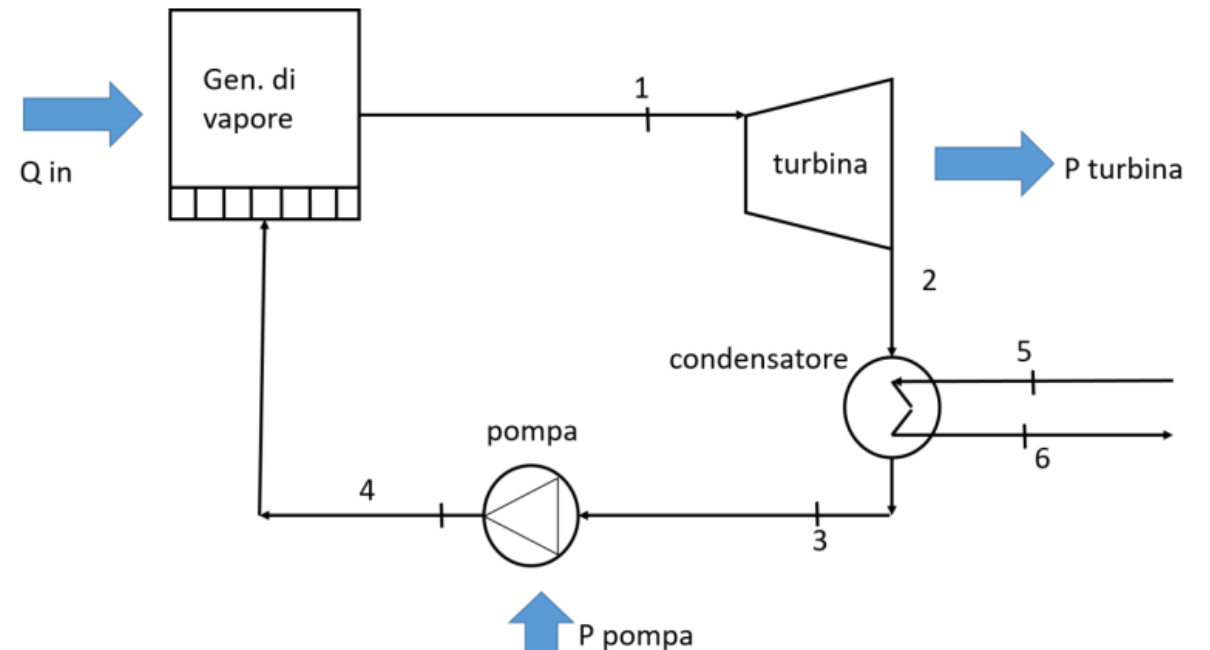
Ciclo Rankine, esercizio

Ciclo Rankine, esercizio

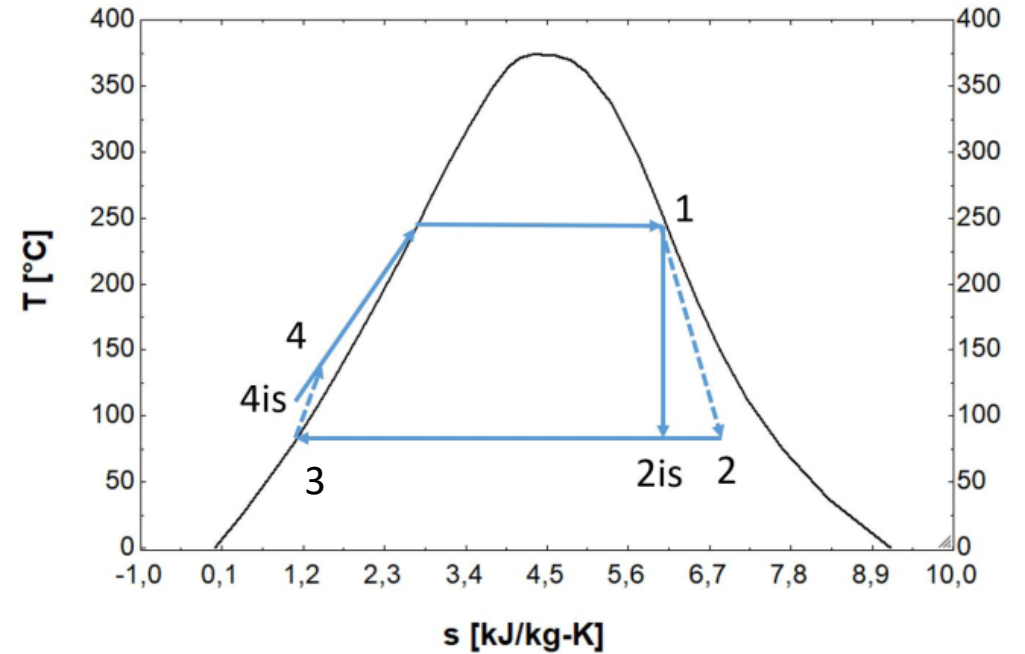
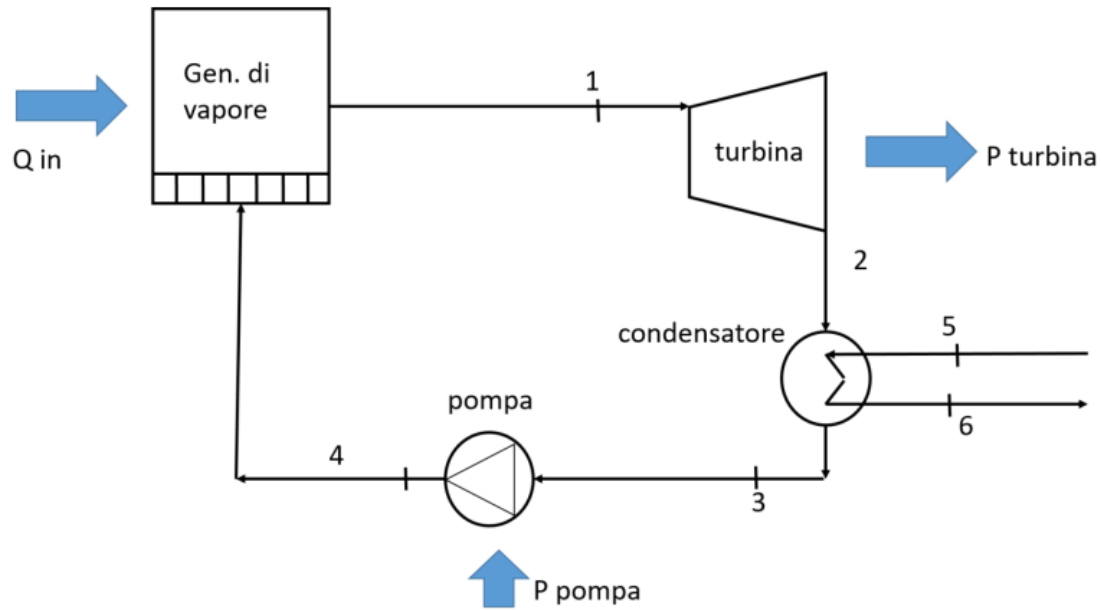
Calcolare la portata d'acqua necessaria per ottenere una potenza netta del ciclo pari a 100 MW

Dati

- Pressione al condensatore 0.08 bar
- Liquido saturo all'uscita del condensatore
- Pressione all'ingresso in turbina 80 bar
- Vapore saturo all'ingresso in turbina
- Rendimenti isoentropici pompa e turbina 85%
- Si trascurano le perdite di carico
- Temperature dell'acqua al condensatore ingresso e uscita: 15°C e 35°C



Ciclo Rankine

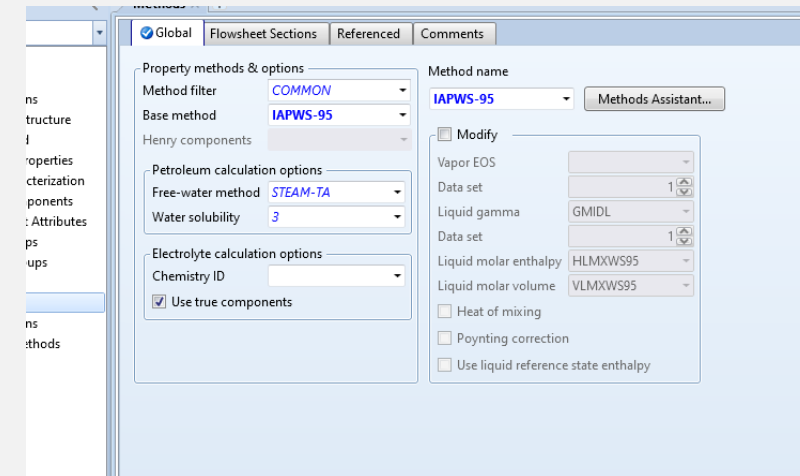
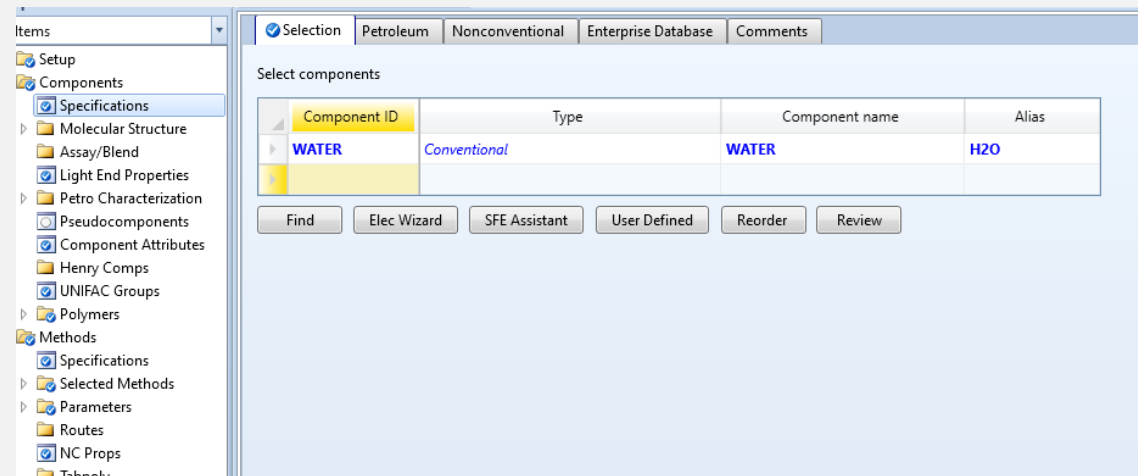


$$\eta_{th} = \frac{P_{NET}}{\dot{Q}_{in}} = \frac{P_{turbina} - P_{pompa}}{\dot{m}(h_1 - h_4)}$$

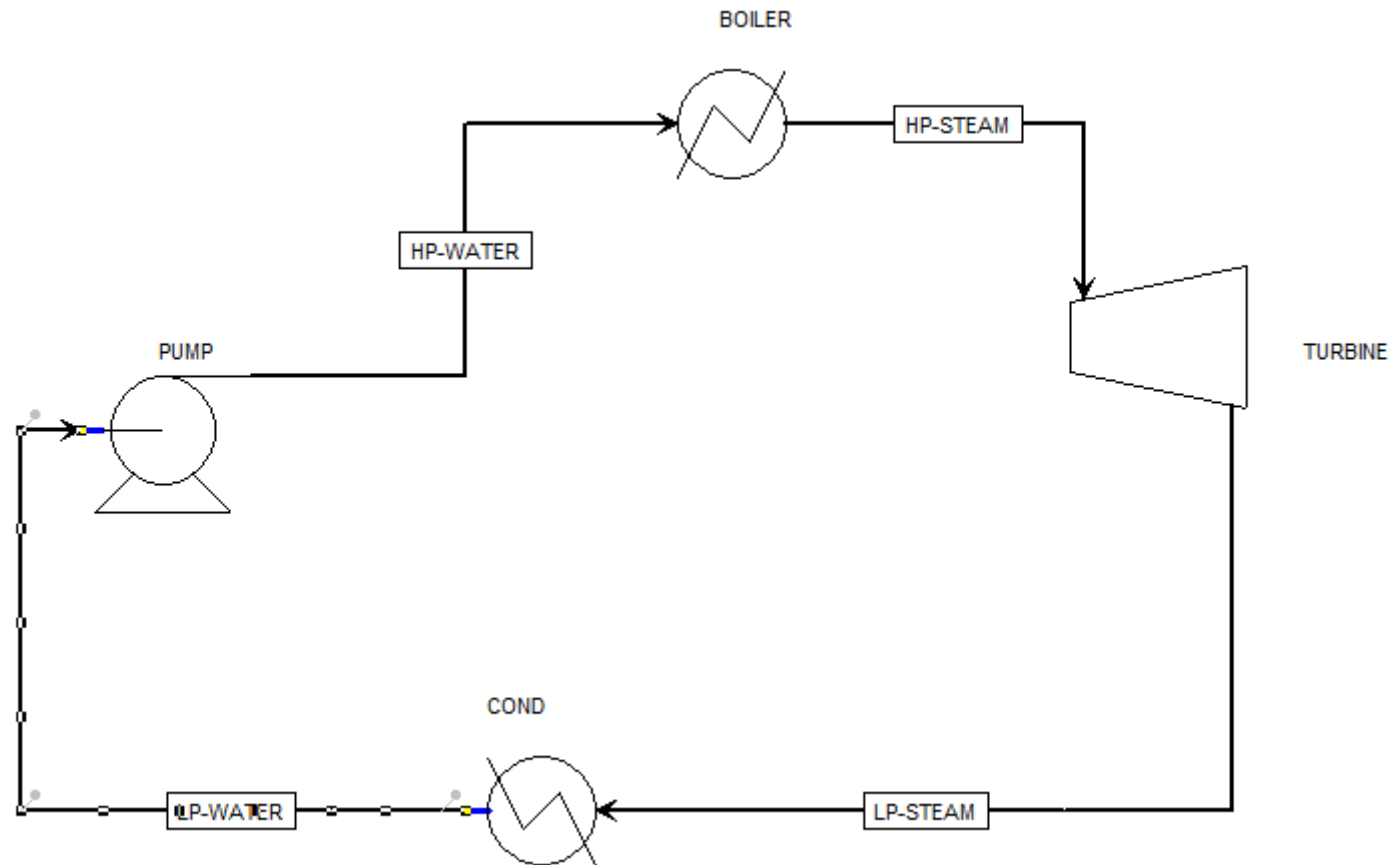
Simulazione di processo con Aspen Plus

Definizione delle proprietà della simulazione

- Scelgo come componente l'acqua
- Scelgo il metodo: IAPWS-59 (International Association for the Properties of Water and Steam)



Definizione del flowsheet



LP-WATER stream definition

☑ Mixed | CI Solid | NC Solid | Flash Options | EO Options | Costing | Comments

⤴ Specifications

Flash Type: **Pressure** | **Vapor Fraction**

State variables

Temperature: [] C

Pressure: **0.008** bar

Vapor fraction: **0**

Total flow basis: **Mass**

Total flow rate: **1** kg/hr

Solvent: []

Reference Temperature

Volume flow reference temperature: [] C

Component concentration reference temperature: [] C

Composition: **Mole-Frac**

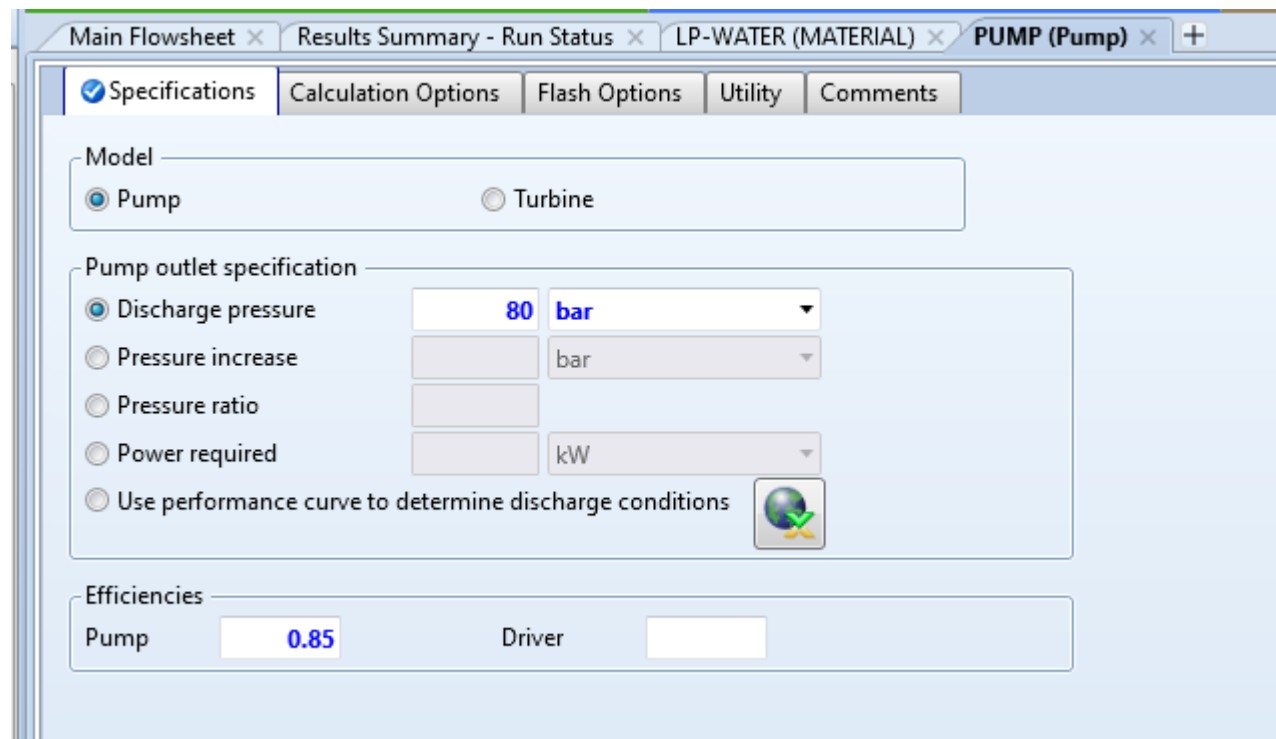
Component	Value
WATER	1

Total: [] 1

⤵ Component Attributes

⤵ Particle Size Distribution

PUMP block definition



Main Flowsheet x Results Summary - Run Status x LP-WATER (MATERIAL) x **PUMP (Pump)** x +

Specifications Calculation Options Flash Options Utility Comments

Model

Pump Turbine


Pump outlet specification

Discharge pressure

Pressure increase

Pressure ratio

Power required

Use performance curve to determine discharge conditions 

Efficiencies

Pump Driver

BOILER block definition

The screenshot displays the configuration interface for a BOILER (Heater) block. The window title is "Main Flowsheet x BOILER (Heater) x". The "Specifications" tab is active, showing the following parameters:

- Flash specifications:**
 - Flash Type: **Pressure** (dropdown)
 - Vapor fraction: **Vapor fraction** (dropdown)
 - Temperature: [] C (dropdown)
 - Temperature change: [] C (dropdown)
 - Degrees of superheating: [] C (dropdown)
 - Degrees of subcooling: [] C (dropdown)
 - Pressure: **0 bar** (dropdown)
 - Duty: [] kW (dropdown)
 - Vapor fraction: **1** (input field)
 - Pressure drop correlation parameter: [] (input field)
 - Always calculate pressure drop correlation parameter
- Valid phases:**
 - Vapor-Liquid (dropdown)

TURBINE block definition

The screenshot shows the 'Specifications' tab of the TURBINE (Compr) block definition window. The 'Model and type' section has 'Turbine' selected and 'Isentropic' as the type. The 'Outlet specification' section has 'Discharge pressure' selected with a value of 0.08 bar. The 'Efficiencies' section has 'Isentropic' efficiency set to 0.85.

Model and type
Model Compressor Turbine
Type **Isentropic**

Outlet specification
 Discharge pressure
 Pressure decrease
 Pressure ratio
 Power produced
 Use performance curves to determine discharge conditions

Efficiencies
Isentropic Polytropic Mechanical

The screenshot shows the 'Convergence' tab of the TURBINE (Compr) block definition window. The 'Flash parameters' section has 'Valid phases' set to 'Vapor-Liquid-FreeWater', 'Maximum iterations' set to 30, and 'Tolerance' set to 0.0001. The 'Entropy balance parameters' section has 'Constant entropy flash type' set to 'Iterative', 'Maximum iterations' set to 30, and 'Tolerance' set to 0.0001.

Flash parameters
Valid phases **Vapor-Liquid-FreeWater**
Maximum iterations
Tolerance

Entropy balance parameters
Constant entropy flash type **Iterative**
Maximum iterations Tolerance

Free water: this represents any unbound, uncondensed liquid water that may be present in the system. It refers to water that is not associated with the vapor-liquid equilibrium but exists as a separate phase. This phase could occur, for example, in systems where water droplets are suspended in a gas stream

CONDENSER block definition

The screenshot displays the 'COND (Heater)' block definition window. The window has a title bar with tabs for 'Main Flowsheet', 'BOILER (Heater)', 'TURBINE (Compr)', and 'COND (Heater)'. Below the title bar are four tabs: 'Specifications' (selected), 'Flash Options', 'Utility', and 'Comments'. The 'Specifications' tab contains the following fields:

- Flash specifications**
 - Flash Type: **Pressure** (dropdown)
 - Vapor fraction: **Vapor fraction** (dropdown)
 - Temperature: [] C (dropdown)
 - Temperature change: [] C (dropdown)
 - Degrees of superheating: [] C (dropdown)
 - Degrees of subcooling: [] C (dropdown)
 - Pressure: **0 bar** (dropdown)
 - Duty: [] kW (dropdown)
 - Vapor fraction: **0** (input field)
 - Pressure drop correlation parameter: [] (input field)
 - Always calculate pressure drop correlation parameter
- Valid phases**
 - Vapor-Liquid** (dropdown)

DESIGN SPECIFICATION

Net power output

Define Spec Vary Fortran Declarations EO Options Comments

Active

Sampled variables (drag and drop variables from form to the grid below)

Variable	Definition
PTURB	Block-Var Block=TURBINE Variable=BRAKE-POWER Sentence=RESULTS Units=kW
PPUMP	Block-Var Block=PUMP Variable=BRAKE-POWER Sentence=RESULTS Units=kW

New Delete Copy Paste Move Up Move Down View Variables

Edit selected variable

Variable: **PPUMP**

Category:

- All
- Blocks
- Streams
- Model Utility
- Property Parameters
- Reactions

Reference:

Type: **Block-Var**

Block: **PUMP**

Variable: **BRAKE-POWER**

Sentence: **RESULTS**

Units: **kW**

EO input:

Open variable:

Description:

Main Flowsheet x NETPOWER x Results Summary - Run Status x NETPOWER - Input x +

Define Spec Vary Fortran Declarations EO Options Comments

Manipulated variable:

Type: **Stream-Var**

Stream: **LP-STEAM**

Substream: **MIXED**

Variable: **MASS-FLOW**

Units: **kg/sec**

Manipulated variable limits:

Lower:

Upper:

Step size:

Maximum step size:

Report labels:

Line 1	Line 2	Line 3	Line 4
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

EO input:

Open variable:

Description:

Copy Paste Clear

Main Flowsheet x NETPOWER x Results Summary - Run Status x NETPOWER - Input x +

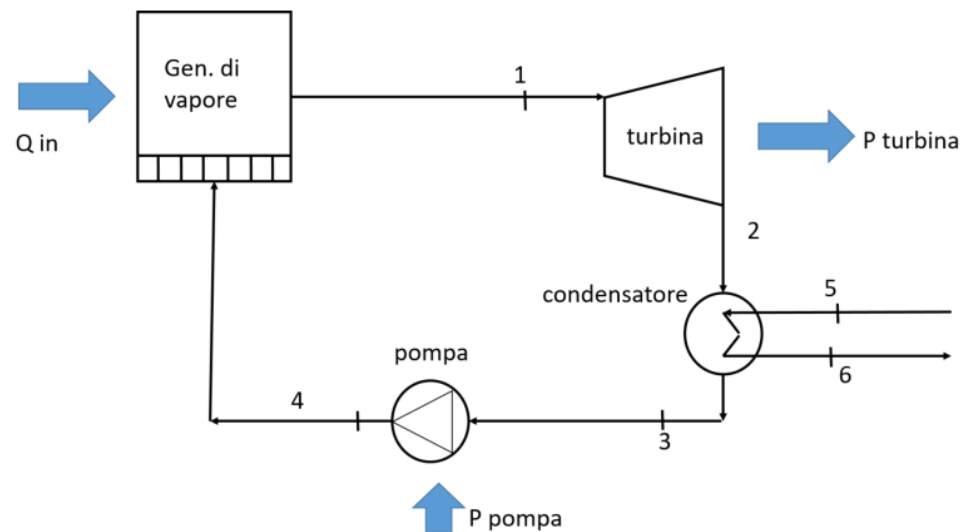
Define Spec Vary Fortran Declarations EO Options Comments

Design specification expressions:

Spec	PTURB+PPUMP
Target	-100000
Tolerance	1

Risultati attesi (calcolati con EES, Engineering Equation Solver)

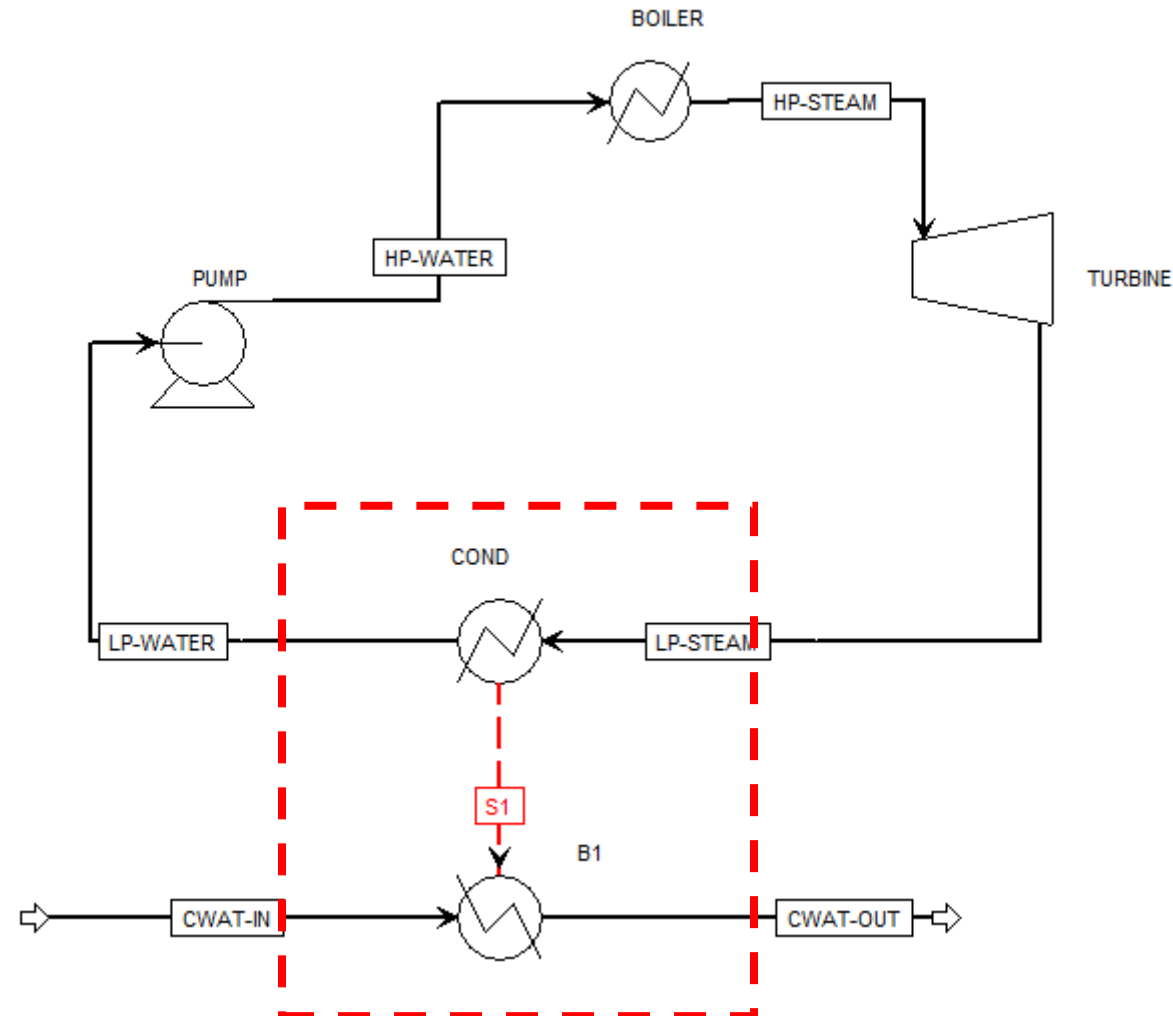
	1	2	3	4	5	6	7
	h_i [kJ/kg]	p_i	s_i [kJ/kg-K]	T_i [C]	x_i	$h_{is,i}$ [kJ/kg]	$s_{is,i}$ [kJ/kg-K]
[1]	2758	80	5,743	295	1		
[2]	1939	0,08	6,202	41,49	0,7348	1794	5,743
[3]	173,7	0,08	0,5921	41,49	0		
[4]	183,2	80	0,5967	42,07		181,8	0,5921



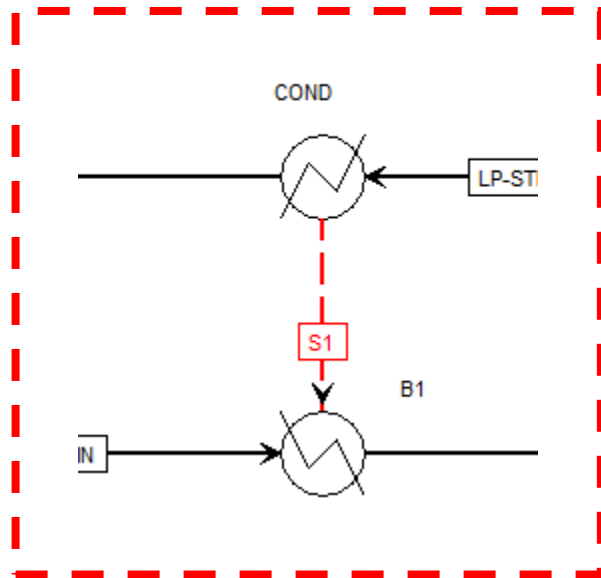
BKP SLIDES

DESIGN SPECIFICATION

Cooling water flow rate



Condenser cold side block definition



Main Flowsheet × B1 (Heater) × Results Summary - Run Status × CWAT-IN (MATERIAL) × Cont

Specifications Flash Options Utility Comments

Flash specifications

Flash Type Pressure

Inlet heat stream

Temperature 35 C

Temperature change C

Degrees of superheating C

Degrees of subcooling C

Pressure 0 bar

Duty kW

Vapor fraction

Pressure drop correlation parameter

Always calculate pressure drop correlation parameter

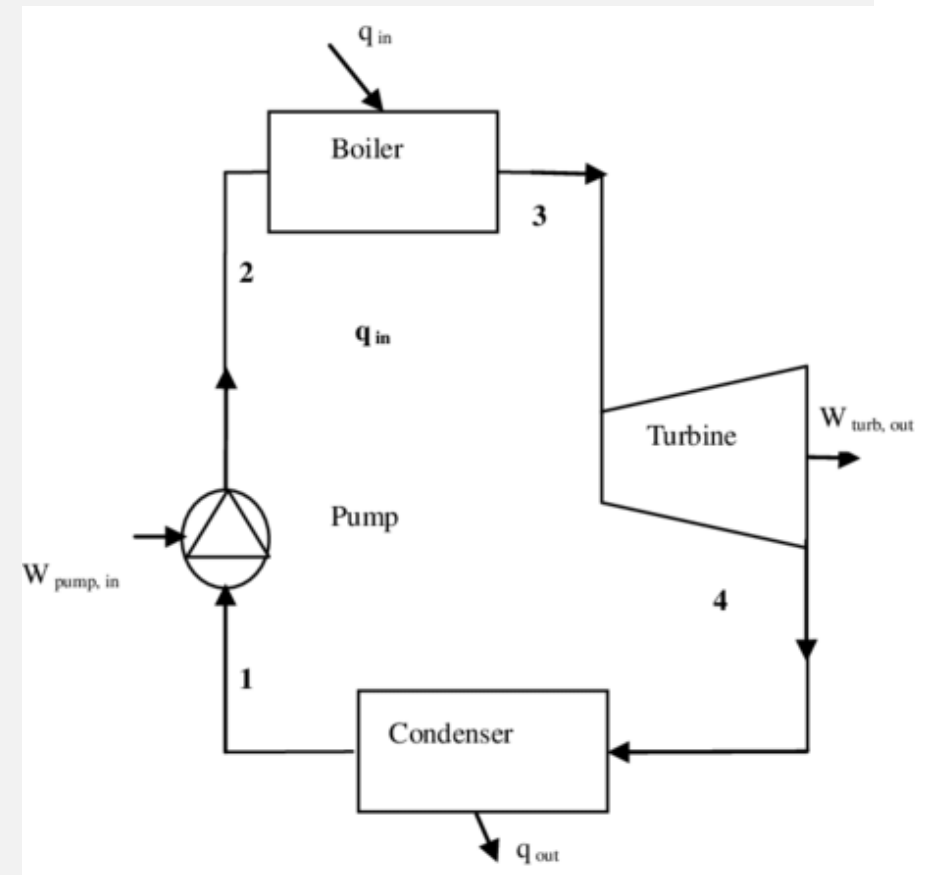
Valid phases

Vapor-Liquid

Process simulation example with Aspen Plus: Rankine cycle

Rankine cycle data and aim

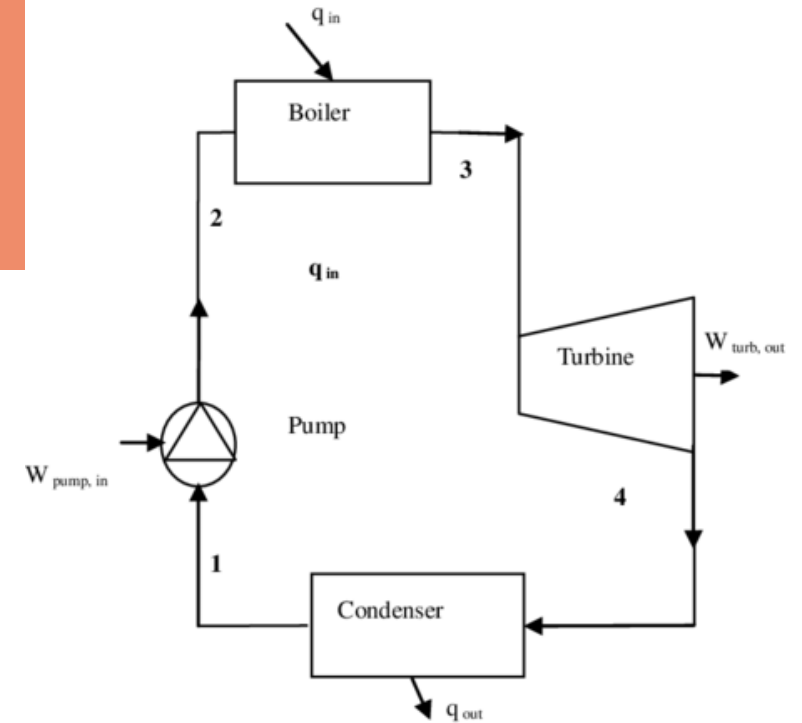
- Data
 - 1 kg/s water
 - 600 °C steam temperature @ 3 MPa
 - Turbine discharge pressure @ 101325 Pa
 - Condenser @ 100 °C liquid phase
- Aim
 - Heat required
 - Work produced



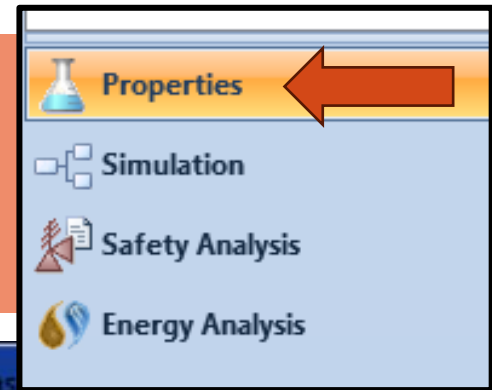
Rankine cycle

A steam engine consists of the following steps:

- Water is pumped into a boiler using a pump.
- Water is vaporized in a boiler and becomes high temperature and pressure steam.
- Steam flows through a turbine and does work. The pressure and temperature go down during this step. The steam is also partially condensed.
- The steam is further cooled to be condensed completely. Then, it is fed to the pump mentioned in the first step to be re-used.



Components



Simulation 1 - Aspen Plus V8.0 - as

File Home View Customize Get Started

Cut Copy Paste METCBAR Unit Sets Setup Components Methods Na⁺ Chemistry Customize Prop Sets Draw Structure Methods Assistant Clean Parameters Retrieve Parameters TDE NIST DECEMA Analysis Estimation Regression Control Panel

Properties All Items

- Setup
- Components
 - Specifications
 - Molecular Structure
 - Assay/Blend
 - Light End Properties
 - Petro Characterization
 - Pseudocomponents

Start Page Components - Specifications

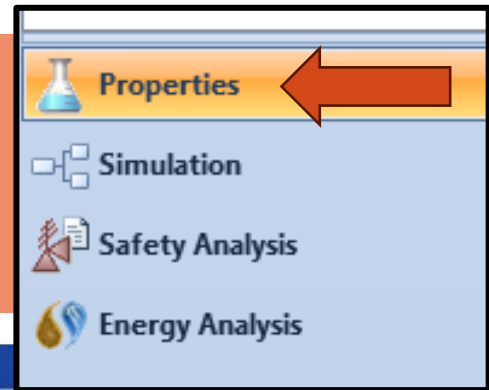
Selection Petroleum Nonconventional Databanks Information

Select components:

Component ID	Type	Component name	Alias
▶ WATER	Conventional	WATER	H2O

Find Elec Wizard User Defined Reorder Review

Method



The screenshot displays the Aspen Plus V8.0 interface. The top-left pane shows the 'Method name' dropdown set to 'IAPWS-95' and a 'Methods Assistant...' button circled in red. The main workspace shows the 'Methods - Specifications' panel with the following settings:

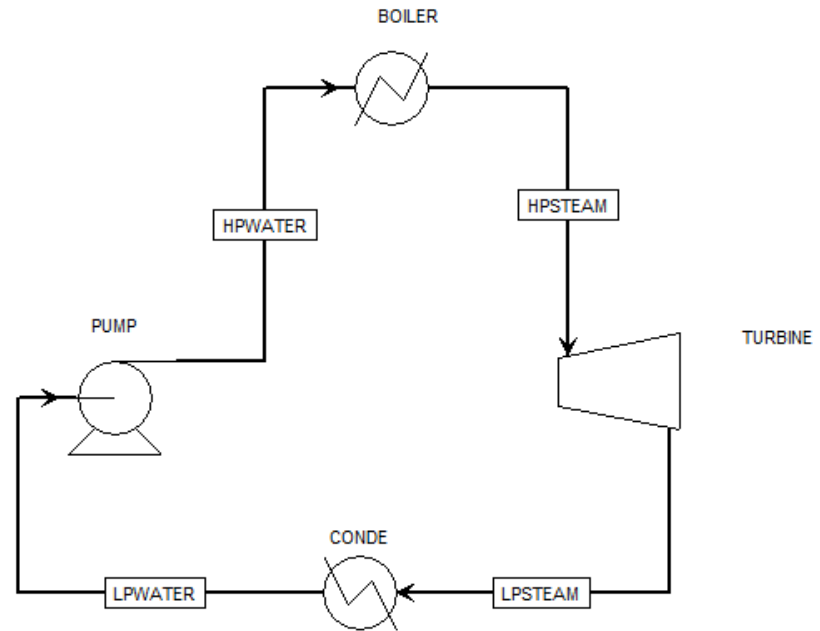
- Method name: IAPWS-95
- Method filter: COMMON
- Base method: IAPWS-95
- Henry components: (empty)
- Petroleum calculation options:
 - Free-water method: STEAM-TA
 - Water solubility: 3
- Electrolyte calculation options:
 - Chemistry ID: (empty)
 - Use true components

The left-hand tree view shows the 'Methods' folder expanded, with 'Specifications' selected. The right-hand pane shows the 'Modify' section with the following settings:

- Vapor EOS: (empty)
- Data set: 1
- Liquid gamma: GMIDL
- Data set: 1
- Liquid molar enthalpy: HLMXWS95
- Liquid molar volume: VLMXWS95
- Heat of mixing
- Poynting correction
- Use liquid reference state enthalpy

IAPWS: International Association for the Properties of Water and Steam

Flowsheet definition



LPWATER

Main Flowsheet x LPWATER (MATERIAL) x +

Mixed CI Solid NC Solid Flash Options EO Options Costing Comments

Specifications

Flash Type: **Temperature** Pressure

State variables

Temperature: 100 C

Pressure: 10325 Pa

Vapor fraction:

Total flow basis: **Mass**

Total flow rate: 1 kg/sec

Solvent:

Reference Temperature

Volume flow reference temperature: C

Component concentration reference temperature: C

Composition

Mole-Frac

Component	Value
WATER	1

Total: 1

Component Attributes

Particle Size Distribution

PUMPè

Main Flowsheet x LPWATER (MATERIAL) x **PUMP (Pump)** x +

Specifications Calculation Options Flash Options Utility Comments

Model

Pump Turbine

Pump outlet specification

Discharge pressure MPa

Pressure increase bar

Pressure ratio

Power required kW

Use performance curve to determine discharge conditions

Efficiencies

Pump Driver

BPOILER

Main Flowsheet x LPWATER (MATERIAL) x PUMP (Pump) x **BOILER (Heater)** x +

Specifications Flash Options Utility Comments

Flash specifications

Flash Type **Temperature** ▾
Pressure ▾

Temperature **C** ▾
Temperature change C ▾
Degrees of superheating C ▾
Degrees of subcooling C ▾

Pressure **bar** ▾
Duty cal/sec ▾
Vapor fraction
Pressure drop correlation parameter

Always calculate pressure drop correlation parameter

Valid phases
Vapor-Liquid ▾

TURBINE

The image shows a software interface with several tabs: Specifications (selected), Calculation Options, Power Loss, Convergence, Integration Parameters, Utility, and Comments. The main content area is divided into three sections:

- Model and type:** Model is set to Turbine. Type is set to **Isentropic**.
- Outlet specification:** Discharge pressure is set to **101325 Pa**. Other options include Pressure decrease (bar), Pressure ratio, Power produced (kW), and Use performance curves to determine discharge conditions.
- Efficiencies:** Isentropic, Polytropic, and Mechanical efficiency fields are present, with the Isentropic field currently empty.

Specifications Flash Options Utility Comments

Flash specifications

Flash Type Pressure

Vapor fraction

Temperature C

Temperature change C

Degrees of superheating C

Degrees of subcooling C

Pressure 0 bar

Duty cal/sec

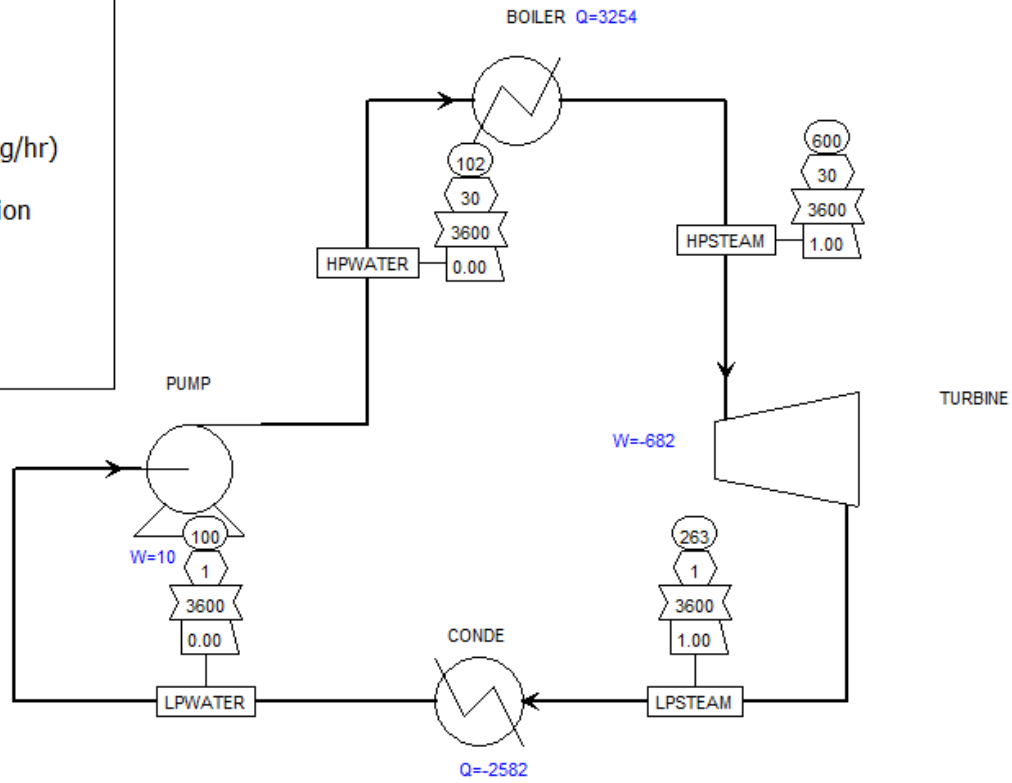
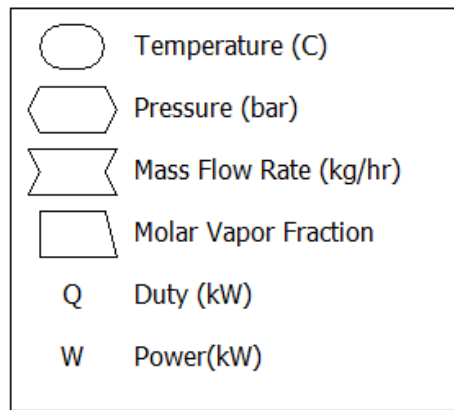
Vapor fraction 0

Pressure drop correlation parameter

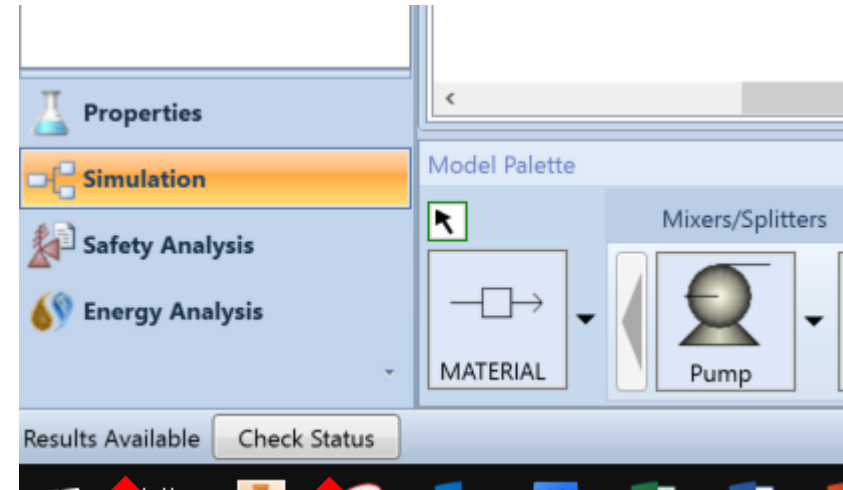
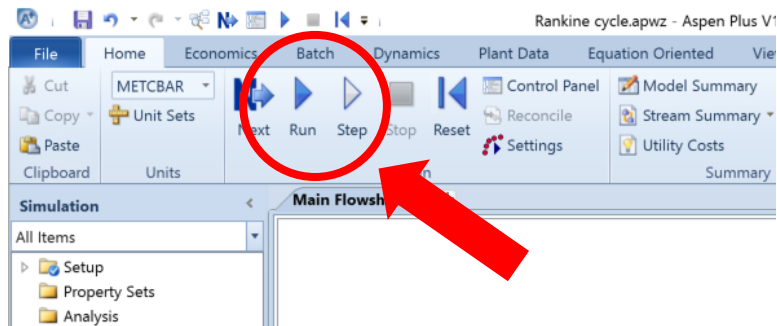
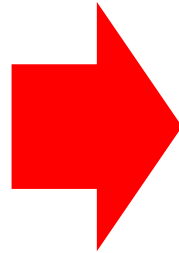
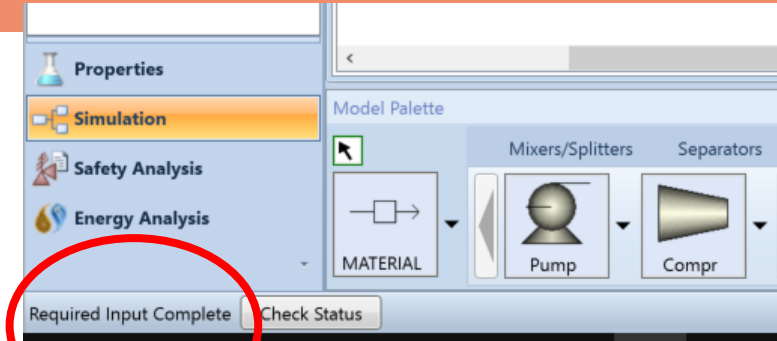
Always calculate pressure drop correlation parameter

Valid phases

Vapor-Liquid



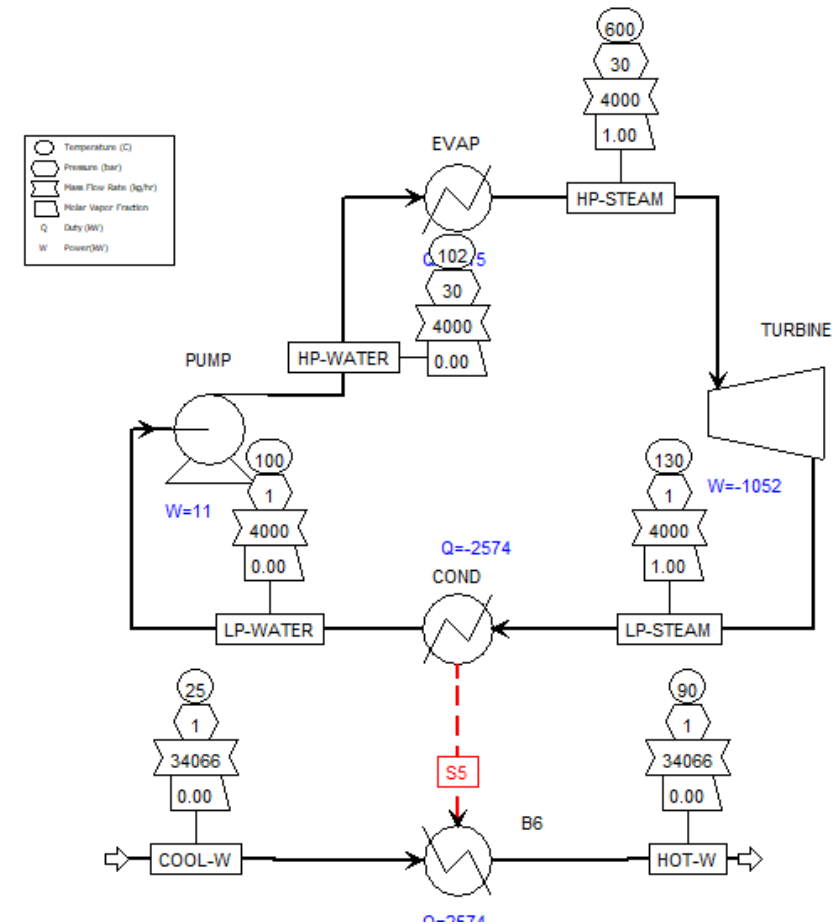
Run the simulation



Warnings – Errors
check

Link to Excel: calculator

Aim:
Calculated cycle efficiency value

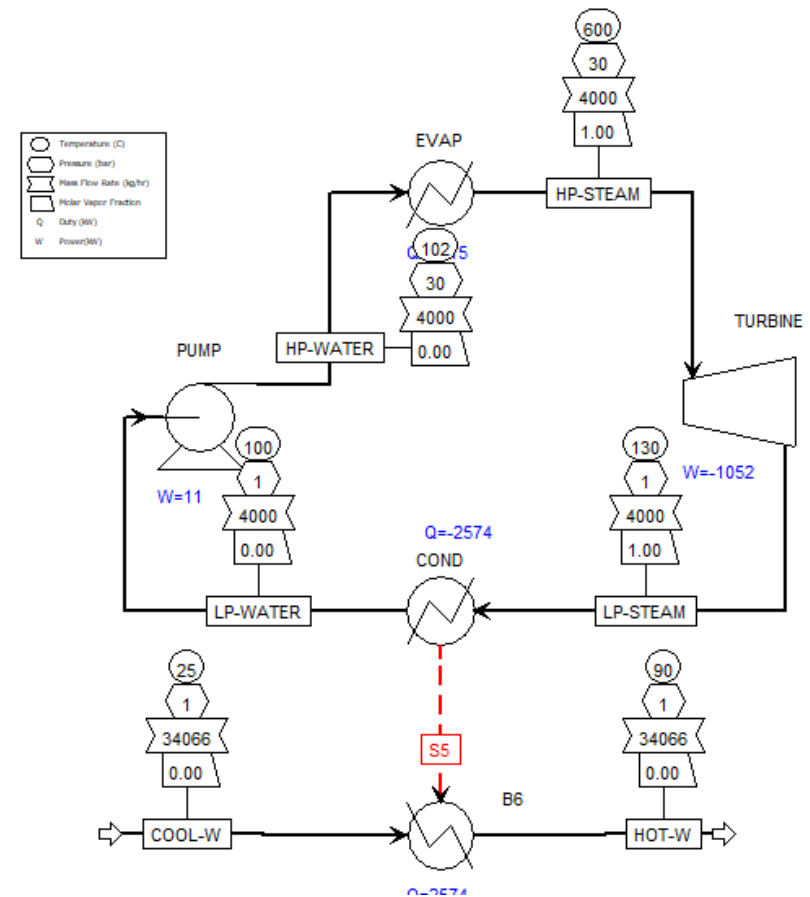


Design specification: calculate water flow rate at condenser

Aim:

Calculate the cooling water flow rate to the condenser.

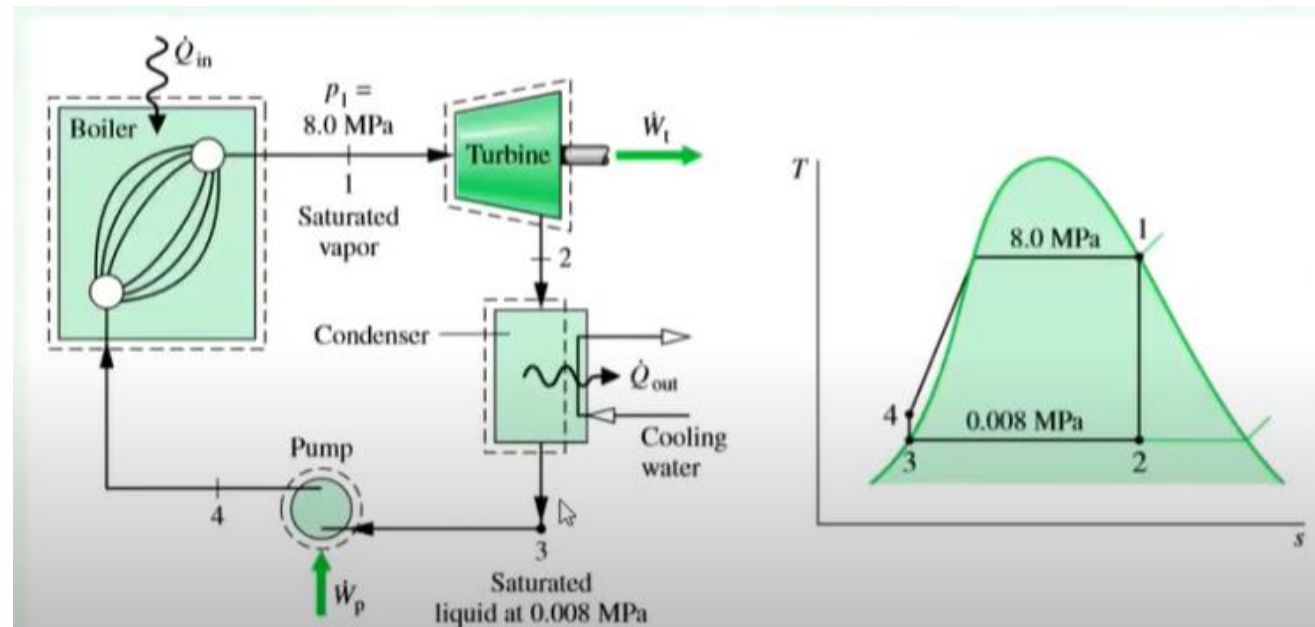
Exit water at condenser should be for example 40 °C



Exercise

EXAMPLE 8.1 Ideal Rankine Cycle

Steam is the working fluid in an ideal Rankine cycle. Saturated vapor enters the turbine at 8.0 MPa and saturated liquid exits the condenser at a pressure of 0.008 MPa. The *net* power output of the cycle is 100 MW. Determine for the cycle (a) the thermal efficiency, (b) the back work ratio, (c) the mass flow rate of the steam, in kg/h, (d) the rate of heat transfer, \dot{Q}_{in} , into the working fluid as it passes through the boiler, in MW, (e) the rate of heat transfer, \dot{Q}_{out} , from the condensing steam as it passes through the condenser, in MW, (f) the mass flow rate of the condenser cooling water, in kg/h, if cooling water enters the condenser at 15°C and exits at 35°C.



Thermodynamic and transport component property analysis

It is possible to use Aspen Plus to retrieve thermodynamic component properties

Tutorials:

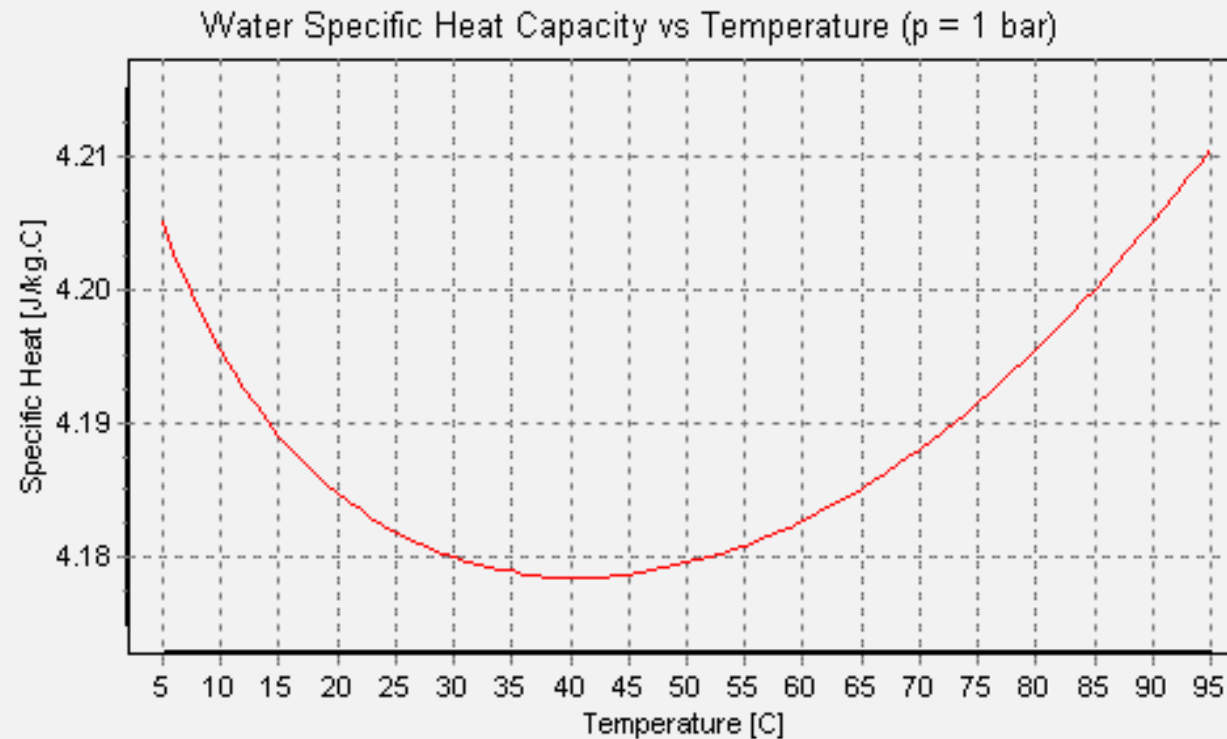
- find the *specific heat capacity (CP-M mass constant pressure heat capacity)* variation with temperature for water between 20 and 95°C using the properties tool
- find the *viscosity (CP-M mass constant pressure heat capacity)* variation with temperature for water between 20 and 95°C using the properties tool

For water → IAPWS-95 method

(International Association for the Properties of Water and Steam)

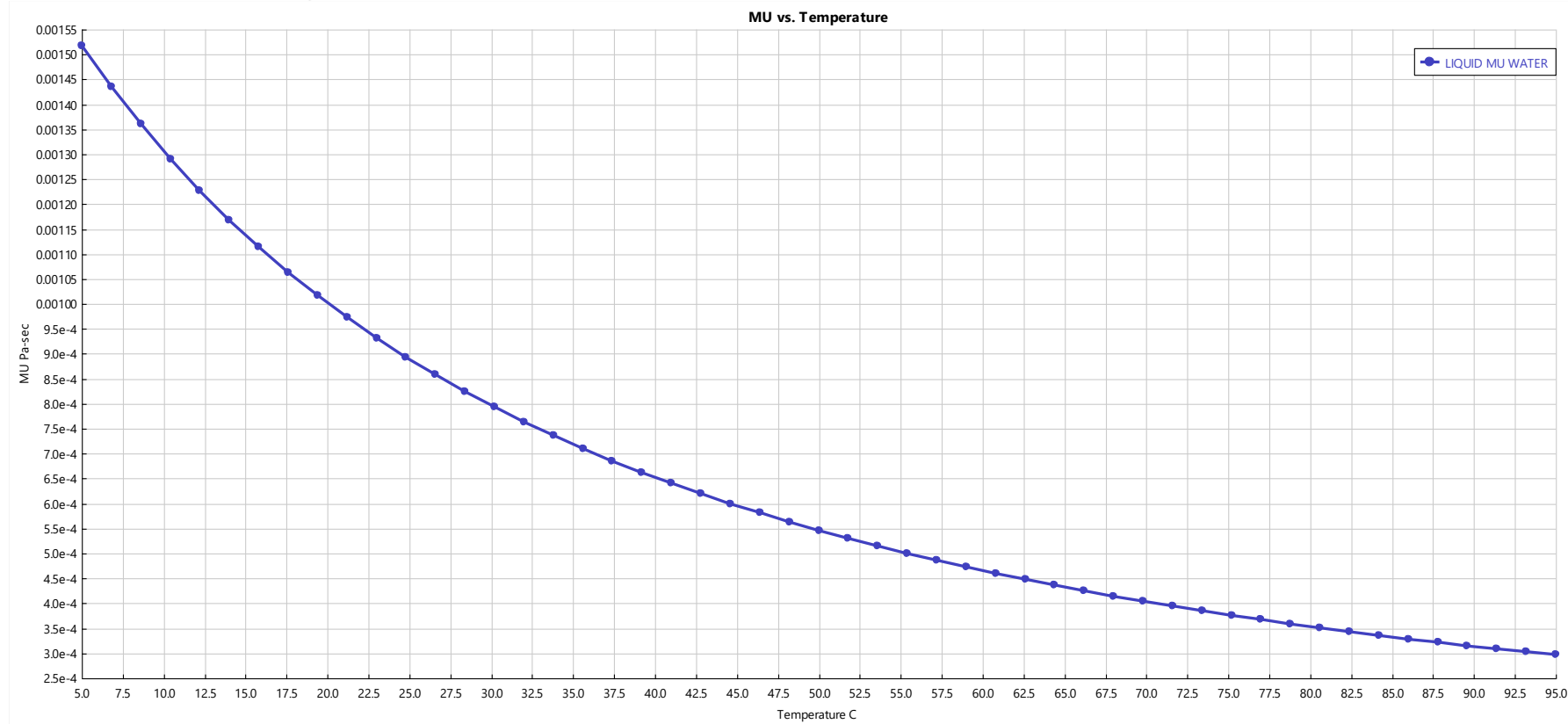
Thermodynamic and transport component property analysis

- Water c_p variation , 5 ÷ 95 °C result



Thermodynamic and transport component property analysis

- Water viscosity, 5 ÷ 95 °C result



Blk slides

Analisi del ciclo reale

<u>Condizioni ambientali</u>	
Temperatura e umidità relativa ambiente	15°C, 60%
Pressione ambiente	101325 Pa
<u>Compressore</u>	
Δp filtro aspirazione	1 kPa
Δh_{is} per ogni stadio	27 kJ/kg
Massa trafilamenti allo scarico compressore	0.8%
Rendimento politropico	
SP < 1:	$\eta_p = 0.895 \cdot [1 - 0.07108 \cdot \log_{10}^2 (SP)]$
SP \geq 1:	$\eta_p = 0.895$
Rendimento organico	99.7%
<u>Combustore</u>	
Combustibile: gas naturale (93% CH ₄ - LHV = 44.14 MJ/kg)	
Temperatura combustibile	15°C
Pressione combustibile	30 bar
$\Delta p/p$ combustibile (min.)	33%
$\Delta p/p$ aria	3%
Perdite termiche (% del calore sviluppato)	0.4%
Temp. totale ingresso 1° rotore (TIT)	1280°C
<u>Turbina</u>	
Δh_{is} , stadi raffreddati	300 kJ/kg
Δh_{is} , stadi non raffreddati	100 kJ/kg
Rendimenti politropici	
SP < 1:	$\eta_p = \eta_{p,\infty} \cdot [1 - 0.02688 \cdot \log_{10}^2 (SP)]$
SP \geq 1:	$\eta_p = \eta_{p,\infty}$
$\eta_{p,\infty}$:	0.89 (stadi raffr.), 0.925 (stadi non raffr.)
Rendimento politropico 1° ugello	0.95
Rendimento organico	0.997
Temperatura massima palettature 1° ugello	830°C
Temperatura massima pale di altre schiere	800°C
$\Delta p/p$ medio refrigerante	40%
Numero di Mach assiale allo scarico	0.45
Rendimento del diffusore	0.50
Δp scarico	1 kPa
<u>Generatore elettrico</u>	
Rendimento:	vedi fig.2.15

Il parametro SP usato nella valutazione di η_p è definito come $V^{0.5} / \Delta h_{is}^{0.25}$, dove V è la portata volumetrica all'uscita per gli stadi di turbina e la portata volumetrica media per il compressore.

Tab.3.1: Esempio di assunzioni necessarie per il calcolo di una moderna turbina a gas. Questi valori saranno utilizzati nello sviluppo degli esempi del presente testo, quando non specificato diversamente.

Ciclo reale

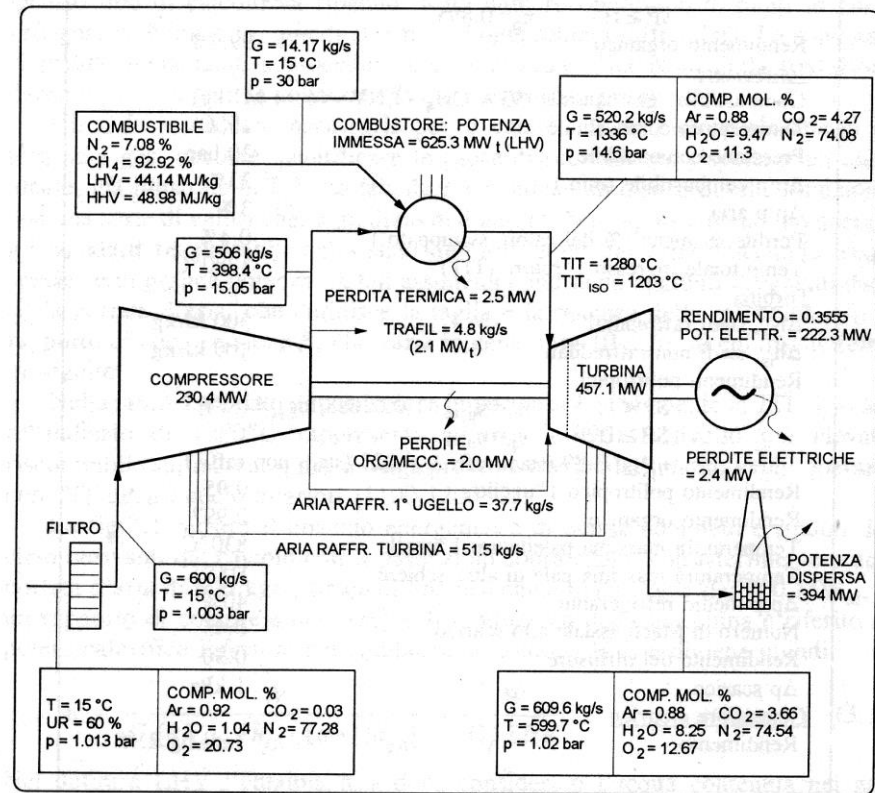


Fig.3.1: Bilancio termico completo di una turbina a gas in ciclo semplice con $\beta=15$, $TIT=1280^\circ\text{C}$, portata aria 600 kg/s. Assunzioni di calcolo da Tab.3.1.