Software Information

- Please check, whether your inputs, the equations applied and the charactersitics are displayed correctly.
- You are welcome to send your feedback via `https://github.com/oemof/tespy/issues`.
- LaTeXpackages required are:
  - graphicx
  - float
  - hyperref
  - booktabs
  - amsmath
  - units
  - cleveref
- To supress these messages, call the model documentation with the keyword draft=False.

TESPy Version:	0.4.0 - dev
Commit:	d918f10d@feature/self_documenting_models
CoolProp version:	6.4.0
Python version:	3.8.0 (default, Oct 28 2019, 16:14:01) [GCC 8.3.0]

1 Connections in design mode

1.1 Specified connection parameters

label	m in kg/s (??)	p in bar (1)	T in °C (2)
ambient air:out1_compressor:in1	250.000	1.000	20.000
combustion:out1_gas turbine:in1	-	-	1200.000
economizer:out1_waste heat recovery:in1	-	-	290.000
waste heat recovery:out1_chimney:in1	-	1.000	100.000
superheater:out2_ls cycle closer:in1	-	100.000	550.000
steam turbine:out1_condenser:in1	-	0.800	-
district heating backflow:out1_condenser:in2	-	5.000	60.000
waste heat recovery:out2_district heating feedflow:in1	-	-	90.000

Table 1: Specified connection parameters

1.2 Equations applied

$$0 = \dot{m} - \dot{m}_{\mathrm{spec}} \tag{1}$$

$$0 = p - p_{\mathrm{spec}} \tag{2}$$

$$0 = T\left(p, h\right) - T_{\mathrm{spec}} \tag{3}$$

1.3 Specified fluids

label	Ar (3)	CH4 (4)	CO2 (5)	H2O (6)	N2 (7)	O2 (8)
ambient air:out1_compressor:in1	0.013	0.000	0.000	0.000	0.755	0.231
fuel source:out1_combustion:in2	0.000	0.960	0.040	0.000	0.000	0.000
superheater:out2_ls cycle closer:in1	0.000	0.000	0.000	1.000	0.000	0.000
district heating backflow:out1_condenser:in2	0.000	0.000	0.000	1.000	0.000	0.000

Table 2: Specified fluids

1.4 Equations applied

$$0 = x_{\mathrm{Ar}} - x_{\mathrm{Ar,spec}} \tag{4}$$

$$0 = x_{\mathrm{CH4}} - x_{\mathrm{CH4,spec}} \tag{5}$$

$$0 = x_{\mathrm{CO2}} - x_{\mathrm{CO2,spec}} \tag{6}$$

$$0 = x_{\mathrm{H2O}} - x_{\mathrm{H2O,spec}} \tag{7}$$

$$0 = x_{\mathrm{N2}} - x_{\mathrm{N2,spec}} \tag{8}$$

$$0 = x_{\mathrm{O2}} - x_{\mathrm{O2,spec}} \tag{9}$$

1.5 Referenced values for mass flow

label	reference	factor in -	delta in kg/s
evaporator:out2_drum:in2	drum:out2_superheater:in2	4	0

Table 3: Referenced values for mass flow

1.6 Equation applied

$$0 = \text{value} - \text{value}_{\text{ref}} \cdot \text{factor} + \text{delta} \tag{10}$$

1.7 Referenced values for temperature

label	reference	factor in -	delta in °C
fuel source:out1_combustion:in2	ambient air:out1_compressor:in1	1	0

Table 4: Referenced values for temperature

1.8 Equation applied

$$0 = \text{value} - \text{value}_{\text{ref}} \cdot \text{factor} + \text{delta} \tag{11}$$

2 Components in design mode

2.1 Components of type Compressor

2.1.1 Mandatory constraints

$$0 = \dot{m}_{\text{in},i} - \dot{m}_{\text{out},i} \; \forall i \in [1] \tag{12}$$

$$0 = x_{fl,\text{in},i} - x_{fl,\text{out},i} \; \forall fl \in \text{network fluids}, \; \forall i \in [1] \tag{13}$$

2.1.2 Inputs specified

label	eta_s (??)	pr (??)
compressor	0.910	14.000

Table 5: Parameters of components of type Compressor

2.1.3 Equations applied

$$0 = -\left(h_{\text{out}} - h_{\text{in}}\right) \cdot \eta_{\text{s}} + \left(h_{\text{out,s}} - h_{\text{in}}\right) \tag{14}$$

$$0 = p_{\text{in},1} \cdot pr - p_{\text{out},1} \tag{15}$$

2.2 Components of type CombustionChamber

2.2.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in,1}} + \dot{m}_{\mathrm{in,2}} - \dot{m}_{\mathrm{out,1}} \tag{16}$$

$$\begin{split}0 =& p_{\mathrm{in,1}} - p_{\mathrm{out,1}}\\ 0 =& p_{\mathrm{in,1}} - p_{\mathrm{in,2}}\end{split} \tag{17}$$

$$\begin{split}\Delta\dot{m}_{\mathrm{fluid}} &= \dot{m}_{\mathrm{in,1}} \cdot x_{\mathrm{fluid,in,1}} + \dot{m}_{\mathrm{in,2}} \cdot x_{\mathrm{fluid,in,2}} - \dot{m}_{\mathrm{out,1}} \cdot x_{\mathrm{fluid,out,1}}\\ \dot{m}_{\mathrm{fluid,m}} &= \frac{\dot{m}_{\mathrm{in,1}} \cdot x_{\mathrm{fluid,in,1}} + \dot{m}_{\mathrm{in,2}} \cdot x_{\mathrm{fluid,in,2}}}{M_{\mathrm{fluid}}}\\ \dot{m}_{\mathrm{H,m}} &= \dot{m}_{\mathrm{CH4,m}} \cdot 4\\ \dot{m}_{\mathrm{C,m}} &= \dot{m}_{\mathrm{CH4,m}} \cdot 1\\ \dot{m}_{\mathrm{O2,m,stoich}} &= \frac{\dot{m}_{\mathrm{H,m}}}{4} + \dot{m}_{\mathrm{C,m}}\end{split} \tag{18}$$

$$0 = \Delta\dot{m}_{\mathrm{Ar}} \tag{19}$$

$$0 = \Delta\dot{m}_{\mathrm{CH4}} - \dot{m}_{\mathrm{CH4,m}} \cdot M_{\mathrm{CH4}} \tag{20}$$

$$0 = \Delta\dot{m}_{\mathrm{CO2}} + \dot{m}_{\mathrm{C,m}} \cdot M_{\mathrm{CO2}} \tag{21}$$

$$0 = \Delta\dot{m}_{\mathrm{H2O}} + \frac{\dot{m}_{\mathrm{H,m}}}{2} \cdot M_{\mathrm{H2O}} \tag{22}$$

$$0 = \Delta\dot{m}_{\mathrm{N2}} \tag{23}$$

$$0 = \Delta\dot{m}_{\mathrm{O2}} - \dot{m}_{\mathrm{O2,m,stoich}} \cdot M_{\mathrm{O2}} \tag{24}$$

$$\begin{split}0 =& \sum_i \dot{m}_{\mathrm{in},i} \cdot (h_{\mathrm{in},i} - h_{\mathrm{in},i,\mathrm{ref}}) - \dot{m}_{\mathrm{out,1}} \cdot (h_{\mathrm{out,1}} - h_{\mathrm{out,1,ref}})\\ &+ LHV_{fuel} \cdot \left(\sum_i \dot{m}_{\mathrm{in},i} \cdot x_{fuel,\mathrm{in},i} - \dot{m}_{\mathrm{out,1}} \cdot x_{fuel,\mathrm{out,1}}\right)\\ &\forall i \in \mathrm{inlets}\\ &T_{\mathrm{ref}} = 298.15\,\mathrm{K}\ p_{\mathrm{ref}} = 10^5\,\mathrm{Pa}\end{split} \tag{25}$$

2.3 Components of type Turbine

2.3.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in},i} - \dot{m}_{\mathrm{out},i}\ \forall i \in [1] \tag{26}$$

$$0 = x_{fl,\mathrm{in},i} - x_{fl,\mathrm{out},i}\ \forall fl \in \text{network fluids},\ \forall i \in [1] \tag{27}$$

2.3.2 Inputs specified

label	eta_s (??)
gas turbine	0.880
steam turbine	0.850

Table 6: Parameters of components of type Turbine

2.3.3 Equations applied

$$0 = -\left(h_{\mathrm{out}} - h_{\mathrm{in}}\right) + \left(h_{\mathrm{out,s}} - h_{\mathrm{in}}\right) \cdot \eta_{\mathrm{s}} \tag{28}$$

2.4 Components of type HeatExchanger

2.4.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in},i} - \dot{m}_{\mathrm{out},i} \; \forall i \in [1, 2] \tag{29}$$

$$0 = x_{fl,\mathrm{in},i} - x_{fl,\mathrm{out},i} \; \forall fl \in \text{network fluids}, \forall i \in [1, 2] \tag{30}$$

$$0 = \dot{m}_{\mathrm{in},1} \cdot \left(h_{\mathrm{out},1} - h_{\mathrm{in},1}\right) + \dot{m}_{\mathrm{in},2} \cdot \left(h_{\mathrm{out},2} - h_{\mathrm{in},2}\right) \tag{31}$$

2.4.2 Inputs specified

label	ttd_l (??)	pr1 (??)	pr2 (??)
superheater	-	0.990	0.834
evaporator	25.000	0.990	-
economizer	-	0.990	1.000
waste heat recovery	-	0.990	0.980

Table 7: Parameters of components of type HeatExchanger

2.4.3 Equations applied

$$0 = ttd_{\mathrm{l}} - T_{\mathrm{out},1} + T_{\mathrm{in},2} \tag{32}$$

$$0 = p_{\mathrm{in},1} \cdot pr1 - p_{\mathrm{out},1} \tag{33}$$

$$0 = p_{\mathrm{in},2} \cdot pr2 - p_{\mathrm{out},2} \tag{34}$$

2.5 Components of type Drum

2.5.1 Mandatory constraints

$$0 = \sum \dot{m}_{\mathrm{in},i} - \sum \dot{m}_{\mathrm{out},j} \; \forall i \in \text{inlets}, \forall j \in \text{outlets} \tag{35}$$

$$0 = x_{fl,\mathrm{in},1} - x_{fl,\mathrm{out},j} \; \forall fl \in \text{network fluids}, \forall j \in \text{outlets} \tag{36}$$

$$0 = \sum_i \left(\dot{m}_{\mathrm{in},i} \cdot h_{\mathrm{in},i}\right) - \sum_j \left(\dot{m}_{\mathrm{out},j} \cdot h_{\mathrm{out},j}\right) \; \forall i \in \text{inlets} \; \forall j \in \text{outlets} \tag{37}$$

$$
\begin{aligned}
0 &= p_{\mathrm{in},1} - p_{\mathrm{in},i} \ \forall i \in \mathrm{inlets} \setminus \{1\} \\
0 &= p_{\mathrm{in},1} - p_{\mathrm{out},j} \ \forall j \in \mathrm{outlets}
\end{aligned} \tag{38}
$$

$$
\begin{aligned}
0 =& h_{\mathrm{out},1} - h\left(p_{\mathrm{out},1}, x=0\right) \\
0 =& h_{\mathrm{out},2} - h\left(p_{\mathrm{out},2}, x=1\right)
\end{aligned} \tag{39}
$$

2.6 Components of type CycleCloser

2.6.1 Mandatory constraints

$$0 = p_{\mathrm{in},i} - p_{\mathrm{out},i} \ \forall i \in [1] \tag{40}$$

$$0 = h_{\mathrm{in},i} - h_{\mathrm{out},i} \ \forall i \in [1] \tag{41}$$

2.7 Components of type Condenser

2.7.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in},i} - \dot{m}_{\mathrm{out},i} \ \forall i \in [1,2] \tag{42}$$

$$0 = x_{fl,\mathrm{in},i} - x_{fl,\mathrm{out},i} \ \forall fl \in \mathrm{network\ fluids}, \forall i \in [1,2] \tag{43}$$

$$0 = \dot{m}_{\mathrm{in},1} \cdot \left(h_{\mathrm{out},1} - h_{\mathrm{in},1}\right) + \dot{m}_{\mathrm{in},2} \cdot \left(h_{\mathrm{out},2} - h_{\mathrm{in},2}\right) \tag{44}$$

2.7.2 Inputs specified

label	pr1 (44)	pr2 (**??**)	subcooling (47)
condenser	0.990	0.980	True

Table 8: Parameters of components of type Condenser

2.7.3 Equations applied

$$0 = p_{\mathrm{in},1} \cdot pr1 - p_{\mathrm{out},1} \tag{45}$$

$$0 = p_{\mathrm{in},2} \cdot pr2 - p_{\mathrm{out},2} \tag{46}$$

$$0 = h_{\mathrm{out},1} - h\left(p_{\mathrm{out},1}, x=0\right) \tag{47}$$

2.8 Components of type Pump

2.8.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in},i} - \dot{m}_{\mathrm{out},i} \ \forall i \in [1] \tag{48}$$

$$0 = x_{fl,\mathrm{in},i} - x_{fl,\mathrm{out},i} \ \forall fl \in \mathrm{network\ fluids}, \forall i \in [1] \tag{49}$$

2.8.2 Inputs specified

label	eta_s (??)
feed water pump	0.750

Table 9: Parameters of components of type Pump

2.8.3 Equations applied

$$0 = -\left(h_{\mathrm{out}} - h_{\mathrm{in}}\right) \cdot \eta_{\mathrm{s}} + \left(h_{\mathrm{out,s}} - h_{\mathrm{in}}\right) \tag{50}$$

3 Busses in design mode

3.1 Bus "power output"

This bus is used for postprocessing only.

label	$\dot{E}_{\mathrm{comp}}$	$\dot{E}_{\mathrm{bus}}$	η
gas turbine	$\dot{m}_{\mathrm{in}} \cdot \left(h_{\mathrm{out}} - h_{\mathrm{in}}\right)$	$\dot{E}_{\mathrm{comp}} \cdot \eta$	1.000
compressor	$\dot{m}_{\mathrm{in}} \cdot \left(h_{\mathrm{out}} - h_{\mathrm{in}}\right)$	$\dot{E}_{\mathrm{comp}} \cdot \eta$	1.000
steam turbine	$\dot{m}_{\mathrm{in}} \cdot \left(h_{\mathrm{out}} - h_{\mathrm{in}}\right)$	$\dot{E}_{\mathrm{comp}} \cdot \eta$	1.000
feed water pump	$\dot{m}_{\mathrm{in}} \cdot \left(h_{\mathrm{out}} - h_{\mathrm{in}}\right)$	$\dot{E}_{\mathrm{comp}} \cdot \eta$	1.000

Table 10: power output

3.2 Bus "heat output"

This bus is used for postprocessing only.

label	$\dot{E}_{\mathrm{comp}}$	$\dot{E}_{\mathrm{bus}}$	η
condenser	$\dot{m}_{\mathrm{in,1}} \cdot \left(h_{\mathrm{out,1}} - h_{\mathrm{in,1}}\right)$	$\dot{E}_{\mathrm{comp}} \cdot \eta$	1.000
waste heat recovery	$\dot{m}_{\mathrm{in,1}} \cdot \left(h_{\mathrm{out,1}} - h_{\mathrm{in,1}}\right)$	$\dot{E}_{\mathrm{comp}} \cdot \eta$	1.000

Table 11: heat output

3.3 Bus "heat input"

This bus is used for postprocessing only.

label	$\dot{E}_{\mathrm{comp}}$	$\dot{E}_{\mathrm{bus}}$	η
combustion	$LHV_{\mathrm{fuel}} \cdot \left[\sum_i \left(\dot{m}_{\mathrm{in},i} \cdot x_{\mathrm{fuel,in},i}\right) - \dot{m}_{\mathrm{out,1}} \cdot x_{\mathrm{fuel,out,1}}\right]$	$\dot{E}_{\mathrm{comp}} \cdot \eta$	1.000

Table 12: heat input