# 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 offdesign mode

## 1.1 Specified connection parameters

| label | p in bar (1) | T in °C (2) | v in $^{\mathrm{m}3}/_{\mathrm{s}}$ (3) |
|---|---|---|---|
| consumer cycle closer:out1_district heating pump:in1 | 10.000 | 60.000 | - |
| condenser:out2_consumer:in1 | - | 90.000 | - |
| ambient air:out1_fan:in1 | 1.000 | 12.000 | 41.624 |
| splitter:out1_superheater:in1 | - | - | 39.635 |
| evaporator:out1_sink ambient 1:in1 | 1.000 | - | - |

Table 1: Specified connection parameters

## 1.2 Equations applied

$$0 = p - p_{\mathrm{spec}} \tag{1}$$

$$0 = T\left(p, h\right) - T_{\mathrm{spec}} \tag{2}$$

$$0 = \dot{m} \cdot v\left(p, h\right) - \dot{V}_{\mathrm{spec}} \tag{3}$$

## 1.3 Specified fluids

| label | NH3 (4) | air (5) | water (6) |
|---|---|---|---|
| coolant cycle closer:out1_condenser:in1 | 1.000 | 0.000 | 0.000 |
| consumer cycle closer:out1_district heating pump:in1 | 0.000 | 0.000 | 1.000 |
| ambient air:out1_fan:in1 | 0.000 | 1.000 | 0.000 |

Table 2: Specified fluids

## 1.4 Equations applied

$$0 = x_{\mathrm{NH3}} - x_{\mathrm{NH3,spec}} \tag{4}$$

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

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

## 1.5 Referenced values for mass flow

| label | reference | factor in - | delta in $^{\mathrm{kg}}/_{\mathrm{s}}$ |
|---|---|---|---|
| evaporator reciculation pump:out1_evaporator:in2 | valve:out1_drum:in1 | 1.250 | 0 |

Table 3: Referenced values for mass flow

## 1.6 Equation applied

$$0 = \mathrm{value} - \mathrm{value_{ref}} \cdot \mathrm{factor} + \mathrm{delta} \tag{7}$$

# 2 Components in offdesign mode

## 2.1 Components of type CycleCloser

### 2.1.1 Mandatory constraints

$$0 = p_{\mathrm{in},i} - p_{\mathrm{out},i} \; \forall i \in [1] \tag{8}$$

$$0 = h_{\mathrm{in},i} - h_{\mathrm{out},i} \; \forall i \in [1] \tag{9}$$

## 2.2 Components of type Condenser

### 2.2.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in},i} - \dot{m}_{\mathrm{out},i} \; \forall i \in [1, 2] \tag{10}$$

$$0 = x_{fl,\mathrm{in},i} - x_{fl,\mathrm{out},i} \; \forall fl \in \text{network fluids}, \forall i \in [1, 2] \tag{11}$$

$$0 = \dot{m}_{\mathrm{in},1} \cdot (h_{\mathrm{out},1} - h_{\mathrm{in},1}) + \dot{m}_{\mathrm{in},2} \cdot (h_{\mathrm{out},2} - h_{\mathrm{in},2}) \tag{12}$$

### 2.2.2 Inputs specified

| label | pr1 (13) | zeta2 (14) | kA_char (15) | subcooling (16) |
|---|---|---|---|---|
| condenser | 0.990 | 4850715.036 | True | True |

Table 4: Parameters of components of type Condenser

### 2.2.3 Equations applied

$$0 = p_{\mathrm{in},1} \cdot pr1 - p_{\mathrm{out},1} \tag{13}$$

$$0 = \begin{cases} p_{\mathrm{in},2} - p_{\mathrm{out},2} & |\dot{m}_{\mathrm{in},2}| < 0.0001\,\mathrm{kg/s} \\ \frac{\zeta}{D^4} - \frac{(p_{\mathrm{in},2} - p_{\mathrm{out},2}) \cdot \pi^2}{8 \cdot \dot{m}_{\mathrm{in},2} \cdot |\dot{m}_{\mathrm{in},2}| \cdot \frac{v_{\mathrm{in},2} + v_{\mathrm{out},2}}{2}} & |\dot{m}_{\mathrm{in},2}| \geq 0.0001\,\mathrm{kg/s} \end{cases} \tag{14}$$

$$\begin{split} 0 = & \dot{m}_{\mathrm{in},1} \cdot (h_{\mathrm{out},1} - h_{\mathrm{in},1}) \\ & + kA_{\mathrm{design}} \cdot f_{\mathrm{kA}} \cdot \frac{T_{\mathrm{out},1} - T_{\mathrm{in},2} - T_{\mathrm{sat}}(p_{\mathrm{in},1}) + T_{\mathrm{out},2}}{\ln \frac{T_{\mathrm{out},1} - T_{\mathrm{in},2}}{T_{\mathrm{sat}}(p_{\mathrm{in},1}) - T_{\mathrm{out},2}}} \\ f_{\mathrm{kA}} = & \frac{2}{\frac{1}{f(X_2)} + \frac{1}{f(X_2)}} \end{split} \tag{15}$$

$$0 = h_{\mathrm{out},1} - h(p_{\mathrm{out},1}, x = 0) \tag{16}$$

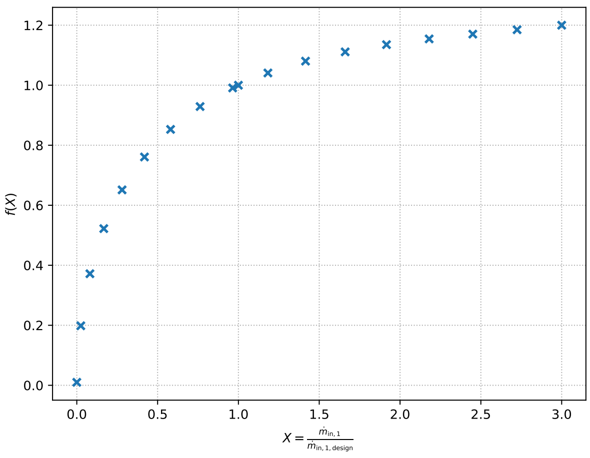


Figure 1: Characteristics of condenser (eq. 15)

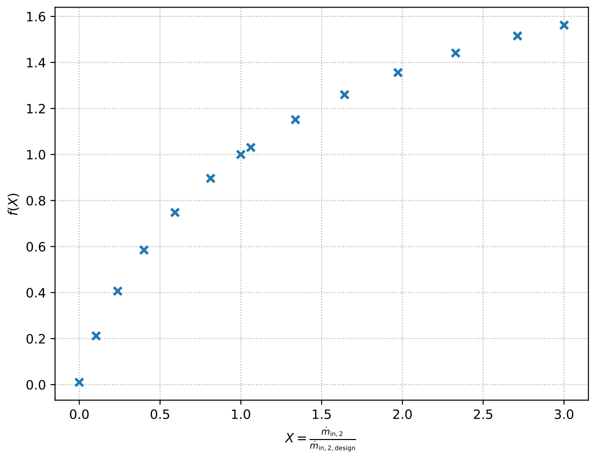


Figure 2: Characteristics of condenser (eq. 15)

## 2.3 Components of type Pump

### 2.3.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in},i} - \dot{m}_{\mathrm{out},i} \; \forall i \in [1] \tag{17}$$

$$0 = x_{fl,\mathrm{in},i} - x_{fl,\mathrm{out},i} \; \forall fl \in \text{network fluids}, \forall i \in [1] \tag{18}$$

### 2.3.2 Inputs specified

| label | eta_s_char (19) |
|---|---|
| district heating pump | True |
| evaporator reciculation pump | True |

Table 5: Parameters of components of type Pump

### 2.3.3 Equations applied

$$0 = (h_{\mathrm{out}} - h_{\mathrm{in}}) \cdot \eta_{\mathrm{s,design}} \cdot f\left(X\right) - (h_{out,s} - h_{in}) \tag{19}$$

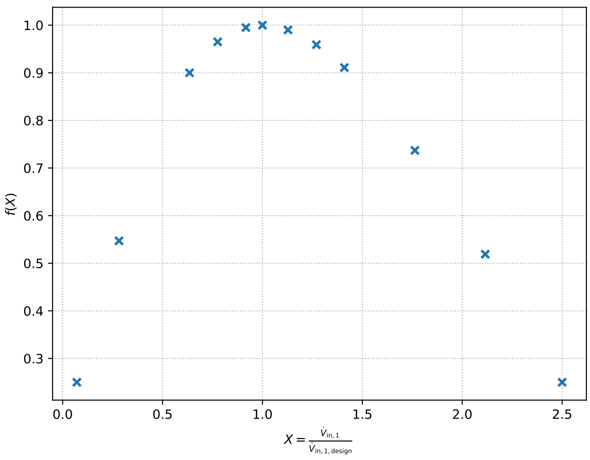


Figure 3: Characteristics of district heating pump (eq. 19)

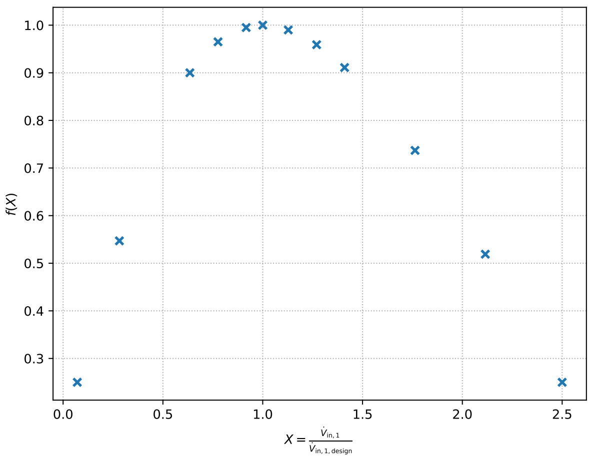


Figure 4: Characteristics of evaporator reciculation pump (eq. 19)

## 2.4 Components of type HeatExchangerSimple

### 2.4.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in},i} - \dot{m}_{\mathrm{out},i} \; \forall i \in [1] \tag{20}$$

$$0 = x_{fl,\mathrm{in},i} - x_{fl,\mathrm{out},i} \; \forall fl \in \text{network fluids}, \forall i \in [1] \tag{21}$$

### 2.4.2 Inputs specified

| label | Q (22) | zeta (23) |
|---|---|---|
| consumer | -200000.000 | 4802189.049 |

Table 6: Parameters of components of type HeatExchangerSimple

### 2.4.3 Equations applied

$$0 = \dot{m}_{\mathrm{in}} \cdot (h_{\mathrm{out}} - h_{\mathrm{in}}) - \dot{Q} \tag{22}$$

$$0 = \begin{cases} p_{\mathrm{in},1} - p_{\mathrm{out},1} & |\dot{m}_{\mathrm{in},1}| < 0.0001 \, ^{\mathrm{kg}}/_{\mathrm{s}} \\ \frac{\zeta}{D^4} - \frac{(p_{\mathrm{in},1} - p_{\mathrm{out},1}) \cdot \pi^2}{8 \cdot \dot{m}_{\mathrm{in},1} \cdot |\dot{m}_{\mathrm{in},1}| \cdot \frac{v_{\mathrm{in},1} + v_{\mathrm{out},1}}{2}} & |\dot{m}_{\mathrm{in},1}| \geq 0.0001 \, ^{\mathrm{kg}}/_{\mathrm{s}} \end{cases} \tag{23}$$

## 2.5 Components of type Valve

### 2.5.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in},i} - \dot{m}_{\mathrm{out},i} \; \forall i \in [1] \tag{24}$$

$$0 = x_{fl,\mathrm{in},i} - x_{fl,\mathrm{out},i} \; \forall fl \in \text{network fluids}, \forall i \in [1] \tag{25}$$

$$0 = h_{\mathrm{in},i} - h_{\mathrm{out},i} \; \forall i \in [1] \tag{26}$$

## 2.6 Components of type Drum

### 2.6.1 Mandatory constraints

$$0 = \sum \dot{m}_{\mathrm{in},i} - \sum \dot{m}_{\mathrm{out},j} \;\forall i \in \mathrm{inlets}, \forall j \in \mathrm{outlets} \tag{27}$$

$$0 = x_{fl,\mathrm{in},1} - x_{fl,\mathrm{out},j} \;\forall fl \in \text{network fluids}, \forall j \in \mathrm{outlets} \tag{28}$$

$$0 = \sum_i \left(\dot{m}_{\mathrm{in},i} \cdot h_{\mathrm{in},i}\right) - \sum_j \left(\dot{m}_{\mathrm{out},j} \cdot h_{\mathrm{out},j}\right) \;\forall i \in \mathrm{inlets}\; \forall j \in \mathrm{outlets} \tag{29}$$

$$\begin{aligned} 0 &= p_{\mathrm{in},1} - p_{\mathrm{in},i} \;\forall i \in \mathrm{inlets} \setminus \{1\} \\ 0 &= p_{\mathrm{in},1} - p_{\mathrm{out},j} \;\forall j \in \mathrm{outlets} \end{aligned} \tag{30}$$

$$\begin{aligned} 0 =& h_{\mathrm{out},1} - h\left(p_{\mathrm{out},1}, x = 0\right) \\ 0 =& h_{\mathrm{out},2} - h\left(p_{\mathrm{out},2}, x = 1\right) \end{aligned} \tag{31}$$

## 2.7 Components of type HeatExchanger

### 2.7.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in},i} - \dot{m}_{\mathrm{out},i} \;\forall i \in [1, 2] \tag{32}$$

$$0 = x_{fl,\mathrm{in},i} - x_{fl,\mathrm{out},i} \;\forall fl \in \text{network fluids}, \forall i \in [1, 2] \tag{33}$$

$$0 = \dot{m}_{\mathrm{in},1} \cdot \left(h_{\mathrm{out},1} - h_{\mathrm{in},1}\right) + \dot{m}_{\mathrm{in},2} \cdot \left(h_{\mathrm{out},2} - h_{\mathrm{in},2}\right) \tag{34}$$

### 2.7.2 Inputs specified

| label | pr2 (35) | zeta1 (36) | zeta2 (37) | kA_char (38) |
|---|---|---|---|---|
| evaporator | 0.990 | 0.065 | - | True |
| superheater | - | 0.064 | 603565.771 | True |
| intercooler | - | 7181598.682 | 25.945 | True |

Table 7: Parameters of components of type HeatExchanger

### 2.7.3 Equations applied

$$0 = p_{\mathrm{in},2} \cdot pr2 - p_{\mathrm{out},2} \tag{35}$$

$$0 = \begin{cases} p_{\mathrm{in},1} - p_{\mathrm{out},1} & |\dot{m}_{\mathrm{in},1}| < 0.0001\,\mathrm{kg/s} \\ \frac{\zeta}{D^4} - \frac{(p_{\mathrm{in},1} - p_{\mathrm{out},1}) \cdot \pi^2}{8 \cdot \dot{m}_{\mathrm{in},1} \cdot |\dot{m}_{\mathrm{in},1}| \cdot \frac{v_{\mathrm{in},1} + v_{\mathrm{out},1}}{2}} & |\dot{m}_{\mathrm{in},1}| \geq 0.0001\,\mathrm{kg/s} \end{cases} \tag{36}$$

$$0 = \begin{cases} p_{\mathrm{in},2} - p_{\mathrm{out},2} & |\dot{m}_{\mathrm{in},2}| < 0.0001\,\mathrm{kg/s} \\ \frac{\zeta}{D^4} - \frac{(p_{\mathrm{in},2} - p_{\mathrm{out},2}) \cdot \pi^2}{8 \cdot \dot{m}_{\mathrm{in},2} \cdot |\dot{m}_{\mathrm{in},2}| \cdot \frac{v_{\mathrm{in},2} + v_{\mathrm{out},2}}{2}} & |\dot{m}_{\mathrm{in},2}| \geq 0.0001\,\mathrm{kg/s} \end{cases} \tag{37}$$

$$\begin{aligned} 0 =& \dot{m}_{\mathrm{in},1} \cdot \left(h_{\mathrm{out},1} - h_{\mathrm{in},1}\right) \\ & + kA_{\mathrm{design}} \cdot f_{\mathrm{kA}} \cdot \frac{T_{\mathrm{out},1} - T_{\mathrm{in},2} - T_{\mathrm{in},1} + T_{\mathrm{out},2}}{\ln \frac{T_{\mathrm{out},1} - T_{\mathrm{in},2}}{T_{\mathrm{in},1} - T_{\mathrm{out},2}}} \\ f_{\mathrm{kA}} =& \frac{2}{\frac{1}{f(X_1)} + \frac{1}{f(X_2)}} \end{aligned} \tag{38}$$

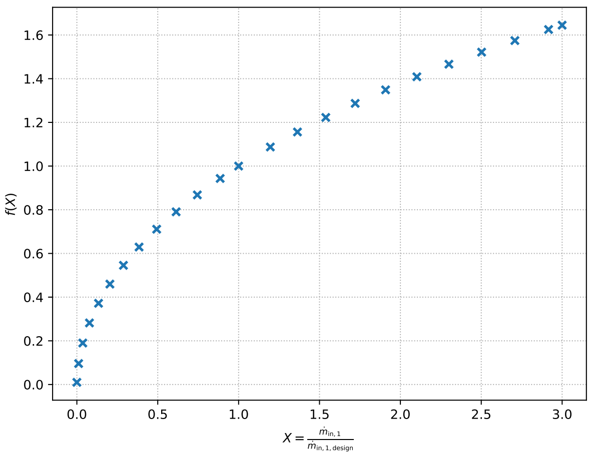


Figure 5: Characteristics of evaporator (eq. 38)

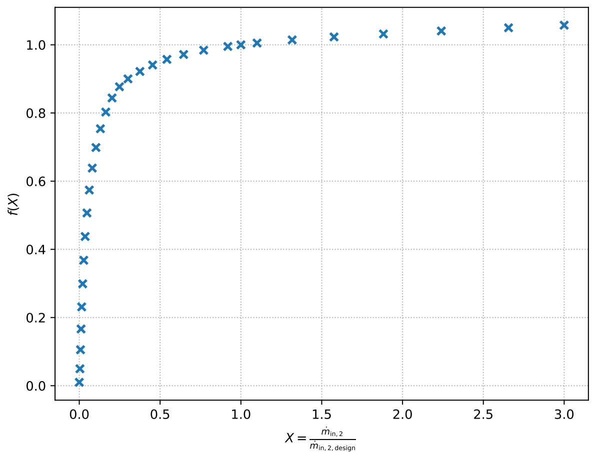


Figure 6: Characteristics of evaporator (eq. 38)

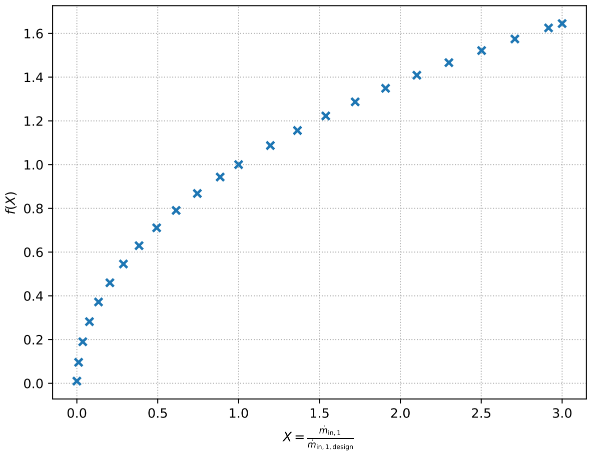


Figure 7: Characteristics of superheater (eq. 38)

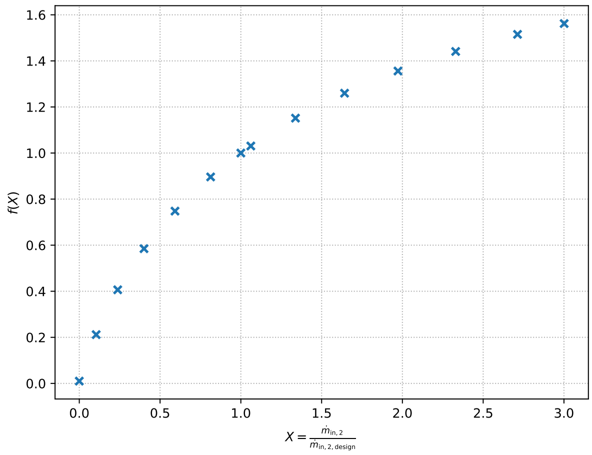


Figure 8: Characteristics of superheater (eq. 38)

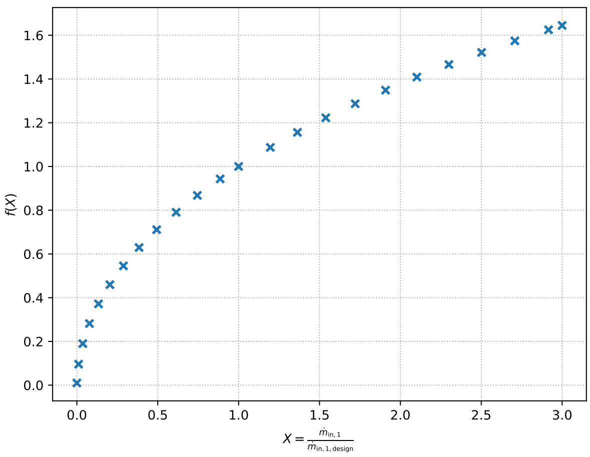


Figure 9: Characteristics of intercooler (eq. 38)

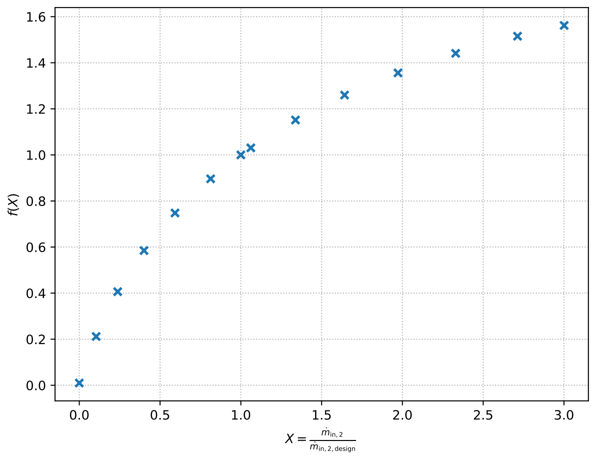


Figure 10: Characteristics of intercooler (eq. 38)

## 2.8 Components of type Compressor

### 2.8.1 Mandatory constraints

$$0 = \dot{m}_{\mathrm{in},i} - \dot{m}_{\mathrm{out},i} \; \forall i \in [1] \tag{39}$$

$$0 = x_{fl,\mathrm{in},i} - x_{fl,\mathrm{out},i} \; \forall fl \in \text{network fluids}, \forall i \in [1] \tag{40}$$

### 2.8.2 Inputs specified

| label | eta_s_char (41) | pr (42) |
|---|---|---|
| fan | True | - |
| compressor 1 | True | - |
| compressor 2 | True | 3.000 |

Table 8: Parameters of components of type Compressor

### 2.8.3 Equations applied

$$0 = (h_{\mathrm{out}} - h_{\mathrm{in}}) \cdot \eta_{\mathrm{s,design}} \cdot f\left(X\right) - (h_{out,s} - h_{in}) \tag{41}$$

$$0 = p_{\mathrm{in},1} \cdot pr - p_{\mathrm{out},1} \tag{42}$$

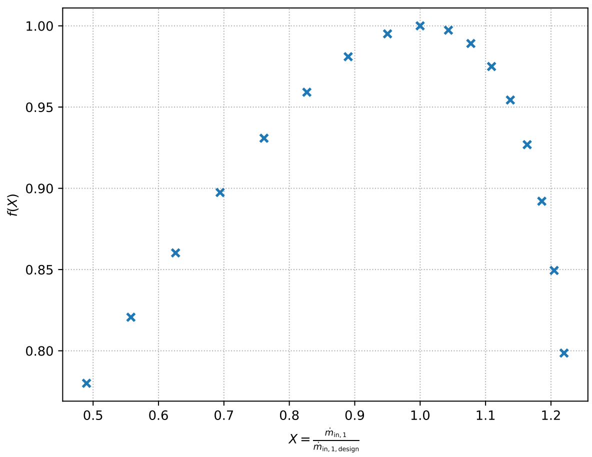


Figure 11: Characteristics of fan (eq. 41)

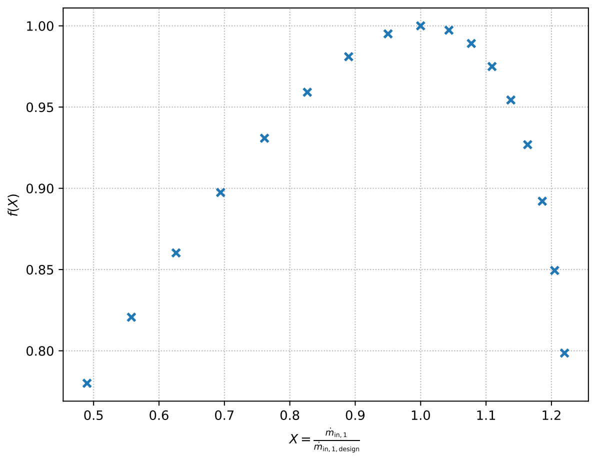


Figure 12: Characteristics of compressor 1 (eq. 41)

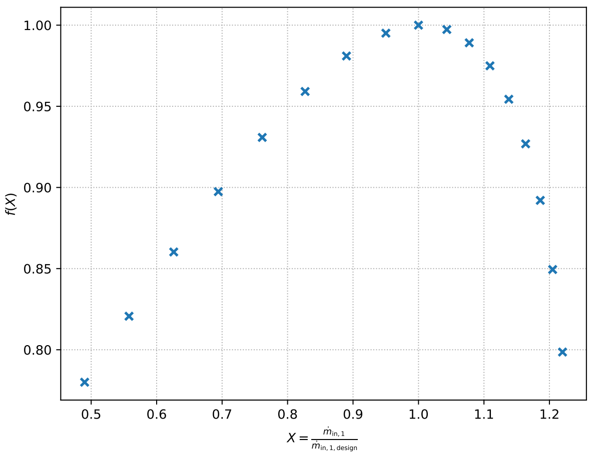


Figure 13: Characteristics of compressor 2 (eq. 41)

## 2.9 Components of type Splitter

### 2.9.1 Mandatory constraints

$$0 = \sum \dot{m}_{\text{in},i} - \sum \dot{m}_{\text{out},j} \ \forall i \in \text{inlets}, \forall j \in \text{outlets} \tag{43}$$

$$0 = x_{fl,\text{in}} - x_{fl,\text{out},j} \ \forall fl \in \text{network fluids}, \forall j \in \text{outlets} \tag{44}$$

$$0 = h_{in} - h_{\text{out},j} \ \forall j \in \text{outlets} \tag{45}$$

$$\begin{aligned} 0 = p_{\text{in},1} - p_{\text{in},i} \ \forall i \in \text{inlets} \setminus \{1\} \\ 0 = p_{\text{in},1} - p_{\text{out},j} \ \forall j \in \text{outlets} \end{aligned} \tag{46}$$