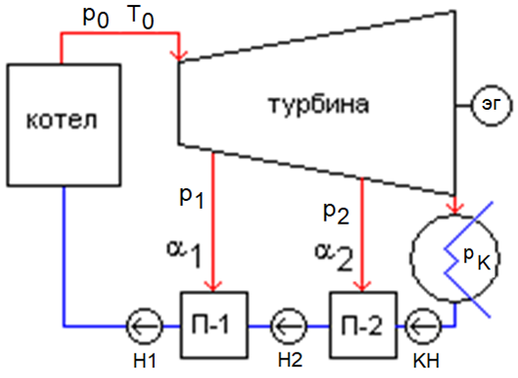
Расчет термического КПД паротурбинной установки с двумя регенеративными подогревателями

$p_0 := 130\ \text{atm}$ $T_0 := 540\ °\text{C}$



Параметры ПТУ

$p_K := 30\ \text{mmHg}$

$\eta_T(p_0; T_0; p_1; p_2; p_K) :=$

$wf := \text{"H2O"}$

$T_K := \text{CoolProp\_Props}(\text{"T"}; \text{"P"}; p_K; \text{"Q"}; 0{,}5; wf)$ $h'_{KH} := \text{CoolProp\_Props}$

$T'_{H2} := \text{CoolProp\_Props}(\text{"T"}; \text{"P"}; p_2; \text{"Q"}; 0{,}5; wf)$ $h'_{H2} := \text{CoolProp\_Prop}$

$T'_{H1} := \text{CoolProp\_Props}(\text{"T"}; \text{"P"}; p_1; \text{"Q"}; 0{,}5; wf)$ $h'_{H1} := \text{CoolProp\_Prop}$

$T_{ПВ} := \text{CoolProp\_Props}(\text{"T"}; \text{"P"}; p_0; \text{"S"}; s_{H1}; wf)$ $h''_{H2} := \text{CoolProp\_Prop}$

$h_0 := \text{CoolProp\_Props}(\text{"H"}; \text{"P"}; p_0; \text{"T"}; T_0; wf)$ $s := \text{CoolProp\_Props}(\text{"S"}$

$h_1 := \text{CoolProp\_Props}(\text{"H"}; \text{"P"}; p_1; \text{"S"}; s; wf)$ $h_2 := \text{CoolProp\_Props}(\text{"H"}$

$T''_{H2} := \text{CoolProp\_Props}(\text{"T"}; \text{"P"}; p_2; \text{"S"}; s_{H2}; wf)$ $h''_{KH} := \text{CoolProp\_Pr}$

$\alpha_1 := \text{roots}(\alpha_1 \cdot h_1 + (1 - \alpha_1) \cdot h''_{H2} = 1 \cdot h'_{H1}; \alpha_1)$

$\alpha_2 := \text{roots}(\alpha_2 \cdot h_2 + (1 - \alpha_1 - \alpha_2) \cdot h''_{KH} = (1 - \alpha_1) \cdot h'_{H2}; \alpha_2)$

$l_{01} := 1 \cdot (h_0 - h_1)$ $l_{12} := (1 - \alpha_1) \cdot (h_1 - h_2)$ $l_{2K} := (1 - \alpha_1 - \alpha_2) \cdot (h_2 - h_K)$

$l_{KH} := (1 - \alpha_1 - \alpha_2) \cdot (h''_{KH} - h'_{KH})$ $l_{H2} := (1 - \alpha_1) \cdot (h''_{H2} - h'_{H2})$

$l_{ПН} := 1 \cdot (h_{ПВ} - h'_{H1})$ $q := 1 \cdot (h_0 - h_{ПВ})$

$$\frac{l_{01} + l_{12} + l_{2K} - l_{KH} - l_{H2} - l_{ПН}}{q}$$

$n := 19$

$p_{1,min} := 28\ \text{atm}$ $p_{1,max} := 30\ \text{atm}$

$p_{2,min} := 2{,}1\ \text{atm}$ $p_{2,max} := 2{,}51\ \text{atm}$

for $j \in [1..(n+1)]$

  for $k \in [1..(n+1)]$

$$p_1 := p_{1,min} \cdot \frac{n+1-j}{n} + p_{1,max} \cdot \frac{j-1}{n}$$

$$p_2 := p_{2,min} \cdot \frac{n+1-k}{n} + p_{2,max} \cdot \frac{k-1}{n}$$

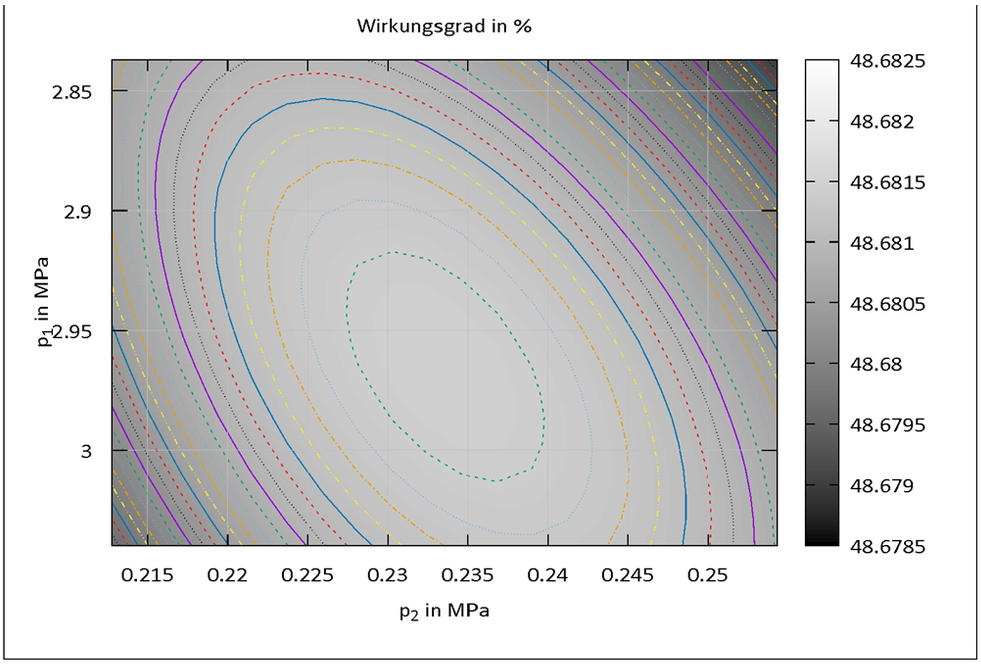
$\text{trace}(j; k; p_1; p_2)$

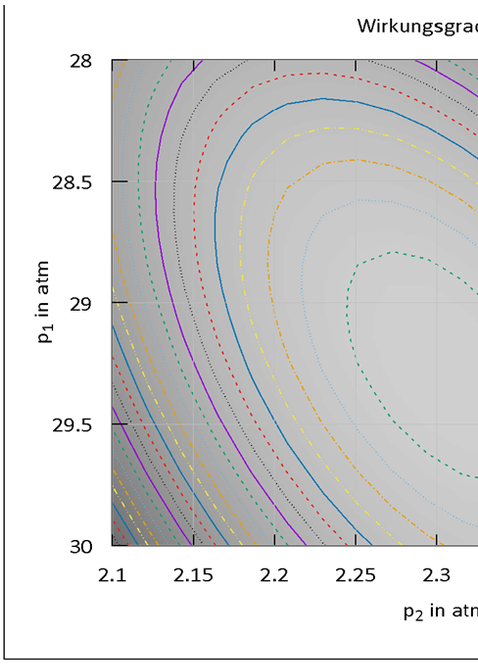
$M_{j\,k} := \eta_T(p_0; T_0; p_1; p_2; p_K)$

$P_{j\,k} := [p_1\ p_2]$

$$\frac{M - 0{,}4868}{0{,}00001} = \begin{bmatrix} 1{,}04 & 1{,}21 & 1{,}34 & 1{,}44 & \cdots \\ 1{,}08 & 1{,}26 & 1{,}41 & 1{,}52 & \\ 1{,}11 & 1{,}3 & 1{,}46 & 1{,}58 & \\ 1{,}13 & 1{,}33 & 1{,}5 & 1{,}63 & \\ 1{,}14 & 1{,}35 & 1{,}53 & 1{,}67 & \\ 1{,}14 & 1{,}36 & 1{,}54 & 1{,}7 & \\ 1{,}12 & 1{,}35 & 1{,}55 & 1{,}71 & \\ 1{,}09 & 1{,}33 & 1{,}54 & 1{,}71 & \\ \vdots & & & & \ddots \end{bmatrix}$$

$\text{Max}(M) = 0{,}48682186$





$$\begin{cases} key = "" \\ elevation\_grid\left(\frac{M}{\%};\ \frac{p_{2,min}}{MPa};\ \frac{p_{1,max}}{MPa};\ \frac{p_{2,max}-p_{2,min}}{MPa};\ -\frac{p_{1,max}-p_{1,min}}{MPa}\right) \\ xyplane = 47 \\ interpolate\_color = true \\ contour\_levels = 50 \end{cases}$$

$$\begin{cases} key = "" \\ elevation\_grid\left(\frac{M}{\%};\ \frac{p_{2,min}}{atm};\ \frac{p_{1,m}}{at}\right. \\ xyplane = 47 \\ interpolate\_color = true \\ contour\_levels = 50 \end{cases}$$

$$\eta_T\left(p_0;\ T_0;\ 2,97\ MPa;\ 0,233\ MPa;\ p_K\right) = 0,4868219$$

$$\eta_T\left(p_0;\ T_0;\ 29,3\ atm;\ 2,3\ atm;\ p_K\right.$$

$$2,97\ MPa$$