CONSEQUENCES OF REACTIVE POWER 1

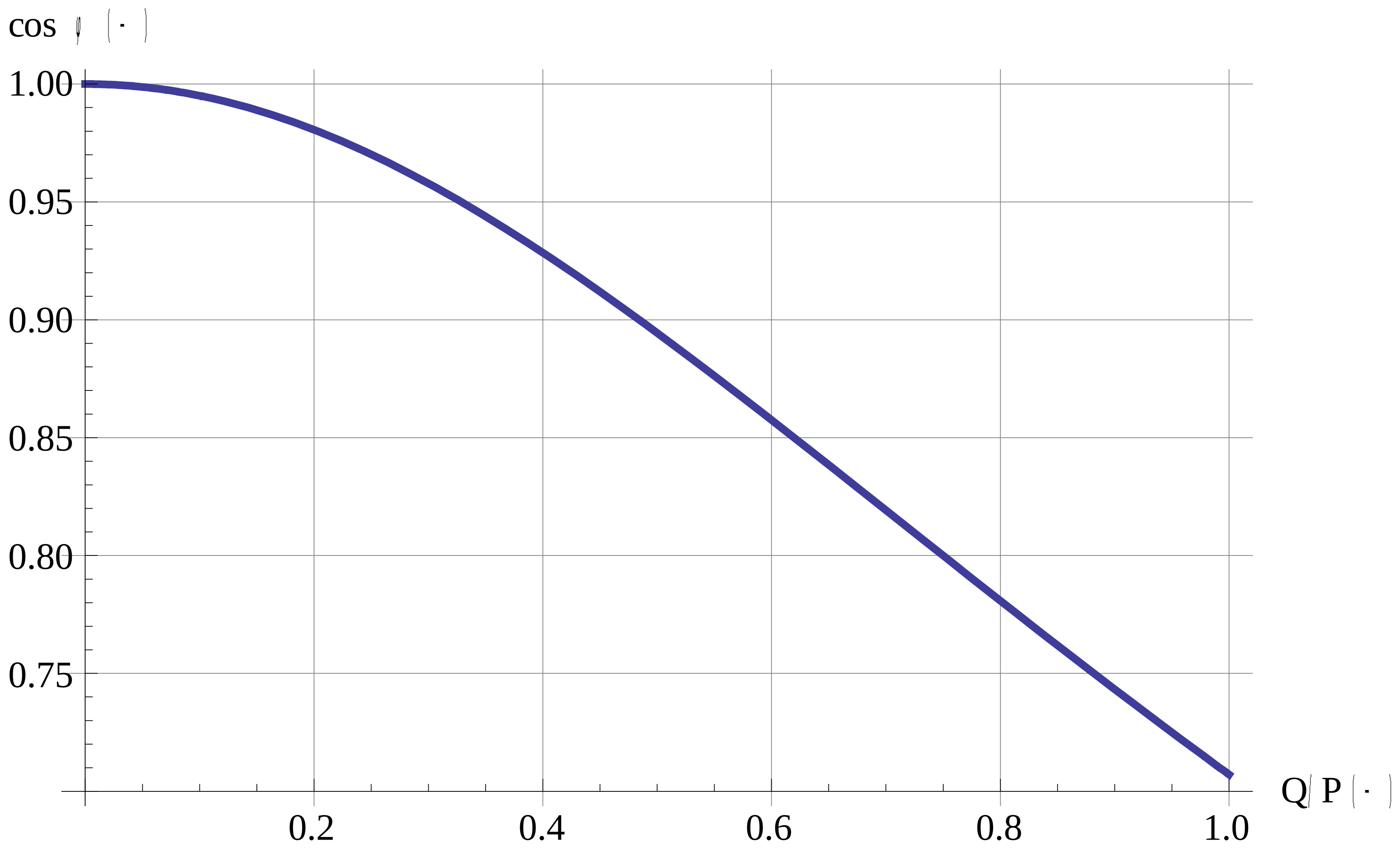
- reduce of the use existing electrical distribution equipment (smaller transmitted active power),

$$P = S \cdot \cos\varphi = U \cdot I \cdot \cos\varphi \quad \text{(W; VA, V, A)}$$

- increase the cost of all equipment dimensioned according to the size of apparent power (transformers, circuit breakers, protections, measurement equipment)
- higher the losses in power distribution (the power losses is depend on the square root of apparent power)

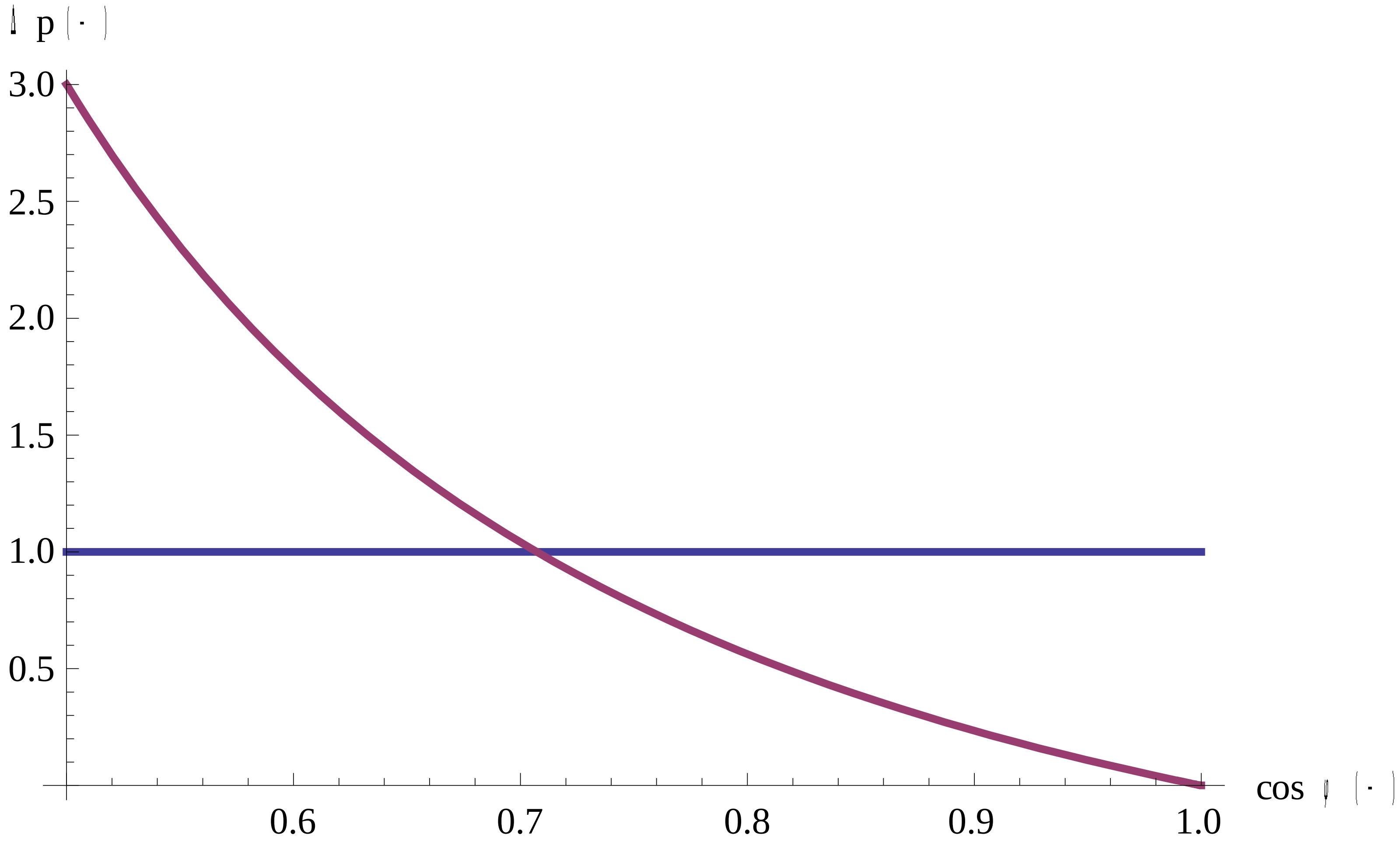
$$P_{ztr} = 3R \cdot I^2 = 3R \cdot \left(\frac{S}{\sqrt{3}U} \right)^2 = \frac{R}{U^2} \cdot S^2 = \frac{R}{U^2} \cdot (P^2 + Q^2) \quad \text{(W)}$$

$$Q = P \cdot tg\varphi \;\rightarrow\; P_{ztr} = k \cdot (1 + tg^2\varphi)$$



cos
1.00
0.95
0.90
0.85
0.80
0.75
0.2
0.4
0.6
0.8
1.0
Q P

The losses due the active and reactive current component



CONSEQUENCES OF REACTIVE POWER 2

- increase of voltage drops in the distribution system (increase of voltage fluctuation in the electricity grid)

$$\Delta U_f = R \cdot I_{\check{c}} \pm X \cdot I_j \quad (V)$$

- the consequences also affect the size of the rate for the consumed electric energy. The distribution companies penalties consumers with bad power factor.

COMPENSATION AT CONSTANT ACTIVE POWER

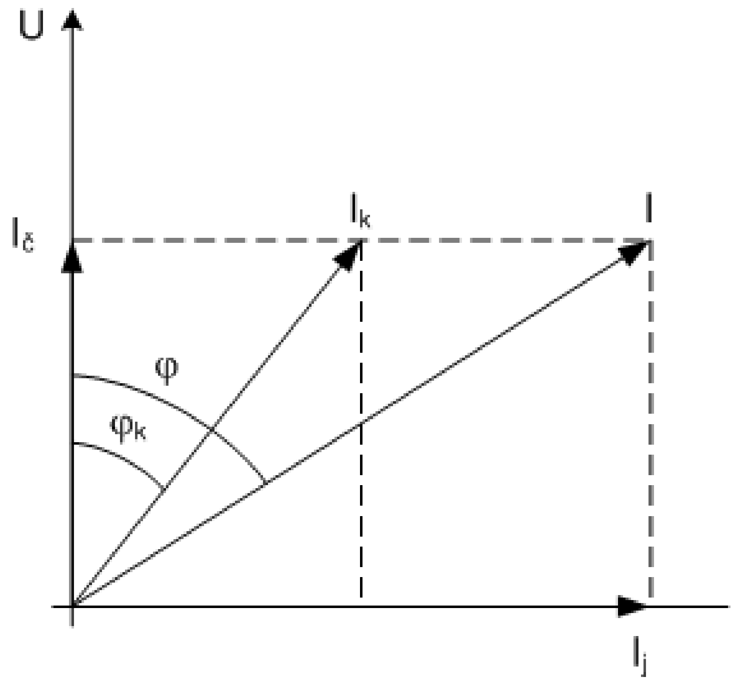
Before compensation $Q = \sqrt{3} \cdot U \cdot I \cdot \sin\varphi$

After compensation $Q_k = \sqrt{3} \cdot U \cdot I_k \cdot \sin\varphi_k \quad (VAr\,;\, V,\, A)$

Compensation power

$$Q_c = Q - Q_k = \sqrt{3} \cdot U \cdot \left(I \cdot \sin\varphi - I_k \cdot \sin\varphi_k\right) \quad (VAr\,;\, V,\, A)$$

$$I_{\check{c}} = I \cdot \cos\varphi = I_k \cdot \cos\varphi_k$$



Size of capacity

$$I_{kap} = \frac{U}{X_{kap}} = U \cdot \omega \cdot C \quad (A;\, V,\, \Omega)$$

$$Q_c = Q_{kap} = \omega \cdot C \cdot U^2$$

$$C = \frac{Q_c}{\omega \cdot U^2} \quad (F;\, VAr\,,\, s^{-1},\, V)$$

COMPENSATION AT CONSTANT APPARENT POWER

Before compensation $Q = \sqrt{3} \cdot U \cdot I \cdot \sin\varphi$

After compensation $Q_k = \sqrt{3} \cdot U \cdot I \cdot \sin\varphi_k \quad (VAr; V, A)$

Compensation power

$$Q_c = Q - Q_k = \sqrt{3} \cdot U \cdot I \cdot (\sin\varphi - \sin\varphi_k)$$

$$I_{čk} = I_k \cdot \cos\varphi_k$$

Increase of active power

$$P = \sqrt{3} \cdot U \cdot I \cdot \cos\varphi$$

$$P_k = \sqrt{3} \cdot U \cdot I \cdot \cos\varphi_k$$

$$\Delta P = P_k - P = \sqrt{3} \cdot U \cdot I \cdot (\cos\varphi_k - \cos\varphi) =$$

$$= S \cdot (\cos\varphi_k - \cos\varphi) \quad (W; V, A)$$