CONSEQUENCES OF REACTIVE POWER 1

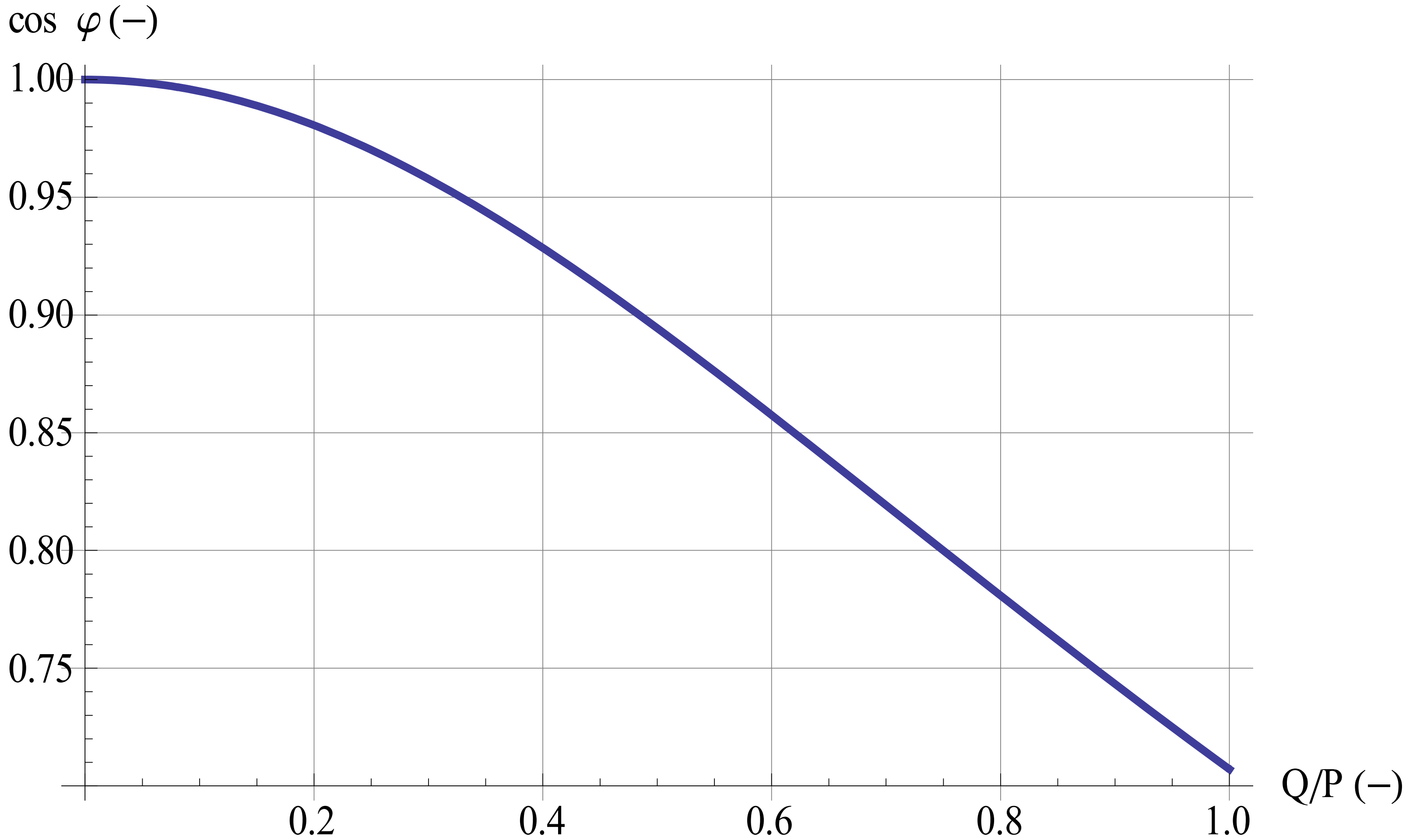
- lower use of existing electrical distribution equipment (smaller transmitted active power),

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

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

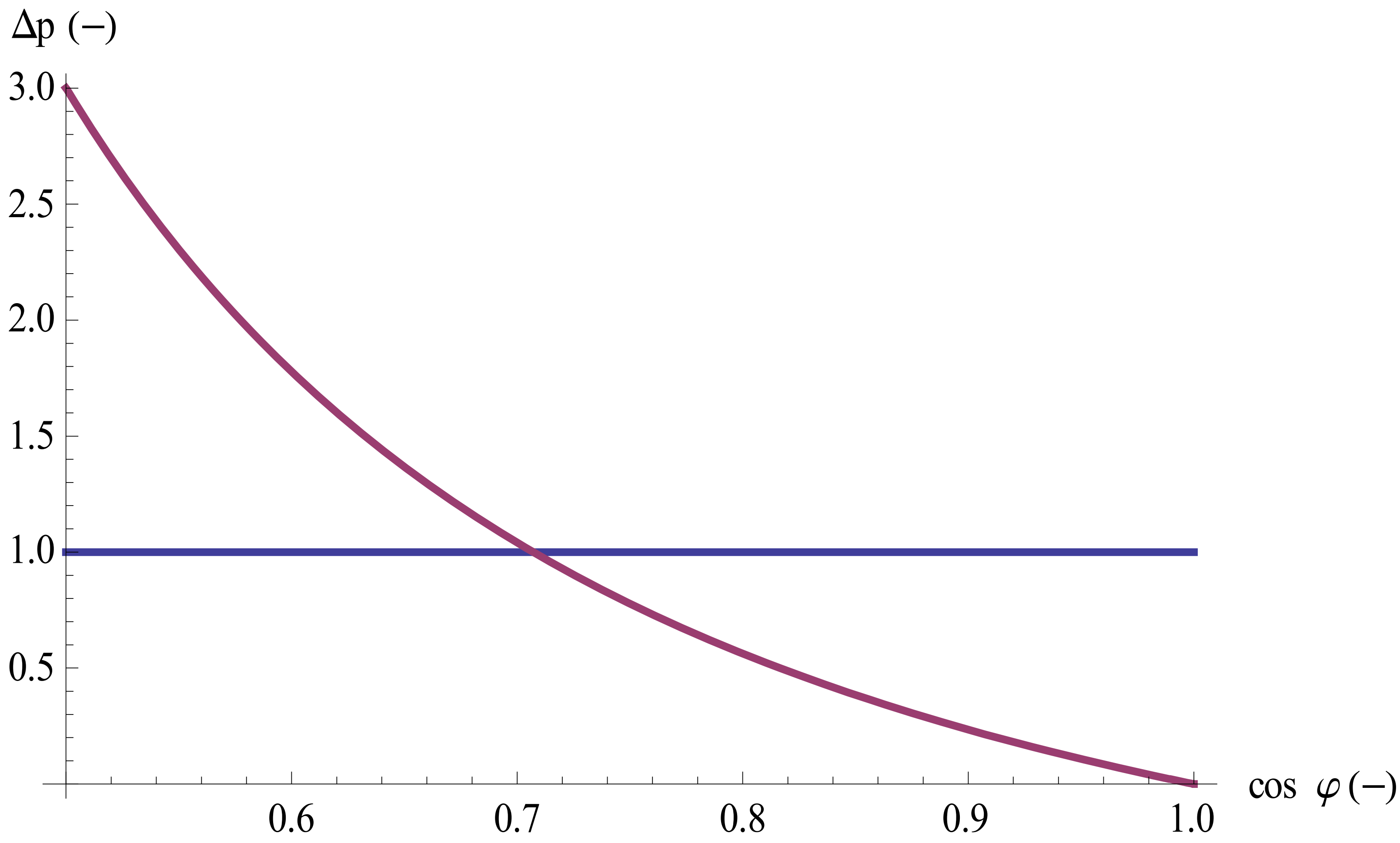
$$P_{ztr} = 3R \cdot I^2 = 3R \cdot \left(\frac{S}{\sqrt{3}U} \right)^2 = \frac{R}{U^2} \cdot S^2 = \frac{R}{U^2} \cdot (P^2 + Q^2) \quad (W)$$

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



cos φ (−)
1.00
0.95
0.90
0.85
0.80
0.75
Q/P (−)
0.2
0.4
0.6
0.8
1.0

The losses due to 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)

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

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

COMPENSATION AT CONSTANT ACTIVE POWER

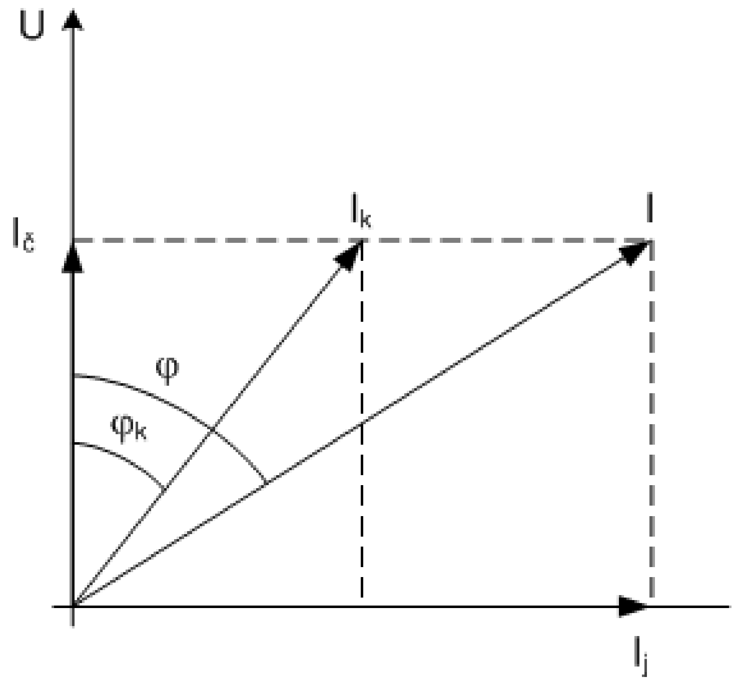
Before compensation $Q = \sqrt{3} \cdot U \cdot I \cdot \sin\varphi$

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

Compensation power

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

$$I_č = I \cdot \cos\varphi = I_k \cdot \cos\varphi_k$$



Capacity value

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

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

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

COMPENSATION AT CONSTANT APPARENT POWER

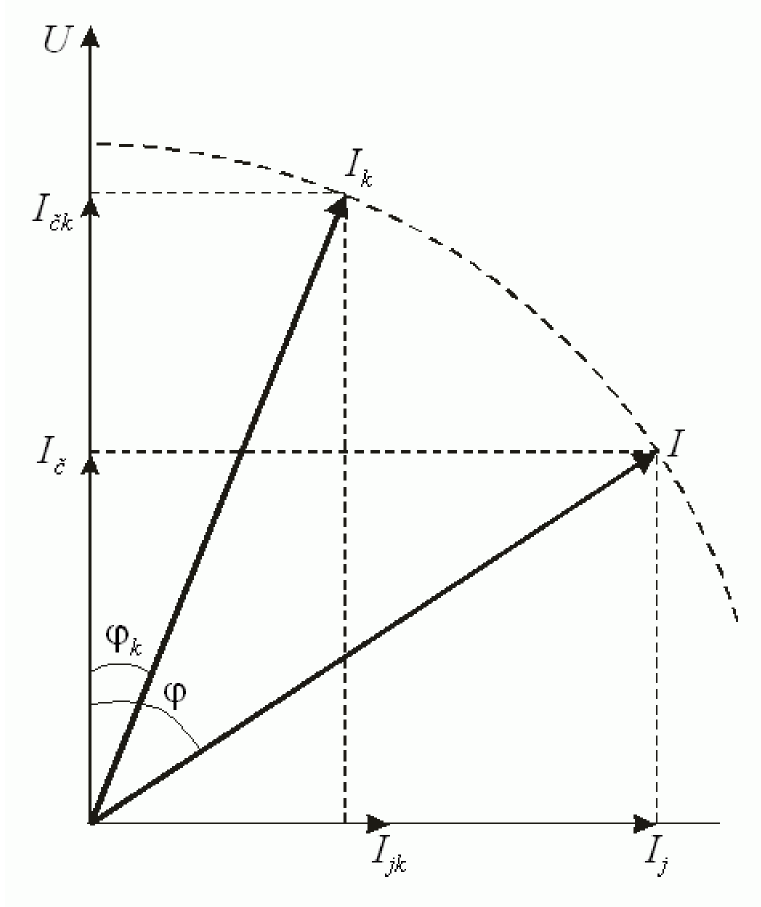
Before compensation $Q = \sqrt{3} \cdot U \cdot I \cdot \sin\varphi$

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

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

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

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

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