(1) Tegne HPS system og nevne alle deler

Kan forklare

(2) Kan definere

Head energy

$$H_n = H_{gr} - \frac{E_t}{g} = H_{gr} - H_t = h_p + \frac{c^2}{2g}$$

$$E_n = g H_n$$

Power:

$$P_n = \rho Q g H_n$$

(3) Kan nevne 3 turbin typer

- Kaplan
- Pelton
- Frances

Karakteristikk av den

(4) Total available power

$$P_n = \rho Q g H_n$$

Power of Runner

$$P_R = \rho Q (u_1 c_{u1} - u_2 c_{u2})$$

Simplyfied, hvorfor? nevn?

Hydralic efficiency

$$\eta_h = \frac{P_R}{P_n} = \frac{1}{g H_n} (u_1 c_{u1} - u_2 c_{u2})$$

(5) Effekten av de ulike turbinene

(6) Speed Number

$$\frac{n_q}{89} = {}^*\underline{\Omega} = {}^*\omega\sqrt{{}^*Q} = \frac{\pi n\sqrt{Q}}{30\sqrt[4]{2gH_n}}$$

Forklare hva de ulike er

${}^*\underline{\Omega}$ = Speed number
${}^*\omega$ = Reduced rotation speed
${}^*\underline{Q}$ = Reduced dischrge

(7) Hvilke speed nummer til ulike turbiner

(8) Spessiffic speed

$$n_q = \frac{{}^*n\sqrt{{}^*Q}}{\sqrt[4]{H_n^3}} \qquad k = \frac{{}^*\omega\sqrt{{}^*Q}}{\sqrt[4]{gH_n^3}}$$

(9) Design of Pelton Turbine

(10) Hva er:

Controll Volume

In and extuse properties

3 conversation lows

(11) Kunne nevne:

Droop controll

to Primary
Secondary
Tertiary
→ controll

Hun de gjør

Droop:

$$R_g = \frac{\Delta f / f_r}{\Delta P_g / P_g}$$

(12) Network power-frequency Characteristic

$$\lambda = -\frac{\Delta P\,[MW]}{\Delta f\,[Hz]}$$ bias factor

$$\Delta P = \sum \Delta P_g = \sum \left(-\frac{1}{R_g} \cdot \frac{P_g}{f_r} \cdot \Delta f\right)$$

$$\Rightarrow \lambda = -\frac{\Delta P}{\Delta f} = \sum \left(\frac{1}{R_g} \cdot \frac{P_g}{f_r}\right)$$

(13) Self Regulation

$$\lambda = -\frac{\Delta P}{\Delta f} = \sum \left(\frac{1}{R_g} \cdot \frac{P_g}{f_r}\right) + \frac{\mu}{100} P$$

$$\mu = \frac{\Delta P / P}{\Delta f} \cdot 100\%$$

(14) Control Error of control area

$$ACE_i = (P_{ai} - P_{is}) + \lambda (f_a - f_b) = \Delta P_i + \lambda \Delta f$$

(15) Kan tegne TF
Lo ikke viktig med PID

Nevn 2 timeconstant