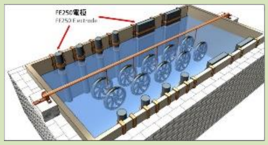
Mid term examination report

Nguyễn Phú Minh Nhật 20202795 **EE-E8 01 – K65**

I, OVERVIEW:

Design of a controlled rectifier power supply for a plating bath



Technology requirements

- Small output voltage, large load current
- Current must be stable, accurate High
- The voltage to be adjusted is low in startup process
- Large flow requires cooling valve

Designed parameters:
Rated voltage: 24V
Rated current: 3600A
Power supply 3x380V, 50Hz

II, DESIGNED OPTION

1, Rectifier selection

- With large current and relatively low voltage (Ud=24V, Id=3600A)

→ Using a ray diagram is the most suitable option

- Large required power and current over 1000A

→ Using a 6-phase beam diagram with a balanced reactor.

2, Advantage and Disadvantage

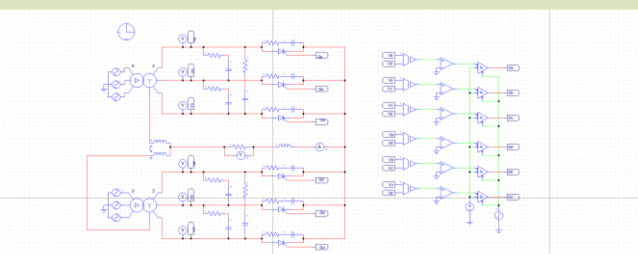
Advantage:

✓ Medium flow through small valve equal to 1/6 of rated current.
✓ Output voltage and current stable.
✓ Is a suitable rectifier circuit for circuits with low voltage high current.

Disadvantage:

✓ Complex transformer design more complex than other schemes.
✓ Number of valves used and equipment valve protection so much cost high production

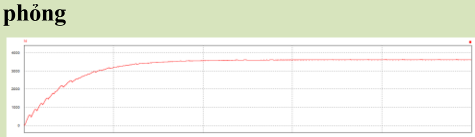
IV, SIMULATION



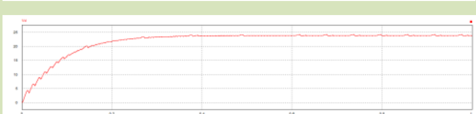
Schematic diagram of rectifier circuit by PSIM

2. Kết quả mô phỏng

Output current



Output voltage



Comment:

- The output follows the desire value, ensure the current and voltage deviation is less than 10%.
- The graph form is relative similar in theory.
- Satisfying the pulse rate requirement Kp < 20%.
- It takes about 3,2s to reach the set value due to the filter coil, reactor.

III, DESIGNED RECTIFIER CIRCUIT:

Requirements:
Output rated voltage: Ud = 24V
Output rated current: Id = 3600A
Input voltage source: 3x380V, 50Hz $\pm$10%
Choose: $e_r = 3\%, e_x = 9\% \; (e_{nm} = 9{,}5\%), \alpha = 10^o$

1. Calculate transformer parameters

– No-load recifier voltage:

$$U_{d,kt} = U_d + \Delta U_v + \Delta U_R + \Delta U_X$$

Where: $2\Delta U_v = 1{,}5(V), U_{do} = \frac{Ud}{\cos\alpha} = 24{,}37(V)$

$\Delta U_R = 2R_\alpha I_d = \frac{I_d e_r 3U^2}{S_{ba}} = 3.48 e_r U_{d,kt}$

$\Delta U_X = 6\frac{X_\alpha I_d}{2\pi} = \frac{3}{\pi}\frac{3U_2^2}{S_{ba}} e_x I_d = 1.66 e_x U_{d,kt}$

$\rightarrow U_{d,kt} = \frac{U_d + 2\Delta U_v}{1-(3{,}48e_r + 1{,}66e_x)} = 35{,}17(V)$

$\rightarrow U_2 = \frac{U_{d,kt}}{1.17} = 30.1(V)$

$U_1 = 380V$

- Apparent power: $S_{ba} = 1{,}26P_d = 1{,}26.3600.35{,}17 = 160(KVA)$
- Power factor (Voltage source drop 10%)

$$k_{ba} = \frac{U_1(1-0{,}1)}{U_2} = \frac{380(1-0{,}1)}{30{,}1} = 11{,}36$$

- Other parameters:

$I_2 = 0{,}29.I_d = 0{,}29.3600 = 1044(A)$

$I_1 = \frac{I_2}{k_{ba}} = \frac{1044}{11{,}36} = 91{,}9(A)$

2. Value selection

- Average current through value:

$$I_v = \frac{I_d}{6} = 600(A)$$

- Maximum revered voltage:

$$U_{ng,max} = 1.1\sqrt{6}\,U_2 = 80{,}1(V)$$

- Assuming natural cooling condition, the value mounts on the heatsink. Choose value has $I_v = 600(A)$ and $U_{max} = 100(V)$
- Choose thyristor **T370N** with the following parameters:
- $I_v = 650V, V_{DRM} = 1800V, V_{RRM} = 1800$
- $\frac{di}{dt} = 200A/\mu s, \frac{du}{dt} = 1000V/\mu s$

3. Value protection

- RC circuit connected parallel with thyristor to protects current rate and voltage rate:

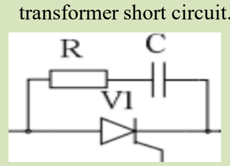
$L_a = \frac{\sqrt{6}U_2}{2(\frac{di}{dt})} = 0{,}184(\mu H)$ $C > \frac{8L_a}{R} = 0{,}59(\mu F)$

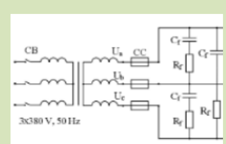
$R = \frac{L_a}{\sqrt{6}U_2}\left(\frac{du}{dt}\right) = 2{,}5(\Omega)$

- $R_f C_f$ to protect input secondary rectifier

$C_f = \frac{mI_o}{\omega a^2 U_2 (K^2-1)} = 4(\mu F)$ $R_f = 2\sqrt{\frac{2L_a}{C_f}} = 12{,}5(\Omega)$

- Fuses CC protects short circuit in valve circuit
- Aptomats CB protect schematic valve short circuit and transformer short circuit.





4. Calculate balanced reactor

$$L_{cb} \geq \frac{U_2}{6\omega 0{,}1 I_d} = 4{,}43.10^{-5}(H)$$

Choose $L_{cb} = 0{,}45.10^{-6}(H)$

5. Filter coil

The filter coil can be added at the output to make the signal output flatter. Choose L_{filter}= $1(mH)$