SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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Accredited by NBA – AICTE and Accredited by NAAC – UGC with ‘A’ Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19EE407 ELECTRICAL MACHINES AND DRIVES

I YEAR /IV SEMESTER MECH

Unit 1 – OVERVIEW OF ELECTRICAL DRIVE

TOPIC: HEATING AND COOLING CURVE

Heating & Cooling of Electric Drive

- ✓ Various losses takes place like Copper loss, Core loss & Windage loss etc.
- ✓ Due to these losses heat is produced inside the machine. This increases the temperature of motor.
- ✓ When temperature reaches ambient value, the heat generated = heat dissipated.
- ✓ Heat dissipation is proportional to the difference of the temp. Of the body and surrounding medium.
- ✓ If Cooling is not provided then motor can not dissipate heat to surrounding medium.

HEATING CURVE

- ✓ Consider a homogeneous machine, developing heat internally at a uniform rate & gives to surrounding proportional to temp. rise.

Total Losses in the machine during the small time interval ‘dt’ $= W*dt$

Heat dissipation during the same time interval

$= A\lambda\theta dt$

Additional heat stored in the machine

$= GSd\theta$

✓ Heat Developed = Heat absorbed + Heat Dissipated

$$Wdt = GSd\theta + A\lambda\theta dt$$

$$\therefore \quad W \cdot dt - A\lambda\theta \cdot dt = G.S.d\theta$$

$$\therefore \quad (W - A\lambda\theta)\, dt = G.S.d\theta$$

$$\frac{dt}{G.S.} = \frac{d\theta}{W - A\lambda\theta}$$

$$\frac{dt}{\left(\frac{GS}{A\lambda}\right)} = \frac{d\theta}{\left(\frac{W}{A\lambda} - \theta\right)}$$

By solving

$$\theta = \theta_F - (\theta_F - \theta_1)\, e^{-t/\tau}$$

There fore

$$\theta = \theta_F\, (1 - e^{-t/\tau})$$

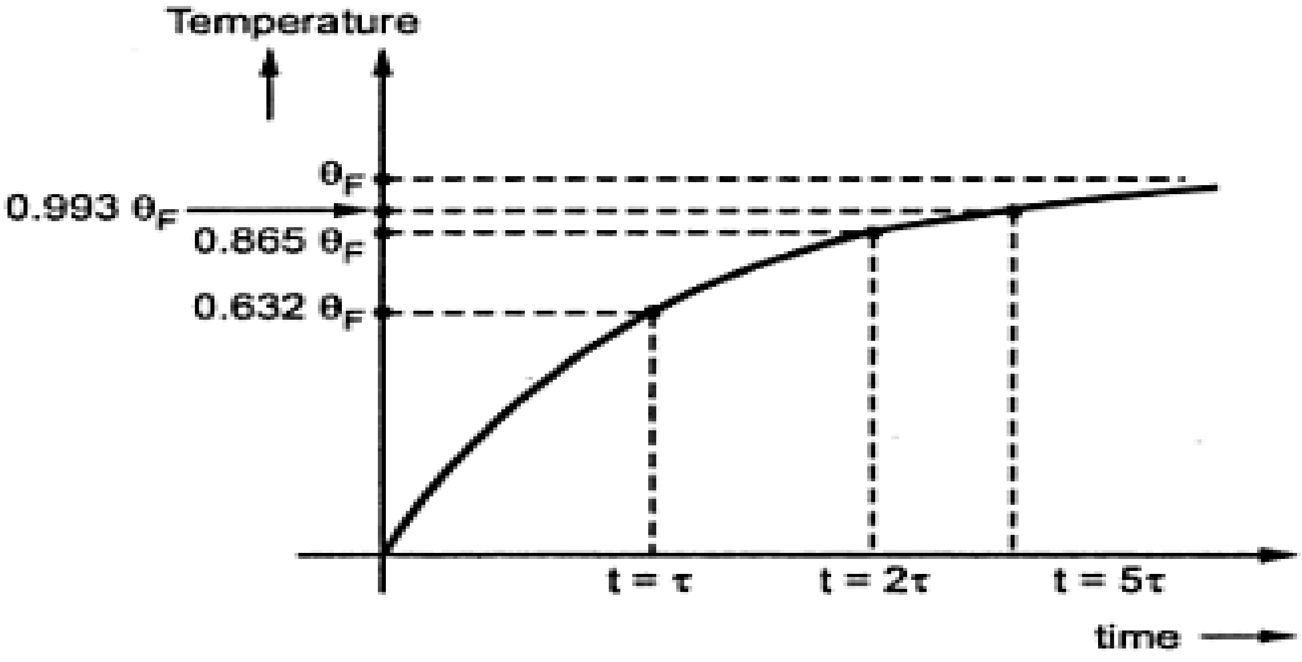
Let us consider time period $t = \tau$ then

$$\theta = \theta_F(1 - e^{-1}) = \theta_F\left(1 - \frac{1}{e}\right) = 0.632\ \theta_F$$

Similarly, at $t = 2\tau,\ \theta = 0.865\ \theta_F$

$t = 3\tau,\ \theta = 0.95\ \theta_F$

$t = 4\tau,\ \theta = 0.982\ \theta_F$



COOLING CURVE

- ✓ If the machine is switched off or when the load is reduced, the machine cools.
- ✓ Then there is No Heat generation & the heat stored in the machine is dissipated to surroundings.

Heat Developed + Heat Absorbed = Heat Dissipated

$$Wdt + GSd\theta = A\lambda'\theta dt$$

By solving the above eqn.

$$\theta = \theta_0 e^{-t/\tau'}$$

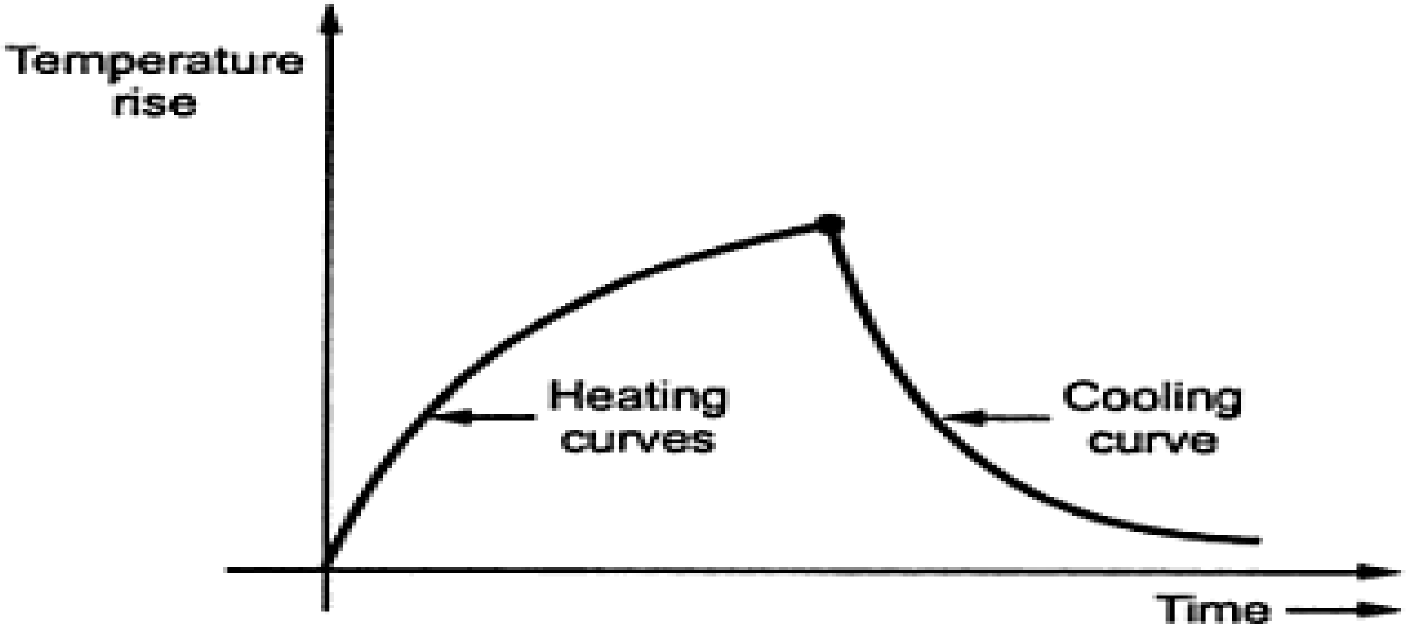
At $t = \tau$, $\theta = \theta_0 e^{-1} = 0.367\ \theta_0$

$t = 2\tau$, $\theta = 0.135\ \theta_0$

$t = 3\tau$, $\theta = 0.05\ \theta_0$

$t = 4\tau$, $\theta = 0.018\ \theta_0$

$t = 5\tau$, $\theta = 0.007\ \theta_0$



Heating and cooling curves

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