SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

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: 16EE214/ELECTRICAL MACHINES AND DRIVES

III YEAR / VI SEMESTER

UNIT 1- OVERVIEW OF ELECTRICAL DRIVE

Topic 4 – Heating and cooling curves

SUCCESSFUL STUDENT

Positive Attitude

Professionally Groomed

Socially Interactive

Technically Skillful

HEATING AND COOLING CURVES

A machine can be considered as a homogeneous body developing heat internally at uniform rate and dissipating heat proportionately to its temperature rise,

RELATION SHIP BETWEEN TEMPERATURE RISE AND TIME

Let,

P =heat developed, joules/sec or watts

G =weight of active parts of machine, kg

h =specific heat per kg per deg cell

S = cooling surface, m2

λ = specific heat dissipation (or) emissivity, J per sec per m^2 of

HEATING AND COOLING CURVES

q = temperature rise, deg cell

qm =final steady temperature rise, deg cell

t =time, sec

t =heating time constant, seconds

t' =cooling time constant, seconds

HEATING AND COOLING CURVES

Assume that a machine attains a temperature rise after the lapse of time t

seconds. In an element of time “dt” a small temperature rise “d” takes place.

Then,

Heat developed = p.dt

Heat developed = Gh.dq

Heat dissipated = Sql. dt

HEATING AND COOLING CURVES

Therefore, total heat developed=heat stored + heat dissipated

$$Ghd\theta + S\theta\lambda.\, dt = p.dt$$

$$\frac{d\theta}{dt} + \theta\frac{s\lambda}{Gh} = \frac{p}{Gh}$$

This is a differential equation and solution of this equation is,

$$\theta = \frac{p}{s\lambda} + ke^{-(s\lambda/Gh)t}$$

Where k is a constant of integration determined by initial conditions.

Let the initial temperature rise to be zero at t=0.

HEATING AND COOLING CURVES

Then, $0 = \frac{p}{s\lambda} + k$

$$k = \frac{-p}{s\lambda}$$

Hence, $\theta = \frac{p}{s\lambda}(1 - e^{-\left(\frac{s\lambda}{Gh}t\right)})$ - - - - - - - - - - - - - - (1)

When t= ∞ , $\theta = \frac{p}{s\lambda} = \theta_m$, the final steady temperature rise.

Represent $\frac{p}{s\lambda} = \theta_m$ and $\frac{Gh}{s\lambda} = \tau$ - - - - - - - - - - - - - - -(2)

Equation 1 can be written as

$$\theta = \theta_m(1 - e^{-1}) \quad \text{- - - - - - - - - - - - -(3)}$$

Where is called as heating time constant and it has the dimensions of time.

ASSESSMENT

REFERENCE

- D.P.Kothari and I.J.Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill publishing company ltd, second edition, 2007

- S.K.Pillai, “ A First Course on Electrical Drives” New age publishing Ltd, 1989. (UNIT I, IV,V)

THANK YOU!!