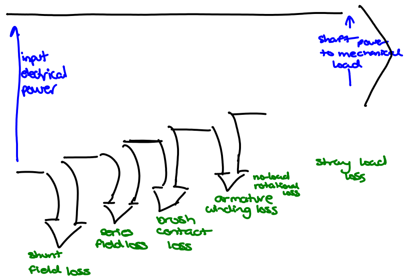
Lecture 15

Monday, 5 October 2009
10:30 AM

Efficiency of a DC motor



$\eta = \frac{\text{output}}{\text{input}}$

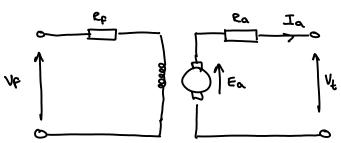
$= \frac{\text{output}}{\text{output + losses}}$

$= \frac{\text{input - losses}}{\text{input}}$

$= 1 - \frac{\text{losses}}{\text{input}}$

DC Generators

1. separately excited DC generator



$E_a = K_a \phi \omega_m$, $\tau = K_a \phi I_a$ } $P_a = E_a I_a$

$V_t = E_a - I_a R_a$

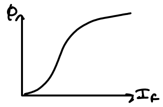
Control of Terminal Voltage

1. $E_a = K_a \phi \omega_m$

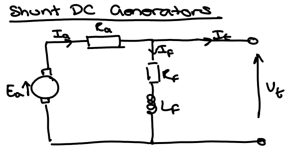
so, if $\omega_m \uparrow \Rightarrow E_a \uparrow$ and $V_t \uparrow$

2. $E_a = K_a \phi \omega_m$

so, if $I_f \uparrow \Rightarrow \phi \uparrow \therefore E_a \uparrow$ and $V_t \uparrow$



Shunt DC Generators



$E_a = K_a \phi \omega_m$, $\tau = K_a \phi I_a$ } $P_a = E_a I_a$

$V_t = E_a - I_a R_a$

$I_a = I_f + I_t$

$I_f = \frac{V_t}{R_f}$

control of terminal voltage

1. $E_a = K_a \phi \omega_m$

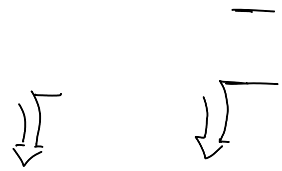
if $\omega_m \uparrow \Rightarrow E_a \uparrow$ and $V_t \uparrow$

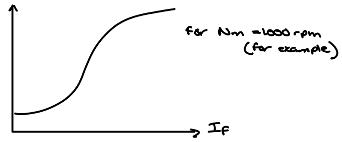
$\Rightarrow i_f \uparrow \therefore \phi \uparrow \Rightarrow E_a \uparrow$ & $V_t \uparrow$

2. A series resistance inserted in the field cct will allow control of I_f and $\therefore \phi \to E_a$

We observe that the relationship between the ϕ (and hence E_a) and I_f is non-linear

The curve is typically re-scaled to give E_a vs I_f at a particular speed.





If the speed of operation is different from the speed given in the Ea v If curve then it will be necessary to scale the value of Ea

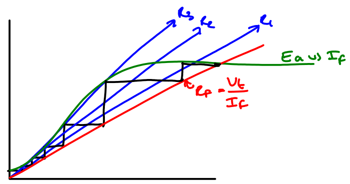
$$\frac{E_a}{E_{ao}} = \frac{N_m}{N_{mo}}$$

If shunt generator fails to build up voltage:

1. There may be zero residual flux.

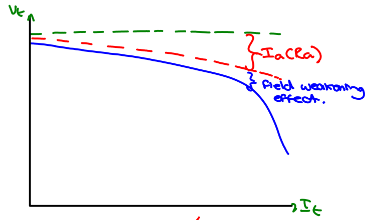
$\Rightarrow \phi = 0 \Rightarrow E_a = 0$

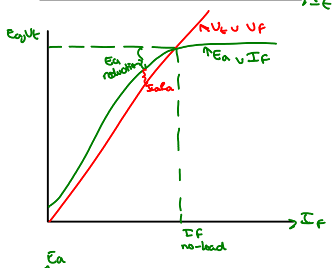
2. The direction of rotation of the generator may have been reversed, or the connection of the field may have been reversed.

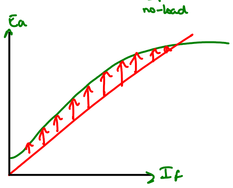


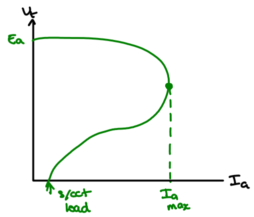
Voltage build-up starting a shunt-generator.

If $R_f > R_3$ (R_3 = critical field resistance) then the voltage will not build up.

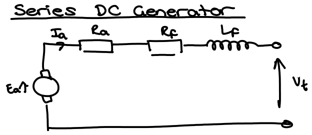








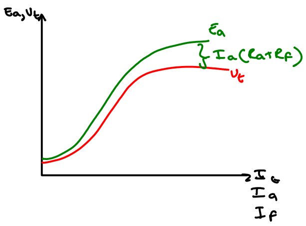
Series DC Generator



$$\left.\begin{aligned} E_a &= K_a \phi \omega_m \\ \tau &= K_a \phi I_a \end{aligned}\right\} P_a = E_a I_a$$

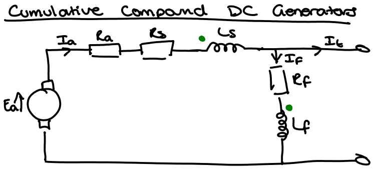
$V_t = E_a - I_a(R_a + R_f)$

$I_a = I_t = I_f$



- seldom used.

Cumulative Compound DC Generators



$$E_a = K_a \phi \omega_m, \quad \tau = K_a \phi I_a \quad \Big\} \; P_a = E_a I_a$$

$$K\phi = \frac{E_a}{\omega_m}$$

$$\tau = \frac{E_a I_a}{\omega_m}$$

$$I_a = I_t + I_f$$

$$V_t = E_a - I_a(R_a + R_s)$$

$$I_f = \frac{V_t}{R_f}$$

$$\mathcal{F}_{net} = N_f I_f + N_s I_a$$

$$\Rightarrow I_f^* = I_f + \frac{N_s}{N_f} I_a$$