Effect of Voltage and Frequency on Active Power

Introduction

- The complex load power is given by

$$S = P + jQ$$

$$= VI$$

$$= Y|V|^2$$ Where Y is admittance of load

$$S = |V|^2 Y$$

$$= |V|^2 / (R - jX)$$

$$= |V|^2 (R + jX) / (R - jX)(R + jX)$$

$$= [\, |V|^2 R / (R^2 + X^2) \,] + j\, [\, |V|^2 X / (R^2 + X^2) \,]$$

$$= P + jQ$$

Therefore

$$P = [\,|V|^2\; R / (R^2 + X^2)\,]$$

$$Q = [\,|V|^2\; X / (R^2 + X^2)\,]$$

- ***Therefore we can say that the active power and reactive power is directly proportional to square of the supply voltage.***

Change in Supply Voltage

$$P = [\,|V|^2\ R / (R^2 + X^2)\,]$$

$$dP / dV = [\ 2\,|V|\,R / (R^2 + X^2)\,]$$

(dP / dV) / P

$$= [\ 2\,|V|\,R / (R^2 + X^2)\,] / [\,|V|^2\ R / (R^2 + X^2)\,]$$

$$= [\ 2\,|V|\,R / (R^2 + X^2)\,] / [\,|V|^2\ R / (R^2 + X^2)\,]$$

$$= 2 / |V|$$

Therefore

$$dP / P = 2\, d|V| / |V|$$

- ***We can say that change in voltage directly affect the change in real power of the load. If there is 10% change in supply voltage, 20% change in the real power of the load.***

Change in Supply Frequency

The change in active power with respect to supply frequency

$$P = [\, |V|^2 \, R / (R^2 + X_L^{\,2})\,]$$

Inductive reactance $X_L = 2\pi f L$

$$P = [\, |V|^2 \, R / (R^2 + (2\pi f L)^2\,]$$

$$dP / df =$$

$$[(R^2 + (2\pi fL)^2][0] – [| V |^2 R][0 + 2(2\pi fL)(2\pi L)] / [(R^2 + (2\pi fL)^2]^2$$

$$[dP / df] / P =$$

$$– [| V |^2 R][2(2\pi fL)(2\pi L)][(R^2 + X_L^2)] / [| V |^2 R] [(R^2 + (2\pi fL)^2]^2$$

$$[dP / P] = – 2 X_L^2 / [(R^2 + X_L^2)] [df / f]$$

Where $\text{Sin}^2 \Phi = X_L^2 / [(R^2 + X_L^2)]$

If the load power factor $\cos \Phi = 0.6$, $\sin \Phi = 0.8$

$$[dP / P] = \{ -2 \sin^2 \Phi [df / f] \}$$

$$= \{ -1.28 [df / f] \}$$

It means that if there is 10% percentage drop in frequency, there will – 12.8 active power decreases.

Thank You
www.myelectrical2015.com