Experiment No.

Aim: - To measure three phase power and power factor in a balanced three phase circuit using two single-phase wattmeter. Calculate the three phase power for unbalance load condition.

Apparatus: -

1. Three Phase Load.
2. A.C Wattmeter - 2 nos.
3. A.C Voltmeter.
4. A.C ammeters.
5. Three Phase supply
6. Connecting Wires.

Theory: - Single phase power can be measured using single wattmeter, But for measurement of 3 phase power can be done using following methods:

1. One wattmeter method.
2. Two wattmeter method.
3. Three wattmeter method.

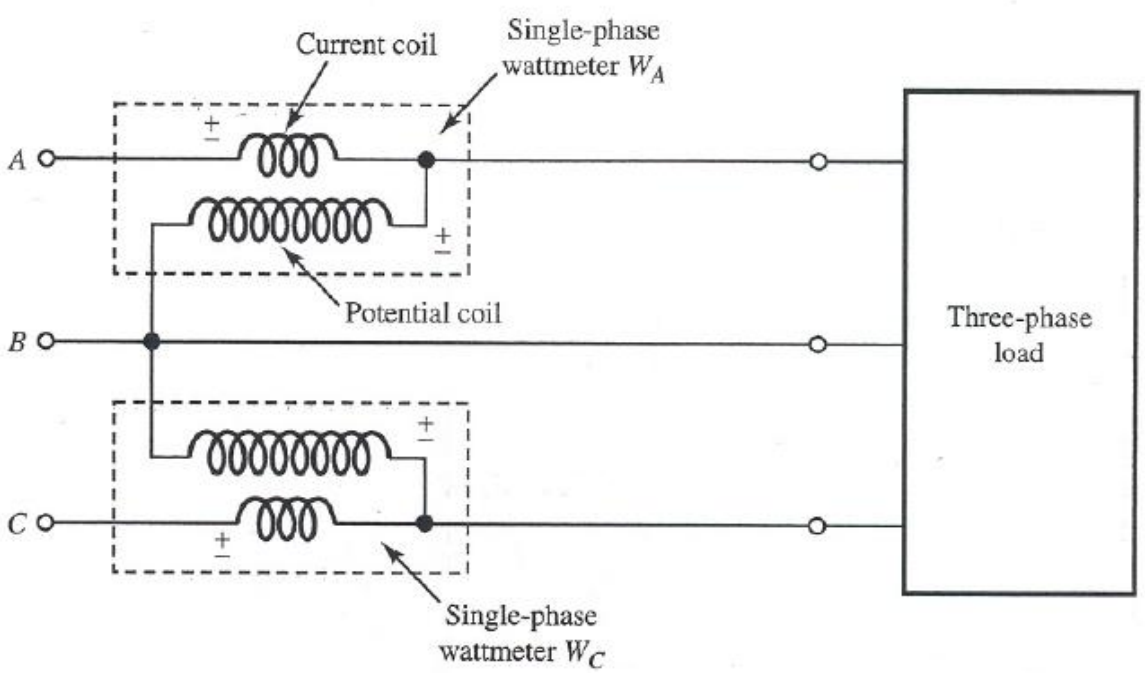

Figure 1 Connection diagram for two-wattmeter method of measuring three phase power

Two wattmeter method

This method is commonly used for the power measurement in the 3 phase circuits. Here as name suggests, only two wattmeters are used. The current coils of the two wattmeters are connected in series on any two lines. The corresponding pressure coils are connected between these lines and the third line on which no wattmeter is connected.

The two wattmeter method is used for the power measurement in the 3-phase systems, irrespective of whether the load is balanced or unbalanced, star or delta connected.

$\text{Total Power} = W_1 + W_2$

$\text{As it is a balance condition}, V_a = V_b = V_c = \text{phase voltage}$

$\text{Three Phase power} = 3V_{ph}I_{ph}\cos\Phi$

$\text{As it is a balance condition}, V_a = V_b = V_c = \text{phase voltage}$

$I_a = I_b = I_c = \text{phase current}$

For resistive load cos ϕ = 1.

$\text{So, Three phase power} = 3V_{ph}I_{ph}$

$W_1 = V_{AB}I_A\cos(30-\Phi) = \sqrt{3}V_{ph}I_{ph}\cos(30-\Phi)$

$W_2 = V_{BC}I_C\cos(30+\Phi) = \sqrt{3}V_{ph}I_{ph}\cos(30+\Phi)$

$W_1 + W_2 = \sqrt{3}V_{ph}I_{ph}[2\cos30^0\cos\Phi] = 3V_{ph}I_{ph}\cos\Phi = \sqrt{3}V_L I_L\cos\Phi$

The above equation shows that the sum of the two wattmeter readings gives the total power consumed in the three-phase balanced system. We can also calculate the load power factor angle from the measurement of W_1 and W_2.

$$\frac{W_1}{W_2} = \frac{\cos(30-\Phi)}{\cos(30+\Phi)}$$

$$\frac{W_1 - W_2}{W_1 + W_2} = \frac{\cos(30-\Phi) - \cos(30+\Phi)}{\cos(30-\Phi) + \cos(30+\Phi)} = \frac{2\sin30\sin\Phi}{2\cos30\cos\Phi} = \tan30\tan\Phi$$

$$\tan\Phi = \sqrt{3}\frac{W_1 - W_2}{W_1 + W_2}$$

For Unbalance Load Condition:

$\text{Measured power} = W_1 + W_2$

$$\text{Calculated power} = V_a I_a + V_b I_b + V_c I_c$$

$$\%\ \text{Error} = \frac{\text{Calculated power} - \text{Measured power}}{\text{Calculated power}} \times 100$$

Procedure:-

1. Make the connections as per the circuit diagram.
2. Switch on A.C supply.
3. For balanced load condition measured the values of wattmeters, ammeters and Voltmeter.
4. Repeat the same process for unbalance load condition.
5. Switch off all the loads and supply.

Circuit Diagram:-

Observation Table:-

	V_R	V_Y	V_B	I_R	I_Y	I_B	W_1	W_2	Total Power = W_1+W_2
Balanced load									
Unbalanced load									

Calculations:-

Conclusion:-