Power factor pdf download

Power factor is a term related to energy efficiency. We will talk about the power factor of a machine or a circuit if it is an AC circuit. Since power factor is related to energy efficiency, it is always desirable to have a maximum power factor. The value of power factor ranges from 0 to 1. To understand what exactly the power factor is, we should first have a clear idea about true power, apparent power and reactive power. Then we will see what the power factor is and its significance. What is Power Factor and Phase Angle? In an ac circuit, we use different types of electronic components like capacitors, inductors and resistors. Phase angle is defined as the angle between the voltage and current in a phasor diagram. Phasors are rotating vectors used to represent voltage and current in an ac circuit. The voltage and current phasor rotates with an angular velocity equal to the angular frequency of the ac circuit. The phase angle can also be defined as the phase difference between the voltage and current wave of an ac circuit. Let v(t) be the source voltage of an ac circuit represented by the equation given by,v(t) = v0sin(ωt)   Where, v0 - Maximum voltage of the source voltage   ω - Angular frequency of the source voltage   Let i(t) be the source voltage of an ac circuit represented by the equation given by,i(t) = i0sin(wt+Φ)   v0 - Maximum voltage of the source voltageω - Angular frequency of the source voltageThen the phase angle of the ac circuit is given by the angle Φ.The power factor of an ac circuit is defined as the cosine of the angle between the voltage and the current phasors. Therefore, to calculate the power factor of an ac circuit, we have to take the cosine of the phase angle. So, we can calculate the power factor of the ac circuit given by the formula, ⇒power factor= cos(Φ)The maximum cosine value is 1. Therefore, the value of the power factor varies from 0 to 1.The phase angle of an ac circuit can be calculated if we know the power factor of the ac circuit using the formula,⇒ Φ = cos-1(power factor)Power Factor of Pure Resistive LoadConsider an ac voltage source connected to a pure resistive load. Then if we draw the phasor diagram of the ac circuit of pure resistive load, then the angle between the voltage and current phasor is 0°. Therefore, we can say that the voltage and current in an ac circuit of pure resistive load is in the same phase. (Image will be Uploaded Soon)The source voltage and the current passing through the ac circuit can be represented as follows:v(t) = v0sin(ωt) i(t) = i0sin(wt) As you can see, the value of phase angle (Φ) is 0. The formula to calculate the power factor is given by,⇒power factor = pf = cos(Φ)Substitute the value of phase angle for pure resistive load in a circuit to obtain the power factor.⇒power factor = cos(Φ)⇒power factor = cos(0)⇒power factor = 1So, the power factor of a pure resistive ac circuit is 1.Power Factor of Pure Inductive LoadConsider an ac voltage source connected to a pure inductive load. In the phasor diagram, the angle between the voltage and current phasor is 90°. The current in an ac circuit of pure inductive load is lagging behind the voltage by an angle of 90°. In terms of radian, 90° corresponds to π/2 radian.(Image will be Uploaded Soon)The source voltage and the current passing through the ac circuit can be represented as follows: v(t) = v0sin(ωt) i(t) = i0sin(wt-π/2)Therefore, the value of phase angle in a pure inductive load is 2 rad. Now. we can calculate the power factor of the pure inductive ac circuit using the formula for power factor as follows:⇒power factor = pf = cos(Φ)⇒power factor = cos(π/2)⇒power factor = 0Therefore, the power factor of an ac circuit having pure inductive load is 0. Ideal pure inductive load is not possible in the real case.Power Factor of Pure Capacitive LoadConsider an ac voltage source connected to a pure capacitive load. The phase diagram of the ac circuit of pure capacitive load shows that the angle between the voltage and current phasor is 0°. But the current in the ac circuit of pure capacitive load is leading the voltage by an angle of 90° or π/2 radian.(Image will be Uploaded Soon)The source voltage and the current passing through the ac circuit of pure resistive can be represented as follows:v(t) = v0sin(ωt) i(t) = i0sin(wt+π/2)Therefore, the value of phase angle in a pure capacitive load is π/2 rad. We can calculate the power factor of the pure capacitive ac circuit using the formula for power factor as follows:⇒power factor = pf = cos(Φ)⇒power factor = cos(π/2)⇒power factor = 0Therefore, the power factor of an ac circuit having pure capacitive load is 0. The pure capacitive load is possible only in ideal cases.Power Factor in Terms of True Power and Apparent PowerWe have already seen how power factor is defined in terms of phase angle. Another way of defining power factor is using true power and apparent power. For that, we have to know what true power and apparent power of an ac circuit are. True power of an ac circuit is the power dissipated in the load of the ac circuit. It is denoted by the letter P. The unit of true power is watt (W). The true power is also called active power or real power. The true power is the power really transferred and dissipated in the load. The formula to calculate the true power is given⇒True power = P = VIcos(Φ)Where, P- true power of the ac circuit V - source voltage of the ac circuit I - current drawn from the ac sourcecos(Φ) - power factor of the ac circuit.The value of true power is maximum when the power factor of the circuit is maximum. That is, true power is maximum when the power factor of the ac circuit is 1.Apparent power is the product of total rms current and rms voltage neglecting the phase angle. The apparent power is expressed as kilovolt ampere (kVA) and the SI unit is VA. The apparent power is also called demand. Apparent power is the amount of power required to run a machinery or equipment. But this amount of power given by the source is not completely used for useful work. Only a part of power is used for useful work called true power which we already discussed earlier. The apparent power is denoted by the letter S .The formula to calculate apparent power of a circuit is given by,⇒Apparent power = S = VIS - Apparent power of the ac circuit. V - source voltage of the ac circuit. I - current drawn from the ac source.The power factor of an ac circuit can be defined as the ratio of true power to the apparent power. The true power can always be less than or equal to the apparent power. If the power factor of an electrical system is more , then the efficiency is considered greater. A circuit will be 100% efficient if the true power and apparent power of the circuit are equal. For such a circuit, the power factor is unity. The formula to calculate power factor in terms of true power and apparent power is given by,⇒power factor = P/SWhere,P - True power dissipated in the load S - Apparent power supplied by the source. What is Power Factor Correction?We have seen what power factor is and why it is important .Power factor correct is a technique used to increase the power factor of a circuit using various methods. The most commonly used power factor methods are passive power factor correction and active power factor correction.The passive power factor correction methods are used for ac circuits having small power supplies around 100 W. A low pass harmonic filter at the AC input with the capacitor and inductor forming a series resonance circuit is used in this power factor correction method. The passive power factor correction method is a less expensive and efficient power factor correction method. For low power requirements , passive power factor correction is highly reliable.The active power factor method is costlier than the passive power factor correction. But the active power factor correction is efficient compared to the latter method. This active power factor correction method can attain the power factor around 0.95. But it needs several components which makes it complex compared to the passive power factor correction method. It can work over a wide range of voltage which makes it more reliable for high power circuits. The active power factor correction method uses components which are small and light and make use of a control circuit to make the voltage and current in phase. ConclusionThe power factor of an ac circuit can be defined as the ratio of true power to the apparent power. A circuit having high power factor is considered highly efficient compared to a circuit having low power factor. The value of power factor ranges from 0 to 1. For a pure resistive load, the value of power factor is 1. When the load becomes more and more inductive or capacitive, the power factor of the circuit decreases. There are different methods used to increase the power factor of the circuit and make the circuit more efficient. These methods are called power factor correction methods. A circuit will be 100% efficient if the true power and apparent power of the circuit are equal. For such a circuit, the power factor is unity.

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