Electric Energy and Electric Power

Energi Listrik dan Daya Listrik

1. Electric Energy

 Energi listrik

Electric current caused by the current of electric charges can produce the energy which is useful for human. In this case, the energy produced from the current of electric charges in a certain closed electric circuit is called electric energy. Electric energy can be determined by the equation as follow.

Arus listrik yang disebabkan oleh aliran muatan-muatan listrik dapat menghasilkan energi yang bermanfaat bagi manusia. Dalam hal ini, energi yang dihasilkan dari aliran muatan listrik dalam suatu rangkaian listrik tertutup disebut dengan energi listrik. Energi listrik dapat ditentukan dengan persamaan sebagai berikut.

W = Q V (electric energy equal electric charges multiplied by potential difference)

Where

Dengan

W = electric energy (joule)

 energi listrik (joule)

Q = electric charges (c)

 muatan listrik (c)

V = potential difference or voltage (volt)

 beda potensial atau tegangan (volt)

Because Q = I . t and V = I R, then

Karena Q = I . t dan V = I R, maka

W = V I . t (electric energy equal potential difference multiplied by current multiplied by time)

W = $I^{2}$ R t (electric energy equal electric current squared multiplied by resistance multiplied by time)

W = $\frac{V^{2}}{R}$ t (electric energy equal potential difference squared multiplied by time divided by resistance)

Where

Dengan

I = electric current (A)

 arus listrik (A)

R = electric resistance (Ω)

 hambatan listrik (Ω)

t = time (s)

 waktu (s)

2. Electric Power

 Daya Listrik

The amount of electric energy used by a certain electric device per unit of time is called electric power, which can be determined by the equation as follow.

Besarnya energy listrik yang digunakan oleh suatu peralatan listrik tiap satuan waktu disebut daya listrik, yang dapat ditentukan dengan persamaan sebagai berikut.

P = $\frac{W}{t}$ (electric power equal electric energy divide by time)

Where

Dengan

P = electric power (watt)

 daya listrik (watt)

Based on the electric energy equation, then the electric power also can be determined by equation as follow.

Berdasarkan persamaan energy listrik, maka daya listrik juga dapat ditentukan dengan persamaan sebagai berikut.

P = VI = I2R = $\frac{V^{2}}{R}$ (electric power is potential difference multiplied by current equal electric current squared multiplied by resistance equal potential difference squared multiplied by time divided by resistance)

In everyday life, we often find an electric device that has specification of a certain power, such as on lamp printed 25 W (twenty five Watt), 220 V(two hundred twenty Volt), it means the electric power used by the lamp is 25 W (twenty five Watt) if the lamp is set at the voltage of 220 V (two hundred twenty Volt) . But if the lamp is set on the voltage which smaller than the specification of the lamp, then power which is used the lamp also smaller then power printed on the lamp and complies the following equation.

Dalam kehidupan sehari-hari kita sering menemukan suatu peralatan listrik yang mempunyai spesifikasi daya tertentu, seperti pada lampu tertera 25 W, 220 V, ini berarti daya listrik yang digunakan oleh lampu adalah 25 W jika lampu dipasang pada tegangan 220 V. Tetapi jiak lampu dipasang pada tegangan yang lebih kecil dari spesifikasi lampu, maka daya yang digunakan lampu juga lebih kecil dari daya yang tertera pada lampu dan memenuhi persamaan berikut ini.

$P\_{2}$ = $\left(\frac{V\_{2}}{V\_{1}}\right)$ x $P\_{1}$(power used by the device equal voltage used divided by specification voltage of the device multiplied by specification power of the device)

Where

Dengan

$P\_{2}$ = power used by the device (W)

 = daya yang digunakan oleh alat (W)

$P\_{1}$ = specification power of the device (W)

 = daya spesifikasi alat (W)

$V\_{2}$ = voltage used (V)

 = tegangan yang digunakan (V)

$V\_{1}$ = specification voltage of the device (V)

 = tegangan spesifikasi alat (V)

Based on the case above, then to make a certain electric instrument we must determine the resistance using the following equation.

Berdasarkan hal diatas, maka untuk membuat suatu peralatan listrik kita harus menentukan hambatannya dengan menggunakan persamaan berikut ini.

R = $\frac{V^{2}}{P}$ (resistance equal voltage squared divided by power

Where

Dengan

R = resistance of the device ($Ω$)

 = hambatan alat ($Ω$)

V = specification voltage of the device (V)

 = tegangan specifikasi alat (V)

P = specification power of the device (W)

 = daya spesifikasi alat (W)

3. The Relation of Energy and Power Units

Hubungan Satuan Energi dan Daya

In SI unit system, electric power is expressed in Watt, while electric energy is expressed in Joule, so that from the relation of power and energy of electric (W = P . t or P = $\frac{w}{T}$ ) is obtained the relation of electric power and energy units as follow.

Dalam system satuan SI daya listrik dinyatakan dalam Watt, sedangkan energy listrik dinyatakan dalam Joule, sehingga dari hubungan daya dan energy listrik (W = P . t or P = $\frac{w}{T}$ ) diperoleh hubungan satuan daya dan energy listrik sebagai berikut.

1 W = 1 $\frac{J}{s}$

4. The Equivalence of Heat with Electric Energy

Kesetaraan Kalor dengan Energy Listrik

In electric heaters occur the process of change from electric energy into heat, and in this case, the equivalence of electric energy with heat can be expressed by the equation as follow.

Pada pemanas listrik terjadi proses perubahan dari energy listrik menjadi kalor, dan dalam hal ini, kesetaraan energy listrik dengan kalor dapat dinyatakan dengan persamaan sebagai berikut.

W = Q (electric energy equal electric charges)

P t = m c $Δ$T (electric power multiplied by time equal mass multiplied by specific heat of substance multiplied by temperature change of substance)

V I t = m c $Δ$T (voltage multiplied by electric current multiplied by time equal mass multiplied by specific heat of substance multiplied by temperature change of substance)

$I^{2}$ R t = m c $Δ$T (electric current squared multiplied by resistance multiplied by time equal mass multiplied by specific heat of substance multiplied by temperature change of substance)

$\frac{V^{2}}{R}$ t = m c $ΔT$ (potential difference squared multiplied by time divided by resistance equal mass multiplied by specific heat of substance multiplied by temperature change of substance)

Where

Dengan

m = mass of substance (Kg)

 = massa zat (Kg)

c = specific heat of substance (J/Kg0C)

 kalor jenis zat (J/Kg0C)

ΔT = temperature change of substance (0C)

 = perubahan suhu zat (0C)

Q = heat (joule)

 = kalor (joule)

The five equations above are the ideal equation for electric heaters (efficiency of devices = 100%), but actually the electric heaters are almost impossible to have efficiency of 100%, therefore in this state holds the equation as follow.

Lima buah persamaan di atas merupakan persamaan ideal untuk pemanas listrik (efisien alat = 100%), tetapi sebenarnya pemanas listrik hamper tidak mungkin mempunyai efisiensi 100%, sehingga dalam keadaan ini berlaku persamaan sebagai berikut.

W = $η$ Q

Where

Dengan

$η$ = efficiency of devices (%)

 = efisiensi alat (%)

Sample Problem

An electric heater has the resistance of 5k$Ω$(five ohm), passed current of 2 A (two ampere) in 2 (two) hours. Calculate the electric energy which is used by the heater in the kWh!

Sebuah pemanas listrik mempunyai hambatan 5k$Ω$, dilalui arus 2 A selama 2 jam. Hitunglah energy listrik yang digunakan oleh pemanas tersebut dalam kWh!

Solution

Penyelesaian

W = $I^{2}$ R t

Because I = 2 A, R = 5 k$Ω$ = 5000 (five thousand) $Ω$, and t = 2 hours = 7200 s, then

Karena I = 2 A, R = 5 k$Ω$ = 5000 $Ω$, dan t = 2 jam = 7200 (seven thousand two hundred) s, maka

W = $I^{2}$ R t

 = (2 A)2 (5000 $Ω$) (7200 s)

 = 144.000.000 J

 = $\frac{144000000}{3600000}$ kWh

 = 40 kWh