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EMF, CURRENT, VOLTAGE, RESISTANCE -

Let's start with the analysis of the simplest electrical circuit. Source of electricity, Connecting wires and Loads!

You ask, what is strange here? I agree with you one hundred percent, *but first try to solve the problem* :

Task : It is necessary to calculate the EMF [**E =?**] of a single-phase generator, with a connected load of power: **Pz = 1 kW** (*heating element*, *active load*); frequency in the circuit: **f = 50Hz** ; voltage at the generator terminals; **U= 220V** , active resistance of the generator phase: **r = 5 Ohm** . The resistance of the connecting wires does not need to be taken into account.

You have all the data for the decision, I'm just sure that many will make a blunder. (*if you have an answer, you can provide it in the form of a solution in the corresponding topic of* the EMF in CURRENT forum - Over Unity Ukraine (do.am))

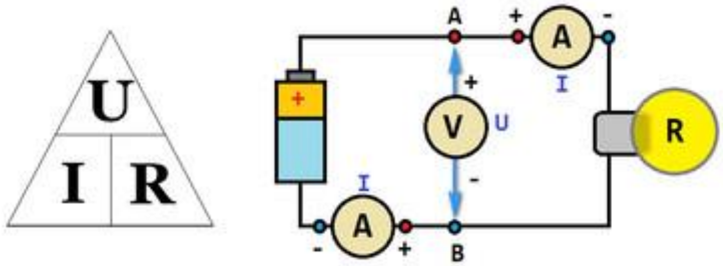
Let's start with such a phenomenon in a direct current electrical circuit as, **Voltage drop [*U*]** is a gradual decrease in voltage along a conductor through which an electric current *flows* , due to the fact that the conductor has an active resistance. The voltage drop also means the amount by which the potential changes during the transition from one point of the circuit to another. According to Ohm's law, the current ***I*** creates a voltage drop U=IR on a section of a conductor that has an active resistance R, which does not depend on the magnitude of the applied voltage (*this is an interpretation from a physics textbook*)

According to Ohm's Law, Current ***I*** , *which is measured in* ***Amperes*** , is the ratio of Voltage ***U*** (electrical potential difference), *which is measured in* ***Volts*** , to Electrical Resistance ***R*** , *which is measured in* ***Ohms*** **:** ***I*** = ***U*** / ***R.*** We see that the CURRENT is derived from voltage and resistance, that is, the resulting component. CURRENT is the result of some action.

Ohm's law is a statement about the proportionality of the current in a conductor to the applied voltage, which is valid for metals and semiconductors at not too large applied voltages. If Ohm's law is valid for an element of an electric circuit, then this element has a linear current-voltage characteristic.

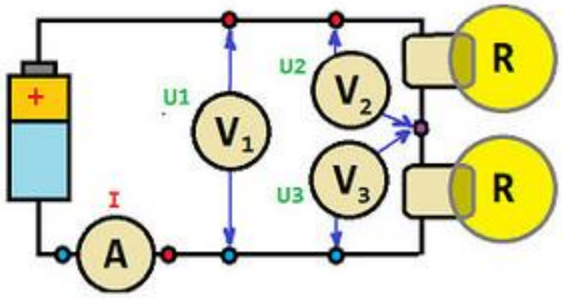
Further, in electrical engineering, it is customary to write Ohm's law in integral form:: $\boldsymbol{U = IR}$, where $\boldsymbol{U}$ is the applied voltage, $\boldsymbol{I}$ is the current, $\boldsymbol{R}$ is the electrical resistance of the conductor.

When analyzing electrical circuits, three equivalent expressions of Ohm's law are used interchangeably: $\boldsymbol{I = U/R}$, or $\boldsymbol{U = IR}$, or $\boldsymbol{R = U/I}$. How to consider this on the diagram:

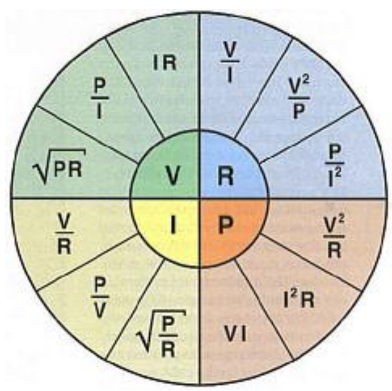


In the diagram, we have a simple circuit with a galvanic source of electric potential difference U, connecting wires and a load with resistance R. To measure Voltage and Current, we have a voltmeter connected to points A, B, and two shunt ammeters, which are included in circuit according to the diagram. Under conditions of full charge of the galvanic source in the circuit, we will have measurements of the voltmeter in Volts, and the ammeter in Amperes. Suppose that the voltmeter indicates a voltage of 4.5V, and the ammeter indicates a current of 0.3A. We can calculate the resistance of the light bulb: $\boldsymbol{R = U/I}$ = 4.5 / 0.3 = 15 Ohm. On the " engineer tips " page, they tell you: how to calculate the voltage drop in an electrical circuit: *"The voltage drop is calculated according to Ohm's law: U=I·R=0.3·15=4.5V. The voltage between points 1(A) and 2(B) of the bulb (see diagram) is 4.5 V. The bulb lights normally if the rated current flows through it or if there is a rated voltage between points 1 and 2 (the rated current and voltage are indicated on the bulb)."* This is so clear, let's turn to one more source: ***Voltage drop*** *— the potential difference between the ends of the section of the electric circuit in which the electric current flows. Denoted mostly by the letter ΔU, measured in volts. The voltage drop is determined by the strength of the current and the properties of the elements of the electric circuit. The voltage drop across the resistor with resistance R is equal to U = IR, where I is the current .*

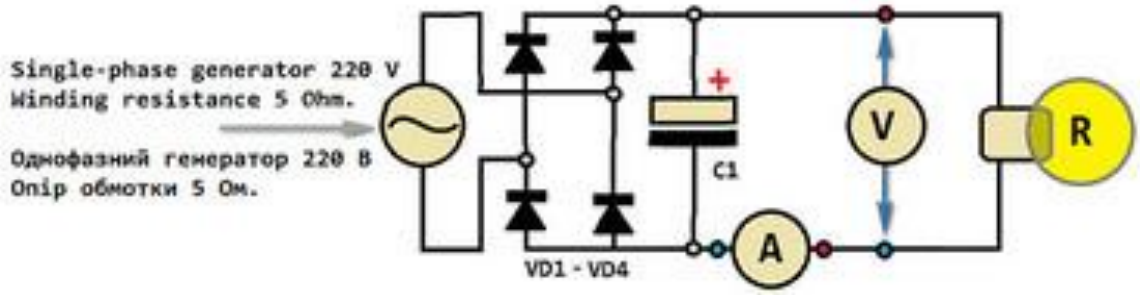
If you are satisfied with this matter and have not been alarmed, I will give you a hint. Everything that we have considered can be applied to the circuit section, or rather to the load. Ohm's law doesn't say anything about voltage drop, only about voltage or applied voltage. If we take and connect to the source not one light bulb, but two, connected in series, and measure each of them (see figure)



Provided that the bulbs have a resistance of 15 ohms and the first voltmeter will show 4.5V, which corresponds to the battery voltage, the other two voltmeters will show 2.25V. The current will have a value of 0.15A. And if our galvanic element consists of two consecutive elements of 2.25V + 2.25V. And if our voltage source will be galvanic 220V, and the alternating voltage will be produced by a suitable convector, then we can solve our problem based on Ohm's Law. We don't have the generator resistance, so we will take the resistance of the charged battery as r = 0.02 Ohm (standard method of electrical circuit calculation).



To begin with, we need to know the current strength for a load of 1 kW at 220V: P = UI from here I = P/U = 1000 W/ 220V = 4.545A. Next, we specify the load resistance R = U/I = 220V / 4.545A = 48.4 Ohm. To find out the emf, we need to use the formula for the current strength for a full circle: I = E / (R+r) where E = I(R+r) = 4.545A*(48.4 Ohm + 0.02 Ohm) = 220, 0689 V. From this we can conclude that E = U. It seems that the task is solved, but we have the source resistance in the task [r] not 0.02 Ohms, but as much as 5 Ohms. Let's take our time, we model a circuit with an alternating generator, the current of which is rectified through a diode bridge, we also plan a capacitor C1 in the circuit, which acts as a storage device for smoothing pulses. As a result, we get a constant voltage of 220V on the load. We do not count the resistance of the capacitor and diodes. The approximate capacity of the capacitor after the diode bridge can be calculated using the formula: C = (3200 * I) / (U*k), where k is the ripple coefficient (1-0.001%).



We calculate with the source resistance element: E = I(R+r) = 4.545A*(48.4 Ω + 5 Ω) = 242.703 V. Let's turn to the academic statements [. Free energy (at.ua)] : [photo57.jpg (2628×1789) (at.ua)]

The voltage at the terminals of the generator is less than the EMF it develops by the amount of the voltage drop in its resistance U = E-(Ir) . Thus, the expression ***U = IR*** also has the meaning of the level of the voltage drop in the section. Let's take to denote the voltage drop ***Ui = Ir*** = 4.545A * 5 Ohm = 22.725V. Then the emf can be expressed through the formula: ***E =U+Ui*** = 220B + 22.725V = 242.703V. As we can see, the formula ***U = IR*** has a double meaning, which we need to understand. You are aware that there are electrical networks with direct current. Let's calculate the short-circuit current of our generator ***I = E/r*** = 242.7 V / 5 Ω = 48.5 A. We check the reverse calculation ***E = Ir*** = 48.5 A * 5 Ω = 242.7 V. What is remarkable is that with a short circuit, the voltmeter will show a value close to zero. You can actually see that the entire electric potential difference has turned into an Amperage. For example, let's take an alternating current generator with excitation from permanent magnets, the voltage of which is rectified and directed to the buffer battery, while the load is connected through an inverter converter to the converter, in our desired case 1 kW. Let's assume that the EMF of the generator phase is 242V, the battery voltage is 220V, we know the phase and load resistances. Builders of wind generators calculate the current strength in the chain of similar structures according to the formula:

Ug-Ua=U / (R+r) = **I** = ***(EU) / (R+r)*** .

For example, take excitation from permanent magnets? Everything is simple, it will be obvious, since in the Dynamo the setting electromagnet of the rotor is subject to adjustment. We have to find out the actual initial state without regulation. Just insert the initial values into the formula used by wind turbine builders:

$$I = (E - U) / (R+r) = (242.7 V - 220 V) / (48.4 \Omega + 5 \Omega) = 0.425 A.$$

As you can see, the current according to the calculation was 0.425 A, which **is** (4.545A / 0.425=) **10.6 times** less than the required value for the operation of our load (TEN 1 kW). Let's try to calculate the required emf in the winding of the generator phase so that the condition of the specified current strength in the circuit for the load is met. Let's calculate the full drop in the level of the electric potential difference, for the corresponding current: (ΔU) Uи = I(R+r) = 4.545 A * (48.4 Ω + 5 Ω) = 242.703 V, this is the total voltage drop for the resistances in the circuit . It remains only to calculate the EMF: E = U + Ui = 220V + 242.703V = 462.703V. Next, we will write down the general equation of the current in the complete circuit and in the section of the circuit with a load:

$$(E - U) / (R+r) = I = U/R$$

where: E - EMF or generator idle voltage (V); U - voltage at the terminals of the generator with a connected load (V); R - load resistance (Ohm); r - active resistance of the winding of the generator phase (Ohm) ..

(462.703 V - 220 V) / (48.4 Ohms + 5 Ohms) = 4.525 A = 220 V / 48.4 Ohms

We solved the problem ***that the EMF*** of the generator phase is equal to ***462.7 Volts,*** and along the way we found out that the current in the circuit is equal to the ratio of the EMF drop level to the total resistance in the circuit.
The formula **I = E / (R + r)** must be understood exactly in this way and it can be written in the form **I = Ui / (R + r)** , which will not lead to a double interpretation.

Operation of a synchronous electric generator.

Currently, synchronous generators are the main source of electricity. Their power ranges from a few kilowatts to hundreds of thousands of kilowatts. Synchronous generators are installed in thermal and hydroelectric power stations, airplanes, ships, they are equipped with various mobile sources of electricity.
The main properties of a synchronous generator are given by the characteristics that determine the relationship between the voltage on the armature clamps, the excitation current, the load current at the rated speed and the constant power factor in steady state.

Designing an electric machine is an ambiguous task, since the number of initial calculation equations describing the electromagnetic connections in it is less than the number of unknown quantities. Therefore, nominal data can be provided for different ratios of the main dimensions and electromagnetic loads of the machine. The optimal result largely depends on the experience of the designer and is usually achieved when comparing several options. As a universal criterion of optimality, the minimum total costs are most often accepted, that is, the cost of materials, manufacturing and operating costs. Operating costs, for their part, depend on efficiency, power factor, quality, maintainability and a number of other factors.

Calculation of nominal parameters. Nominal phase voltage ((in the case of connecting the stator winding in star Y) according to [1] formula 6.1 p. 188))

$$U_{\text{нф}} = \frac{U_{\text{н}}}{\sqrt{3}} = \frac{400}{\sqrt{3}} = 230{,}94$$

Unfortunately, the educational literature does not disclose the relationship between the EMF drop and the current (load) and operating voltage in a closed circuit.

I can already see that the question has arisen, but where is the EMF drop in galvanic current sources?
Electromotive force (EMF) *is a scalar physical quantity that characterizes the operation of extraneous forces acting in direct or alternating current circuits. In a closed conducting circuit, the emf is equal to the work of these forces to move a unit positive charge along the entire circuit. The current source is also characterized by internal resistance, which depends on the conductive qualities of the source itself. The emf and internal resistance of the current source are included in Ohm's law for a closed circuit. Applying this law to an electric circuit with variable external resistance makes it possible to calculate both values.*

For current to flow through an electric circuit, it is necessary that the circuit have elements that move electrical charges, increasing their energy. Forces that perform this function are called external forces. ***By their nature, external forces can be diverse*** *:* ***chemical, as in electric batteries and accumulators*** *, thermoelectric, as in thermocouples, or due to the phenomenon of electromagnetic induction, as in electric current generators. Each power source is characterized by its electromotive force and internal resistance.*

" ***During the passage of the current, there is a continuous decline of charges, more precisely, the neutralization of positive and negative electricity. In order for the field strength E, and with it the density of the electric current j to remain unchanged, some processes are necessary that continuously replenish electric charges.*** "

To maintain the voltage, physicists assume an external emf ($\boldsymbol{E}_{ext}$), that is, the resulting current in the circuit will be the same case that we considered for the generator winding, only it can be written in the form for a load connected to a galvanic source: $\boldsymbol{E} = \boldsymbol{E}_{ext} + \boldsymbol{U}_{Bat}$, where: $\boldsymbol{U}_{Bat}$ - voltage at the terminals of the battery; $\boldsymbol{E}_{ext}$ - action of a chemical reaction to restore the voltage at the battery terminals; $\boldsymbol{E}$ is the total EMF of the battery under the connected load.

An electromagnetic generator and a galvanic element in electrical engineering are sources of voltage and current. The difference is in the principle of action. A galvanic cell produces part of the EMF that is lacking to maintain the electrical voltage at the battery terminals, for this very reason it is called **a Voltage Generator** . An electromagnetic generator initially produces a full EMF, which is later converted into Current by a voltage drop. It is for this reason that it is called a **Current Generator** . In both devices, EMF will turn into CURRENT.

Your Electricity * Over Unity: AMPERE FORCE (rakatskiy.blogspot.com)
Your Electricity * Over Unity: EMF and CURRENT (rakatskiy.blogspot.com)
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