Chapter 5. Energy processes of the Generator

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1. Introduction

In Chapter 3 it was shown that when the generator is functioning, a volatile stationary electromagnetic wave is being generated, and in Chapter 4 it was shown that it exchanges energy with the environment in which it exists – let us call it the first medium. In the region of first medium the temperature falls. In the region of lowered temperature there must exist an inflow of energy from the environment as a more external medium. WE shall call it the second medium. The generator is located in the first medium. Consequently, it must get thermal flow from the second medium. This is exactly the energy that is transformed into kinetic energy of moving magnets.

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2. Energy Transformation in Searl's Generator

In the analysis of generator functioning the following types of energy should be considered:

1. the magnetic energy of permanent magnets W ,
2. the inner energy of permanent magnets U ,
3. the kinetic energy of rotor K ,
4. the energy consumption of the starting engine and the generator load A ,

5. inner energy of the second medium, its alteration Q

and the following energy transformations:

$Q \Rightarrow \Delta U$: the heat transmission from the second medium to the generator,

$\Delta U \Rightarrow \Delta W$: this transformation is confirmed by the fact, that when cooling the permanent magnets have lost some quantity of their inner energy as a result of processes, taking place in the crystal lattice of permanent magnet material; it is exactly the energy that has turned into magnetic energy of permanent magnets;

$W \Rightarrow K$, $W \Rightarrow A$: we must acknowledge the existence of these transformations simply because, as it was shown in Chapter 2, the potential energy of permanent magnets is transformed in certain constructions into kinetic energy of these magnets motion.

So, we have the following chain of energy transformation $Q \Rightarrow \Delta U \Rightarrow \Delta W \Rightarrow K + A$. To simplify the quantitative analysis we shall skip some intermediate transformations and examine straight away the transformation $Q \Rightarrow (K + A)$.

Let us concentrate on the transformation $\Delta U \Rightarrow \Delta W$ and pay attention to some other facts ranking with it from the point of view of the discussed question.. It is appropriate to assume that the permanent magnet in certain situations may serve as a transformer of magnetic energy into inner energy. It becomes quite evident in view of the existence of magnetocaloric effect – MCE. MCE consists in the capacity of any magnetic material to change its temperature under the influence of magnetic field. The maximal MCE effect is observed in ferromagnets. Some materials (for instance, gadolinium) increase their temperature quite significantly. At the present time this effect is used as a base of home refrigerators construction. The evaluations show, that the use of magnetic refrigerators allows to reduce the general energy consumption in USA by 5 %. So we see that the magnetic materials are capable to transform the magnetic energy into inner energy Consequently w may assume that there exists an inverse transformation of the inner energy into magnetic energy, and this is what we wanted to emphasize.

3. Differential Equation of Energy Process

As to the energy of heat exchange, it does not turn into the magnets energy, and so the magnets preserve the same temperature all the time, and this ensures the heat exchange process.

The differential equation of the generator's energy processes will be deduced now on the base of the above said. This equation allows to analyze the generator's behavior under different conditions and to perform some "virtual" experiments.

The differential equation has a following appearance:

$$N + \alpha S(T_o - T) - m_r \cdot v \cdot \frac{dv}{dt} = 0, \qquad (1)$$

where

S – the surface of permanent magnets,

T – absolute temperature of the generator's permanent magnets,

T_o – absolute temperature of the environment,

α - heat-transfer coefficient,

N – power of loading on a axle of a rotor (at $N < 0$ – power the acceleration engine),

m_r – mass of the rotor,

v – the linear speed of the rotor's speed

In chapter 4 it is shown, that in connection with formation of a volatile standing wave the ambient temperature varies under the law of a kind

$$(T_o - T) = K_v \cdot v. \qquad (2)$$

Substituting the equations (2) in (1), we receive:

$$\left\{ N + K_v \alpha S v - m_r \cdot v \cdot \frac{dv}{dt} \right\} = 0. \qquad (3)$$

4. Stable Solution

The stable solution is characterized by the fact that the speed of rotation does not change, and consequently the frequency also remains constant. The temperature changes according to (3.12) also does not change.

5. Supplementary Equation

Let us assume that the following function is known

$$N = f(v). \qquad (1)$$

In the construction of Roschin-Godin and in the constructions presented here an accelerating engine is present. In Chapter 1 it was shown that the static characteristic of electrical machine (DCEM) has the following form:

$$N = P_t\left(1 - \frac{v}{v_o}\right). \qquad (2)$$

where P_t, v_o - certain constants determined by the DCEM construction. This static characteristic may be used in our case, because the energy processes are much slower than the transient process in DCEM.

In the construction of Searl and Reed there is no accelerating engine. However, a primary impulse is needed, and then the electrical load power will grow on with the speed growth. Due to this fact, the formula (2) may be used also in these constructions.

Thus, generator is described by the equations (3.3, 5.1).

6. Generalized Equation

From the equations (3.3, 5.1) it follows that

$$\frac{dv}{dt} = \left(N(v) + K_v \alpha S v\right) / \left(m_r v\right). \qquad (1)$$

From the equation (1) at known function $N(v)$ by numerical differentiation a function $v(t)$ may be found, if for $t = 0$ it is known that $v_o = v(0)$. From the known function $v(t)$ the function $T(t)$ may be calculated with the aid of (3.2).

In particular, from (3.3, 5.4) the equation follows

$$\left\{P_t\left(1 - \frac{v}{v_o}\right) + K_v \alpha S v - m_r \cdot v \cdot \frac{dv}{dt}\right\} = 0. \qquad (2)$$

7. The Evaluation of Generator's Characteristics

The formula (6.2) is useful for the evaluation of different constructions with respect to the maximal speed $v_{\max}$, maximal load power $P_{\max}$ and acceleration time $t_{\max}$ – the time that is necessary to the generator for reaching its maximal speed. In the project we show that

$$v_{\max} = P_t \Big/ \left(\frac{P_t}{v_o} - K_v \alpha S \right), \qquad (1)$$

$$P_{\max} = K_v \alpha S v_{\max}, \qquad (2)$$

$$t_{\max} = g m_r, \qquad (3)$$

where g – a constant coefficient of reversible electric machine (5.2). In formula (2) the value $P_{\max}$ is the power introduced by the environment.

On the basis of experimental and rated data in the project it is shown, that

$$P_{\max} = 2000 \cdot S(\text{вт}). \qquad (4)$$

Thus,

- each square meter of the permanent magnets surface draws approximately two kilowatts of power from the environment.
- To increase the generator's power we should work for
    - increasing magnetic induction,
    - increasing the surface area of the permanent magnets,
    - improving the ventilation
- to reduce the acceleration time we should try to use a lightweight design of the rotor

8. Experiments

Fig. 1 shows the results of computer experiments, done in the project with the Roschin-Godin unit. The other parameters are equal to the following values (according to the experiments descriptions in)

$$P_t = 7000\text{вт}, \quad v_o = 15\frac{\text{м}}{\text{сек}}, \quad m_r = 300\text{кг},$$

$$R = 0.5\text{м}, \quad S = 3.6\text{м}^2, \quad \alpha = 250, \quad K_v = 0.25.$$

It is as a result received:

$$P_{max} = 6500\text{вт}, \quad t_{max} = 50\text{сек}, \quad t_o = 2.5\text{сек},$$

$$v_{max} = 29\frac{\text{м}}{\text{сек}}, \quad n_{max} = 553\frac{\text{оборотов}}{\text{мин}}, \quad T_m = 6.5K.$$

Here it is designated:

n_{max} - the maximal number of turns corresponding the maximal linear speed v_{max};

t_o - the moment of time when speed became equal v_o, and power the engine became equal to zero, i.e. reversible electromachine has passed from a mode of the engine in a mode of generation of the electric power.

It is possible to notice the consent with the received experimental results.

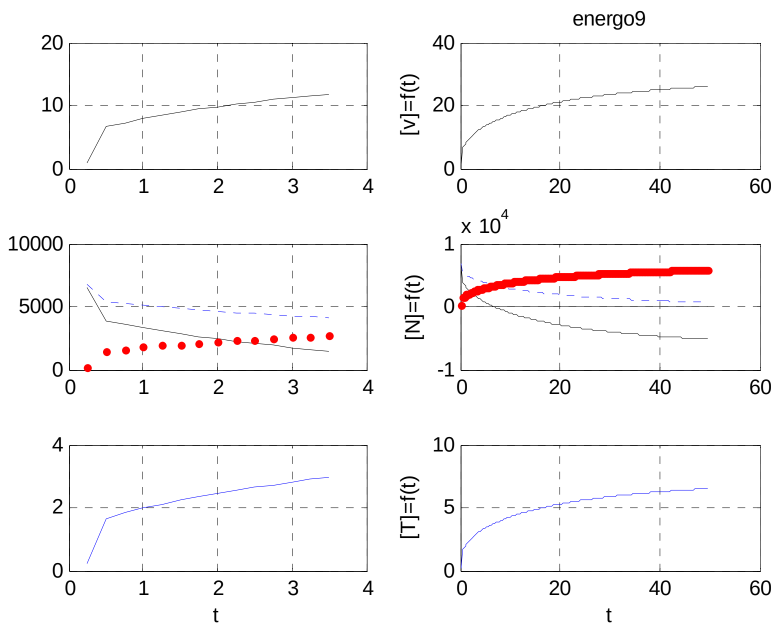

Fig. 1. the notations here are: v – the function found by integrating by (6.4), T – temperature, the function found on (3.12), N – functions of power reversible electromachines (a thin black continuous line), power of an environment (a thick red line), total power (a thin dark blue dotted red line). Right windows show all the time period starting till the maximal speed, and left windows – only its initial part.