T6 Power measurements

**1. Basis**

**Electric component** - the simplest component of the electrical system; it constitutes a standalone constructional whole and shows one characteristic properties in a significant way. Among the many different elements stands out:

- resistive elements, ie conductors and resistors - having the ability to conduct current and convert electric energy into thermal energy; the phenomenon of irretrievable dissipation of electricity is called loss,

- inductive elements, ie coils, chokes, transformers - as a result of the current flowing, they have the ability to accumulate energy in the form of a magnetic field.

- capacitive elements, i.e. capacitors - as a result of the electric charges appearing on the covers have the ability to accumulate energy in the form of an electric field.

**Induction coil -** an electric element made in the form of a coil, the basic parameter of which is inductance. The coils are divided into non-core (air) and with a ferromagnetic core. The properties of coils are most often modeled in the equivalent circuit diagram in the form of an electric double-pole consisting of series L inductances and R resistance connected in series (Fig. 1). L inductance represents the magnetic field created by the coil winding, and the R resistance models the coil loss due to the winding resistance and energy losses in the core.

R

UR

L

ULLL

I

Fig. 1. Inductive coil equivalent circuit

**Choke –** coil with a ferromagnetic core and a single winding, characterized by high and constant inductance as a function of frequency. In the electric circuit it is a large resistance for alternating current (AC), and small for direct current (DC). Chokes are used in electric filters.

**Technical method** - also called the ammeter, voltmeter and wattmeter - it can be implemented in two measuring systems, shown in Fig. 2.



Fig. 2. Systems for measuring parameters of induction coils and capacitors by technical method;

1. a system with correctly measured current, b) a system with correctly measured voltage.

Using one of the systems and measuring the current, voltage and active power with a wattmeter, and using the laws of electrical engineering for sinusoidal AC circuits, the parameters of the tested element are calculated:

- element impedance: ,

- element resistance: ,

- element reactance: 

- element inductance: 

The accuracy of the measurements in Fig. 2 can be influenced by errors in the technical method. A smaller method error determines the selection for measurements of one of them. However, in practice, a system with correctly measured voltage is more often chosen, and this is due to the easy way to calculate for him corrections for the ammeter and wattmeter, and thus - for more accurate results.

If the measuring system is supplied from the network, where the voltage frequency is 50Hz and has a high degree of stability, then frequency measurement is not required. Otherwise, the measuring system should be supplemented with a frequency meter.

1. **Measurement program**

Use a technical method to measure the substitute parameters of the choke - its inductance and resistance. For this purpose:

1. Set up the measuring system in the structure of correctly measured voltage Fig.3.

2. Perform measurements for 4 ... 5 settings of the current flowing through the choke.

Choke

Rys. 3. Measurement circuit

Tab. 1. Measurements of choke no ........substitude parameters (Ich.max = ...... A)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Lp. | Readings | | | | | | | | | | | | | | |
| Current I | | | Voltage U | | | Frequency f | | Power P | | | | | | |
| In A | IA A | ur(I)  % | Un  V | UV  V | ur(U)  % | f  Hz | ur(f)  % | Pn  W | cw W/dz | αw  dz | Pw W | ur(Pw)  % | pw  W | Pc  W |
| 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**continue. Tab. 1.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measurement results** | | | | |
| Z | R | | L | |
| Ω | R ± U(R), p=0,95 Ω | % | L ± U(L) , p=0,95 mH | % |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

In the table: *In, Un, Pn* – used instrument ranges,

; ;  - relative standard uncertainties,

 - correction on wattmeter indication,

 - load (choke) power (correct value),

*Z = UV / IA*– choke impedance.

**3. Metrological analysis**

# Uncertainty of resistance R measurement

From relation ****, indicates formula of total relative uncertainty of resistance measurement

 [%].

In the calculation of the expanded uncertainties at the confidence level p = 0.95, the expansion coefficient k = 2 should be assumed, and then:

[%],

and 

# Uncertainty of inductance L measurement

From formula: , can be determined formula of total relative uncertainty of inductance measurement:

 ,

there:  .

when p=0,95 - k=2, then:

 [%]

.

**The report should contain:**

• list of instruments

• data of the measuring object

• drawing of the measurement circuit

• measuring table and sample calculations of all measured quantities

• graphs showing the variability of the gland parameters as a function of current:   
L = f (I), R = f (I),

• assessment of the measurements made in terms of their accuracy

• assessment of the choke properties (based on the plots made).