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Model of cup gland part 2

Instructions for the laboratory exercise

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Jarosław Guziński, Marcin Morawiec

1. Description

The purpose of the exercise is to prepare the model and perform calculations and their analysis for choke using the Lua scripting language.

A gland with a cup core is shown in Fig. 1.

and)

b)

Fig. 1. Cup gland: a) core drawing, b) view of finished gland

2. Description

The throttle core is an *iron powder core* . Material
the core is made of crushed iron in special milling devices.
Iron particles have a size of 5 to 200 µm. They are covered with insulating material, st
thickness from 0.1 to 3 µm, ensuring galvanic separation. So prepared material

is formed in the press. Powder cores are characterized by high saturation induction (B_{sat} = 0.5-1.9 T), high resistivity (ρ = 1 Ωm) and reduced current losses vortex. The air gap is distributed throughout the core volume. permeability the relative material of μ_r is in the range of 10 to 550. The maximum operating temperature to reach maybe up to 175-200 ° C. exceeding it causes damage to the insulating material and short circuits between iron particles. Powder cores are used in systems high frequency switching converters. Compared to others materials used in such applications are competitively priced and enable reducing the dimensions of the device - fig. 2.

Fig. 2. Comparison of choke dimensions with powder and ferrite cores designed for identical working conditions

The exercise should use powder cores manufactured by HaKRon (*HKR - Elektronischer Gerätebau GmbH*) available at: http://www.hkrweb.de/ [1].

There are 5 types of powder materials available: PA2, PA3, PA6, PB5 and PC3. The diameter of the glands is 60 mm, 80 mm, 100 mm, 120 mm, 150 mm and 175 mm. for each of the cable gland diameters is determined by the manufacturer, the height to be selected choke. Available choke diameters made of various materials are given in tab. 1.

Tab. 1. Diameters of chokes made of various materials offered by HKR [1]

Gland diameter [Mm]	Material			
60	PA2	PA6	PB5	PC3
80	PA2	PA6	PB5	PC3
100	PA2	PA6	PB5	PC3
120	PA2	PA6	PB5	PC3
150	PA2	PA6	-	PC3
175	PA2	PA6	-	PC3

3. Exercise program

Exercise is carried out in two ways:

a. By creating a new project directly in FEMM and carrying out calculations and analysis as in exercise 1.

b. Creating a script in Lua that automatically generates analysis results.

1. Open a new project - a magnetic problem to solve.
2. Define the new ferromagnetic material by entering the characteristics magnetizing BH.
3. Define one coil wound with copper wire. Take current density $4A / mm^2$ and a window fill factor in copper $k_{cu} \leq 0.3$.

4. Select the number of turns and current so as to obtain maximum induction in the core similar to the induction of B_{sat} saturation given in the catalog sheet (called *saturation induction*).
5. In the FEMM program:

   and. draw the choke induction distribution perpendicular to the axis symmetry

   b. read the maximum induction value in the core and determine in which spot occurs,

   c. read the inductance and winding resistance,

   d. check the obtained copper fill factor.
6. Based on the constant A_L given in the core catalog card and the adopted number coils calculate the inductance of the choke. Compare with the value obtained in FEMM program.
7. Analytically calculate the maximum induction in the core and compare with the value obtained in the FEMM program.
   The maximum induction can be calculated from the formula:

$$B_{max} = \frac{L \cdot AND_{max}}{N \cdot AND_e} \qquad (1)$$

   where: L is the choke inductance, I_{max} is the maximum choke current,
   N is the number of turns while A_e is the cross-sectional area of the active core.
   Parameter A_e is given in the catalog card.

4. Literature

1. HKR Elektrotechnischer Gerätebau GmbH: *Finnovation in material and form. Technical date.* Germany, 2008. (http://www.hkrweb.de/ - *Data_book-E.pdf*)
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3. Xiaoguang Zheng, Tomoyuki Ishimine, Shinichiro Yamamoto, Terukazu Tokuoka, Shingo ohashi, Kenji Matsunuma, Hiroyuki Fujikawa and Toshikatsu Hayasaki: *Downsized High-Heat-Dissipation Choke Coil Designed with Powder Cores* . SEI Technical Review, No 75, OCTOBER 2012.
4. Konopiński T., Pac R.: *Transformers and chokes for electronic power devices* . WNT, Warsaw 1979.