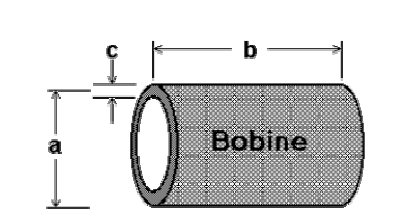
Air Coil Sizing

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# Equations and Parameters

We consider an air coil defined on fig.1

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**figure 1 : air coil schema**

According n to be the turn number, L the self-inductance of the coil, we have:

If δis the root mean square current density in the coil and the cupper resistivity, the Joule losses in the coil can be evaluate by the following formula:

The coil root mean square current can be expressed by:

We can find the magnetic energy stocked in the coil by:

With the cupper density, the mass M of the coil is equal to:

These equations will be used to optimize the design of the coil. The next table summarize the different variables that we use, the unit system and an initial value if needed.

# First step: model check

After having code the model. You must first verify that the model is correct. The following table give the correct set you must find:

|  |  |  |  |
| --- | --- | --- | --- |
| Symbol | Definition | Unit | Value (for test) |
| a | Mean diameter of the coil | m | 0.3 |
| B | Coil Length | m | 0.5 |
| c | Coil thickness | m | 0.01 |
|  | Root mean square current density |  | 1e+6 |
| I | Root mean square Intensity | A | 5 |
| L | Self-Inductance | H | 0.83e-3 |
| M | Mass | kg | 41,5 |
|  | Cupper density |  | 8800 |
| N | Turn number | - | 1000 |
| Pj | Joules Losses | W | 81,2 |
|  | Cupper resistivity |  | 1.724e-8 |
| Wmag | Magnet Energy | J | 0.01 |
| **Table 1** | | | |

# Technical specifications :

The specifications are summarized here under. If you code directly the given set of equations some variables appear naturally as inputs, other as outputs. But you can eventually change the equations and this give other inputs and other outputs.

By example if you code you get as inputs and as output. But if you reformulate the equation as inputs change () as outputs () but mathematically it’s the same equation!

The following tables assume the you have code directly the equations. In this case the first table represent the inputs. The first column represents the name of variable the second and the third the bounds of the input variables. Two variables are fixed ().

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Min value | Max value | Initial value (if needed) |
| a | 0.1 | 0.5 | 0.3 |
| b | 0.1 | 1 | 0.5 |
| c | 0.005 | 0.1 | 0.01 |
|  | 0.1e+6 | 10e+6 | 1e+6 |
|  | Fixed | | 8800 |
| n | 10 | 5000 | 1000 |
|  | Fixed | | 1.724e-8 |
| **Table 2** | | | |

# Second step: optimization

For optimization we need a specification sheet (table 3).

The second table fixed the status of some (decision or design) variables. Naturally written they are output variables. Some are fixed and can be shown as target values (L) some are free (observable variables not constraint) (I, Wmag) and some are constraint by interval (Pj). In our case we want to minimize M (Mass of the coil)

|  |  |  |
| --- | --- | --- |
| Parameter | Type | Value |
| I | Free | - |
| L | Fixed | 1e-3 |
| M | Objective function to minimize | 20 < M < 100 |
| Pj | Constraint by Interval | 70 < Pj < 90 |
| Wmag | Free | - |
| **Table 3** | | |

If the optimization algorithm need a starting point the last column of Table 2 give you one potential starting point.

Remark : depending of your approach and as there is at least one fixed output value of the model, you must sometimes considered to rewrite the mathematical the model to avoid fixed output values or to transform it using Augmented Lagrangian approach.

# Question to answer in the report

* Is the problem nonlinear or linear? Give a proof.
* Where are the difficulties due to the specifications?

# Synthesis of the report

Give a pseudo language document with comments of your method

Study the influence of the starting point (if required in your method)

Study the convergence?

Define your criteria to evaluate your method. Explain your choice.

# Code to give me

Documented code must be given

A file explaining how to use it must also be given.