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Design of an open coil for inductive preheating of wires in production line

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1 Introduction

This project is focused on development of an open coil for induction heating of wires. The original design consisted of a closed coil geometry. Hereby proposed coils have a square, open shape. Their main purpose is a simpler manipulation of the heating machine. If an operator want to move maneuver the device while using the closed coils, he has to disassemble it first. With open coil, the machine can be moved without disassembling, which can save some production time.

2 Original closed coils

The original closed coils are mainly of 2 types: twin-screw and double twin-screw coils. The double twin-screw coil is similar to the ordinary 4-screw coil, but has smaller value of inductance. This type has been used in older machines. The newer machines contain ordinary twin-screw coils.

Figure 1. Double twin-screw coil

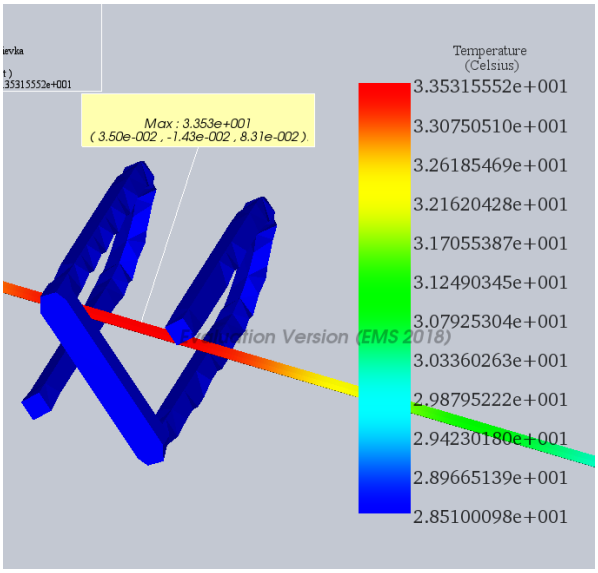

Figure 2. Twin-screw coil (EMS simulation)

3 Initial open coil design

The initial open coil design (Figure 3) has been tested before the project. It came short, because these coils couldn't create a fluctuating magnetic field of sufficient strength. This coil also had very low magnetic inductance.

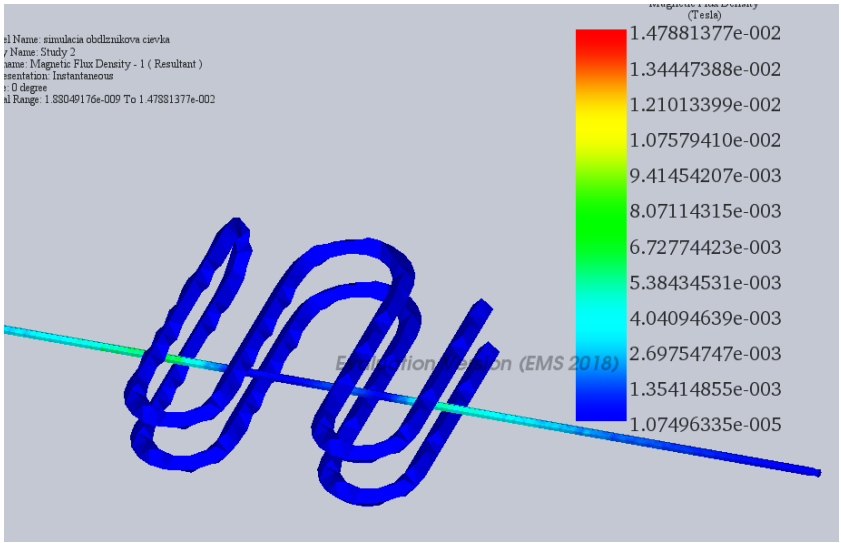

Figure 3. Initial open coil design (EMS simulation)

4 Testing of different types of open coils

Various types of open coils (from external vendors or designed in-house) were simulated and their performance compared. The main goal was to determine the best shape for an open coil. Simulation has been conducted through EMS for Solidworks [1]. Then it was determined that the

coil types ‘U’ and ‘U with middle deployment of wires’ (Figures 4 and 5) are the best solutions among the open coil geometries, in terms of the magnetic field and inductance values.

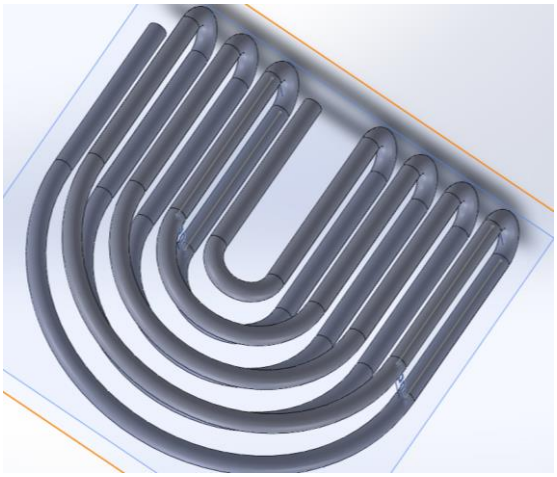

Figure 4. Type U - middle deployment of wires

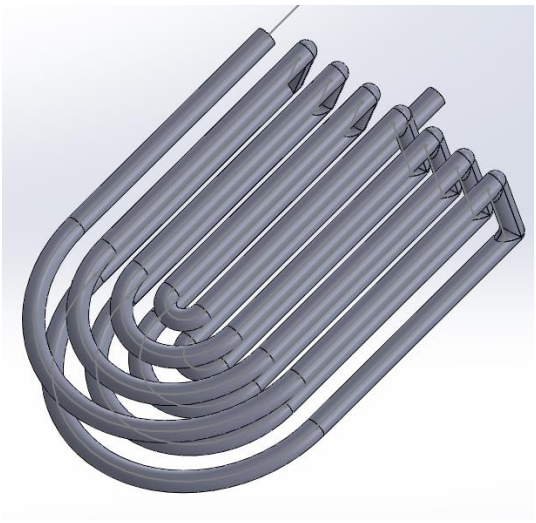

Figure 5. Type U

We also focused on the optimization of the selected coils’ parameters. We changed only one parameter at the time, while keeping rest the same, which allowed us to achieve the most suitable design.

5 Evaluation of software EMS

EMS is a 3D CAD embedded software, suitable for rapid prototyping and simulation. The only difficulty we have experienced has been that the results were strongly dependent on the coil mesh size. However, the results did converge with the sufficient mesh quality (1 mm and smaller). So for objective results comparison, we had to apply same computational conditions in each case, such as the size of solid parts’ mesh elements. All in all, EMS is a great simulation tool.

6 Future work

The coils have undergone the initial testing, but the measurements were not yet successfully completed. The difficulty came from use of off the shelf resonators, which are more suitable for closed coils, and those have a very different value of inductance. The U shaped model of the coil is the final design, which has been sent to the resonators manufacturer, who should create appropriate resonators.

References

[1] "EMS software," [Online]. Available: https://www.emworks.com/product/EMS.