INDUCTION MOTOR EFFICIENCY IMPROVEMENT BY CORE LENGTHENING

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Abstract: This article deals with possibility of induction motor efficiency improvement by the core lengthening. Procedure for turns number choosing according to core length is described here. Impact of core lengthening on a efficiency and loses of actual induction motor is presented due to simulations results

Keywords: induction motor, efficiency

1. INTRODUCTIUON

Induction motors are the most widely used electric machines in industry. It is due to their big reliability and low production costs. Some statistics indicate that motors used in industry consumed about 30 % of all produced electric energy [1]. Therefore, it is logical that demands on induction motors efficiency are increasing. Increasing demands on induction motors efficiency are caused by motors users in effort to save a part of operating expenses and by legislation. Demands on minimal efficiency of motors with output power higher than 750W are prescribed by Commission Regulation no. 640/2009 in European Union [2]. Similarly prescripts exist or being prepared in other countries as well.

Ways to induction motor efficiency improvement can be divided into two main parts – ways that require adjustment or redesign tools used during induction motors manufacturing process (known as the Tooling cost approach) and ways that do not require any tools adjustment (known as the No tooling cost approach). As is obvious, the No tooling cost approach is attractive for motor's manufacturers because of no investment to new tools.

The No tooling cost approaches for induction motors efficiency improvement include [3]:

- Conductivity improvement of rotor cage by copper bars – The copper bars are placed in rotor slots and then the aluminium die cast. As is described in [3], this approach does not produce good results.
- Sheets annealing – The magnetic circuit sheets are annealed after tooling in order to improve their magnetic properties.
- Core lengthening – The magnetic circuit is lengthened in order to reduction of flux density.

This article deals with possibility of induction motor efficiency improvement by the core lengthening.

2. CORE LENGHTENING

Possibility of induction motor efficiency improvement by core lengthening is demonstrated on small induction motor. Characteristics of this motor were measured in the laboratory and its finite element model was created in the Maxwell program. The accuracy of finite element model was verified due to comparison with the laboratory measurement results. Attributes of the original motor are in Table 2.1.

Output power [W]	Torque [Nm]	Speed [rpm]	Efficiency [%]	Core Length [mm]	Number of turns [-]
672.5	2.26	2840	80.24	60	92

Table 2.1: The original motor attributes (from simulation).

If core length is changed, number of turns of one coil has to be changed to in order to mechanical attributes remains unchanged [4]. The suitable number of turns for given core length was determined due to simulations results. ”Map of output power” was created from simulations results for constant torque (Figure 2.1) and from this was chosen number of turns for considered core length in this way output power remains unchanged. It is possible to create “map of efficiency” too (Figure 2.2). In this picture, impact of core length and number of turns on efficiency of the considered induction motor can be observed.

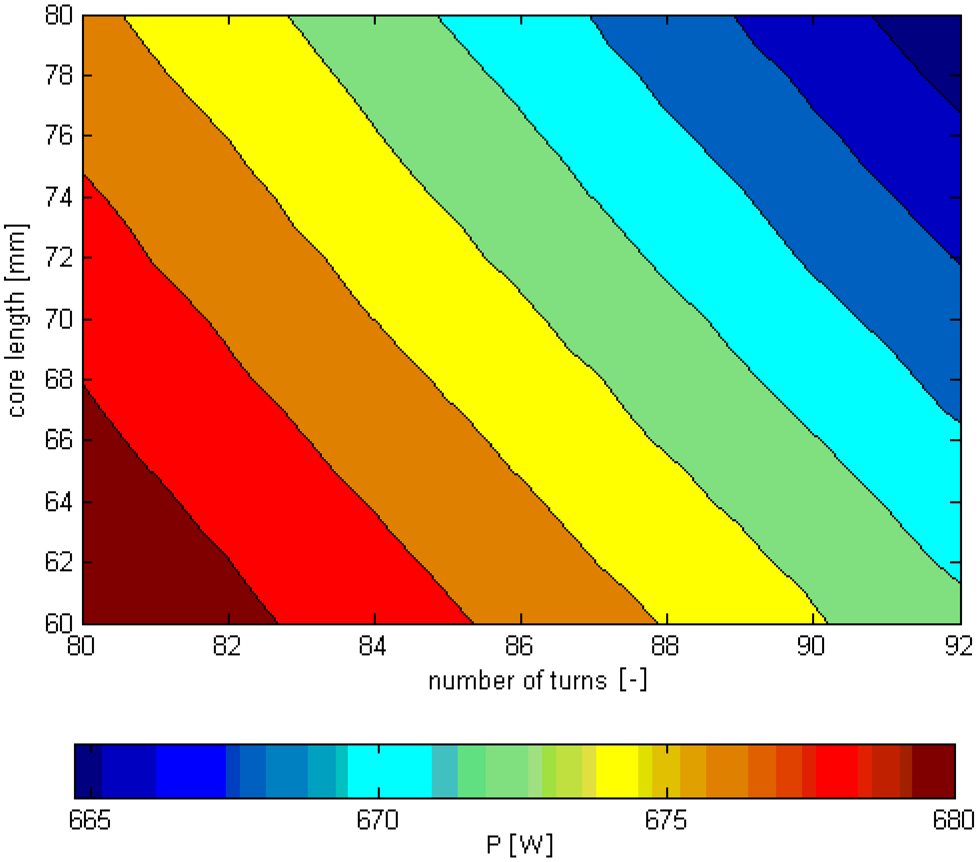

Figure 2.1: Dependence of output power on core length and number of turns.

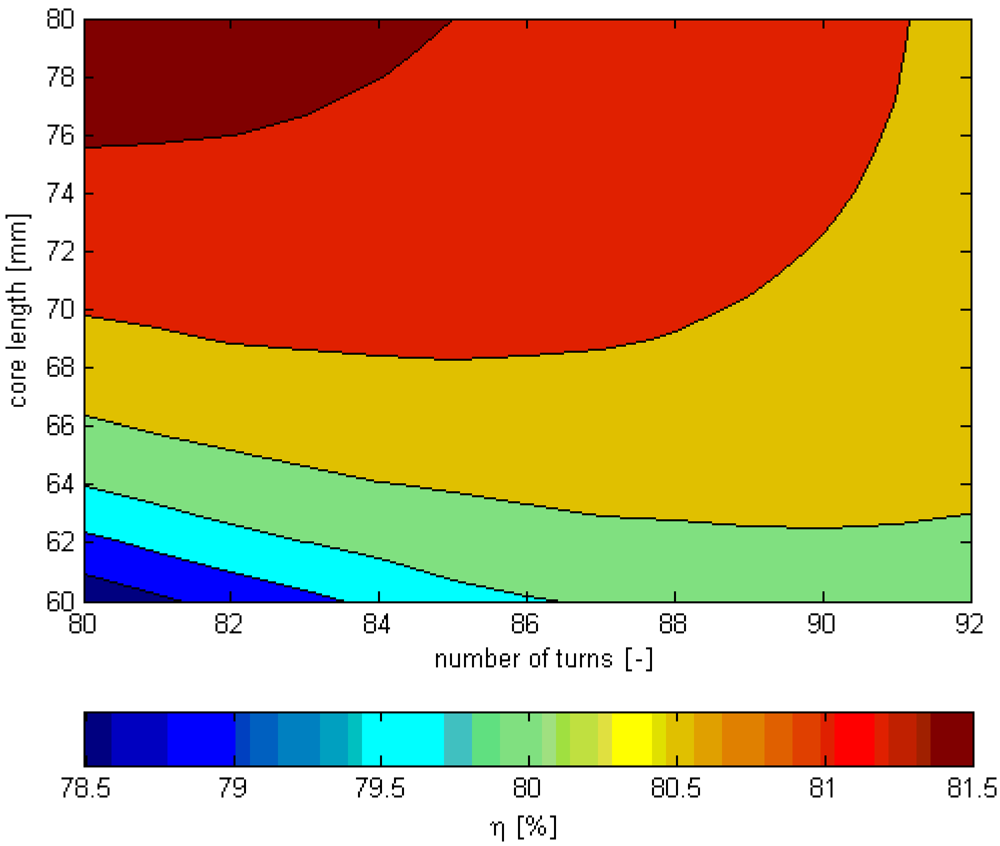

Figure 2.2: Dependence of efficiency on core length and number of turns.

It was considered core length as follow: 65 mm, 70 mm, 75 mm and 80 mm. Numbers of turns were chosen according to Figure 2.1. Simulations results for considered core length are in Table 2.2. Torque characteristic and efficiency for considered core length in working area are shown in Figure 2.3 and Figure 2.4.

Core Length [mm]	Number of turns [-]	Output power [W]	Torque [Nm]	Speed [rpm]	Efficiency [%]	Joules loses in stator [W]	Joules loses in rotor [W]	Iron core losses [W]
60	92	672.5	2.26	2840	80.24	63.1	38.8	36.6
65	90	672.4	2.26	2840	80.69	59.6	38.9	35.3
70	88	672.5	2.26	2840	81.03	57.0	38.9	34.4
75	86	672.6	2.26	2840	81.31	55.0	38.8	33.7
80	85	672.2	2.26	2837	81.50	53.6	39.5	32.4

Table 2.2: Simulations results for considered core length.

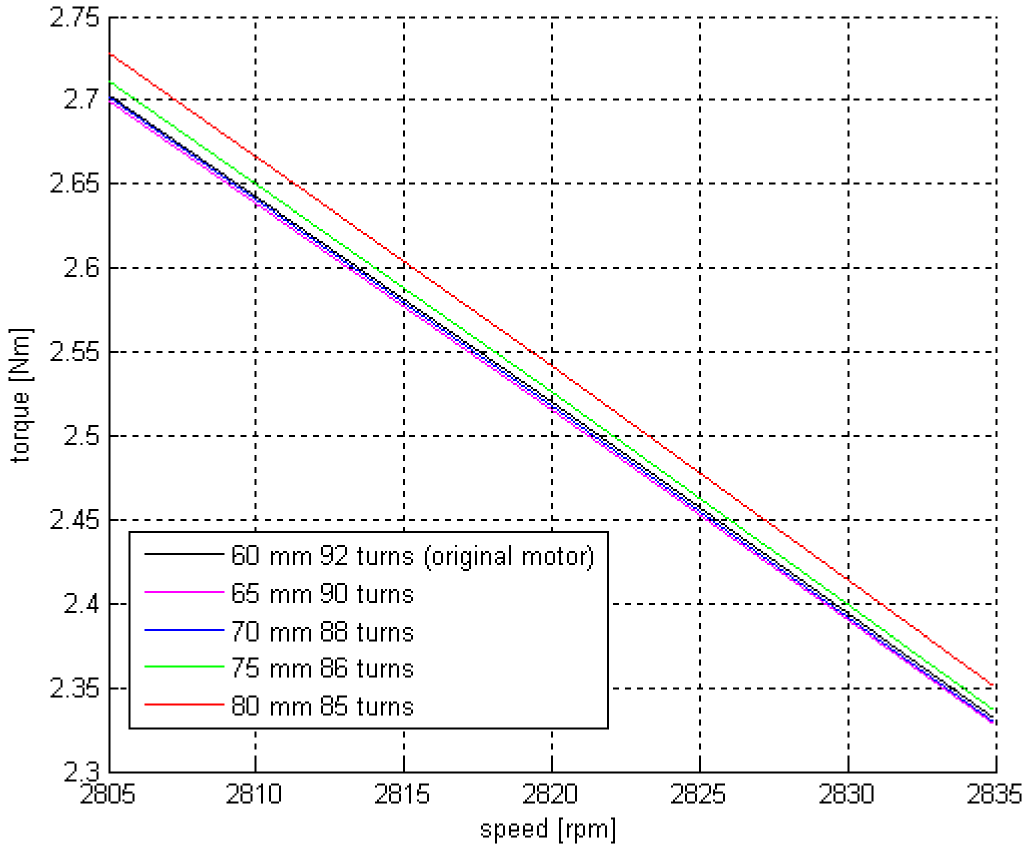

Figure 2.3: Torque characteristic from simulations. There are only small difference between new characteristics and original one.

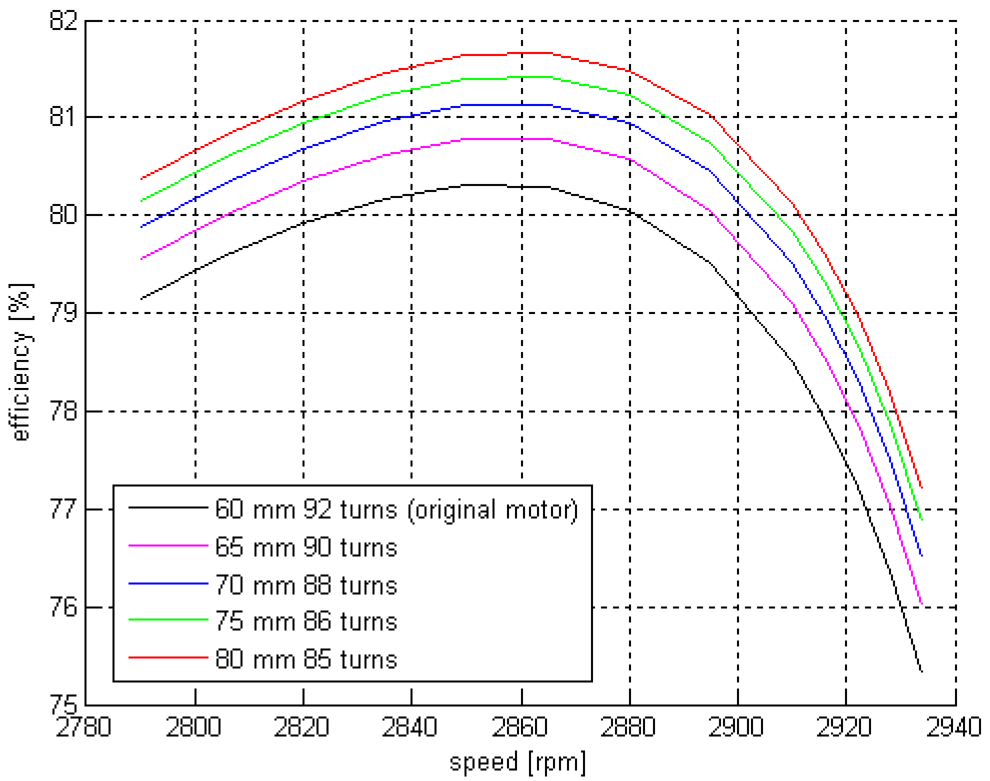

Figure 2.4: Efficiency from simulations.

3. CONCLUSION

Figures 2.3 and 2.4 show impact of core lengthening and appropriate turns-number adjustment on torque-speed characteristics and efficiency. Torque-speed characteristics are demonstrated only around nominal speed in order to good agreement with original one was evident.

As can be seen from results presented here, it is possible to improve the induction motor efficiency by core lengthening. If core length is changed it is necessary to change numbers of turns too in order to motor mechanical attributes remains unchanged. As can be seen from Table 2.2, if considered induction motor core is lengthened by 1/3, Joules loses in stator are reduced by approximately 15 % and iron core losses are reduced by approximately 13 %. Whereas rotor Total motor efficiency is increased about 1.25 % by core lengthening from 60 mm to 80 mm and corresponding turns number changing.

ACKNOWLEDGEMENT

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