

INDUCTION HARDENING OF MILL ROLLS

Hardening of mill rolls is one of very important induction technologies. There are several technologies of induction treatment of rolls: preheating, stress relieving, surface hardening and tempering. One of the technologies includes roll hardening using two inductors, Fig. 1.

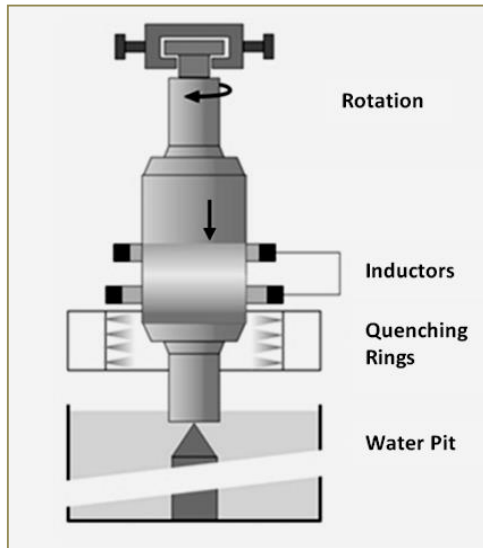


Fig. 1. Scheme of a big roll hardening (Akers' website, www.akersrolls.com)

It is very important to predict the results of design especially for big rolls, which can weigh more than 20 tons and cost more than 50,000 Euros each.

Company INEL, Slovenia, uses ELTA program for a long time in order to design different processes and installations. One of the most interesting applications is surface hardening of the mill rolls. ELTA allows the designers to develop single and multi-stage processes of preheating, final heating, transfer to the quenching sprayer and into the water pit for final cooling. It can accurately predict limited cooling with a possibility of self tempering using residual heat after quenching and cooling. ELTA is also a powerful tool for optimal design of matching circuit

"inductor-converter", predicting required power and the coil parameters..

Single frequency hardening

Fig. 2 shows process of single frequency hardening of a mill roll. Installation can harden rolls with diameter up to 400 mm and weight up to 3 tons. Converter power is 650 kW, frequency 200-1000 Hz.

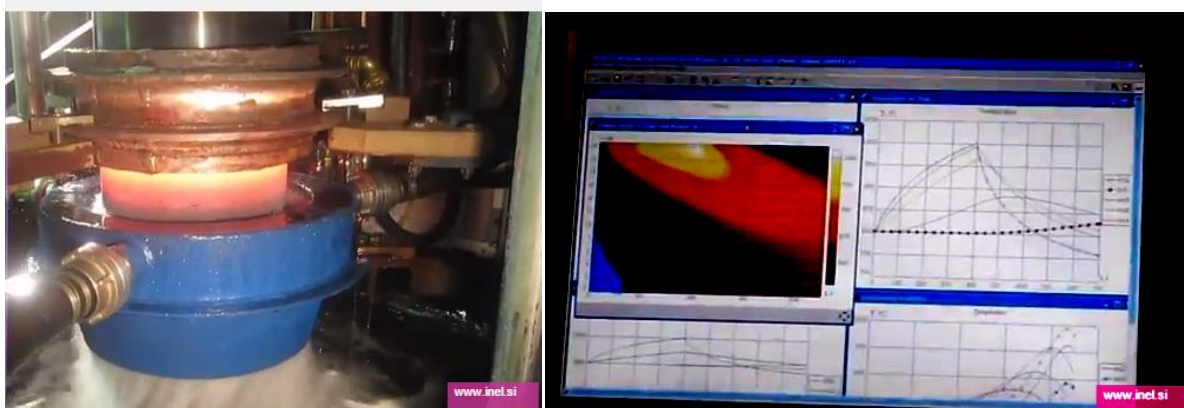


Fig. 2. Single frequency hardening of a mill roll (left) and screen of computer with simulation results (courtesy INEL doo).

<http://www.youtube.com/watch?v=d6k-q85qI3o#t=18>

Dual frequency hardening of big rolls

This installation has two inductors supplied from two converters of different frequencies. The first converter has power 800 kW and frequency range 50-200 Hz. The second one can deliver 650 kW at frequencies from 200 to 800 Hz. Due to this design, the installation is very flexible and may be used for rolls of different diameters. When using both frequencies it is possible to obtain deep heating of rolls with diameter up to 800 mm providing hardness depth up to 40 mm!

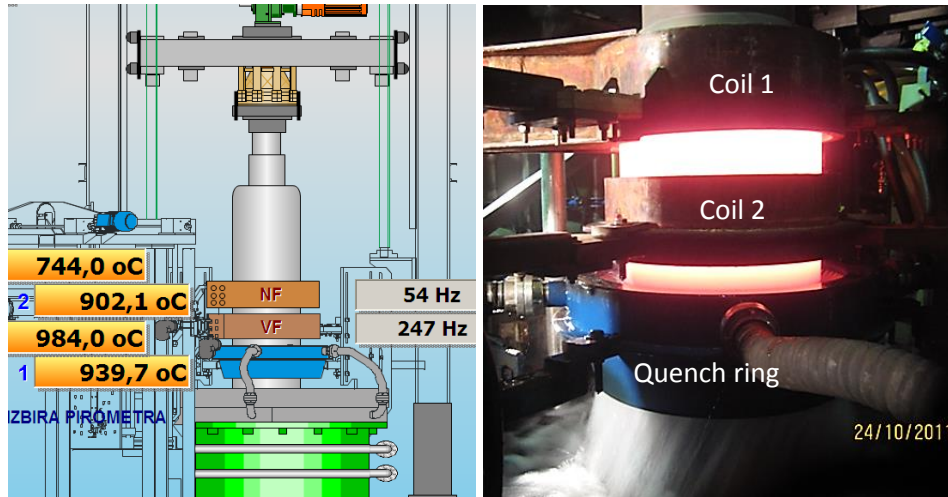


Fig. 3. Control system (left); dual frequency heating and quenching of roll (right)

<http://www.youtube.com/watch?v=SGUyQ4mPD40>

Fig. 3 shows hardening of a roll with diameter 440 mm at a speed 0.7 mm/sec. Control system makes possible to change temperatures at the end of heating in the first inductor (NF) and the second one (HF). Two inductors are also convenient for temperature control at the start and end of the roll heating. Fig.4 displays temperature dynamic curves and temperature colour map generated by ELTA 5.

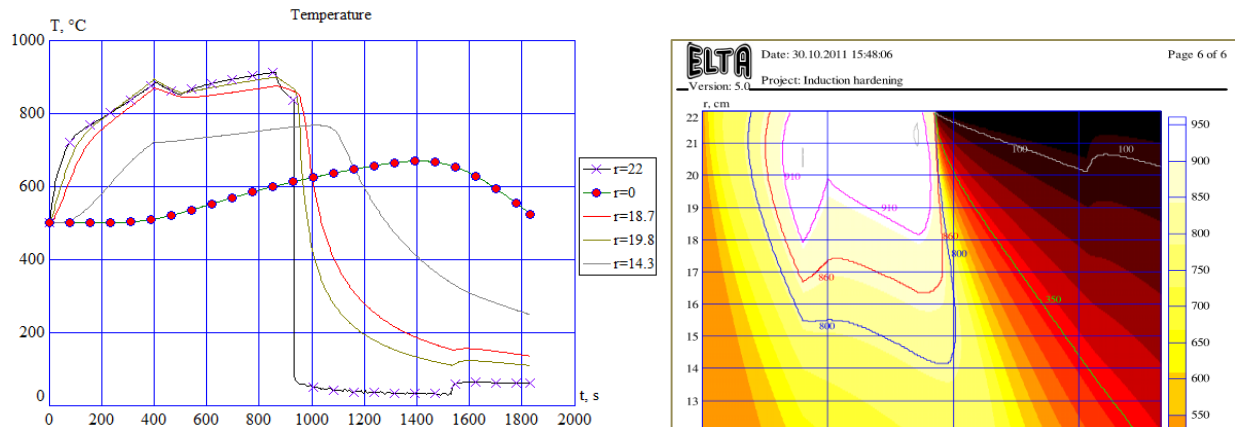


Fig. 4. Temperature curves and color map for dual frequency heating of the roll

Computer simulation helped to select optimal powers and frequencies for both inductors, their length, components of matching circuit, etc. The latest programs ELTA 5.5 and 6.0 have an additional option of the microstructure prediction using TTT or CCT diagrams.

Endorsement:

“ELTA program is a powerful tool for optimal design of induction installations especially in the case of multi-stage processes such as heat treating of large rolls when experimental process development would be very laborious, expensive and time consuming. It is also very useful for optimal selection of the power converter and parameters of the matching circuits”

Franc Mavrič, Director of INEL d.o.o., Slovenia 