

# **New Power Efficient Industrial Technologies for Induction Heating**

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In the framework of the Program for engineering modification and modernization of casting, galvanic and other power-intensive productions for 2010–2015 approved by the Enactment of the Council of Ministers of the Republic of Belarus, the Physical-Technical Institute of the National Academy of Sciences of Belarus is the head organization for scientific-technical support of the Program for modernization of industrial enterprises which use induction equipment. A part of enterprise which use heating operations in gas, electric and induction sets in heat and power consumption is more than 10%, at that, the processes with induction heating is less than 1%. Application of induction heating has a range of advantages in comparison with the conventional heating sets. This is uppermost high efficiency 90–97%, compactness of induction sets that allows installation of them into mechanical processing lines, high productivity of heating operations, and formation of thermal hardened layers on the surface of parts which ensure an increase of exploitation features and some special properties. It should be noted that induction heating is often used for forging, stamping, pressing, volumetric and surface heat treatment of metals and alloys. However, the speed of broadening of the sphere of induction heating application is restrained by a necessity to buy up-to-date equipment, to elaborate and to correct technological processes that ensure high quality of the products and a decrease of their net cost.

A second important task is elaboration of new promising technologies for induction heat treatment of different parts and blanks to replace out-of-date unprofitable technologies of furnace heating.

To solve the tasks, the R&D Centre “Induction Technologies and Heat Treatment Problems” was founded in 2011 in the Physical-Technical Institute of the National Academy of Sciences of Belarus.

The general directions of the Centre activity are as follows:

1. Elaboration and manufacture of high-frequency generators modular units with 2.4 – 60 kHz frequency and up to 1200 kW power.
2. Elaboration and manufacture of automated induction heating sets for heat treatment and heating before deformation of metals and alloys.
3. Elaboration and manufacture of additional equipment for induction heating (quenching, matching transformers, inductors).
4. Elaboration of induction heating technologies.
5. Elaboration of a control system of induction thermal equipment using up-to-date industrial controllers.
6. Certification, assemblage and adjustment of induction heating equipment.

In 2012 the Institute and PLC “MAZ” have executed some works for elaboration of an energy-saving technology and a complex of automated induction equipment for heating before deformation using an upsetting machine. The complex is intended to replace the gas furnace used now in a forging shop of PLC “MAZ” to heat blanks with 40–50 mm diameter up to 1150–1250<sup>0</sup>C temperature with sequent deformation using the upsetting machine and manufacture of parts as brake cam and semi-axle. The technical and economic assessment has shown that replacement of gas heating with 30–40% efficiency of a furnace for induction heating with 95–97% efficiency of a complex allows 3.8 times energy saving. Besides, there is an increase of heating quality at the expense of exclusion of decarbonisation and fuming. Full automation of the heating technology and blanks feeding will allow increasing of labour productivity by no less than 20%. Recouperment of the complex is about 3 years. Starting from 2014 the technology will be used to produce about 400 000 parts per year. An induction heating complex includes: a transistorized thyristor frequency converter, a heating set with full automation, a programmed module of control system. A complex operation is shown by the functional scheme. Blanks are put on the feeding mechanism and one by one moved to the pushing mechanism, where pseudocylinders push them into an inductor for 250–300 mm depth. (3 independent heating positions). In the inductor the edge of the blank is heated up to 1200–1250<sup>0</sup>C, temperature control is executed using a pyrometer. After achievement of the set temperature the blanks are pushed out for the unloading mechanism to the working place of an operator of an upsetting machine for the sequent plastic deformation. The blanks are pushed out with 12–20 second speed depending on the control system settings.

Due to modernization of forging and thermal shops in the industrial enterprises of the Republic of Belarus and due to exclusion of natural gas consumption, there is a big demand for such complexes.