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MODELLING OF PROCESS OF HEATING OF PIPES IN THE ZONE OF THE WELDED SEAM

Abstract
This article discusses the method of modelling the process of induction heating of large-diameter pipes before welding. The main area of large-diameter pipes (up to 1420 mm) is gas pipelines and oil pipelines. The example of modelling is given.

Keywords: induction heating, welded seam, thermal field.

Introduction

Now when performing welding works on pipes of big diameter induction heating of a zone of a welded seam is widely used. Before design of induction heating installation, it is necessary to execute previously modelling of installation for the purpose of determination of its key parameters. To perform modelling with the lowest labour costs, finite element simulation programs [1-3] should be used. Pictures and curves of distribution of power of thermal emission in a pipe and temperatures and also integrated indicators - the power consumption, efficiency, cos(φ), etc. are result of the calculation.

Technique of carrying out researches and results

Installation for induction heating (IIH) consists of the inductor and the power supply current of average frequency. When developing IIH mathematical modelling of heating zone for definition of geometry of the inductor, parameters of the power supply and distribution of temperature in a pipe wall was performed. For performance of calculations it is expedient to use a software finite-element program. Calculation was done in two steps. At the first stage accepting assumption - the pipe has no gap in the place of future seam. This stage allowed to define the key power indicators of installation and schedules of distribution of temperature in a pipe wall. Calculations was done for on a steel pipe with a diameter of 1420,0 mm with wall thickness 33,4 mm. Installation contains the two-section inductor which each section has two round of a wire. Distance between sections of 160 mm that it is quite enough for installation of an external pipe centralizer. Power consumption of installation (50 kW), time of heating to the set temperature (10 min.) and electric efficiency of installation (81,7%) are determined by a settlement way. Curve distributions of temperature along a pipe wall are given in fig. 1. It is visible that heating zone width with the temperature of 100 of 0C and is more equal to 260 mm.

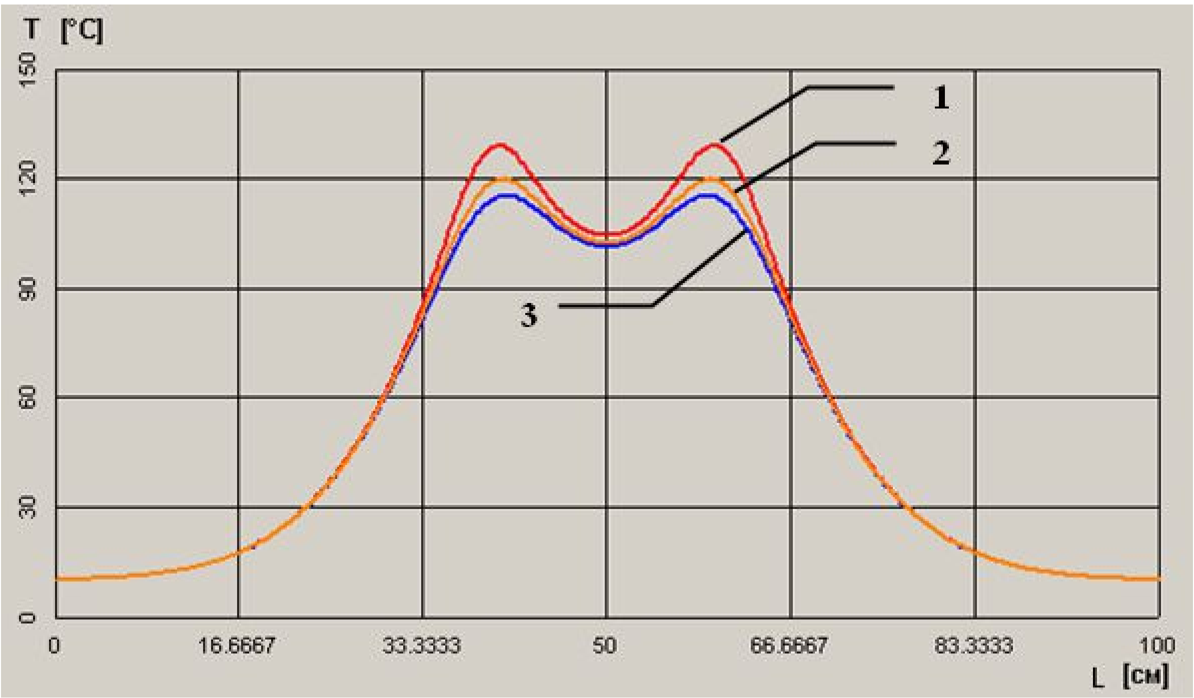


Fig. 1. Results of calculation at the first stage: 1, 2 – temperature of external and internal surfaces, respectively; 3 – average temperature

At the second stage carried out calculations took into account a form of end path of pipes (fig. 2) and also electromagnetic and thermal problems were solved. These calculations allowed to receive a picture of the thermal field, schedules of temperature distribution along the pipe contours and also schedules of temperature change in time when heating and cooling a pipe. In fig. 3 the picture of the thermal field is given in a heating zone and also an arrangement of control point X and contours of A and B The maximum temperature – 130 ^{0}C pipe has in zones of an arrangement of rounds of the inductor, and in a zone of a welded seam - about 100 ^{0}C. Curves of temperature distribution along contours of A and B at the end of a heating interval, on which it is visible that temperature on the welded surfaces is equal 100 ^{0}C and on a pipe surface under the inductor does not exceed admissible values are provided on fig. 3 and 4.

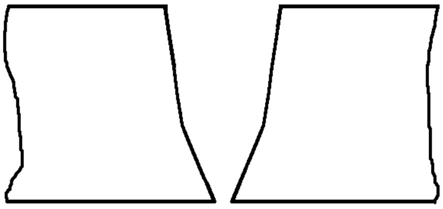


Fig. 2. Path outline form of the ends of the faces of pipes

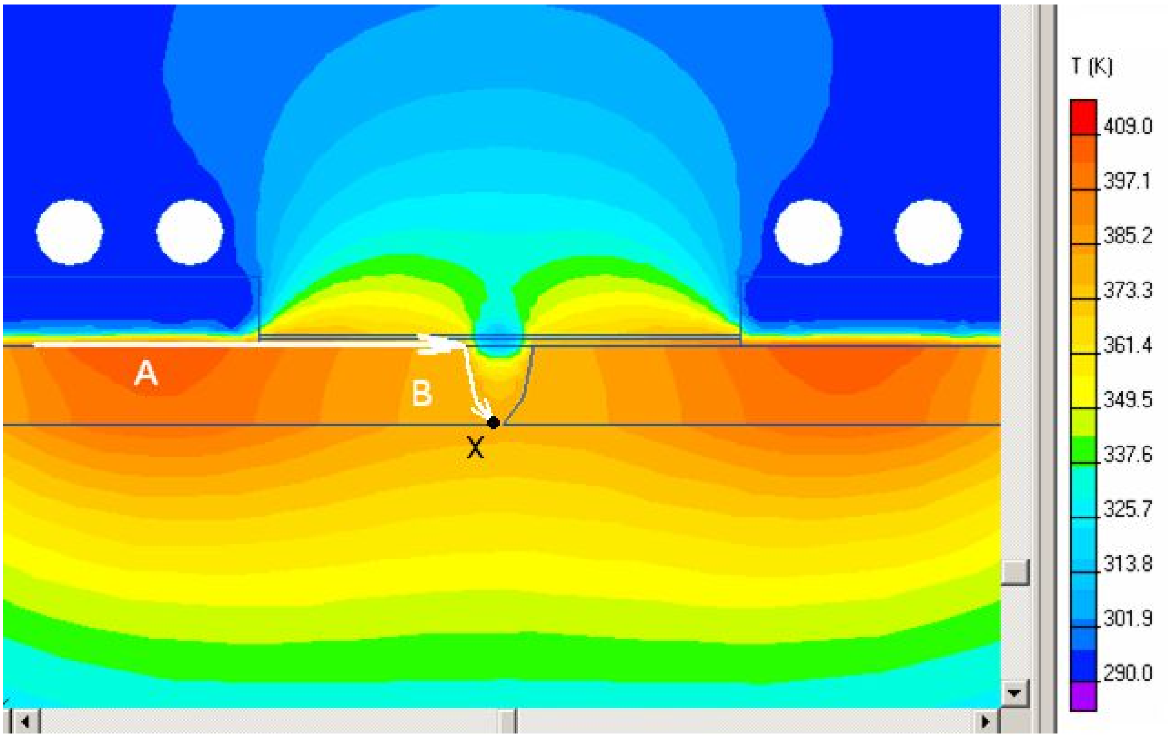
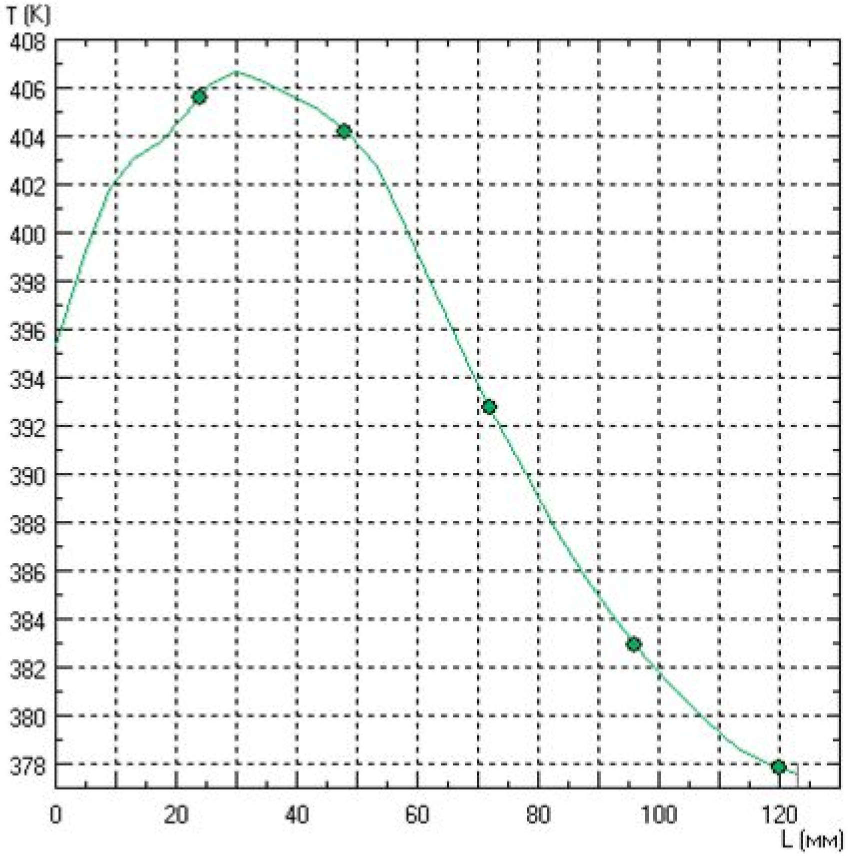
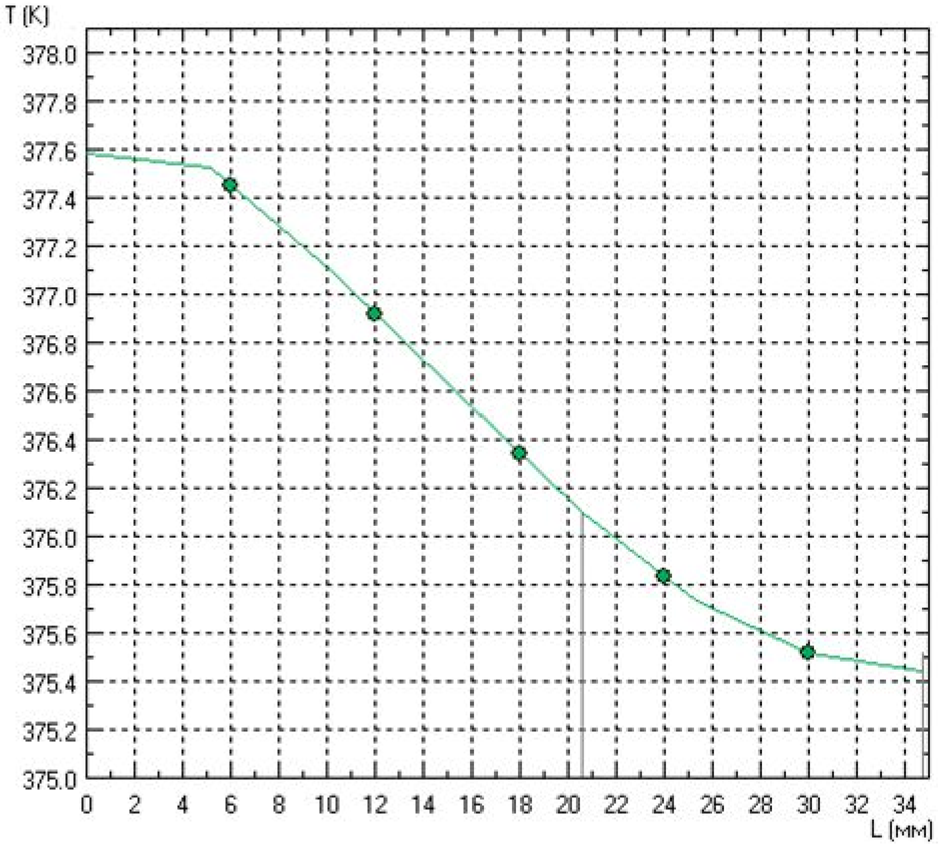


Fig. 3. The thermal field in a heating zone



a)



b)

Fig. 4. Distribution of the temperature on contours A and (a) and B (b) at the end of heating

At the second stage in addition counted the mode of natural cooling of a pipe at disconnection of the inductor from the power supply. The chart of temperature change in the control point X when cooling is provided on fig. 5. According to the chart it is visible that the surface in a zone of a welded seam remains heated to temperature of 100 of ^{0}C about 10 more min.

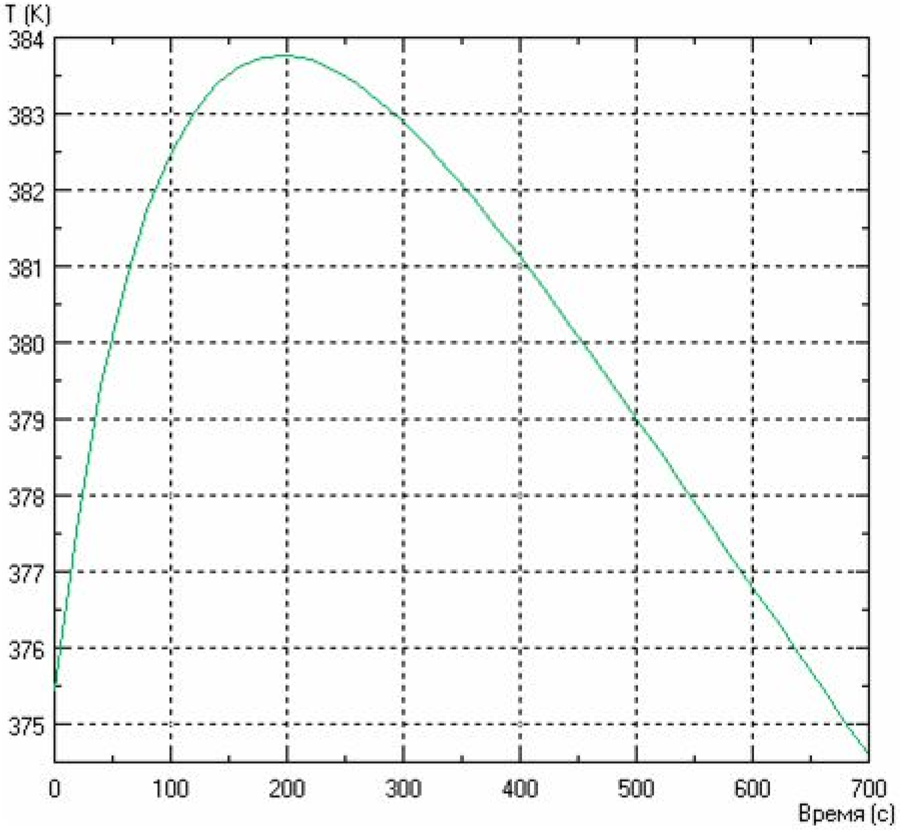


Fig. 5. Change of temperature in control point X when pipe is cooling

Conclusions

By results of calculations constructive solutions and operating modes of installation of induction heating of ELTERM-S UINT-50-2,4 were optimized. The inductor and the heated pipe are given in fig. 6.

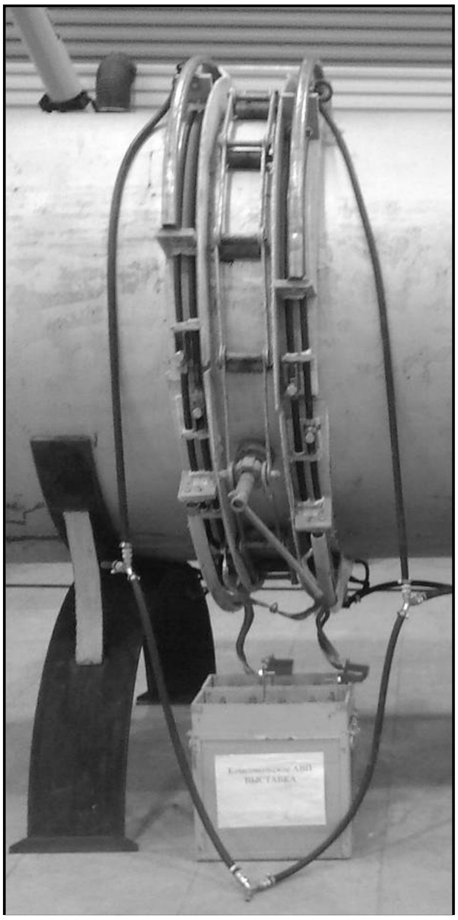


Fig. 6 Inductor and the heated pipe

References

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