THE RESEARCH OF INDUCTIVE HEATING PROCESS IN THE MAGNETIC CORE GAP

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Annotation

The inductive heating devices based on ferrite open magnetic core have high speed of contactless local heating. These devices are effective for electronics soldering. The optimal inductors construction for concentrating of magnetic flows in soldering area is required to produce of high-quality soldered joints. This technology is widely used in production of industrial electronics. The influence of high-frequency electromagnetic fluctuations allows to produce high-performance contactless heating in different processes: thermal treating, melting, hardening, welding, soldering, crystal growing etc.

Inductive heating research

Nowadays the concentrated flows of electromagnetic field radiation are widely used for heating of soldered joints forming areas. The influence of high-frequency electromagnetic field energy on soldered units presents as high-performance contactless heating up to soldering temperature with the help of eddy currents. The heating area is determined by inductors construction. Additionally, the heating speed can be increased up to 10 times more in comparison with convective sources [1].

The scheme of heating device is shown at figure 1. The magnetic core is wrapped by power winding, which is connected to high-frequency generator. The bias coil is added to control the heating process. The dependence of cores magnetic penetration on the DC bias value is assumed as a basis [2]. As the result, with the changing of DC bias value, the high-frequency field strength will be also changed.

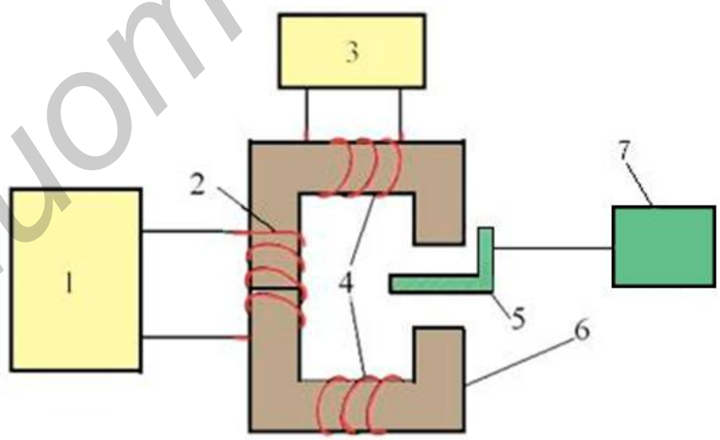


Figure 1 – The scheme of inductive heater based on magnetic core:
1 – high-frequency generator, 2 – power winding, 3 – current source, 4 – bias coil, 5 – heated material, 6 – magnetic core, 7 – measuring instrument

The generator is additionally equipped by DC source, which is used for heating process control. It is possible to perform by changing the DC bias value.

The field strength is maximized in the middle of the gap and can be defined as:

$$H = \frac{1.26 \cdot U}{f \cdot a} \cdot 10^5, \quad (1)$$

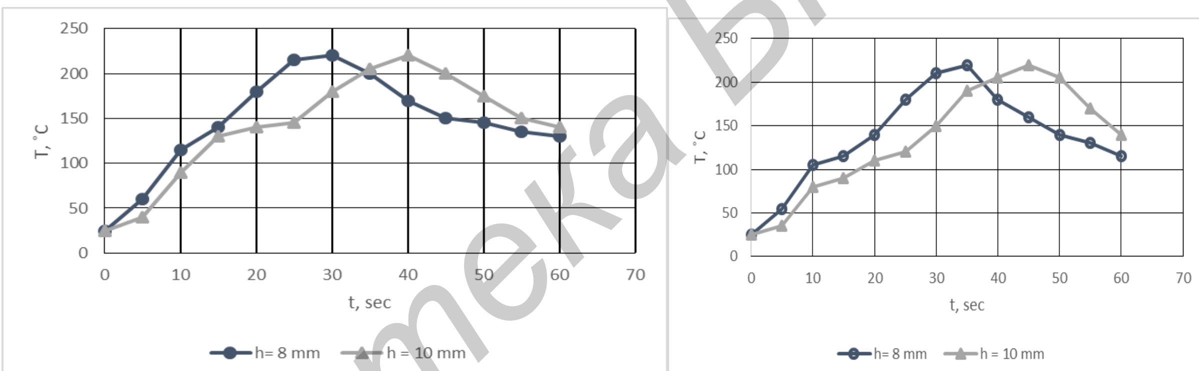
where U – voltage, V; f – frequency, kHz ; a – dimensional frame width, mm.

The dimensional frame represents copper wire loop, where the potential difference is generated when the frame is entered into the electromagnetic field. The potential difference and voltage are determined by measuring instrument. The results of field strength measuring are shown at table 1.

Table 1 – The dependence of field strength on frequency

f, kHz	U, V	H, A/m × 10^6
23.0	6.7	2.42
23.8	6.9	2.43
24.4	7.3	2.51
25.3	7.65	2.53
26.3	8.05	2.56
27.0	8.25	2.58

Practical results of inductive heating process in the magnetic core gap are shown at figure 2.



a b

Figure 2 – The dependence of heated material temperature on time:
a) f = 23 kHz, *b)* f = 27 kHz

The heating process was performed until the heated material temperature achieves 223 ˚C (the temperature of 63Sn37Pb solder melting (183˚C) + 40 ˚C). The experiment results show that the frequency increment improves heating speed. Decreasing the gap in the magnetic core on 20% gives the heating speed increment up to 23.5%.

Inductive local heating in the magnetic gap is effective for small details soldering. Inductive devices based on magnetic gap can support the heating temperature of details with a very high accuracy during the soldering process. The heating intensity is 2.5–3,0 times more than soldering iron has. The heating speed depends on covering gap coefficient and can achieve 40 ºC per second.

References

1. Kyle C. Embedded High-Power-Density Heating // Industrial Heating, September 2008. –P. 88–90,
2. Lanin V., Sergachev I.I. High-performance inductive devices for electronics soldering // Technology in industrial electronics, 2012? № 1.– P. 26-29 http://www.tech-e.ru/