

Induction heating of metals

Scientists of the laboratory №1 «Electro-technological and electro-mechanical systems» of scientific research and design institute «PARAMETR» of DonSTU carry out their work on the following directions:

- 1) Development of mathematical models of semiconducting power source, induction heating systems.
- 2) Theoretical and experimental researches of semiconducting power sources, electro-technological systems of induction heating of metals.
- 3) Development and manufacturing of semiconducting power sources and other equipment for wide range of electro-technological systems of induction heating of metals.
- 4) Development, manufacturing and implementation of melting complexes and units for induction heating of metals for various electro-technological processes (melting, hardening, soldering, thermo-processing, overlaying, press forming etc.)

Laboratory performs state-supported research works as well as commercial works with scientific-research and industrial organizations.

Laboratory scientists have developed, manufactured and implemented:

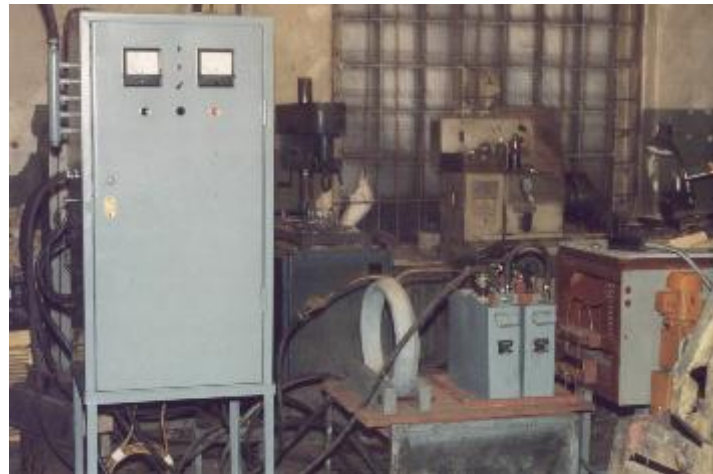
- 1) Power source (thyristor frequency converter TFC 10/8) of induction melting complex (IMC) for melting of silicate melts.
This work was performed along with the scientists from Institute of Electrodynamics of Ukraine's Academy of Science.



- 2) Laboratory-type induction melting complex ИПК0,02/40-8 for scientific-research laboratory of chemical-metallurgical factory of Public Corporation “Mariupol iron-and-steel works”. The complex includes: thyristor frequency converter ТПЧ40-8; compensatory bank of capacitors; induction melting furnace with capacity 20 kg for ferrous and non-ferrous melting.



- 3) Small-sized induction melting complex ИИК0,032/20-8 for silver melting. The work was performed for «Argentum» Ltd. (Kiev).



- 4) Induction melting complex IMC 0,4/0,25 for steel melting. The work was performed for Public Corporation «Donetskcoke» (Donetsk).

This complex includes: thyristor frequency converter TFC 250-2,4; compensatory bank of capacitors; two induction melting furnaces with capacity 400 kg for steel melting. The furnaces can be applied for melting of other metals and alloys (including non-ferrous) after their necessary setting-up and lining.





- 5) Small-sized induction unit for melting of precious metals. The work was performed for Close Corporation «DOIREA» (Dnepropetrovsk).
- 6) Induction melting furnace IMF-0,4 for iron and steel melting. The work was performed for «Scientific-production company «Ukrpromecologia» (Zaporozhje).
- 7) Induction melting complex IMC 0,16/250-1 for aluminum melting for Public Corp. «Pervomaisk electro-mechanical plant» (Pervomaisk).



- 8) Other induction melting complexes and heating units for more than 50 industrial enterprises.

Our projects are implemented and successfully operate at the enterprises of Ukraine, Russia and Kazakhstan.

Laboratory №1 propose developing, manufacturing and implementing of:

1. THYRISTOR FREQUENCY CONVERTERS series TFC-X-X-XX4 of medium frequency are intended for converting of 3-phase current of commercial frequency into alternative current of medium frequency. They are used for power supply of induction melting units, through and surface heating of metals.

Symbolic representation of TFC-X-X-YXJ14:

TFC – thyristor frequency converter;

X – nominal output capacity, kWt;

X – nominal output frequency, kHz;

XX4 – climatic performance and placement category according to GOST 15150-69

CONVERTERS ARE SUPPLIED WITH SYSTEMS OF:

- diagnosis and defense;
- automatic limitation (stabilization) of output voltage;
- remote control and regulation

Cooling – water two-circuit

ADVANTAGES:

- high reliability of work;
- simplicity and comfort in operation;
- high efficiency – $0,93 \div 0,95$;
- unique feature to be operated in wide range of changing the load parameters – from short-circuit mode to blank run mode.



INDIVIDUAL SETTING is according to CUSTOMER'S requirements.
Spare parts supply, service and personnel training.
Complex turnkey basis.
Warranty service.

TECHNICAL CHARACTERISTICS

Type of converter	U _{sup} V	U _{out} V	P _{out} kWt	F _{out} kHz	Total dimensions, mm	Weight, kg
TFC-20-2,4	3x380	400	20	2,4	500x1300x600	200
TFC -30-8,0	3x380	400	30	8,0	500x1300x600	250
TFC -50-8,0	3x380	400	50	8,0	800x1700x700	250
TFC -63-8,0	3x380	800	63	8,0	800x2000x700	600
TFC -100-2,4	3x380	800	100	2,4	800x2000x700	600
TFC -160-2,4	3x380	800	160	2,4	800x2000x700	600
TFC -250-2,4	3x380	800	250	2,4	800x2000x700	600
TFC -320-2,4	3x380	800	320	2,4	800x2000x700	800
TFC -320-1,0	3x380	800	320	1,0	800x2000x700	800
TFC -500-1,0	3x380	1000	500	1,0	1000x2200x1200	1200
TFC -800-1,0	3x550	1000	800	1,0	1000x2200x1200	1200

2. INDUCTION MELTING COMPLEXES (IMC) with capacity from 5 kg to 1,0 ton are intended for induction melting of ferrous, non-ferrous and precious metals of high frequency current.

Advantages of IMC:

- active mixing of metals;
- precise adjustment of melting temperature;
- immediate availability to operation;
- high melting speed;
- small specific indexes of power consumption per 1 ton of melted metal;
- ecological compatibility of technological process;
- keeping the quality of supply net;
- melting of non-ferrous metals in padded crucible

We PROVIDE:

- complex turnkey basis;
- development of building assignment for mounting the complex considering local conditions;
- equipment setting on CUSTOMER's requirements;
- supply with auxiliary units and spare parts;
- servicing;
- personnel's training;
- performing of starting-up and adjusting work;
- warranty service.

COMPLEX INCLUDES:

- thyristor frequency converters series TFC-X-X-YXJI4;
- induction melting furnaces (IMF) (one or two);
- compensatory capacitors battery (CCB);



- remote control unit (RCU);
- set of connecting buslines (TFC-CCB-IMF);
- cooling unit (CU);
- hydrodrive for furnace overturn (HD);
- power transformer.

TECHNICAL CHARACTERISTICS

Type of complex	Furnace capacity on steel, t	Melting time, hours	Pout, kWt	Fout kHtz	Site's area, length x width, mm
IMC 0,005/10-10(18)	0,005	1,0	10	10(18)	3000x3000
IMC 0,01/20-8,0	0,01	1,0	20	8,0	5000x4000
IMC 0,06/100-2,4	0,06	1,0	100	2,4	6000x5000
IMC 0,16/160-2,4	0,16	1,0	160	2,4	8000x7000
IMC 0,25/250-2,4	0,25	1,0	250	2,4	8000x7000
IMC 0,4/320-1,0	0,4	1,0	320	1,0	10000x8000
IMC 0,4/320-2,4	0,4	1,0	320	2,4	10000x8000
IMC 0,65/500-1,0	0,65	1,0	500	1,0	10000x8000
IMC 1,0/800-1,0	1,0	1,0	800	1,0	15000x12000

* Melting time is given at "hot" starting.

* For other metals melting time corresponds to time of steel melting with the following indexes: Al – 1,0; Cu – 0,6; Au – 0,2; Ag – 0,35.

3. INDUCTION EQUIPMENT FOR THROUGH AND SURFACE THERMOPROCESSING

Installations for induction heating are considered for realization of different technological processes for electro-thermal processing of products.

Installations are made on personal orders taking into account the configuration of processed detail, as well as requirements to the efficiency and specific requirements to technological process.

THE INSTALLATION INCLUDES:

- thyristor frequency converters series TFC-X-X-XX4;
- warming-up unit made in agreement with a CUSTOMER's, with manual or automatic method of loading, moving and unloading.

TECHNICAL CHARACTERISTICS

Technological method	Assignment	Max capacity, kWt	Working frequency, kHtz
Hardening	- drill hoses and other cylindrical products length to 4,3 m; - rolls of rolling mills; - gear teeth; - tools etc.	160	8 – 22
Soldering	- bore bits; - cutting tools; - turbine spades, pipes; - diffusion welding.	160	2,4 – 22



Thermal processing	- welded pipe-line junctions; - baking of enamel utensils; - bolts' upsetting; - cone expansion.	800	0,5 – 10
Overlaying	- internal surfaces of cylinder parts; - the surface of flat parts; - auto valves.	160	8 – 10
Forging	- warming-up the details before forging	800	0,5 – 2,4

Laboratory №1 performs assembly drawings and binding drawings on placing the equipment considering to local conditions for making the whole project.

Laboratory №1 offers development and performance the utility and units for induction melting complexes and installations

THYRISTOR FREQUENCY CONVERTERS are intended for converting 3-phase current of industrial frequency into alternative current of medium frequency and are used for power supply at electro-thermal devices. They are used for power supply in induction melting installations, through and surface warming of metals.



We perform works on replacement of old lamp and machine generators with thyristor frequency converters matching with the parameters of TFC and technological equipment of CUSTOMER as well as replacement and repairing of thyristor frequency converters of any other manufacturer.



COMPENSATORY BANK OF CAPACITIES is intended to compensate the re-active capacity of inductors of induction heating installations (IHI) and induction melting complexes (IMC)



COOLING STATION is intended to cool thyristor frequency converter and compensatory bank of capacities with distilled water.



Cooling station CS-60
(dimensions: 500x1700x700)



Cooling station CS-10
(dimensions: 300x900x600)

1. Cooling station is intended for providing double-circuit water cooling of generators for power supply of induction heating devices at the top output temperature from cooled device not more than $50 \pm 30^{\circ}\text{C}$.
2. Environment is non-explosion, without current-conducting dust within concentration that decrease the parameters of cooling station.
3. The first circuit of heat-exchanger is connected to the cooling system of TFC box, the second one – to the service water supplying system.
4. Supply voltage of cooling station – 220 V, 50 Htz.
5. Calculated parameters of the first circuit:

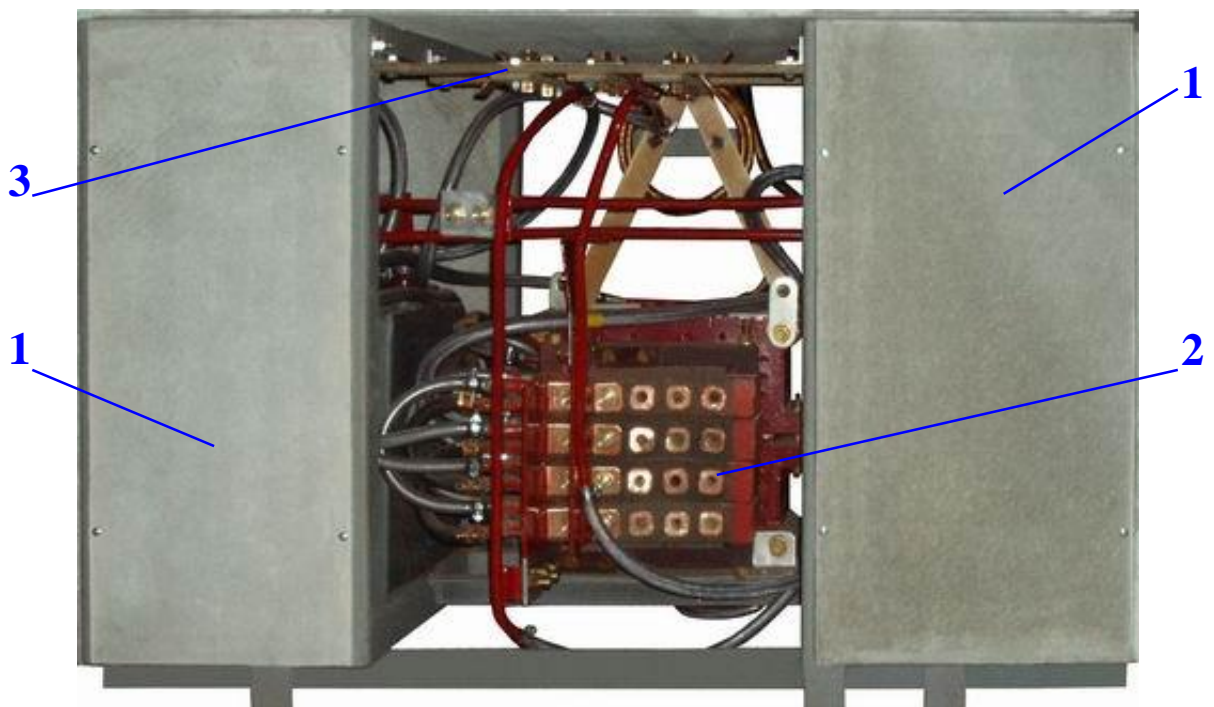
	CO-60	CO-10
- nominal water pressure, kg/cm ²	2,0÷2,9	1,5÷2,5
- water consumption at nominal pressure, litres/min	40÷60	10÷20
- temperature gradient between input and output at nominal water consumption, °C	8÷12	5÷10

A heat carrier of the first circuit is distilled water (or condensate).

6. Cooling station is provided with:

- input of compressed air and drainage for water output and seeping-out of the first circuit;
- protection of water freezing at temperature below 0oC by switching on the pump and the heater;
- protection from water overheating in the first circuit;
- protection at water flow decrease in the first or second circuit;
- control for water leak in the first circuit.

LOAD COORDINATION DEVICE is intended for coordinating TFC with the inductor of heating device.



- 1 – compensatory bank of capacities;
- 2 – high-frequency transformer;
- 3 – power high-frequency switch.

Bank of capacities compensates reactive power of inductor and provides power index for system “inductor – heating element” close to 1.

High-frequency transformer provides harmonization of TFC output voltage with in-ductor’s output voltage in heating device.

Power switch provides the opportunity of by-turn operation of two various types of inductors.

INPUT MANIFOLD BLOCK – DRAINAGE HOPPER



IS INTENDED for collecting and distributing of cooling liquid in induction heating devices (IHD) and in induction melting complexes (IMC);

IT PROVIDES:

- 1) visual control for liquid flow in each channel;
- 2) control for water pressure onto supply main and pressure fall protection;
- 3) operating control for water temperature in each channel;
- 4) alarm signaling for temperature exceed in cooling channels

LOADING DEVICE provides billets' supply into the inductor with synchronized turning of billets for even warming-up





INDUCTORS FOR DIFFERENT ELECTRO-TECHNOLOGICAL PROCESSES



Cage with inductor of induction heating furnace IMF type.



Setup inductor.



Inductor for periodical warming-up of cylindrical billets.



Inductor for overlaying of car valves.



Pass-through inductor with magnetic cores for warming-up of pipe billets diameter $D=200$ mm, length $L=2300$ mm

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