SPECIFIC ENERGY CONSUMPTION OF INDUCTION CRUCIBLE FURNACE

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ABSTRACT

This paper deals with the specific energy consumption of the induction crucible furnace single melts during working-day. Single melts and their specific energy consumptions are compared and influenceson melting efficiency are analyzed in this paper. All measurements were carried out on ABB Ecomelt EGP 500 furnace. In the conclusion results for practice are mentioned.

KEYWORDS

Induction crucible furnace, specific energy consumption, melt, workpiece, load.

1. INTRODUCTION

The goal of the measurements was to analyze the specific energy consumption of the induction crucible furnace ABB Ecomelt EGP 500. The measurements were realized on two days – the 25th of November 2010 and the 4th of March 2011. On the 25th of November two melts were measured, on the 4th of March four measurements were carried out. The workpiece was the same for both days – grey cast iron. During the melts important values of frequency, voltage and electric current were monitored and written. Also the amount of the workpiece added into the crucible was controlled. Then specific energy consumption was calculated and the results were compared.

2. DESCRIPTION OF A WORKING DAY IN THE FOUNDRY

During ordinary working day (8 hour - shift) four or five melts are carried out in the foundry. The first melt starts at seven a.m. Before the start of this melt, the furnace is put in action with a few kilograms of the workpiece and with the power of 25 – 30 kW. It is necessary to warm up the crucible. The first, the second and the fourth melt run with maximum load and with maximum power. The third melt takes longer time. The reason is the pause for the dinner. The furnace is fully charged and the melt is carried out for 30 min. time period with reduced power. After the pause the furnace works with its maximum power and the furnace operator fills the crucible according to the company standards. The last melt runs with the full maximum power but the weight of the workpiece used for this melt depends on the requirements of the foundry. After the melting temperature of the workpiece is measured (it has to be around 1600°C) and the furnace operator empties the crucible.

All operations are carried out by the furnace operator. He sets the power of the furnace, loads the crucible during the process of melting according to the company standards for grey cast iron producing.

After emptying the furnace cast iron has to be casted into moulds. Moulds for casting are hand-made and consist of two parts – the upper part and the lower part. At the bottom of an iron frame the mould is inserted. Further it is powdered with non-adhesive mixture and covered in bentonite mixture. This mixture is also produced in the foundry. After the filling of the mould bentonite is compressed and rammed. Further the mould is removed from the bottom and the frame is put on the ground. The second part of the mould is made in the same way. After cast iron casting is the mould loaded with weight. Cast iron is cast to the mould by hand from above.

Daily diagram of energy consumption in the foundry can be seen in the picture 1.

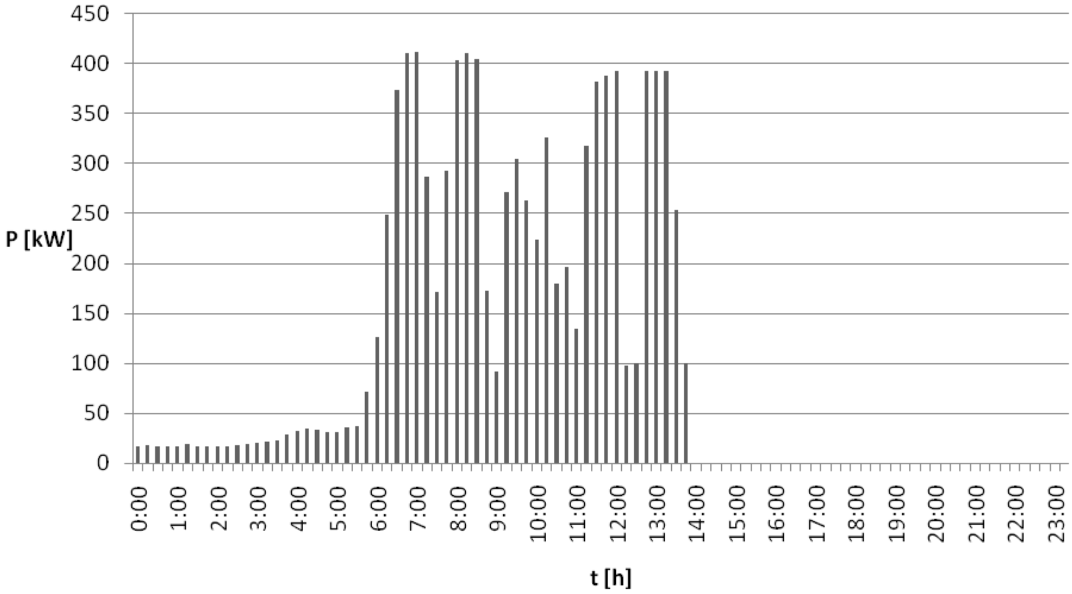

Figure 1 – Energy consumption of the foundry – 4th of March 2011

3. DESCRIPTION OF THE FURNACE – TECHNICAL DATA

Furnace type:	Ecomelt EGP 500
Nominal power:	350 kW
Capacity of the crucible:	500 kg
Workpiece:	containing steel and grey cast iron
Input voltage:	3*380V AC
Output voltage:	1000V
Nominal frequency:	1000 Hz
Cooling system:	water cooled
Power consumption:	595 kWh/t – steel
	576 kWh/t – cast iron
Speed of melting:	620 kg/h – steel
	690 kg/h – cast iron
Casting temperature:	1600°C – steel
	1450°C – cast iron
Hydraulic pump engine:	3 kW

The induction crucible furnace was produced by the ABB company in Dortmund, Germany. It is the furnace with the only one crucible. The capacity of the crucible is 500 kg. This equipment has no shielding and no mats for detection of crucible break out. The only break out protection is ensured by the grounding. The cooling of the coil has only one circuit, water comes from the tank placed in the space under the furnace through water hoses. The inner space of the crucible is made of these parts: the first part is the separation foil made of mica material. It separates the coil from the material of the crucible. Further into the space of the crucible a shape is placed (it has got diameter of the melting space) and the gap between the coil and this shape is filled with powder material which is pressed and rammed. After this process the shape is removed and the equipment is turned on. It is necessary for the hardening of the crucible. The whole furnace is controlled by the static frequency converter that is placed close to the furnace. On the display of the converter values of frequency, power, voltage or electric current can be seen. It also has indicator lights for crucible break out and for the water temperature in the coil.

Figure 2 – Outpour of the furnace

4. MEASURED DATA

Table 1 – Measured data

1st day				
/	t [min]	P_{avg} [kW]	m [kg]	q [kWh/kg]
2nd melt	92	248.7957	498	0.766
4th melt	87	226.7558	402	0.8179
2nd day				
/	t [min]	P_{avg} [kW]	m [kg]	q [kWh/kg]
1st melt	113	192.3158	498	0.7273
3rd melt	117	186.839	500	0.7411
4th melt	82	231.9157	499	0.6506
5th melt	79	246.15	491	0.66

In table 1 all important data are mentioned (time of measurement, average power, weight of the workpiece, specific energy consumption). It is necessary to mention that all melts were not carried out by the same furnace operator. The first furnace operator carried out all the melts from the first day. The second furnace operator did all the melts from the second day. It is also impossible to compare melts from the first day to melts from the second day. Furnace operators have different styles of melting and it can also have influence on specific energy consumption and time of melting.

5. CONCLUSIONS

The 4th melt from the first day was the worst melt. It was carried out with the load of only 402 kg and its specific energy consumption was 0.8179 kWh/kg. It was caused also by the damage on the cooling system. It was necessary to turn off the furnace and after the reparation it was possible to carry on with the melt. But this fact had the influence on the measured parameters – time of melting, specific energy consumption and average power.

On the other hand the 4th melt of the second day had the best measured values. With the load of 499 kg of the wokpiece the melt took 82 minutes and specific energy consumption was 0.6506 kWh/kg.

There was not any surprising value among the other measured values.

The process of the first melt of the day is always similar. It is necessary to warm up the crucible and this process cannot be accelerated.

It would be possible to carry out the second melt with full power from the beginning and only add the workpiece according to the standards of the company. But there is unfortunately a restriction caused by the lack of prepared moulds. It is not possible and suitable to melt 500 kg of cast iron and then due to the lack of moulds keep it at the high temperature. It would extend the time of melting and the specific energy consumption would rise.

The third melt of the day takes the most time. The melt could be carried out at maximum power but its end would meet the beginning of the dinner pause. Then it would be necessary to keep the melted workpiece at very high temperature for the whole 30 minutes and this would not be very effective.

The 4th and the 5th melt of the second day showed us the best way how to carry out melts after warming out the crucible. Times of melting were the shortest and the specific energy consumption was the lowest. But there is also the question if the number of moulders and moulding working places is sufficient.

REFERENCES

[1] http://www.galvanovna.cz

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