ARCHIVES of FOUNDRY ENGINEERING

ISSN (1897-3310)
Volume 8
Issue 2/2008

77 – 80

16/2

Published quarterly as the organ of the Foundry Commission of the Polish Academy of Sciences

Control of cost heftiness of castings production with improvement of PROJECTS

V. Kafka[a,*], V. Nykodýmová[b], V. Szmek[c], I. Lána[d], D. Doupovec[e], V. Knirsch[f], R. Martinák[f], J. Fošum[g], M. Novobílský[c], R. Jochim[d]

[a] Racio & Racio, Orlová - Lutyně, Czech Republic
[b] Foundry department, VŠB – Technical University of Ostrava, 17. listopadu 15, Ostrava, Czech Republic
[c]SLÉVÁRNY TŘINEC, a.s., Czech Republic
[d] SLÉVÁRNA A MODELÁRNA Nové Ransko, s.r.o., Czech Republic
[e] MENCL Guss s.r.o., Roudnice nad Labem, Czech Republic
[f] ZPS-SLÉVÁRNA, a.s., Zlín, Czech Republic
[g] SAND TEAM, spol. s r.o., Czech Republic
*Corresponding author. E-mail address: vaclav.kafka@iol.cz

Received 08.02.2008; accepted in revised form 29.02.2008

Abstract

The Specialized Commission for Economy of Czech Foundrymen Society in the Czech Republic systematically follows a solution of particular phases of castings production from iron and non-ferrous metals already for eighth years. These separate studies are uniformly aimed at cost analysis of chosen phases of castings production. The analysis of cost heftiness and recommendations for concrete remedies for particular foundries are the results. The contribution is aimed at transparent description of topics of the PROJECTS I – VII. Further on it describes in more details the PROJECT VIII, especially the costs of preparation of moulding mixtures. The team solving this problem gathers the results of costs comparison of preparation of fifteen moulding mixtures in five Czech foundries in this project. The inquiry topics are bentonite moulding mixtures (unit, pattern, and heap), further on the self-setting mixtures (with waterglass and furane). The inquiry is closed with Cold-Box-Amine core mixture. The evaluation is aimed both at own cost comparison, and at prediction of moulding mixture costs resulting from knowledge of their structure. Further on it deals with the future growth of waste costs. Subsequently, the possibilities of costs specification concerning to power consumption are viewed. Very interesting results are described for studying the relations of costs of moulding mixtures and particular castings. Questions of determining the price of used return moulding mixture are remarkable too. The way to achieve another costs reduction is also the investigation of costs changeableness for mixing the mixtures.
The work ends with summary suggestion of next progress.

Keywords: Costs; Moulding mixture; Foundry; Cost reduction.

1. Introduction

The Specialized Commission for Economy of Czech Foundrymen Society deals with costs analysis of particular phases of casting production from iron and non-ferrous metals for last ten years. Eight projects /1 – 8/ were already elaborated. The result is the costs analysis and recommendation of particular remedies for participating foundries. Subsequently, these projects were reviewed by special foundry public.

2. Solved projects

The first project (Project I) was solved in 2001 and it dealt with comparison of used technologies and their costs of liquid phase production of irons with lamellar and spheroidal graphite and cast steels. During the next year problems of costs comparison for production of castings from ferrous metals concurred (Project II). The third project summarises questions of continuous following of castings costs in Czech foundries (Project III). The fourth project topic, which was solved during 2004, is the verification of the model of continuous following of castings costs in Czech foundries (Project IV). In the next year, the problems concerning to possibility of costs reduction during production of liquid phase of cast irons in Czech foundries was solved (Project V). The Project VI – Possibilities of cost savings during the production of liquid phase of steels and cast irons closes the series of works relevant to costs of liquid phase.

The following project from the year 2007 (Project VII) already dealt with another area relevant to the production of castings, especially moulding mixture preparation. The main aim of this project was to create the costs model of moulding mixtures. The last work (Project VIII) concurs with questions of evaluation of costs of moulding mixtures.

3. Examination of moulding mixture costs (Project VIII)

Four foundries participated in this project as follows: SLÉVÁRNY TŘINEC, a.s., SLÉVÁRNA A MODELÁRNA Nové Ransko, s.r.o., MENCL Guss s.r.o., Roudnice nad Labem, ZPS – SLÉVÁRNA, a.s., Zlín, and also foundry FERAMO METALLUM INTERNATION, a.s., was joined which participated also in the Project VII. In the following text the foundries will be marked through the use of letters of the alphabet. In total, 15 moulding mixtures were studied:

- Unit bentonite (UB) one – the B foundry (lamellar graphite cast iron foundry – below GJL, use of removable flask moulding line), the C foundry (2 moulding mixtures).
- Pattern bentonite (PB) one – the D foundry, the C foundry (2 moulding mixtures for mechanical moulding of graphitic cast iron foundry and for mechanical and hand moulding foundry of Al and Cu alloys).
- Heap bentonite (HB) one – the D foundry, the C foundry (2 moulding mixtures – for mechanical moulding of graphitic cast iron foundry and for mechanical and hand moulding foundry of Al and Cu alloys).
- Self-setting waterglass (WGC) one – the A foundry (GJL department I, hand ramming, vibration ramming), the E foundry (GJL castings and spheroidal graphite cast irons – below GJS).
- Self-setting furane (FC) one – the C foundry (2 moulding mixtures) the D foundry (mechanized workplace).
- Core Cold-Box-Amine (CB-A) one – the C foundry (mechanical coring).

3.1. Determination of mould mixtures costs

For mentioned mixtures the incomplete production costs were calculated – below IPC (Tab. 1, line 11) according to 9 production phases determined in the Project VII [1], namely new sand, reclaim, return sand, binder system, additives, water, preliminary mixed mixture, mixing, tests, wastes.

Determined differences between IPC were analysed in details during the phase calculation. During this process, we knew the fact that the determined mixture costs are dependent on the produced assortment of castings and also on utilization of moulding mixtures on the unit of production.

Having compared the costs the gained IPC were converted to uniform price and cost levels. This unification related to electric energy – 2.75 CZK/kWh, natural gas – 1 CZK/kWh, water 0.03 CZK/l, compressed air – 0.2 CZK/m^3, personal costs – 140 CZK/hour, oil – 36 CZK/l. Differences of IPC in united prices range within a zone from 25.9 CZK/t to 155.9 CZK/t. IPC are shown in Table 1, line 12.

Table 1.
Summary table for moulding mixtures [CZK/t]

	Moulding mixture	Unit bentonite			Pattern bentonite			Heap bentonite			Self-setting waterglass		Self-setting furane			Core amine
	Foundry	A	C	C	D	C	C	D	C	C	A	E	C	C	D	C
line/column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	New sand	6	11	57	543	60	89	-	51	111	-	-	69	72	31	1863
2	Reclaim	-	-	-	-	-	-	-	-	-	-	-	86	76	476	-
3	Return sand	12	128	46	-	54	59	33	33	43	-	-	-	-	-	-
4	Binder system	15	9	123	287	142	107	25	111	71	109	-	238	478	475	904
5	Additives	7	5	-	1.4	84	-	-	49	-	233	214	-	-	-	-
6	Water	1	-	1.4	2.0	1.4	3.5	1.2	1.4	2.3	-	-	-	-	-	-
7	Mixed sand	-	-	-	-	-	-	-	-	-	272	486	-	-	-	-
8	Mixing	18	23	130	387	125	129	106	71	105	31	1.4	192	109	11	888
9	Tests	0.2	3	6	129	7.8	7.6	-	4	2.6	3.2	3.7	3.9	15	12	105
10	Waste	5	10	74	3.3	23	36	33	19	34	30	112	10	4.8	75	24
11	Total – original prices	64	189	437	1352	498	431	198	340	369	678	817	599	755	1080	3784
12	Total – united prices	69	212	451	1347	519	455	164	355	384	720	791	625	771	1075	3940

3.2. Development of costs for moulding mixtures preparation

The attention was firstly paid to prediction of waste costs development and then to calculation of dividing the costs of all studied moulding sands for estimating their future development.

The result in the field of predication of costs on waste is an important note concerning to probably significant (till of ordinal) increase of fees spent on foundry waste.

The next attention paid to development of moulding mixtures costs was based on newly composed costing IPC model for preparation of moulding mixtures.

Calculating classification of IPC was divided into two main groups: moulding material and processing costs. The processing costs were then particularized to energies (electric, gas, oil, air), personal costs, repair costs, depreciations and other costs. During estimation of groups of evaluated moulding mixtures according to given conditions it was found out that for unit bentonite mixture the IPC range from 64 CZK/t to 437 CZK/t. Costs ratio of moulding materials from the total costs ranges from 11 % to 41 %. Costs ratio of processing costs ranges from 59 % to 89 %.

The IPC for pattern bentonite mixture range within 431 CZK/t and 1352 CZK/t. Costs ratio of moulding mixture raw materials from total costs ranges from 43 % to 55 %. Material costs for all evaluated mixtures range around one half. Processing costs range in a zone from 225 CZK/t to 817 CZK/t. Their part is from 45 % to 57 %.

The IPC for heap bentonite mixtures range from 198 CZK/t to 369 CZK/t. From that the costs of moulding mixture raw materials range from 21 CZK/t to 204 CZK/t. Their part ranges from 13 % to 60 %. It is necessary to notice that these costs are higher than the costs of unit bentonite mixture. Processing costs range in a zone from 136 CZK/t to 213 CZK/t. Their part ranges from 40 % to 87 %. It can be stated that they are comparable with unit bentonite mixture ones.

The IPC for self-setting waterglass mixtures range from 678 CZK/t to 817 CZK/t. From that the costs of moulding mixture raw materials range from 445 CZK/t to 528 CZK/t. Given facts evidently show relatively low cost diffusion (about 18 %). The part of costs of moulding mixture raw materials from total costs range from 65 % to 67 % and therefore it is equable. Processing costs range in a zone from 222 CZK/t to 286 CZK/t. Their part is from 33 % to 35 %. It can be stated that they are coming near to one third of total IPC.

The IPC of self-setting furane mixtures vary from 599 CZK/t to 1,080 CZK/t. The mixture of the D foundry includes a new reclamation line which produces high depreciations (accounting depreciations amounts to 345 CZK/t). When they are excluded from the calculation division the IPC are 704 CZK/t only. Therefore the IPC of furane mixtures are comparable with the IPC of wateglass mixtures. From the IPC the costs of moulding mixtures raw materials range from 306 CZK/t to 548 CZK/t. Given analysis shows relatively higher cost dispersion (80 %) in comparison with self-setting waterglass mixture (18 %). Processing costs range in a zone from 201 CZK/t to 549 CZK/t. In relative conception the range is from 27 % to 53 %. When depreciations for the D foundry are not taken into account then the costs dispersion ranges from 201 CZK/t to 291 CZK/t. These costs are fully comparable with that ones of wateglass mixtures.

Amine core mixture was not separately evaluated. Its costs were determined for one foundry only and they cannot be compared.

Newly gained information was instrumental to be stimulation for concrete investigation in the given foundry and processing level.

Prediction of the costs increase was determined at first according to construction of a “unit” price and cost level. The calculation (compared with costs of evaluated moulding mixture in a price and cost level of the given foundry) was done in next steps as follows:

a) the increase of price of electrical energy only to 2.75 CZK/kWh,
b) the increase of gas price only to 1 CZK/kWh,
c) the increase of compressed air price only to 0.2 CZK/m^3 was not modelled as it did not significantly influence the costs,
d) the increase of wage scales only to 140 CZK/hour.

Evaluation of whole groups of costs follows here according to:

a) the increase of all costs groups according to the a) to d) items,
b) the increase expected in 2008: the increase of wages by 8 %, of prices of electric energy by 10 %, of prices of gas by 5 %,
c) the unit increase of all evaluated items by 10 %,
d) the unit increase of all evaluated items by 15 %,
e) the unit increase of all evaluated items by 20 %.

With the united price and cost level e.g. for the A foundry and with use of the unit price of electric energy of 2.75 CZK/kWh only the costs of that mixture increase by 5 CZK/t (i.e. 8 %). With increasing the price of natural gas to 1 CZK/kWh the change is negligible. With accepting all the changes (i.e. the rate of 140 CZK/hour next to personal costs) this foundry increases its moulding mixture costs by 6 CZK/t what means 9 %.

With gradual increasing of particular prices of evaluated foundries the impact of first fourteen mixtures was evaluated only. The amine core mixture is considered extraordinary one for its high costs (3,785 CZK/t) as well as for its relatively low appearance. For the b) item the increase ranges from minimum value of 2 CZK/t to the maximum one of 35 CZK/t. For the c) item the minimum value is 2 CZK/t and the maximum one of 47 CZK/t. For the d) item the minimum increase is 2 CZK/t and the maximum one of 71 CZK/t. The minimum increase for the e) item is 4 CZK/t and the maximum one of 95 CZK/t.

Further on following the costs increase there was an endeavour to include the moulding mixtures costs in the finished casting ones what was successful in case of one foundry. An example for the level of 100 % increase of moulding mixture costs where costs of dispatched casting are increased by 1 CZK/t up to 8 CZK/t is given here for information only. Certainly it is very motivating finding! [2]

3.3. Real determination of energy costs

These investigations were aimed at determining more accurate the present method of determination of electric energy costs. Now we start from the so called card achievement of the given electric motor (for example 5 kW) whose value we multiply with the time of functioning of this appliance (e.g. 3 hours). So we have electric work (15 kWh). During our investigations we have found out that the card achievement does not always be the same as the real achievement. Thus the determination of relevant correction coefficient was the aim.

Results were gained practically on the basis of relevant measurements in participating foundries. In the E foundry the groups of equipment (e.g. unloading of wet sand which consists of 7 conveyers, a wagon and undercarriage) were measured only. In other three foundries individual units were always studied.

The measuring method in the D foundry was different too (according to registration of current intensity and following calculation of real power consumption). In next two foundries the method of measuring of electric work was used (kWh). It is also necessary to mention that evaluated electric units have not the same technical level and the same age. This fact relates to the level of overloading of the given electric motors.

It is a result for foundries investigating themselves that now they can judge the real power consumption from their card power consumption for their conditions on a considerably higher level.

Results obtained by measurements hardly make possible to make credible and predicative interpretation for other foundries. E.g. the results obtained for a mill (card power consumption of 26.3 kW for furan mixture) has its coefficient of 0.8. On the contrary in the E foundry (card power consumption of 29 kW for pattern mixture) the determined coefficient is 0.3.

Similar difference is in the C and D foundries for the mills for unit mixture with card power consumption of 55 kW, coefficient 0.9 and for the foundry using heap mixture with card power consumption of 88 kW and coefficient 0.4.

For other foundries it can be stated only as follows:

- coefficients of utilization of card power consumption range in different zones [1],
- other foundries should do similar measurements for their own electric units,
- if an electric unit is similar to the evaluated one in some of studied foundries, it has similar time usage and output, then it can have its coefficient of usage around the measured one.

It is necessary to mention that gained results should lie to be analyzed in more details.

4. Suggestion for continuing study of castings production costs

Chosen partial topics arising in costs comparison of studied fifteen moulding mixtures are given in this chapter. Those suggestions could be the subjects for foundries participating in investigations as well as for other foundries. Following topics are the questions.

Relations of moulding mixtures costs and dispatched casting costs. Integrated solution of problems concerning to determination of the heap mixture price. Targeting to pouring of castings and all problems concerning to this matter. Investigation of the cost field of fettling the castings including the necessary thermal treatment and finishing operations before dispatching.

Realization of technical-economical analysis of the same kinds of moulding mixtures, e.g. for unit bentonite moulding mixtures. More foundries should participate in the technical-economical analysis of those mixtures. Then an output would be a result that would be able to suggest real possibilities of realization of technological, technical, organizational and power changes with the achievement of costs reduction for conditions of each evaluated foundry.

5. Conclusions

The contribution informs about projects solved by the Specialized Commission for Economy and it follows the last project dealing with questions of moulding mixture preparation costs in Czech foundries.

That project includes the resulting file of fifteen moulding mixtures, and namely systematically according to types and also according to technological sequence.

Then the costs of all evaluated fifteen moulding mixtures were transferred to the unit cost and price level. Unification was done by prices of power media and cost rate of personal costs. Subsequently, unit bentonite moulding mixtures were evaluated and the high cost range (from 69 CZK/t to 451 CZK/t) – more than 550 % – can be stated.

It results from all obtained facts that it is necessary to solve problems relating to bentonite mixtures costs more in detail – separately.

In spite of the fact that self-setting waterglass mixtures differ in their costs by relatively low 71 CZK/t – 10 % (from 720 CZK/t to 791 CZK/t) partial cost items in their composition give a stimulation to detail examination.

The IPC for self-setting furane mixtures range from 625 CZK/t to 1 075 CZK/t (420 CZK/t, 72 %).

This fact is very significant for foundry practise and it should be investigated more in detail.

After that the calculation of result to estimated prices of energies and wages was done for the year 2008 and also for next periods. It result in the fact that chosen step costs increasings (electric energy, gas and wages) by 10 to 20 % will cause increasing of moulding mixtures costs by 11 CZK/t to 43 CZK/t. It can be stated that involving those increasings in other phases of processing could cause the increase of obtained numbers even by orders.

In the conclusion the contribution gives possible suggestions for continuing study of problems of casting processing costs.

References

[1] V. Kafka, V. Nykodýmová, J. Fošum, S. Chudáček, V. Szmek, V. Knirsch, D. Doupovec, I. Lána, P. Fryč, M. Novobílský, R. Jochim, R. Martinák, J. Šenberger, Creation cost model mould mixtures, PROJECT VII, Final report, ČSS Brno, (2006) (in Czech).

[2] V. Kafka, V. Nykodýmová, V. Szmek, I. Lána, M. Novobílský, R. Martinák, J. Fošum, D. Doupovec, V. Knirsch, R. Jochim, Problems weighted of cost mould mixture, Final report (2007), ČSS Brno (in Czech).