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INFLUENCE OF AUTOMATION IN DIE CASTING WORKING WITH REGARD TO SAVING OF WORKERS

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ABSTRACT:
The article deals with the times of die cavity filling at pressure die casting and the workers number saving per shift, at the attendance of one pressure die casting machine and at the attendance of more pressure die casting machines, in dependencce on mass of die casting.
KEYWOORDS:
time of die cavity filling, attendance of one pressure die casting machine, attendance of more pressure die casting machines, mass of die casting

1. FILLING TIME OF DIE CAVITY

The filling time of die cavity for die casting in dependence on its mass goes out longer than from the linear relation with the mass. It can be attributed the resistance at flowing liquid metal, the length of flowing and countrer-pressure of gas at filling of die. Then we can consider with the relation:

$$t = k.m^n \quad (1)$$

where is: t – filling time of die cavity [s]; k – constant of proportion [$s.kg^{-n}$]
m – mass of caviting [kg]; n – exponent

$$n > 1 \quad (2)$$

The filling times are longer at complicated casting. We can express it in the relation (1) with the larger constant of proportion k and exponent n. At die castings of lower mass category m = 1kg according to measurement we can consider the filling time of die cavity t = 0,1s. For a simple casting we choose the exponent t = 1,5s. Then the filling times of die cavity go out according to table 1 that are represented on figure 1. At comparing complicated castings for n = 2 filling times of die cavity go out according to table 2 that are represented on figure 2.

Table 1. Calculated filling times of die cavity for masses of die castings for n = 1,5

Mass of casting m [kg]	1	2	3	5	10	15
Filling time of die cavity t [s]	0,1	0,28	0,5 2	1,1 2	3,1 6	5,81

Table 2. Calculated filling times of die cavity for masses of die castings for n = 2

Mass of casting m [kg]	1	2	3	5	10	15
Filling time of die cavity t [s]	0,1	0,4	0,9	2,5	10	22,5

At pressure die cast it was passed from semiautomatic proccess on automatic one of die casting machines and gradually on automatic one of die casting machines and gradually on attendance of two machines. Saving of workers number on shift was followed.

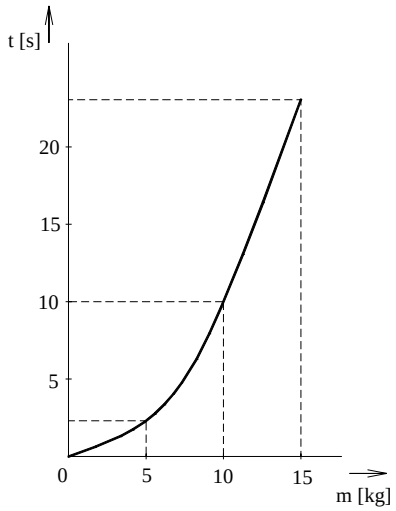

Figure 1. Dependence of filling time of die cavity for masses of die castings for n=1,5

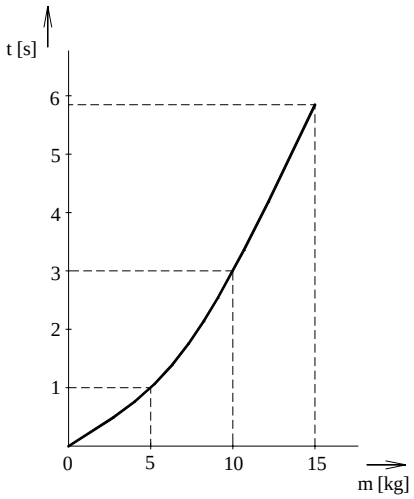

Figure 2. Dependence of filling time of die cavity for masses of die castings for n=2

At castings with small mass saving one worker on shift was reached. At castings with higher mass it is an assumption raising saving of workers number on shift. It can be expressed through the relation:

$$u = k.m^n \tag{3}$$

where is: u – saving of workers numbers on shift; k – constant of proportion [kg-n];
m – mass of casting [kg]; n – exponent

$$n < 1 \tag{4}$$

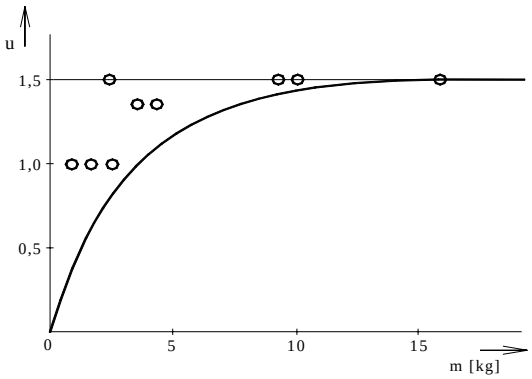

Figure 3. Dependence of saving of workers number on shift with regard to masses of die casting

At castings of small mass the saving of 1 worker on shift was reached. At casting with masses 1,7 kg, 7 kg and 15 kg saving 1,5 workers on shift was reached, at castings with masses 1,9 kg and 3kg saving 1,4 workers on shift was reached. According to (3) the course goes out on figure 3. Saving of workers number on shift was increased at attendance of two machines of small mass castings on 2-3 workers on shift respectively in further case on 3 workers on shift [3,4]. It is possible to express proportionally at small mass castings in dependence on attendance of one and two machines according to relation:

$$u = k.n \tag{5}$$

where is:
u – saving of workers number on shift; k – constant of proportion [kg-n];
n – attendance of more machines

$$k = 1{,}5 \tag{6}$$

This case is represented in figure 4.

2. PROJECT OF AUTOMATED SITE IN CONCRETE WORKING CONDITIONS

In further section the project of machines for automation of the pressure die casting site of the firm Regada Prešov is described. Technological site of aluminium pressure die cast consists of the machines CLH 160.01, CLH 250.01 a CLH 400.03 (table 3) (manufactured Vihorlat Snina).

Materials used in pressure die cast process are Al-226 and 230, respectively according to specification of customer. Melting furnace and maitenance furnances are heated electrically.

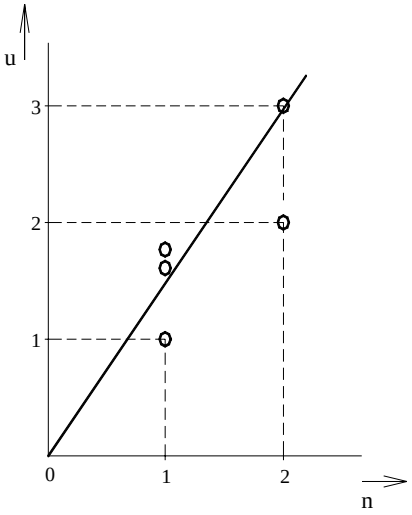

Figure 4. Dependence of workers number saving on shift at attendance of more machines

Table 3. Fundamental parameters of pressure die cast site

Parameter	CLH 160.01	CLH 250.01	CLH 400.03
Closing force (t)	160	250	400
Size of clamping plate (mm)	700 x 700	840 x 840	990 x 990
Dimension between columns (mm)	430 x 430	530 x 530	605 x 605
Height of die max./min. (mm)	600 / 210	700 / 250	750 / 250
Fluently adjustable pressing force (t)	4,8 - 20	8,6 - 17,2	17 - 36
Maximum mass of pourred metal (kg)	2,24	2,5	2,5
Min./max. surface of casting (cm²)	126 - 760	160 - 1150	220 - 1820
Injection sleeve (mm)	100 x 100	100 x 100	100 x 100
Number (pcs)	2	1	1

3. PROJECT OF MACHINERIES FOR AUTOMATION IN WORKING OF PRESSURE DIE CAST

On basis of machine equipment analysis of this shop the followed additional machineries for partial automation of manufacturing were projected:

Machinery of castings taking out MTL 10

Machinery of metal dosing MDT 04.01

Machinery of die lubrication OLV 400

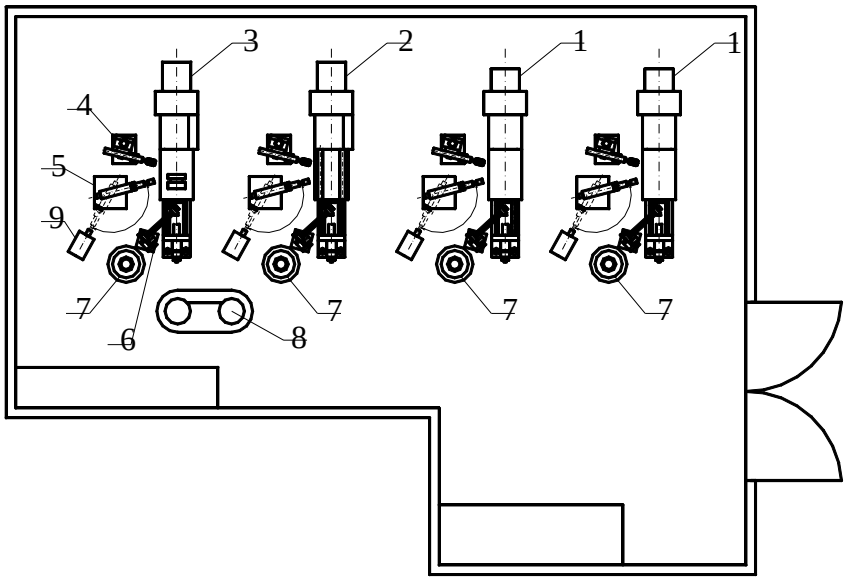

Figure 5. Disposal solution with project of additional machineries, 1 – CLH 160.01, 2 – CLH 400.03, 3 – CLH 250.01, 4 – machinery of die lubrication OLV 400, 5 – machinery of castings taking out MTL 10, 6 - machinery of metal dosing MDT 04.01, 7 – maintenance furmace, 8 – melting furmace, 9 – technological pallet

This selection was conditioned by disposal solution of shop, distributing die casting machines. maintenance furnaces and melting furnace. In figure 5 the disposal solution with projected machineries is represented.

4. ANALYSIS OF SHOP AUTOMATION EFFECTIVENESS FROM TIME STANDPOINT

One from important criteria in evaluation of sites automation is an increasing of shop effectiveness from time standpoint. In this part fundamental relations necessaries for die casting shop analysis from time standpoint are introduced.

At pressure die cast we can consider followed partial times of casting cycle:
- time of machine closing t_1
- time of metal dosing t_2
- time of metal pressing t_3
- time of casting solidifying t_4
- time of machine opening t_5
- time of casting ejecting and transport to finishing casting t_6
- time of finishing casting t_7
- time of die lubrication t_8

In shift time of breaks t_9 for a nosh and change of shifts. We mark these times at manual attendance of machine with the index r and at automatic working with the index a. Then machine times and technological times at pressure die cast with cold chamber t_1, t_3, t_4, t_5 and with warm chamber t_1, t_2, t_3, t_4, t_5 stay without change. The other times at automatic working are shortened. Then we can count to contributions at pressure die casting with cold chamber shortening time for metal dosing

$$\Delta t_{2st} = t_{2r} - t_{2a} \quad (7)$$

time for ejecting casting

$$\Delta t_{6st} = t_{6r} - t_{6a} \quad (8)$$

time for finishing casting

$$\Delta t_{7st} = t_{7r} - t_{7a} \quad (9)$$

time for lubrication of casting

$$\Delta t_{8st} = t_{8r} - t_{8a} \quad (10)$$

It is possible to go to total shortening time at machine with cold chamber.

$$\Delta t_{st} = \Delta t_{2st} + \Delta t_{6st} + \Delta t_{7st} + \Delta t_{8st} \quad (11)$$

The time Δ_{tst} represents the total shortening time necessary for realizing one manufacturing cycle.

5. CONCLUSION

At comparing workers saving for automated technological sites of pressure die casting with cold chamber with various masses of castings it goes out the saving 1 worker on shift for extent of masses from 0,015 up till 1,5 kg, 1,4 workers on shift for the mass 1,5 kg. Since manufacturing program of die casting shop for parts in mass extent from 0,015 up to 1,15 kg respectively manufacturing castings with mass up to 1,5 kg it is necessary to perform workers saving analysis also for manufacturing parts with larger mass. It is neccesary to verify whether saving increasing is also for larger masses of manufactured parts is equal as at products with smaller mass.

We can suppose workers saving increasing at automated technological sites of die casting after installing attendance of more machines, Manufacturing effectiveness at parts of small mass is possible to increase with larger number of parts in die. At attendance of two machines saving of 3 workers on shift is possible and at pouring products with 6 up to 12 castings in die is saving 2 respectively 3 workers on shift.

It is possible to say that automation of technological sites of die casting means increasing work productivity in die casting.

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