THE EVALUATION OF THE USE OF A DEVICE FOR PRODUCING METAL ELEMENTS APPLIED IN CIVIL ENGINEERING

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Abstract

The use of working time of a Samp drawing machine has been assessed in the article. It has been evaluated in the process of drawing a steel wire, ϕ = 1.5 mm in diameter, which is applied in civil engineering. A company producing wires has been characterized briefly. The chemical constitution of steel of a drawn wire has been given. In order to evaluate the working time of the analyzed drawing machine, the PAMCO times, which were indispensable to calculate the value of PAMCO coefficients, have been determined. On the basis of the conducted analysis, it has been found out that the effective time (ET) of the Stamp drawing machine ranged from 26 hours in the first week of research to 37.5 hours in the eighth week of research. However, the coefficient of the effective utilization (EU) for the drawing machine reached minimum and maximum values in the same research weeks as the effective time (ET) - 15.48% and 22.32% respectively.

Keywords: drawing machine, steel wire, PAMCO, civil engineering

1. INTRODUCTION

Both proper maintenance and upkeep of the machines used in production play a very important role for companies. Implementing TPM system [1÷6] allows achieving it. However, some of companies go one step further in applying more rigorous PAMCO coefficients, which strictly determine to what extent the available time of machines and devices was used in the analyzed period. Plant & Machine Control (PAMCO) shows measurement parameters and reporting parameters of the work of technological objects. It defines working time of the machines in order to analyze the work of machines and the processes, and it also reduces the number of parameters which were applied so far. It gives the basis to measure these devices, which could be modified [1, 6÷8]. With regard to the PAMCO coefficients, optimum values should reach the following ones [9]:

– production efficiency (PE) - should be as high as possible and exceed value of approximately 95%,
– operational efficiency (OE) - about 92.5%,
– available utilization (AU) - about 90%,
– asset availability (AA) - about 97%,
– asset utilization (AUt) - it is required that it takes value of 65%,
– operational utilization (OU) - about 62%,
– production utilization (PU) - its optimal value should exceed 60%,
– effective utilization (EU) - its value should be at level 50%.

2. MATERIAL FOR RESEARCH

The company, in which the research was conducted, specializes in producing manufactures from stainless steel and nickelic alloys. It produces high-quality wires and drawn bars, among other things. Thanks to a wide range of dimensions, the products are used not only in the construction sector but also in other branches of economy such as the furniture, car, medical, agro-food, and textile industry. The dimensional range of the wires produced by the company is included in the diameter range from 0.2 mm to 8.0 mm. The charge for all

wires from ϕ = 1.5 mm in diameter is a wire rod of ϕ = 5.5 mm in diameter, which is provided in circles weighing 730 kg.

The analyzed drawn wire was made from austenitic steel EN 1.4567 (X3CrNiCu18-9-4). Its chemical constitution has been presented in **Table 1**.

Table 1 The chemical constitution of the austenitic steel EN 1.4567 (X3CrNiCu18-9-4)

Chemical constitution [%]							
C	Si	Mn	P	S	Ni	Cr	Cu
max 0.04	max 1.00	max 2.00	max 0.045	max 0.015	8.5÷10.5	17÷19	3÷4

The discussed wire is often used as a connecting member. It is characterized by high resistance to corrosion and very good mechanical properties.

3. EFFECTIVENESS OF THE USE OF WORKING TIME OF THE DRAWING MACHINE

The effectiveness analysis of the Samp drawing machine applied in the technology of wire production from the austenitic steel EN 1.4567 (X3CrNiCu18-9-4), employed in civil engineering among other things, in a selected company was conducted for the period of 24 weeks.

3.1 Determining PAMCO times for the Samp drawing machine

Measurements of all PAMCO times for the Samp drawing machine were performed in industrial conditions during realization of technology of drawing a steel wire ϕ = 1.5 mm in diameter, intended for the construction sector. The employees of the company, in which the research was conducted, work eight hours, five days a week. The research results concerning PAMCO time for the analysed drawing machine have been collated in **Table 2**.

On the basis of the conducted research it has been found out that during the realization of drawing the wire from the austenitic steel in the analyzed company unavailable time (UAT) equaled 128 hours apart from the 1st and 18th week - then it equaled 136 hours. Available time unused (AUT) in all of the 24 research weeks equaled 0 hours, therefore available time (AT) reached the same values (32 h ÷ 40 h) in the whole research period as utilized time (UT). Planned time non-operating (PNOT) reached the lowest value (0 h) in eight research weeks (7th, 8th, 10th, 12th, 15th , 17th, 18th and 23rd), however the highest value (2 h) was reached in two weeks (4th and 20th). As the results show, in the examined period there was not a standstill connected with a serious device repair. The planned time non-operating was connected with current overhauls of the drawing machine. The values of operating time (OT) range from 31 h ÷ 40 h. The value of routine stoppages (rps) ranges from 0 h ÷ 2 h. Routine Stoppages (rps) include, first and foremost, the controls of the drawing machine connected with the set-up and the exchange of the drawing die.

Fig. 1 shows the course of production time (PT) and effective time (ET) for the Samp drawing machine used in the production of a steel wire ϕ = 1.5 mm in diameter intended for the construction sector in the examined period.

Table 2 PAMCO times for the Samp drawing machine in the period of 24 weeks

Research period [week]	Total time TT [h]	Unavailable time UAT [h]	Available time AT [h]	Available time unused AUT [h]	Utilized time UT [h]	Planned time non operating PNOT [h]	Operating time [h]	Routine stoppages rps [h]	Production time PT [h]	Unscheduled stoppages us [h]	Effective time ET [h]
1	168	136	32	0	32	1.00	31.00	1.00	30.00	4.0	26.00
2	168	128	40	0	40	1.00	39.00	1.00	38.00	5.0	33.00
3	168	128	40	0	40	1.00	39.00	0.00	39.00	3.0	36.00
4	168	128	40	0	40	2.00	38.00	2.00	36.00	1.0	35.00
5	168	128	40	0	40	0.50	39.50	0.50	39.00	5.0	34.00
6	168	128	40	0	40	1.50	38.50	1.50	37.00	5.5	31.50
7	168	128	40	0	40	0.00	40.00	0.00	40.00	4.0	36.00
8	168	128	40	0	40	0.00	40.00	0.00	40.00	2.5	37.50
9	168	128	40	0	40	1.50	38.50	1.00	37.50	1.0	36.50
10	168	128	40	0	40	0.00	40.00	1.00	39.00	4.5	34.50
11	168	128	40	0	40	1.50	38.50	1.50	37.00	0.0	37.00
12	168	128	40	0	40	0.00	40.00	1.00	39.00	2.0	37.00
13	168	136	32	0	32	1.00	31.00	0.50	30.50	0.0	30.50
14	168	128	40	0	40	1.00	39.00	0.00	39.00	3.5	35.50
15	168	128	40	0	40	0.00	40.00	0.00	40.00	4.0	36.00
16	168	128	40	0	40	1.00	39.00	1.50	37.50	0.5	37.00
17	168	128	40	0	40	0.00	40.00	0.00	40.00	3.0	37.00
18	168	136	32	0	32	0.00	32.00	1.50	30.50	4.0	26.50
19	168	128	40	0	40	1.00	39.00	1.00	38.00	2.0	36.00
20	168	128	40	0	40	2.00	38.00	1.00	37.00	6.0	31.00
21	168	136	32	0	32	1.00	31.00	0.00	31.00	1.5	29.50
22	168	128	40	0	40	1.00	39.00	0.50	38.50	2.5	36.00
23	168	128	40	0	40	0.00	40.00	1.00	39.00	2.0	37.00
24	168	128	40	0	40	1.00	39.00	1.00	38.00	1.5	36.50

As **Fig. 1** and **Table 2** show, effective time (ET) reached a little lower value than production time (PT), apart from the 11th and 13th research period, what is connected with the occurrence of unscheduled stoppages (us). In the examined period in the 11th and 13th research week, Effective time (ET) reached the same value of 37 and 37.5 h as production time (PT), what is the result of lack of unscheduled stoppages (us) of the drawing machine in these two weeks. The longest unscheduled stoppage occurred in the 20th research week (6 h) and was mainly connected with the failure of the drawing machine caused by the drawing die damage.

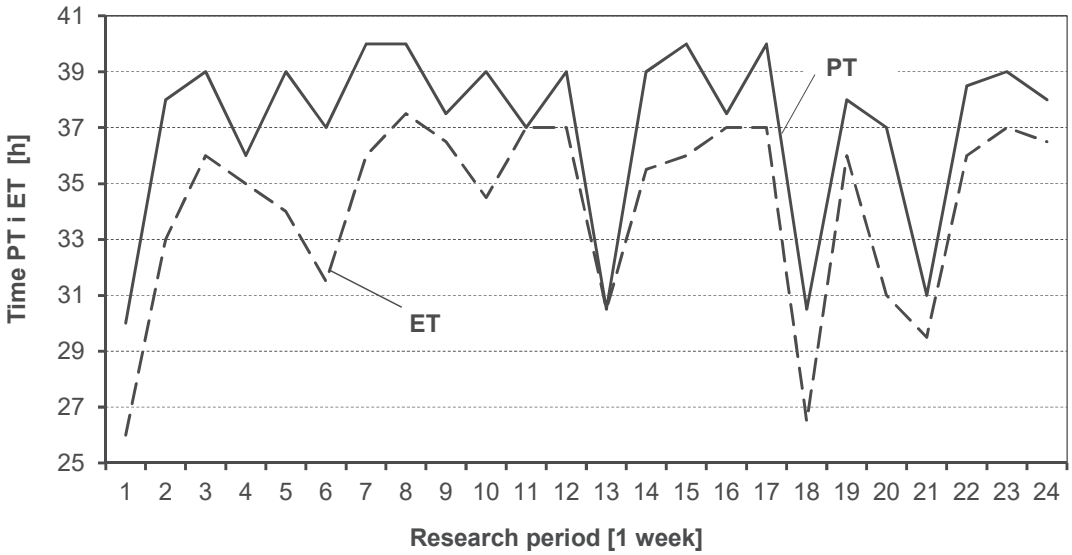

Fig. 1 The course of production time (PT) and effective time (ET) for the Samp drawing machine in the period of 24 weeks

3.2 PAMCO coefficients for the Samp drawing machine

PAMCO coefficients for the Samp drawing machine used in the technology of steel wire drawing ϕ = 1.5 mm in diameter were enumerated on the basis of the times in **Table 2**. The values of calculated PAMCO coefficients for 24 research weeks on the basis of formulae in work [1] have been presented in **Table 3**.

On the basis of the conducted research, it has been found out that the values of the following coefficients: production efficiency (PE) and operational efficiency (OE) for the Samp drawing machine reached values ranching from 83.78% ÷ 100% and 81.58% ÷ 98.39% respectively. The values of operational efficiency (OE) reached smaller values than the production efficiency (PE) in each research week, in which routine stoppages occurred. Available utilization (AU) reached values ranging from 95.00% ÷ 100%. Asset availability (AA) and Asset utilization (AUt) reached the same values in each research week because in the whole research period asset utilization (Aut) = 0 h. Next coefficient - operational utilization (OU), in research weeks in which planned time non-operating (PNOT) equaled 0 h, reached the same values as asset utilization (Aut). The course of the values of two coefficients: production utilization (PU) and effective utilization (EU) has been presented in **Fig. 2**.

As **Table 2** and **Fig. 2** show, production utilization (PU) in two research weeks (the 11th and 13th) reached the same values as effective utilization (EU) because in these weeks unscheduled stoppages (us) of the drawing machine did not occur. In the remaining weeks the values of effective utilization (EU) were lower than the values of production utilization (PU).

Table 3 The PAMCO coefficients for the Samp drawing machine in the period of 24 weeks

Research period [week]	Production efficiency PE [%]	Operational efficiency OE [%]	Available utilization AU [%]	Asset availability AA [%]	Asset utilization AUt [%]	Operational utilization OU [%]	Production utilisation PU [%]	Effective utilisation EU [%]
1	86.67	83.87	96.88	19.05	19.05	18.45	17.86	15.48
2	86.84	84.62	97.50	23.81	23.81	23.21	22.62	19.64
3	92.31	92.31	97.50	23.81	23.81	23.21	23.21	21.43
4	97.22	92.11	95.00	23.81	23.81	22.62	21.43	20.83
5	87.18	86.08	98.75	23.81	23.81	23.51	23.21	20.24
6	85.14	81.82	96.25	23.81	23.81	22.92	22.02	18.75
7	90.00	90.00	100.00	23.81	23.81	23.81	23.81	21.43
8	93.75	93.75	100.00	23.81	23.81	23.81	23.81	22.32
9	97.33	94.81	96.25	23.81	23.81	22.92	22.32	21.73
10	88.46	86.25	100.00	23.81	23.81	23.81	23.21	20.54
11	100.00	96.10	96.25	23.81	23.81	22.92	22.02	22.02
12	94.87	92.50	100.00	23.81	23.81	23.81	23.21	22.02
13	100.00	98.39	96.88	19.05	19.05	18.45	18.15	18.15
14	91.03	91.03	97.50	23.81	23.81	23.21	23.21	21.13
15	90.00	90.00	100.00	23.81	23.81	23.81	23.81	21.43
16	98.67	94.87	97.50	23.81	23.81	23.21	22.32	22.02
17	92.50	92.50	100.00	23.81	23.81	23.81	23.81	22.02
18	86.89	82.81	100.00	19.05	19.05	19.05	18.15	15.77
19	94.74	92.31	97.50	23.81	23.81	23.21	22.62	21.43
20	83.78	81.58	95.00	23.81	23.81	22.62	22.02	18.45
21	95.16	95.16	96.88	19.05	19.05	18.45	18.45	17.56
22	93.51	92.31	97.50	23.81	23.81	23.21	22.92	21.43
23	94.87	92.50	100.00	23.81	23.81	23.81	23.21	22.02
24	96.05	93.59	97.50	23.81	23.81	23.21	22.62	21.73

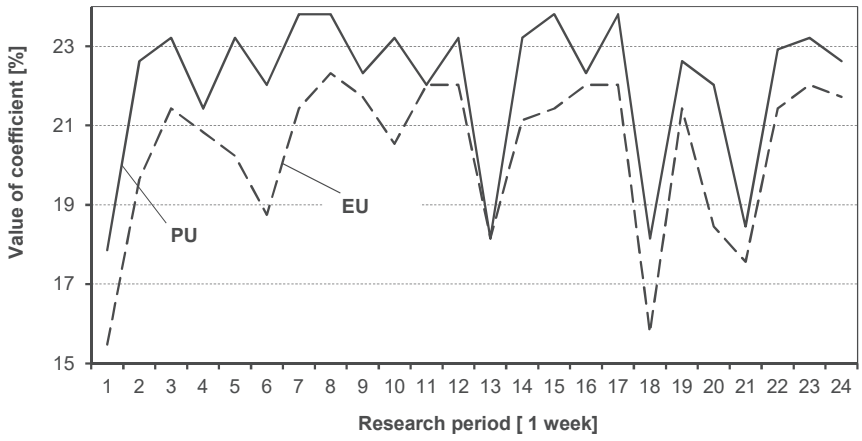

Fig. 2 The course of production utilization (PU) and effective utilization (EU) for the Samp drawing machine in the period of 24 weeks

CONCLUSION

As the conducted analysis shows, only available utilization (AU) for the Samp drawing machine used in the technology of producing a wire which is applied in civil engineering among other things, reached an optimum value of about 90% in the whole research period (see **Table 3**). Reaching values which range from 95.00% ÷ 100% by this coefficient was possible because planned time non-operating (PNOT) reached low values ranging from 0 ÷ 2 h (see **Table 2**). The coefficients which reached optimum values in several research weeks are the following: production efficiency (PE) and operational efficiency (OE). Production efficiency (PE) reached an optimum value of 95% in seven research weeks: 4th, 9th, 11th, 13th, 16th, 21st and 24th, in the remaining weeks, a lower value was caused by the occurrence of longer unscheduled stoppages (us) connected with the failures of the drawing machines. However, operational efficiency (OE) reached an optimum value of 92.5% in 10 research weeks: 8th, 9th, 11th, 12th, 13th, 16th, 17th, 21st, 23rd and 24th. In the remaining weeks it did not reach the optimum value because apart from unscheduled stoppages (us) too long routine stoppages (rps) occurred additionally (see **Table 2**).

The remaining 5 PAMCO coefficients (asset availability (AA), asset utilization (AUt), operational utilization (OU), production utilization (PU) and effective utilization (EU)) for the analyzed Samp drawing machine used in the technology of producing a wire, which is applied in civil engineering among other things, reached values considerably beneath the optimum ones. These coefficients reached values ranging from 15.48% ÷ 23.81%, what was caused by the work specification of the company (8 hours 5 days a week) and the occurrence of minimum unavailable time (UAT) on a level of 128 hours. The structure of total time (TT) which is the sum of unavailable time (UAT) and available time (AT) has been presented in **Fig. 3**.

As **Fig. 3** shows, out of 168 hours of total time (TT) in the 1st, 13th, 18th and 21st week, because of the additional day off, unavailable time (UAT) for the Samp drawing machine equaled as much as 136 hours, and in the remaining weeks 128 hours.

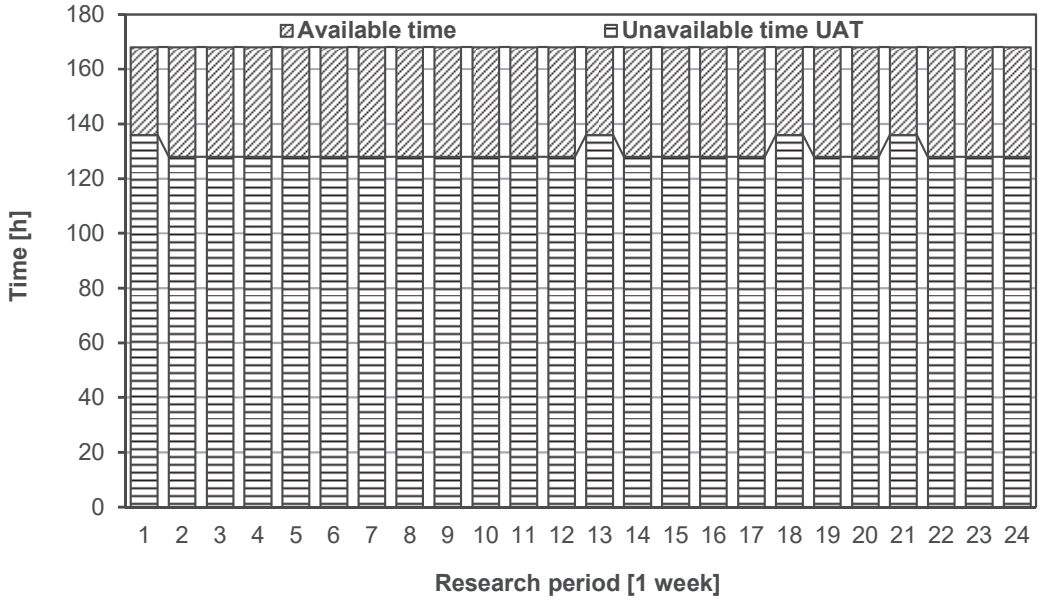

Fig. 3 The structure of total time TT

On the basis of the obtained research outcomes in the examined company, a graphic schedule of the overhauls of the drawing machine was verified. Because of the fact that current overhauls and lubrication were not performed by some employees, what lack of Routine stoppages (rps) is indicative of (see **Table 2**), time sheets of running of the drawing machine were introduced. Employees wrote obligatorily each stoppage of the drawing machine in these sheets. The introduced changes allowed to minimize time of unscheduled stoppages (us) connected with failures.

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