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METHODS OF ESTABLISHING THE COSTS OF THE DISFUNCTIONS OF AN EQUIPMENT

Marius, ROMOCEA
University of Oradea, mromocea@yahoo.com

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Abstract. The need to establish the cost of an equipment's disfunction is motivated by the fact that this is part of the production cost. The paper presents the method of determining the costs of the disfunction of the lathe SN400x1500 used for making a screw with spherical head for the press PAI – 25, used for making the cooking machines working with liquefied gas.

1. INTRODUCTION

By availability we understand the probability for an equipment to be able to function after a period of time spent for repairs required by a breakdown produced after a period of good functioning. This ability of the equipment is characterized by an indicator named average availability (Dm) and it is expressed by the ratio:

$$D_m = \frac{Availability\ period}{Availability\ period + Unavailability\ period} \qquad (1)$$

The availability limit of an equipment is defined as being the minimum value of the equipment's availability from which this ensures a profit. The notion of availability can be analized not only from the technical point of view, that is the equipment's capacity to fulfil its function, but also from the economic point of view, regarding the ratio between incomes and expenses. In this respect, when using an equipment, the goals to follow will be related to the need of establishing an appropriate maintenance strategy, by identifying the minimum value of the equipments' availability, considering that the unavailability has negative effects upon the costs [5]

The term of disfunction characterizes the state of an equipment which doesn't work at the default parameters for which it has been designed. The equipment which is in a disfunctional state can work but at some unappropriate parameters or with a lower productivity. The losses in quality or in productivity influence the costs of production, that's why it is necessary to evaluate them.

2. THEORETICAL GROUND

The cost of the disfunction of an equipment has two components:

a). the cost of re-bringing into operation, which contains the expenses for the spare parts, the salaries of the maintenance operators etc, represented by the cost of the corrective maintenance (C) ; this cost is characteristic for the equipment

b). the cost of the unavailability of the production unit (I), characteristic for the technological line or for the production unit, containing:

- the immediate costs due to the production losses, due to the penalties applied because of the non-observance of the contracts or those due to the inadequate quality
- the fix costs, due to the repayments, losses in profit etc.
- the costs of the serious consequences (critical breakdowns, accidents etc)

As a result, the cost of the disfunction (Cd) has the expression:

$$C_d = C + I \text{ (lei)}$$

A more analytic indicator is represented by the cost of the disfunction per functioning hour expressed by:

$$C_{do} = \frac{C+I}{TBF+TR}\left[\frac{lei}{hour}\right] \quad (2)$$

where:

TBF = the period of good functioning;

TR = the period of non-functioning during repairs

The average cost of disfunction per hour, which can be expressed by:

$$C'_{do} = \frac{C+I}{MTBF+MTR}\left[\frac{lei}{hour}\right] \quad (3)$$

where:

MTBF = the average time of good functioning (hours);

MTR = the average time of repairs (hours);

For a certain functioning period of time of the equipment, the calculation of the global cost of the disfunction can be realized by using the indicator named the cumulated cost of the disfunction (Cdc), expressed by:

$$C_{dc} = \frac{C+I}{MTBF+MTR}\cdot t\left[\frac{lei}{hour}\right] \quad (4)$$

where :

MTBF = the average time of good functioning (hours)

MTR = the average time of repairs (hours)

t = the period of using the equipment, on condition that the costs C and I should stay unaltered

The optimization of the costs resulted from the disfunction of an equipment can be realized by organizing the activities of preventive maintenance. The industrial maintenance represents an ensemble of measures and activities facilitating the prevention, the good upkeep or the restauration of an equipment up to a default state or up to when it can ensure a certain service while minimizing the maintenance costs [2]

From this definition we can conclude the following :

- to restore means here “to correct”, required by the change of the initial value of the functioning parameters of the equipment
- the default state or established service implies to pre-establish the functioning parameters or the aimed service, and to quantify the characteristic levels;
- to minimize the maintenance costs reflects the economic aspect of the activity
- the prevention – an ensemble of activities by which we avoid the unavailability state of the equipment
- the good maintaining in an expected state means to apply methods, procedures, actions which contribute to the progress of the maintenance

3. STUDY CASE

The investigation has been made in an industrial unit specialized in the production of thermic stations for apartments and cooking machines functioning with liquefied gas.

We decided to establish the cost of the disfunction of a lathe used for making a screw with spherical head made of steel rods OLC$% with ϕ74-76 for the ram of the press

PAI-25. The press is used for cold stamping of the iron plate with a thickness up to 4 mm, necessary to produce the cooking machine with liquefied gas. The spherical-headed screw (fig.1) is one of the press's parts with a low reliability, which requires its serial manufacturing. The need to establish the cost of the disfunction of an equipment is motivated by the fact that this is part of the equipment's breakdown cost.

The manufacture of the machine part in case is realized by performing the following operations and phases:

1. cutting with the alternative saw at the length of L=427 mm
2. frontal lathing L= $425 \pm 0,1$
3. making the centring holes with the special auger $\phi 5$
4. lathing $\phi 66$ on the length L= 350 mm
5. lathing $\phi 60^{-0,3}_{-0,2}$ on the length L= 280 mm
6. making the thread M60x6 on the length L= 280 mm
7. the machine part is fixed on the universal lathe having release jaws, in order to make the spherical head.
8. lathing $\phi 72$ on the length L= 132 mm
9. lathing $\phi 50$ on the length L= 50 mm
10. roughing the spherical end with an outside lathing cutter
11. making the sphere with the device for lathing the spherical surfaces, in case of a small or average serial manufacturing. In case of a sole exemplar manufacturing, the lathing of the spherical head can be made with one left form cutter and one right form cutter
12. applying the thermic treatments
13. Q.T.C.

Making a spherical-headed screw for a ram on a normal lathe SN400x1500 takes 16 hours and brings an income of 40 lei. A corrective intervention of an average difficulty is usually realized within 48 hours, its cost being estimated at 2000 lei. In these circumstances, the cost of the unavailability for the production unit (I) becomes:

$$I = 48 \cdot \frac{40}{16} = 120 \text{ lei}$$

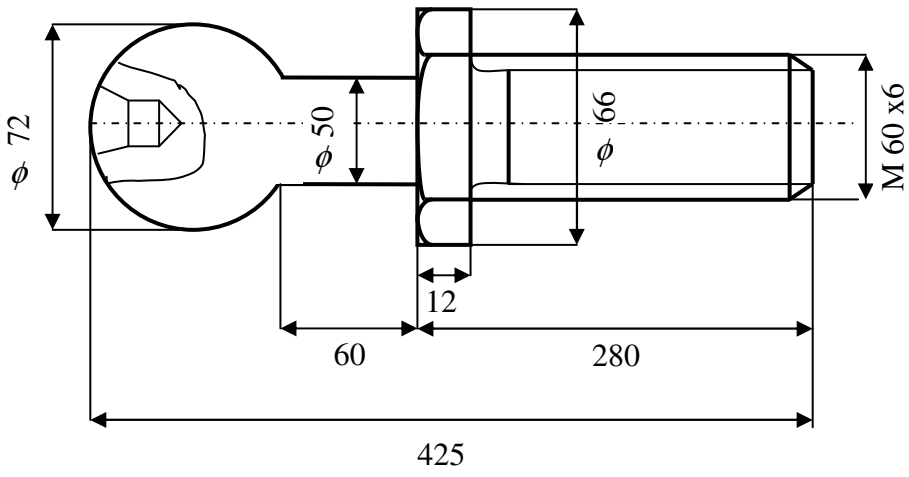

Fig. 1 Spherical-headed screw

As a result, the average cost of the disfunction per using hour, $C_{do,}$ will be calculated with the relation (3):

$$C'_{d0} = \frac{2000+120}{1400+20} = 1.492 \left[\frac{lei}{hour}\right]$$

If the equipment were used during the whole default functioning period, estimated at 170,000 hours, this fact would drive so-called disfunctions cumulated costs C_{dc} which are calculated with the relation (4):

$$C_{dc} = 1.492 \cdot 170{,}000 = 253{,}810 \text{ lei}$$

After being repaired, the press was subjected to tests for working idly and loaded with a view to checking on delivery. The checking of the machine parts was realized in the very manufacturing process : processing, adjustment and fitting-assembling.

It was checked if the materials that had been used met those recommended in the technical book of the machine. Where the technical reference material for this part was missing, we took samples from the original part, which were subjected to lab analyses, in order to establish the chemical, physical and mechanical characteristics. The result of the analysis was registered in an analysis report, on the basis of which we chose the material having characteristics equal or superior to those given by the analysis report.

The quality of the material which was used for repairs was established by the repairing technologist whose job is to ascertain the necessity of the repair, to establish the machine parts that are going to be replaced with new parts from the supply or which are manufactured by own means, to specify the processing and working out technology, the thermic treatments, the tolerances and adjustments suitable for assembling and fitting.

Before applying the thermic treatments we checked the accuracy of the processing and the macro-geometry of the machine part: cylindricity, ovalty, which are supposed not to exceed half of the afferent tolerance field.

4. CONCLUSION

Each hour when the equipment is not functioning brings an expense of 1.492 lei, leading in the end to costs of 253,810 lei for the industrial unit.

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