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Organization of the Process of Productive Operation of Equipment as One of the Necessary Conditions of Rational Production Organization

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***Abstract*: The service and equipment repairing process is the necessary condition for the growth of production capacity of enterprises, and thereafter it predetermines the approach for organization of production and upbuilding of production streams.**

In the article different options of reduction of working hours loss are considered, due to equipment downtime elimination because of repair and equipment maintenance on the reason of the increased operation. Also, in the article reserves of growth of labour productivity and reductions of unit cost are identified. It is proved, that current equipment monitoring allows to eliminate different defects in rationing of operating time of the equipment, it also allows to reach the permanent production's rhythms, to increase the monitoring level, to provide the timeliness delivery of materials and components. As the example, in the research was used factual material of planned measurement of technical condition of the equipment on a separate production of GAS Group, methods of monitoring of technical condition and productive equipment maintenance and standard criteria of the equipment's condition were developed.

Keywords: Efficiency, Equipment maintenance, Equipment's monitoring, Organization of production, Technological process.

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I. INTRODUCTION

Set of factors may have effect on the productivity and efficiency of production, the structure of production and its technological level, intensity of work and non-productive expenses of working hours are taken into account [1, 2, 12, 17, 19, 22, 26]. As an analysis of these enterprises of GAS industrial Group shows, untapped opportunities of improvement of these indicators are closely connected with the systematical losses, which were revealed during use of the equipment. The increase in efficiency can be possible due to increases in relative time of operation of the equipment, simultaneously it should be reduction of unplanned idle times because of breakages. At the same time, productive equipment maintenance can be problematic, because of the general deterioration in technical condition of the equipment – especially, growth of vibration's parameters due to the lack of the system account of "contour indices" of operation of the equipment, but generally – universal techniques of monitoring of productive maintenance of equipment [3, 23, 24].

Thus, the equipment is in operating condition most of the time, so monitoring and recording facts of deviation and the basic service of equipment should be maintained on regular basis. This fact can be proved by the sampling test, which was hold on enterprises of product group "GAS" during 2014-2015, and with this test were found out additional losses due to vibration in amount of 5 percent of annual fund of working hours [18, 20, 21].

This can explain the necessity of current technical control of the operating condition of industrial equipment of enterprises and it demands developing of theoretical and practical approaches for solving revealed range of problems.

II. METHODOLOGY

As any other activity, the activity of equipment service should always be under control and should always be in strongly systematicity of its implementation. The decision making of organizational and administrative questions should be held in next consistency. On the first stage, you need to study operating condition of the equipment and its contour functioning indices. Besides, the factor analysis of the reasons of productive and unproductive losses should be conducted.

It can concern losses, which are connected with breakage of equipment, and as the result – the attendant increase of expenses due to productivity slowdown and unscheduled repairs. On the second stage, you need to form demands to current equipment state and normative (wishing) contour indices of its functioning. At the same time, it can be possible graduation of normative values over the range "very critical" – it can mean the full stop of equipment, thereafter the full stop of production, to the range "uncritical", when descriptions of equipment do not impact the final workshop productivity.

On the third stage, a monitoring system of contour indices of equipment functioning is developed and its technical standards of diagnostics are formed. Diagnostic events are planned to be held in regard to rotor machines with nominal capacity more than 10 kW, machines with an electric drive gear, rotary pumps, electric substations in part of possibility of appearance of defects, and it can be related to the change of emission of heat on purchased enterprises product group "GAS" in 2014-2015 years. The list of the equipment which is the subject of monitoring of its technical state was formed on basis of its technical danger during use and coming from the contour indices of its functioning.

III. RESULTS

As the conducted research has showed, if want to solve this kind of problem, we need to develop two-level system of monitoring of the equipment.

A. The first level of the equipment monitoring system

The first level will provide fulfillment of the efficient control of current parameters of operation of the equipment. Herewith the fulfillment of the monitoring, the measuring of the equipment functioning parameters must be held on regular basis with some periodicity for the [6-8, 15]:

- first and second group – from 1 and more time per day;
- for the equipment of the third and fourth level, depending on its current state: when the value is "good" or "acceptably" – 2 times a week, but not less than once in three weeks, when the current state needs "taking measures";
- for the equipment of fifth group, when the value is "good" or "acceptably" it is allowed to make control once a month; but if the current state demands of "taking measures", we need to make it not less than once in three days or of necessity.

For example, the measuring of parameters of the equipment's vibration, which was equipped with system of the constant control of vibration, must be held:

- for compressors – not less than once in 0.5 second;
- for the equipment of the first, second group – not less than once in 20 seconds.

But at the same time, it is possible to change of the period of measurements of indices of operation of the equipment, depending on the current characteristics of its maintenance [13, 14, 16].

For example, if an intense vibration would be found out, which corresponds to the value "taking measures", the equipment should be stopped, control measuring of operating characteristic should be taken, the act should be made out, and some instructions for elimination of defects should be made also. The further operation of the equipment can be possible, only if the value "good" or "acceptably" will be reached.

B. The examples

The examples of measurements of different kinds of the equipment on enterprises of the product group "GAS" are presented on the Fig. 1 and 2. They are showed in the form of schemes with the indication of points of control.

The example 1. The arrangement of points of control for the vibration's measuring for the centrifugal compressor machines (Fig. 1):

1. the point on bearing body of free shaft end;
2. the point on bearing body of the loaded end of a shaft;
3. the point on the reducer's body in an arrangement zone of the support bearing of low-reverse shaft;
4. the point on the bearing body's components from the side of exit of a high-speed shaft;
5. the point on bearing body of the loaded end of a shaft;
6. the point on bearing body of free shaft end of compressor.

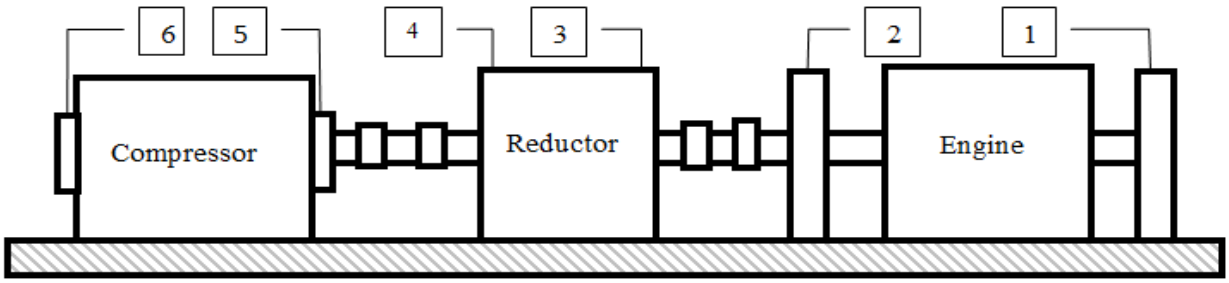

Figure 1. The scheme of the arrangement of points of control for the vibration's measuring for the centrifugal compressor machines

The example 2. The arrangement of points of control for the cradle-mounted pump (Fig. 2):

1. the point of measuring on the engine's body in free shaft end zone (back bearing);
2. the point on bearing body of the loaded end of a shaft of engine –front bearing;
3. the point on the pump crankcase in the zone of bearing, closest to clutch – front bearing;
4. the point on the pump crankcase, in the zone of bearing, distant from clutch – back bearing.

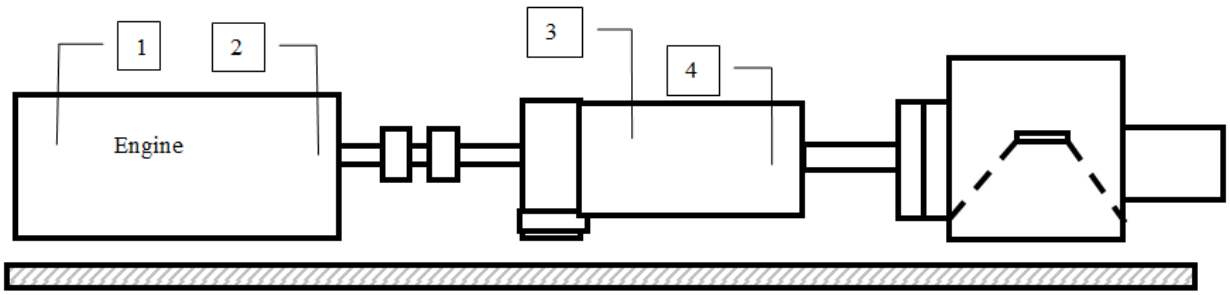

Figure 2. The scheme of the arrangement of points of control for the cradle-mounted pump

C. The second level of the equipment monitoring system

The second level means the organization of the systematic measuring of the equipment on its compliance to a particular "group of criticalness".

There are five groups totally: "very critical" equipment, "critical", "middle critical", "not very critical" and "non-critical".

On this level, some professionals make control with such periodicity:

- for the equipment of the first and second group – not less than once in two months, if the operating condition of the equipment belongs to the category "good", not less than once a month – belongs to the category "acceptably", not less than once a week – if belongs to the category "taking measures";
- for the equipment of the third and fourth group – not less than once in two months, if the operating condition of the equipment belongs to the category "good", not less than once a month if belongs to the category "acceptably" and not less than once in 14 days – if belongs to the category "taking measures";
- for the equipment of the fifth group the measuring can be held according to applications of person, who operates the equipment.

For the description of operating condition of the equipment during the monitoring the following valuation are established:

- "good" – the equipment can be characterized as operable and it is in operating condition;
- "acceptable after repair" – this is a quality rating, which characterizes its condition as efficient;
- "acceptable" – the decision about operation of the equipment is without restriction of terms (with small probability of refusal);
- "notification" – it means the necessity of actions for strengthening of control of the revealed defects;
- "needs taking measures" – it means the decision about short operation due to detection of essential defects, and as a result – it can lead to a possibility of equipment failure;
- "unacceptable" – it means the operation ban due to a high possibility of break-down;
- "stop" – it means certain recommendations to take immediate measures, which are connected with the preservation of integrity of the mechanism.

D. The solutions

As the conducted research has showed, for the solution of certain tasks we need [21, 25]:

Normative indices of operating conditions of the equipment are the values of vibrospeed (Ve) and vibratory displacement (Se). Their normative values can be defined experimentally on a separate production or with the help of benchmarking.

For the equipment which product life is more than 20 years – the main testing criterion is the degree of efficiency of the equipment.

For the value's accuracy, the control cut must contain not less than 1,000 measurements of the current parameters, also should be provided synchronous parallel data collection with different degrees of visualization, with the number of selections not less than 30.

According to the results of measuring, the conclusion of expert's commission on control with conclusions about current operating condition of the equipment and recommendations about its operation and the required volume of repair work in the predicted period (it means indication of exact terms) should be issued.

IV. DISCUSSION

The system control of operating condition of enterprise's industrial equipment with use the two-level monitoring system of the equipment allows us to reach:

The average operating time "on refusal" not less than 40,000 hours with probability not less than 95% [4, 5, 21];

The average term of operation on available capacity is not less than 10 years.

Temperature span is –20 – +500°C during continuous operation condition not less than 8 hours.

It was possible to improve skills of staff, who receives knowledge about technical characteristics of the controlled equipment,

who also receives knowledge about checking technique and access for monitoring in according to requirements of the Rules of personnel certification.

It was possible to reach standard values of restoration time of the equipment's efficiency – no more than half an hour, the maximum time – no more than 2 hours.

The use of the offered methods of monitoring of the equipment in production of industrial group helps us to receive such results as

Laboriousness of products was reduced more than in 2 times (Table 1).

Table 1. The change of laboriousness of products due to implantation of new methods in 2015-2016 years

No.	The laboriousness before use of new methods, hours	The laboriousness after use of new methods, hours	Reduction of laboriousness of production, hours	Reduction of laboriousness of production, %
Prod. 1	58.0	24.0	34.0	58.6
Prod. 2	59.0	23.0	36.0	61.0
Prod. 3	83.0	28.0	55.0	66.3
Total	200.0	75.0	125.0	62.5

Work losses were reduced, which were connected with additional repair and equipment operation – up to 30 percent from general time in a year [9-11].

Some changes were made in operational planning of production activity in the part of resource provision of production lines, which has helped to reduce the specific weight of losses as a result of stoppages in provision up to 3% of annual;

Standard hours of current service of the equipment were formed, and these have helped to reduce losses of working hours, as a result of organizational and technical reasons up to 1.9% in a year.

The organization of workplaces was changed with the purpose of reduction of temporal labor costs for transferring from one operation to another. Rational organization of workplaces and arrangement of the equipment let us to increase average annual manufacture up to 1.26 %.

The share of unplanned repair was reduced, and as a result loss from spoilages were reduced to 35%.

During the examined period were reduced the losses from spoilages on 36.1% of annual.

V. CONCLUSION

That is why, in the research was made the assessment of operation condition of the equipment with the purpose of following transfer to operation on actual state and scheduled preventive repair with flexible schedule and checking of operation condition during operational process and during pre-repair and post-repair periods.

Besides, in the research were considered the possibilities of organization and realization of monitoring of operating condition of machinery equipment during operational process with the help of methods, with use of stationary and portable measuring devices, and devices of the analysis of vibration, thermography and temperature monitoring etc.

During the assessment of operation condition of the equipment during its functioning process, we need to consider either numeral value of vibration parameters, or speed of its changing as a result of current actions, which have been adopted due to experience of previous measuring of operating characteristics of the equipment under "normal" conditions of its functioning. Also, in some cases we need to find out the contour indices of unit, for detection of the reasons of vibration of rotor machines during their functioning. Particular difficulty can be with checking during operation of a vibrostate of bearing mount assemblies with the help of means of vibrometers and temperature by means of pyrometers. It is recommended to use two-level monitoring of operation condition of the equipment, also it is necessary to control equipment's vibration, the temperature of bearing mount assemblies and the distribution of the temperature field. Diagnostics helps us to reach good results on saving of time for repair or the forced stopping of the equipment, which can be connected with an overheat – for example, bearings from vibration. After introduction of methods of diagnostic of the industrial equipment we will be able to receive:

The increase of labour productivity at enterprises – the average annual effect of introduction of such measures for increase of labour productivity will be 13,804 thousand rubles in general at enterprise.

We will be able to reduce cost of production. This index is the situation indicator at industrial enterprises with not planned stops due to failure of the equipment, when usually the defects are made.

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