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# IMPROVING THE RELIABILITY OF AIR COMPRESSORS POS. 101J AT AMMONIA PRODUCTION

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**ABSTRACT**
*Information about the modernization of the compressor unit in order to increase its reliability and efficiency. Description of the design of the installed nodes produced, their advantages and principle of operation.*
**KEY WORDS:** *comprehensive modernization, performance, vibration level, damper bearings, labyrinth seals, elastic couplings.*

## 1. INTRODUCTION

The modernization of air compressors, in this case, means the reconstruction associated with the installation of units designed and manufactured by LLC

Experiment in order to reduce the inevitable power losses in the unit and increase its reliability. The power savings thus obtained can be used to compress additional air. Let us consider in more detail the influence of each node on increasing the efficiency of the unit as a whole.

Elastic couplings (Figure 1) are installed instead of regular gear couplings. The transmission of torque, in such couplings, is carried out through packages of elastic elements. Due to the elastic properties of the packages of elastic elements, the couplings are able to damp vibrations of the shaft line, the elastic couplings have excellent compensating and vibration-isolating properties, due to the elastic properties of the membranes, do not require lubrication, are easy to maintain, have low friction power losses and a long service life. The type-setting membrane design is not subject to jamming.

Elastic couplings simultaneously have torsional rigidity and flexibility in the axial and angular directions, compensating for significant shaft alignment, including misalignment. The couplings comply with the requirements of the API 671 standard "Special Couplings for Use in the Oil Refining Industry".

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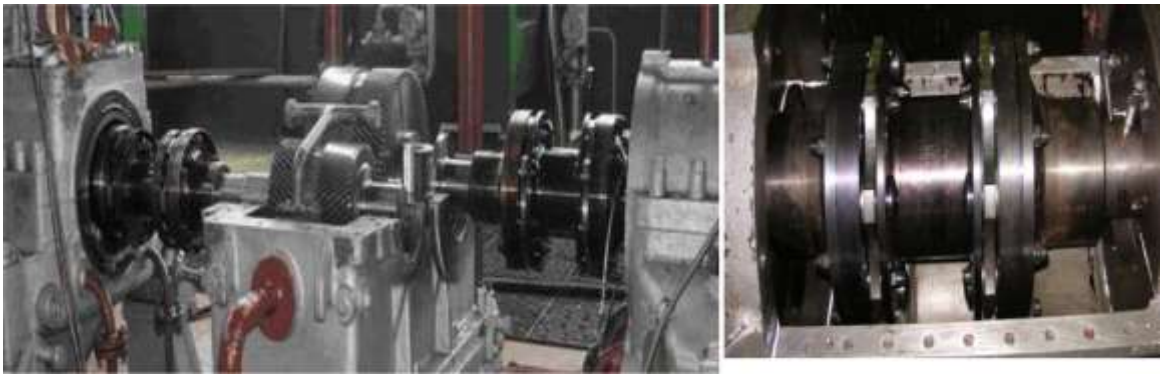

**Figure 1 - Elastic Couplings**

The effect of replacing regular gear couplings with elastic ones:
- Decrease in power losses due to elimination of friction between teeth;
- Reducing the loads acting on the connected shafts and perceived by the supporting bearings due to the best compensating properties of the elastic couplings. Reducing loads leads to a reduction in friction power losses in bearings.

The power loss in the gear clutch is about 1%. The power transmitted to the compressor in nominal mode is about 12 MW. Thus, tentatively, the losses will total about 120 kW. Even considering that the installation of elastic couplings will reduce the loss of transmitted power by 0.5%, the expected annual effect will be:
60 kW x 24 hours. x 365 days = 525 600 kW x hour / year;

**Labyrinth seals** (Figure 2) of the flow part made of polymeric materials can reduce leakage by reducing the gap. Since the polymer material allows the contact of the sealing combs with a rotating rotor, the clearance in the seal can be reduced by 2-3 times. With minor rotor movements, due to the flexibility of the material and design features, the seal ridges deviate. When the load is removed, the ridges return to their original position. This allows you to keep the gaps stable throughout the entire period of operation. With a significant movement of the rotor as a result of increased vibration (violation of the technological mode of operation of the compressor, surging, output to the operating mode of operation, etc.), the seal ridges, at the points of contact with the rotor, are wiped. At the same time, there are no damages on the rotor.

**Figure 2 - Labyrinth seals made of polymer material.**

According to calculations, a decrease in power losses associated with gas flows in labyrinth seals can increase the efficiency of the compressor unit by 2.4 ... 2.7% and reduce power consumption by 191.7 ... 212.6 kW. With constant power consumption, an increase in productivity is possible. Value
Clearances in labyrinth seals and their wear during operation directly depend on the magnitude of the rotor precession in the thrust bearings.

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Damping bearings (Fig. 3) manufactured , compressor rotor precession by 1.5 ... 2 times. The use of damper bearings ensures high stability of the gaps during operation due to the absence of mechanical contacts of the bearing blocks with the bearing housing and their high bearing capacity. The use of damper bearings together with seals made of polymer material allows not only to extend the life of expensive polymer seals, but also to maintain stable unit performance over several overhauls due to the stability of the gaps in the labyrinth seals. As practice shows, it is the increase in the gaps in the standard seals, due to increased vibration of the rotor at the starting and non-design operating conditions, causes a gradual decrease in the performance of the compression housing.

Damping bearings have increased bearing capacity compared to a bearing of a standard design. They are distinguished by simplicity, compactness and high maintainability. The installation of damper bearings allows to increase the reliability and efficiency of the unit, reduce the level of vibration, including during transient and non-stationary operating modes, provides a soft transition through the critical frequency.

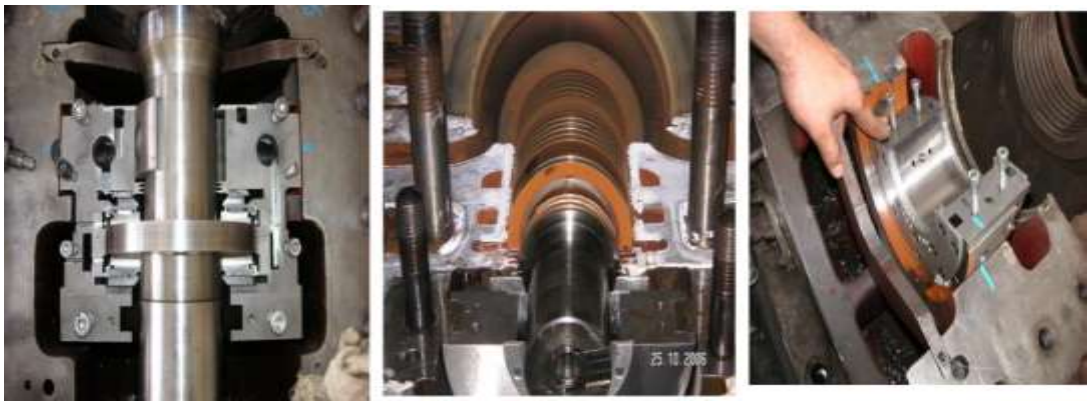

**Figure 3 - Damper bearings for compression housings**

During modernization, the installation of damper bearings is also carried out in the multipliers (Fig. 4). The use of damper bearings in multipliers has the following advantages:

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- Increased, in comparison with "lemon" or multi-V-ribbed bearings, damping ability due to the presence of self-aligning blocks with two damping oil films;
- Increased maintainability of the site. To correct defects of the babbit surface or to restore increased gaps, it is enough to perform boring and installation of a new set of pads. At the same time, there is no need to perform scrapping.

The presence of “crackers” on the outer landing surface reduces the time required for laying the gear pair;

- Wear on the liners is minimal. This allows you to save mounting clearances, prevents distortion of the axes of the gear pair, causing an increase in power loss in the mesh.

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**Figure 4 - Damper bearings for multipliers**

In order to increase the reliability of the support and thrust assembly of the K15-41 steam turbine of the K-1290 compressor drive, the ammonia production workshop of Grodno AZOT, a damper thrust bearing was designed and manufactured (Fig. 5). Improvement of operational characteristics was achieved due to: the rejection of a spherical landing surface, the presence of a damping bearing part, and a thrust-type lever system. The bearing has been in operation since 2007, and during this period no complaints have been received from the technical services regarding its operation.

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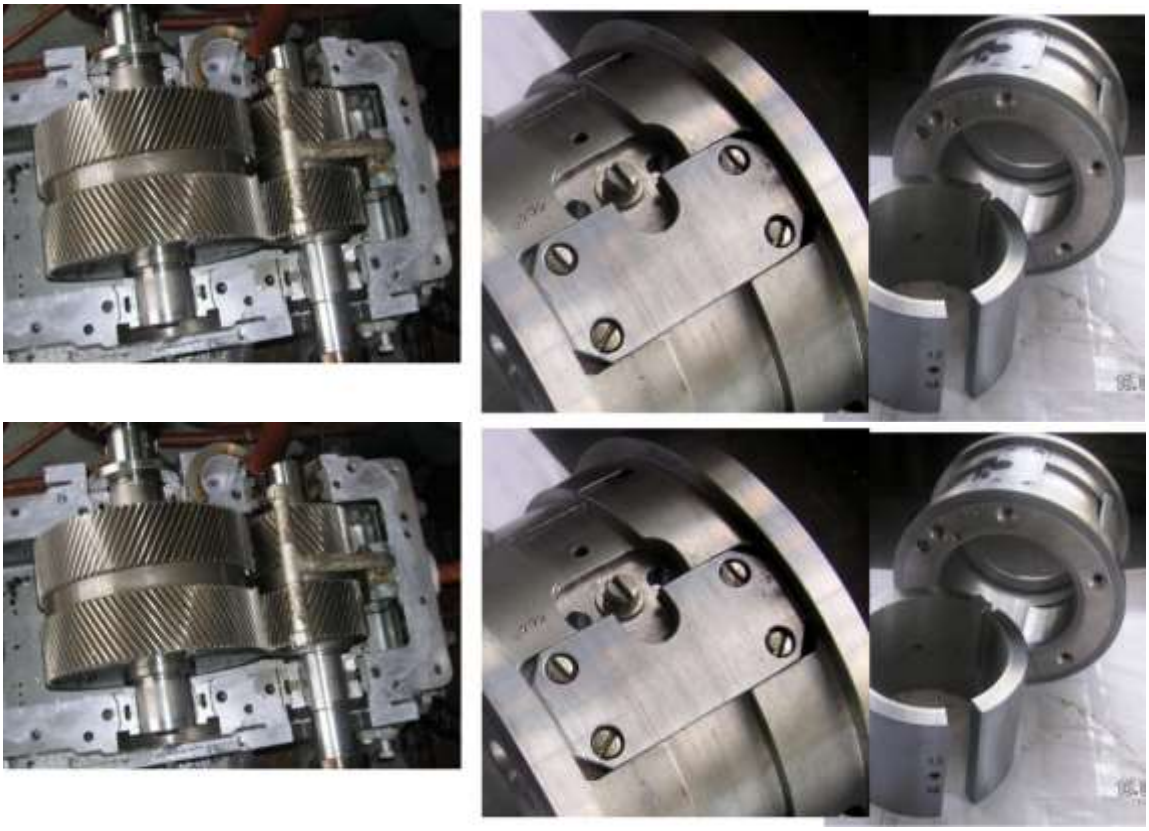

**Figure 5 - Damper thrust bearing of steam turbine K15-41**

## CONCLUSIONS

Operation of the unit with the installed units showed their high reliability and efficiency. It allowed:

- Increase the reliability of the units; - reduce the overall level of vibration;
- reduce the cost of repairs and maintenance;
- increase work efficiency by reducing power losses;