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Selected operating problems of central pumps

Wybrane problemy eksploatacyjne pomp wirowych

Abstract

The article presents problems of maintaining the Z-type supply pumps and network operated in ENEA Wytwarzanie Sp. z o.o. Heat Segment, Białystok Branch with the use of thermovision and vibrodiagnostic studies. The practical aim is to select parameters of the supply pumps (multistage) which ensure energy efficient operation despite a serious operational wear - a 20-year working period. Commissioning of a Z-type feed pump and thermovision tests of selected machine construction elements constituted the subject of the research.

Keywords: centrifugal pumps, feed pumps

Streszczenie

W artykule przedstawiono problematykę utrzymania ruchu pomp zasilających typu Z i sieciowych eksploatowanych w ENEA Wytwarzanie Sp. z o.o. Segment Ciepło, Oddział Białystok z wykorzystaniem badań termowizyjnych oraz wibrodiagnostycznych. Celem praktycznym jest dobór parametrów pomp zasilających (wielostopniowych), zapewniających energooszczędną eksploatację mimo poważnego zużycia eksploatacyjnego – 20 letni okres pracy. Przedmiotem badań był rozruch pompy zasilającej typu Z oraz badania termowizyjne wybranych elementów konstrukcyjnych maszyny.

Słowa kluczowe: pompy wirowe, pompy zasilające

1. Introduction

Z-type supply pumps are multi-stage pump constructions. These pumps consist of pressed and suction bodies and stepped rings joined together with tie bolts.

Housings have horizontal paws in the axial plane to support the pump on the foundation slab. Each member consisting of a step ring, a rotor and a steering wheel is one pump stage. The tightness between individual step rings is ensured by the pressure of lapped sealing surfaces. The pump shaft is guided in radial slide bearings and in a two-way sliding Michella bearing type. Bearings are circulated by oil under pressure. In the place of passage through the gland, the shaft is protected by exchangeable sleeves and sealed with an intense cooling water sealant. Glands together with stuffing box covers are attached to the suction and discharge body of the pump. The axial thrust of the rotating assembly is balanced by the unloading disc and the sliding axial bearing. In addition to inlet and outlet chutes, the pumps have two others: the first one allows for the injection of steam and the second for connecting the pump with the minimum controlled flow valve.

Fig. 1. Steam water pump for the Z-type steam boiler

The valve ensures a minimum flow of water through the pump to protect it from fogging and consequent obliteration. This does not exclude the need to ensure that the suction of the pump is properly inflated, which is always determined. The pump is covered with an insulating mattress and a sheet steel cover. In Fig. 1, photographs illustrate a feed water pump operated at ENEA Wytwarzanie Sp. z o.o. Heat Segment, Białystok Branch.

2. Experimental tests for starting a Z-type power pump

The research was carried out at ENEA Wytwarzanie Sp. z o.o. – Seg-ment Ciepło Białystok Branch. The test object was a Z-type pump supplying a steam boiler.

The scope of the tests included the measurement of vibration of slide bearings mounted on the shaft and checking the correctness of the occurrence of the so-called "Lubricating wedge".

For testing of bearing shells, DIAMOND 401 high quality measuring equipment (Fig. 4) was used together with sensors. The tests were supplemented with measurements from a KSD 400 computerized vibration analyzer. The results of the measurements were presented in graphical form in Figs. 6 and 7.

Fig. 2 presents the rotor model made in the Autodesk Inventor Professional environment. Fig. 5 presents selected results of thermovision tests carried out on bearing housings.

Fig. 2. Rotor model of the Z-type feed pump

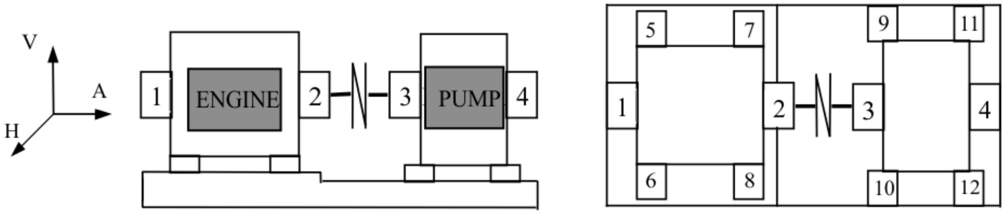

Fig. 3. Scheme of measurement points on the pump set

The measurements were carried out using a KSD 400 vibration analyzer with an eddy current sensor. The effective value of vibration velocity (in mm/s) was measured with automatic selection of bandwidth and filtration.

The performed tests allowed for determination whether the shaft of the rotor machine, in this case the Z-pump "rubs" against the slide bearing, which caused resonance vibrations, and ultimately led to the least expected cause of machine failure.

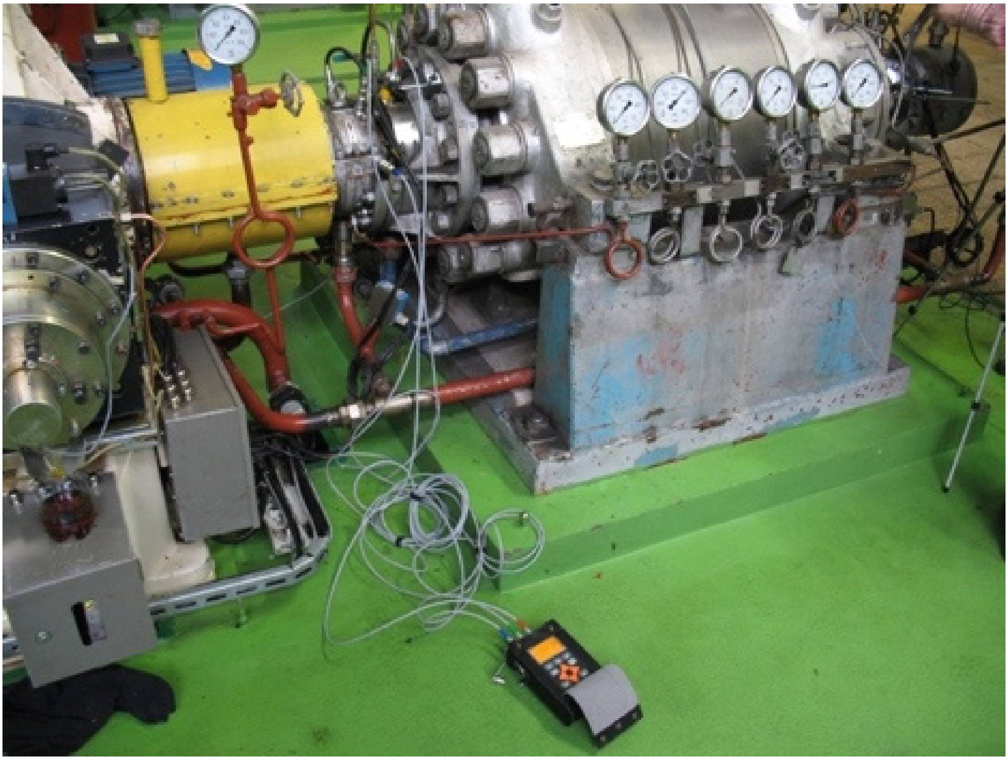

Fig. 4. Diagnostic apparatus used during experimental research

Mainly used acetules, spigots and other retaining elements are the most frequently observed damages of the Z-pump in question. Lack of axiality and the occurrence of a high level of machine vibrations may indicate disturbances and breaks in lubrication, which causes the disappearance of the oil film. The disappearance of the oil film in the final effect leads to the destruction of the surface layer of the sliding bearing shells, to the so-called machine smearing.

Self-excited vibrations generated in bearings while meeting strictly defined conditions constitute another major problem closely related to the lubrication of rotor machine. The most often evoked causes of self-excited vibrations include too low loads (which occurs in our case) and large radial clearances. The vibrations rise irregularly at a rapid rate [1,5].

In order to prevent the occurrence of a given phenomenon, which is a potential cause of the defect and can cause a real failure of the rotor machine, it is necessary to reduce (as much as possible) the risk of instability by correcting misalignment, eliminating excessive slack and possibly changing the slide bearing geometry. Each intervention in the geometry of the machine's structural elements must be made by the manufacturer of the machine, otherwise the failure of the machine may result in an operational catastrophe, as was the case with the carbon ball mill, which was presented in the earlier part of the dissertation.

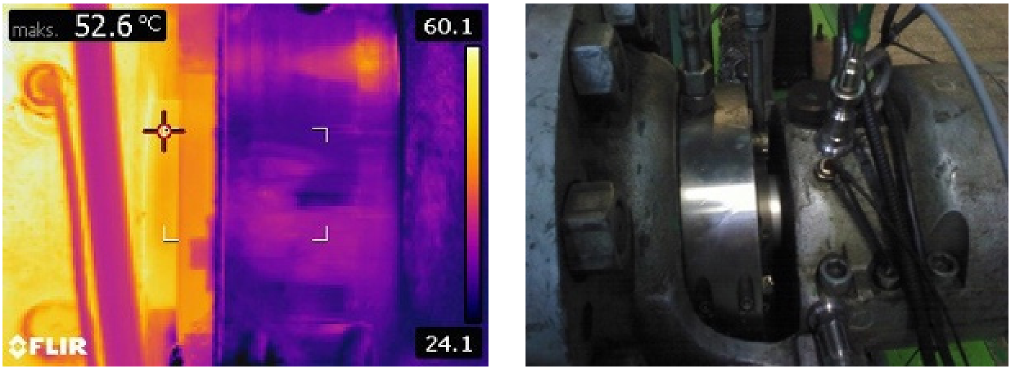

Fig. 5. Testing with the FLIR thermovision camera Z-pumps

On the basis of the vibration spectrum of the rotor shaft, it is possible to recognize the type of work performed by a given shaft [5,8].

Incomplete load of the tested Z-pump (Fig. 1) results from water supply to only one boiler. This type of pump load occurs in summer periods due to a lower demand for thermal energy. The pump shows resonant vibrations, which indicates the need to perform the above-mentioned diagnostic tests to prevent unforeseen emergency stoppages.

The results of the diagnostic tests are presented below in a simple graphical form (Figs. 6 and 7).

It can be stated that at the beginning (below 1500 revolutions per minute) there appears non stability synchronized by the rotation of the shaft, bearing the name of an oil whirl. This phenomenon is manifested in a graphical form as a loop filled with red.

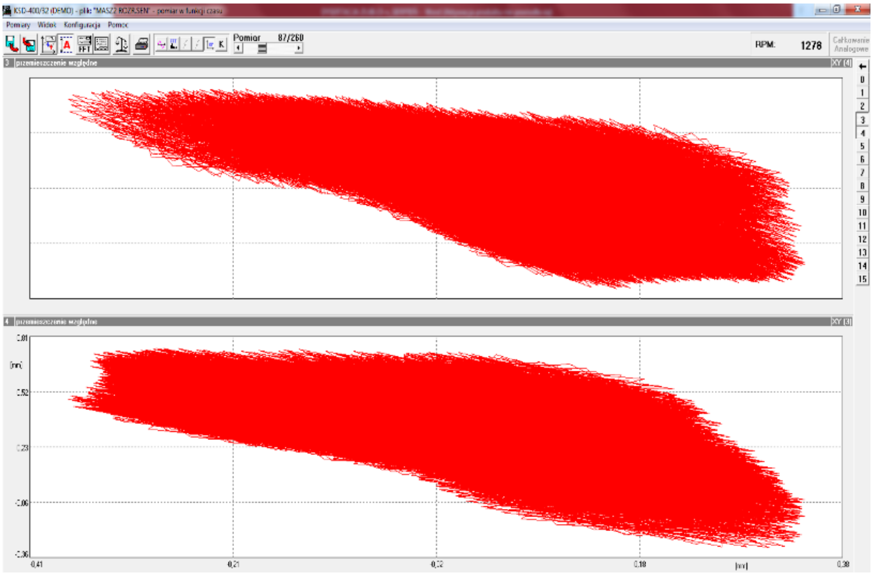

Fig. 6. Screenshot of the KSD 400/32 program - measurement 87 - RPM 1278

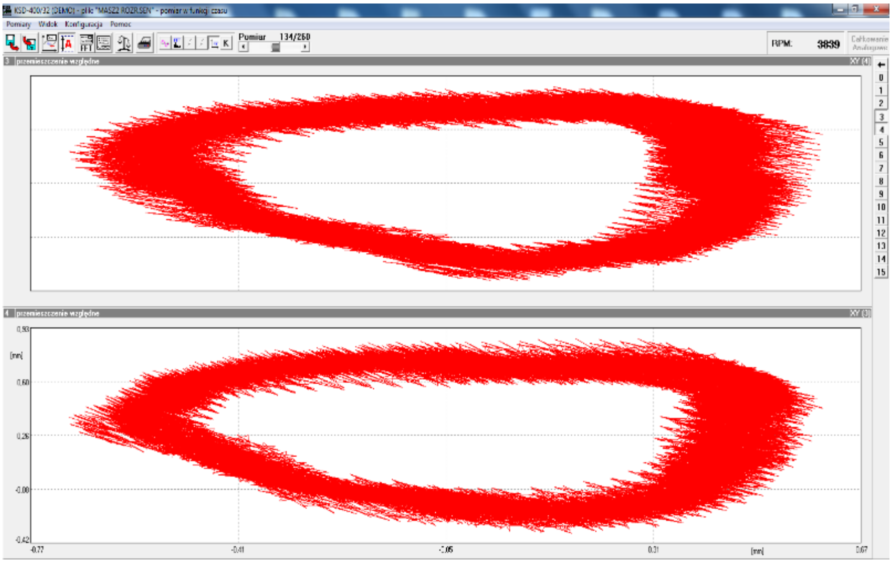

Fig. 7. Screenshot of the KSD 400/32 program - measurement 134 - RPM 3839

The loop begins to take the form of an ellipse with an open center after exceeding 3000 rpm, because the forces caused by rotation are then sufficient to stabilize the oil film. The rotor speed of the rotor stabilizes within the range of 3600–4000 rpm. A further increase in rotor speed would lead to instability, oil vortex, up to the speed corresponding to two times the vibratory frequency of the rotor. Above this speed, the rotor frequency (flexural vibrations) becomes the synchronizing factor.

3. Summary

In many branches of the economy, in particular in power and heat engineering, pumping costs can be a dominant component of production costs. Therefore, it is becoming more and more important to use reliable, high efficiency pump units, correctly selected for the systems and, properly, most economically controlled.

Pumps should be maintained at a high technical level through well-made (periodic) repairs. Stopping the pump for renovation should not be after a certain time but after exceeding the economic threshold (efficiency) or mechanical (vibration) [9].

Every now and then pumps (especially large ones) should be subjected to modernization repairs, which would allow (to industrial practice) progress in the construction of flow elements and thus reduce the energy consumption of the pumping process.

The benefits of repairs carried out according to the technical condition assessment result in the increased reliability and prolongation of life of individual components, and thus the reduction of maintenance costs. Before starting the renovation carried out with this method, critical elements of the device, evaluation criteria and methods of testing should be clearly identified.

The above activities should lead to obtaining qualifying results for its collection after the refurbishment during receiving measurements of the pump set.

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