ON THE DURABILITY OF CENTRIFUGAL PUMPS

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Abstract *Vibration diagnosis has developed rapidly, the practice of applying it proving to be highly effective, along with the development of measurement and signal processing techniques. Vibration diagnosis is preferred, with rare exceptions, to noise diagnosis, which is too much affected by ambient noise sources, requiring either special methods or devices or special measurement conditions. Vibrodiagnose, is one of the applications of fault diagnosis methods through vibration analysis to centrifugal pumps*

Keywords: centrifugal pump, *vibration, noise, spectru*

1. Process centrifugal pumps. Causes of use

The functional parameters of a pump do not keep its values constant throughout its life. This is explained by the fact that the parts that are part of the pump assembly wear out over time. In the case of centrifugal pumps, the nature of the wear of the parts is of two types:
1. Mechanical;
2. Chemical.
Regardless of the nature of the wear, it has the effect of modifying the geometric shapes of the parts, which ultimately reflects the modification of the hydraulic parameters of the pump (flow, pressure, pumping height)
The frequently used parts of centrifugal pumps are the most exposed parts, both abrasive and corrosive:
• rotor;
• labirinţii;
• shaft protection bushing;
• mechanical sealing;
• soft gaskets;
• camps.
When the unit is switched off for maintenance work, the wear condition of the parts is noted and replaced.

2. Vibrations in centrifums pump operation

In the exploitation of machines or installations of the various categories, vibrations may occur which, over a certain limit, lead to shortening the life of the machinery and represent for man often very dangerous polluting factors.
In general, [1] the most important parameters of the oscillatory movement A (t) can be considered as:
• pulse (ωo) - dependent on initial conditions;
• the amplitude - a parameter that characterizes the vibration size;
• Effective speed / aceleration - a parameter that highlights the vibration energy;
Pump aggregate vibration level, expressed as effective velocity (Vef), is measured at significant pump points (housing, bearing body, etc.).

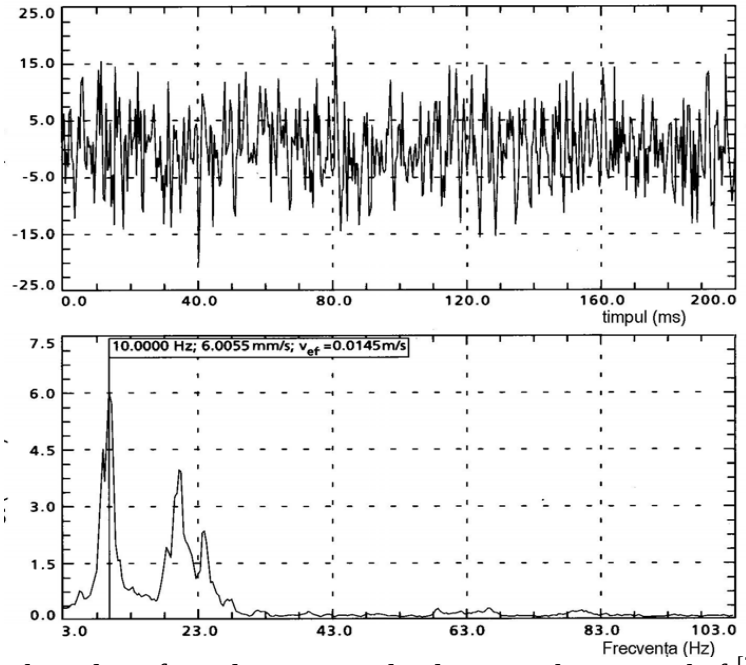


Fig 1.1 The value of accelerations and velocity at the pump shaft[2]

The vibration sources in a dynamic machine can be multiple, including the following:
• Bearing failure;
• Dynamic rotor imbalance;
• centering;
• Defective gearing (defective engagement);
• Resonance (inadequate stiffness, non-observance of working technologies, wrong design);
• Electrical faults (occurring at 2X network frequency and disappearing when power supply is interrupted, electrical circuits are closed by bearings);
• Vibration transmitted;
• Poor couplings;
• High bearing temperature (inefficient cooling systems);
• Flow of fluids through pipes.

Regularly maintained maintenance operations reduce damage caused by failures and accidents. Main maintenance operations in the case of mechanical equipment are replacement of used parts, filling of working fluids (lubricants, for example), adjustment of components and removal of wear factors (water, dust, acids, etc.).

The technical state of operation of a machine can be judged on the basis of the "symptoms" it exhibits during operation: vibrations, noise, increase of bearing temperature, change of temperature and pressure in the cooling circuit, etc. Dintre toate acestea, nivelul de vibraţii şi nivelul de zgomot sunt principalele criterii (principalii parametrii) de evaluare a stării tehnice de funcţionare a unui utilaj conform ISO 10816.

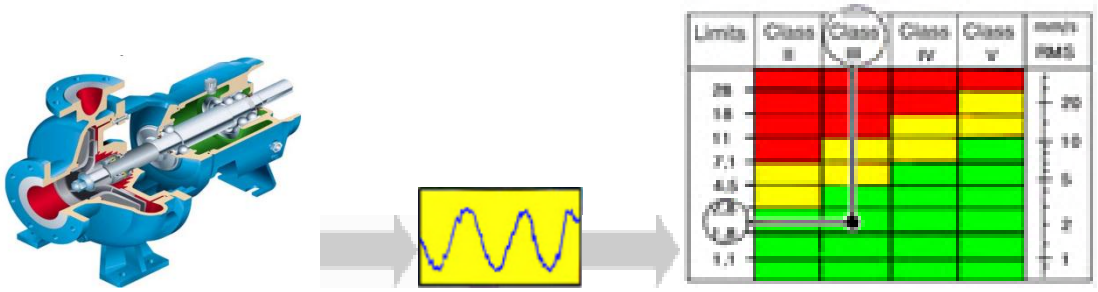


Fig. 2.1 Vibration and noise measurement on bearings[3]

Diagnosis involves periodic measurement of vibrations and noise on the bearings and comparison of the measured values with those prescribed by the machine manufacturer or with the standards in force.

When the vibration level is found to be within the acceptable range, it is advised that the maintenance team is ready to intervene at any time. When the vibration level has exceeded the maximum admissible value, it is necessary to stop the machine, dismantle it to determine the causes of the vibrations and then repair the faults.

Predictive maintenance is a superior quality leap in a modern maintenance system, regardless of industry or production specificity, as it provides all the information needed to:

• early detection of malfunctions;
• their location;
• Diagnosis of faults;
• calculate the service life of the machine.

All this is possible by vibration frequency analysis, FFT (Fast Fourrier Transformation) analysis. In reality, no machine works without vibration.

3. Vibration measurements of the pumps centrifuge

Assessing the technical condition and safety in the operation of a dynamic machine requires the collection of all the technical information from the measuring and control instruments that equip the machine: lubrication, pressures, temperatures etc. But the most useful information, along with those listed above, is the information provided by vibration measurements.

Vibration measurement will indicate whether the vibration level is within normal, still acceptable or inadmissible limits, but will not provide information about the fault and where it is located. The problem is all the more complicated in complex machines where, by evaluating vibrations in a bearing, we will not know if they come from the bearing, from coupling, from engagement.

Their values, compared to the admissible levels recommended by the manufacturer of the dynamic machine or ISO 2372 and ISO 10816, will indicate if the machine is operating in a safe condition.

Basically, to measure the overall vibration level, measurements are made on all the machine bearings on the three relevant directions. horizontally; vertically and axially.

The research addresses the following issues:

- Influence of the bifazic air-water mixture on the centrifugal pump characteristic and the cavitation aspects under these conditions.
- Vibration of the pump under operating conditions at different flows and cavitation

conditions
- Possibilities of using the results of ex perimental investigations at numerical simulations.

3.1 How to conduct experiments

The stand used consists of a centrifugal pump driven by a DC motor. The engine speed can be adjusted by varying the supply current by adjusting the motor winding resistance. A tachometer is mounted on the motor shaft which allows the motor speed (and the pump coupled to the motor via a mechanical coupling) to be viewed. The pump flow control can also be resistive with the valve mounted on its displacement. Pump flow is measured with a diaphragm coupled to a differential pressure gauge. The pressure created by the centrifugal pump is determined by the pressure difference between the pressure gauges mounted on the pump inlet and outlet.

Fig 3.1 Standul experimental al testarii unei pompe centrifuge

4. Experimental investigations results

Assessing the technical condition and operating safety of a dynamic machine requires the collection of all the technical information from the measuring and control instruments that equip the machine: lubrication, pressures, temperatures.
But the most useful information, along with those listed above, is the information provided by vibration measurements.
Vibration measurement will indicate whether the vibration level is within normal, still acceptable or inadmissible limits, but will not provide information about where the fault is and where it is located. The problem is all the more complicated for complex machines where, by evaluating vibrations on a bearing, we will not know whether they come from the bearing, coupling, gearing, etc.
From the point of view of the defects that can be detected we can enumerate:
• dynamic imbalance;
• faulty alignment (parallel or angular, cardan drive problems;
• electro-mechanical problems;
• defective engagement (specific reducer / multiplier symptoms);
• games and weaknesses;
• defects specific to bearings (with bearings or sliding);

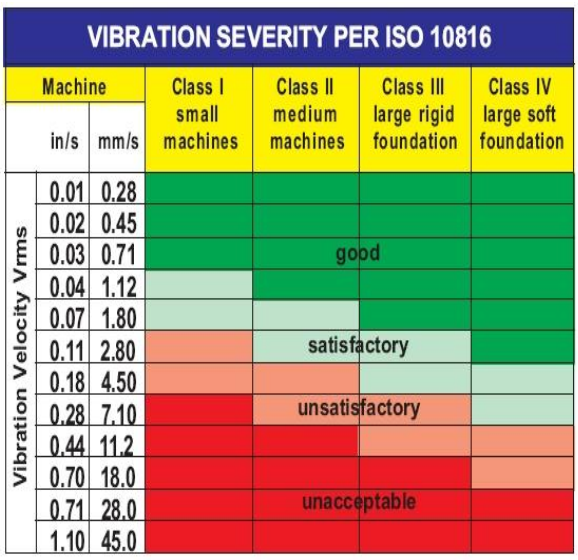
• resonances specific to related equipment or assemblies and much more.
Following the Vibrotest 60 vibration analysis on several centrifugal pumps, the following results were achieved:

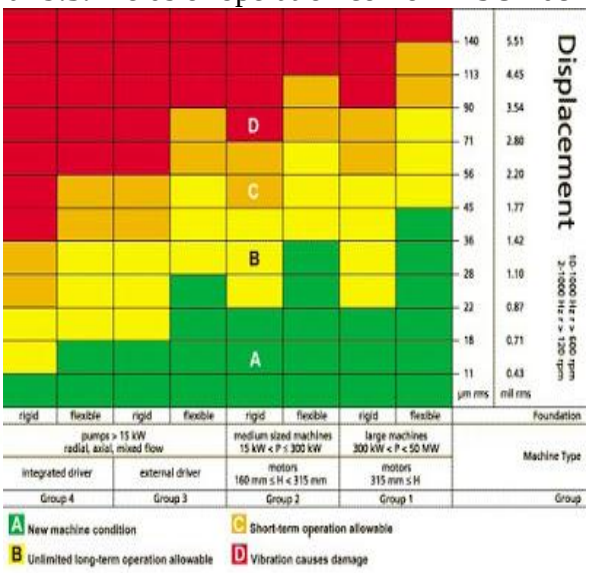
Tab. 4.1 Experimental results from vibration analysis on the centrifugal pump

Speed [rot/min]	Bearing 1			Bearing 2		
	horizontal [mm/s]	vertical [mm/s]	axial [mm/s]	horizontal [mm/s]	vertical [mm/s]	axial [mm/s]
1010	0.235	0.077	0.211	0.149	0.053	0.124
1220	0.279	0.106	0.161	0.130	0.110	0.138
1450	1.144	0.443	0.788	0.990	0.251	0.564
1800	1.365	0.593	0.992	1.293	0.378	0.772

Their values, compared to the admissible levels recommended by the manufacturer of the dynamic machine or ISO 2372 and ISO 10816, will indicate if the machine is operating safety.

Tabelul 9.5. Fields of operation conform ISO 10816





Conclusions

Centrifugal pumps are machines that convert mechanical energy into hydraulic energy by means of the active piece (the rotor), having different forms of construction: single-storey, multi-layered horizontal, multi-layered vertical or multi-layered oblique.
The main causes of centrifugal pump wear may be of a mechanical or chemical nature, and the most affected parts are: the rotor, the bearings, the shaft protection sleeve, the soft seals, the labyrinths and the mechanical sealing.
Vibrations caused by mechanical leaks on trees are the most dangerous because they lead to additional stresses due to shock, shafts and bearings.

Diagnosis of mechanical weakness by the vibration analysis method has a number of advantages such as: reduction of maintenance costs; increasing safety in operation; reducing wear in bearings etc.
Vibration on bearings is one of the global quality indicators, either through direct effects or indirect effects.
With vibration measurements we can determine defects such as dynamic imbalance, faulty alignment, gaming and weaknesses, bearing specific defects, etc.
The VIBROTEST 60 is used for vibration analysis, being a data collector and a balancing instrument at the same time.

Rules for Correct Measurement:

- Always on the camps;
- It is measured in the three directions (H, V, A);
- With the sensor firmly attached to the bearing;
- Using the same bearing numbering system on all machines measured

Following the vibration analysis carried out on three types of centrifugal pumps, namely the single-stage pump, the multi-stage horizontal four-pump pump and the multi-stage horizontal ten-pump pump, these machines do not require repairs because vibrations fall within the prescribed limits.

References

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