

## Diagnostics of Mechatronical Systems with Vibration Insulation

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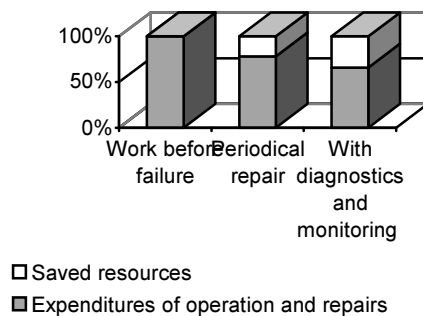
**Keywords:** vibration insulation systems, diagnostics, monitoring.

**Abstract.** The paper work examines the opportunities of diagnostics of vibroinsulated mechanisms based on the measurement of mechanical vibration. Vibration insulation systems distort the diagnostic signal therefore the direct diagnostics of vibration of vibroinsulated mechanisms is impossible. The work objective is to analyse the influence of vibration insulation systems on the diagnostics of such mechanisms and to identify the kind of parameters on which this influence depends.

A stand for tests is made for achievement of this objective; using the stand the vibration of a mechanism can be simultaneously measured both directly and via the vibration insulation system.

### Introduction

Currently diagnostics and monitoring of mechanisms based on the analysis of mechanical vibration is not a novelty. Most of sophisticated and important mechanisms work with the stationary systems of failure diagnostics. Diagnostics of failures of not so sophisticated and important mechanisms can be performed periodically [1-3]. In any case when using the systems of failure diagnostics and monitoring in the operation of mechanisms, a considerable economic effect can be achieved. After the analysis it was discovered that when using the systems of failure diagnostics and monitoring, the expenditures of mechanism operation and repairs decrease by 30-40% (Fig. 1)[1]. The expenditures for installation of these systems are small compared with the profit – 1:10. [2]

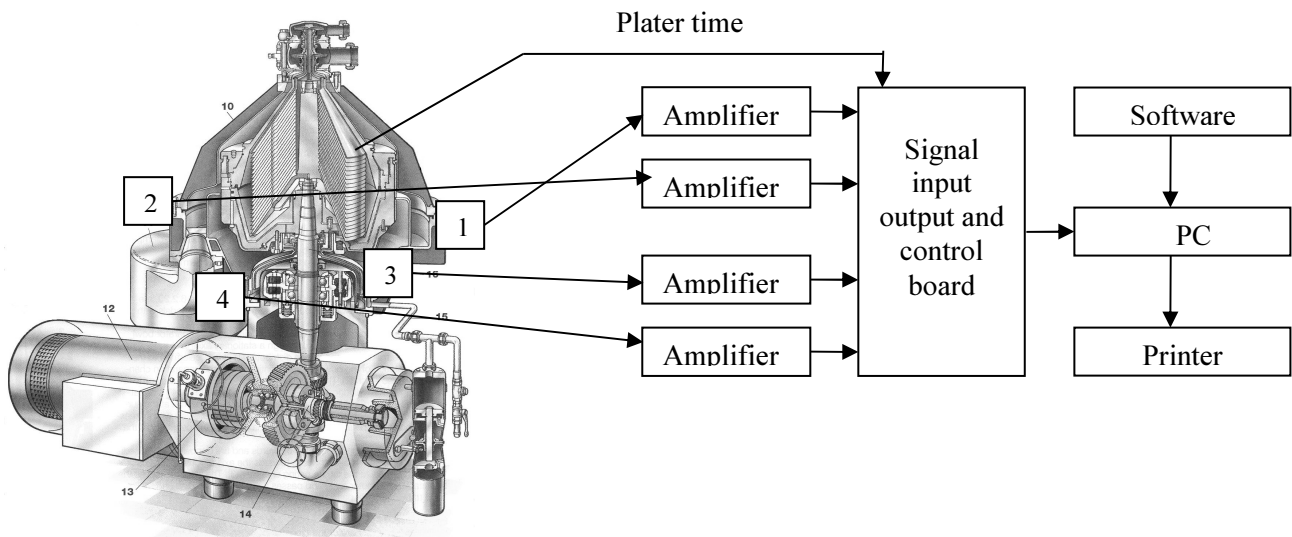


**Fig. 1.** The economic benefit of diagnostics and monitoring was calculated for 1kW power mechanism [1].

Unfortunately, there is a kind of mechanisms or their separate components the diagnostics of which is problematic. These are the mechanisms the mechanical vibration parameters of which cannot be directly identified (i.e. not through vibration insulation systems).

## Diagnostic System

A diagnostic scheme with distribution of converters is presented in Fig. 2. The label of point generates the impulses establishing the rotation angle of the rotary and four accelerometers measure the vibroaccelerations of the frame. The digital discretisation of signals in the system depends on what kind of signal is analysed. The highest frequency for most of the sources of stimulation of such system is 5 kHz, therefore the frequency of discretisation in every channel must make 12,500 rev/s over time. Discretisation using 12 binary lines can make a sufficient dynamical range for data processing. For the existing four channels it makes the full discretisation frequency, over time approximately 600,000 bit/s.



**Fig. 2.** Diagnostic diagram: 1,2,3,4 – accelerometers

At any stage of signal processing the data can be reviewed on the monitor of PC in order to be certain that the signals are processed correctly. The procedure of the signals processing is presented in Fig. 3. The Fourier transformation is used for the selected signal of vibroacceleration and the frequency spectrum of the vibroacceleration is received and after that the cepstrum of the signal is calculated. Cepstrum separates the “short - term” components in the signal, which are related to the spread of the direct vibration from the source and the “long - term” components, which are caused by the reflection and reverberation of waves in the construction. There is a possibility to simplify the procedure of identification of the source characteristics just keeping the “short - term” components of the signal. After that the inverse Cepstrum operation is used, which is suitable for short time. An inverse filtration is used for the received spectrum so that to move from vibroacceleration to the stimulation force. In the simplest case this inverse filter has the transmission function, which is reverse in respect of the transmission function from the stimulation force of the place, where the transformer is installed. In a general case such inverse filter can have a “Cepstrum window” used for the vibroacceleration signal. In the cases, when there are several stimulation and measurement points, more sophisticated inverse filters can be made in order to improve the opportunities of system diagnostics.

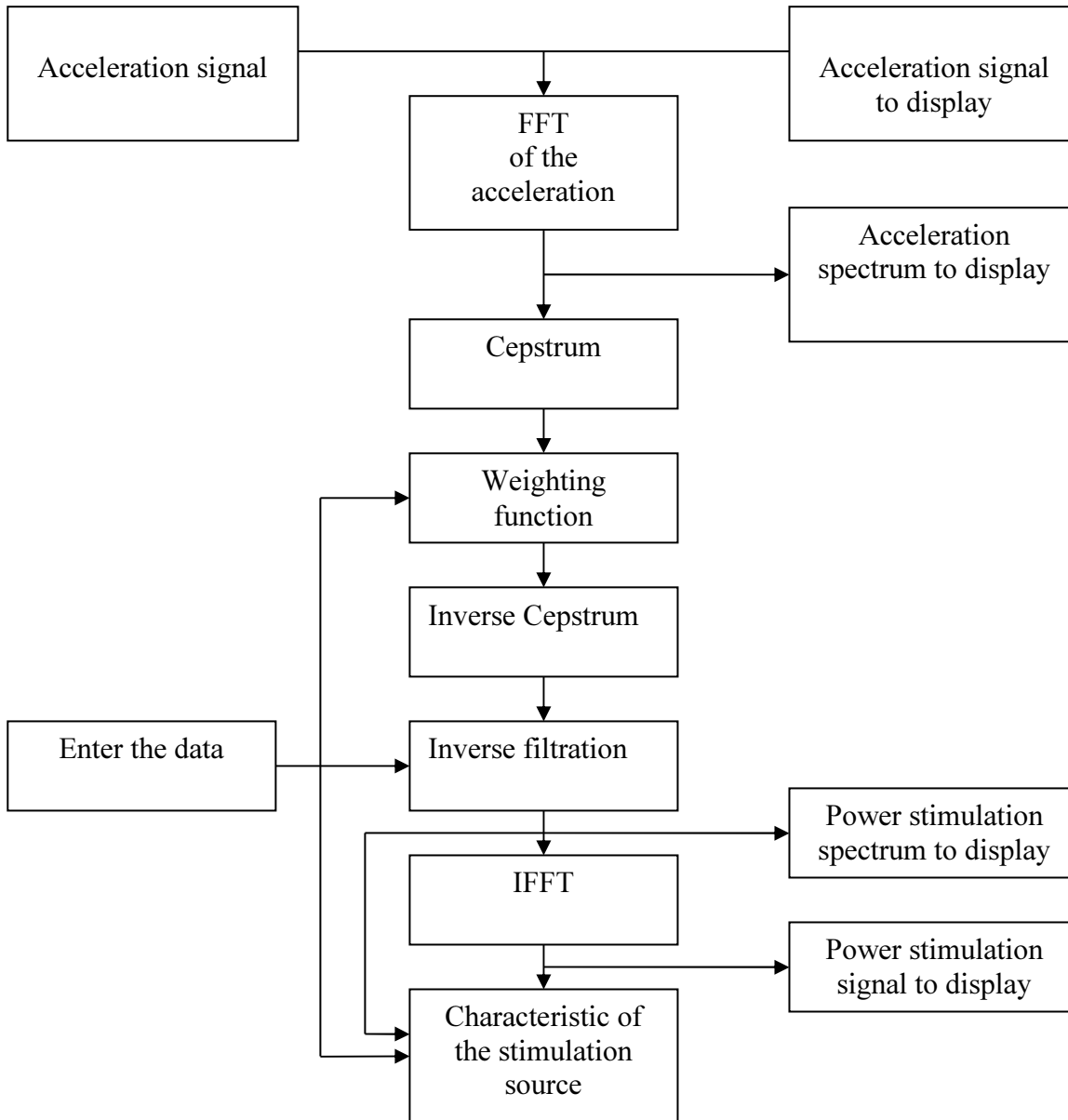


Fig. 3. Diagram of signal processing

When using the right procedures of inverse filtration, a frequency spectrum of one or another stimulation force is got. This spectrum or the respective time signal received by the IFFT can be used for diagnostics, for example, to make a decision of whether this stimulation source may be considered acceptable. This decision can be designated for identification of degree of the signal deflection from the given “standard” signal or for identification of the parameters of the measured signal, the permissible limits of change of which have been established earlier. This diagnostic system (Fig. 2) was implemented by VGTU in diagnostics of the vertical rotors with vibration insulation. Fig. 4 presents the signals of accelerometers and their frequency spectrums recorded, when the rotor is turning at a speed of 5,000 rev/min. These data have been reorganised using the Cepstrum window, which separated the short-time diapason and the inverse filter identified according to the results of the transmission function from power to the bearing acceleration. During the research vibrations of the mechanism were measured using Adash 4300-VA3 vibration measurement equipment. The received data, according to figure 3, were processed (recalculated) using Origin 6.1 software.

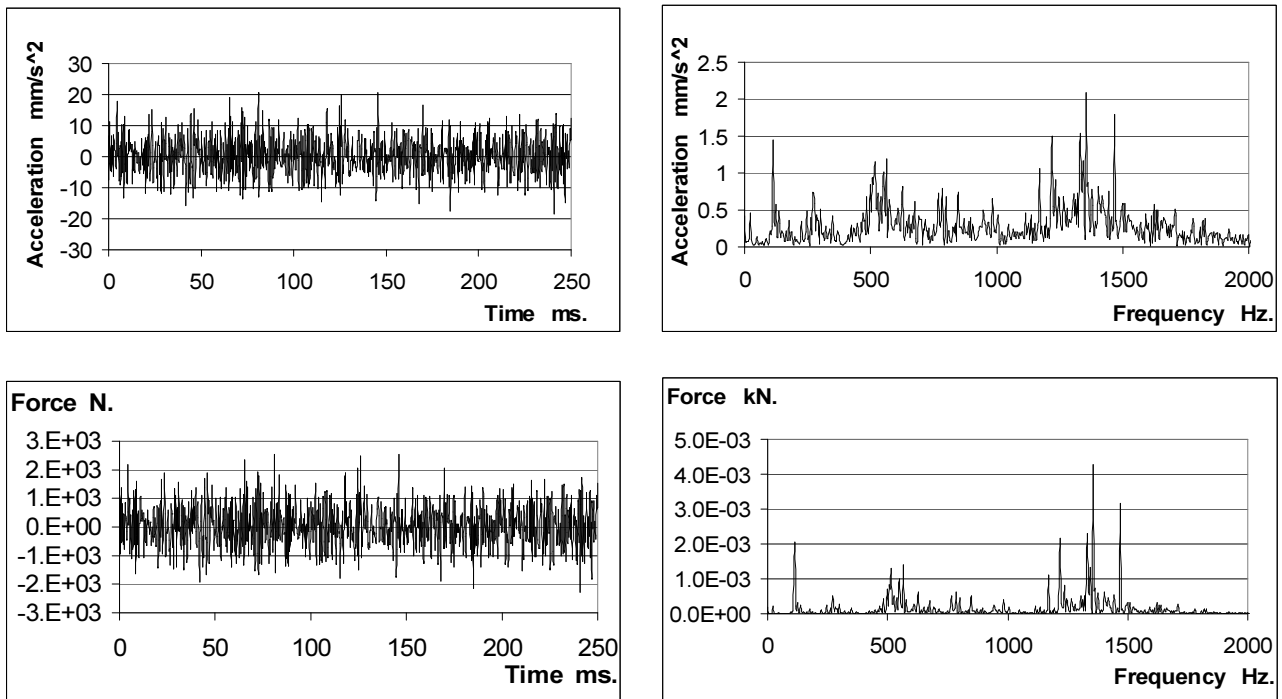


Fig. 4. Diagnostics of the stimulation source in the milk separator

## Conclusion

When using the diagnostic system, the nature of the stimulation source and the power of the stimulation can be identified and the construction of the bearing knot as well as the suppression mechanism can be respectively corrected.

## References

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