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CLASSIFICATION OF VIBRATION INFLUENCES OF PUMP STATIONS FOR WATER PIPES AND SEWAGE SYSTEMS ON MAINTENANCE PERSONNEL

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The development of cities, towns and villages with a well-developed system of communal economy is often accompanied by building up territories, which are next to objects of communal economy, the so called development land. Thus, earlier built facilities of water and sewage systems are in the area next to houses. In the majority of considered cases, expansion of the developed land has been carried out without evaluation of environmental situation. In particular, in the area of influence of production vibration levels, generated by the equipment of pump stations of water and sewage systems of draining pump stations and of heating systems. Due to it, the level of vibration both at work places and in housing zones is often higher comparing to standards. As a rule, this situation is worsened by the fact, that vibration influence is an additional source of noise as well. To make a positive decision of reduction of vibration and production noise influences, filed research of pump stations of water and sewage systems to determine sources of vibration, their classification on the indication of physics of the process of springy oscillation appearance have been carried out.

Pump stations of water and sewage systems are considered active objects of communal economy, technological processes of which are accompanied by presence of a number of dangerous and harmful production factors. Among the names on the list of these factors, increased level of vibration at work places of maintenance personnel is one of the most significant regarding human health [1,2].

Thus, the solution of the task to provide normal vibration situation at work places at the considered objects is actual. It is stipulated by the following main reasons.

Firstly, results of the research show that vibration is considered to be factors that possess significant biological activity towards a human body. Vibration disease, which develops due to influence of heightened level of vibration on workers, has the second place among professional diseases after pneumoconiosis [2,3].

Secondly, the solution of this task is even more difficult due to the fact that as a rule, vibration influences also generate sound oscillation of various frequency range, what leads to the intensification of production noise [1].

Due to the development of settlements, considered active objects of communal economy are often within the territory of development land. Thus, the decrease of the level of vibration allows solving a complex task, which includes provision of acoustic comfort in housing area, next to active objects of water and sewage systems.

The development of measures to decrease influence of dangerous and harmful production factor should be based on the system analysis, which includes a stage of determination, analysis of sources of vibration, as well as ways of its transmission to the environment.

As vibration influences are derivatives to formation of additional sources of noise, the environment means not only production facilities for personnel, but also a housing area of the settlement around it.

One of the variants of organization of considered production objects is location of equipment in underground chambers (fig.1).

Such a type of technological process is used to pump water from artesian wells with multistage water supply in water systems, which includes several levels of taking it up. The second direction is its application to sewage systems, where draining pumps are used.

In this variant, a pump station that is used to pump technological liquids (2) is placed in a chamber (1) and includes the following production equipment: pump equipment that includes the system of pipeline with valves (3); a pump (4); a reducer (5); electrical engine (6), which is used as a pump actuator.

The analysis of sources of vibration influence generation of such a pump enables to classify them, based on the following two indications (fig.2):

- a) vibration influences that are generated by the production equipment of a pump station;
- b) vibration influences that appear during the technological process.

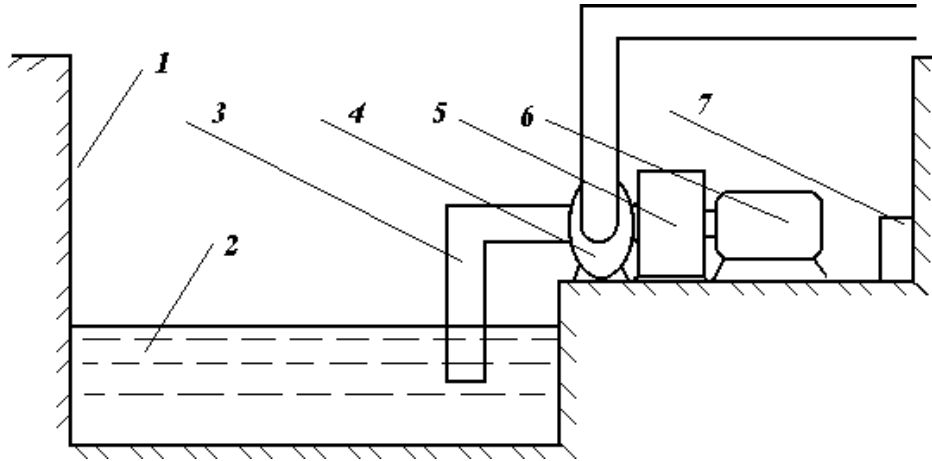


Fig.1. - Chamber with a pump station of water and sewage systems. 1 – pump station chamber; 2 – technological liquid; 3 – pipeline system; 4 – pump; 5 – reducer; 6 – electric engine; 7 – work place.

Such classification allows forming compounds of influences based on physics of the process of appearance and spreading of springy oscillations in a physical body. In the considered case, a physical body is a base, where the production equipment is placed and a work place of maintenance personnel is organized (7).

At the pump stations of the considered systems, appearance and transfer of vibrations to the environment take place from three main physical sources of the pump equipment (fig.2):

- 1 – electric engine; 2 – a reducer; 3 – a pump with equipment.

Vibration influence generated by each of the sources, is determined by a number of reasons which can be a result of insufficient level of production organization, qualification and production discipline of corresponding services and employees of the enterprise, and its economic situation.

Thus, the following reasons of vibration appearance, as a dynamic unbalancing of an electric engine rotor, wear of its shaft, increased clearance in teathed gears of a reducer and wear of rolling bearings, can be a derivative of both a low level of qualification and production discipline of corresponding services and employees of an enterprise, and economic situation of enterprises.

That is why, at the stage of setting a task to decrease a level of production vibration, it is necessary to analyze sources of the main reasons named above. For example, in the first case, checking of following terms of technical service and planed preventive maintenance of pump equipment is necessary.

And in the second case, the analysis of the term of the equipment exploitation, study of possibilities at enterprises from the position of possible investments to improve pump equipment is important.

On the other hand, vibration oscillation of each of the sources differs by the level and range components. Thus, the analysis and ranging of reasons of vibration influences is complicated by the fact that characteristics of every source of vibration go one upon another while working with technological equipment, what causes “masking effect”.

Significant support in the solution of the last compound task can be provided by completing research of amplitude – frequency characteristics of underlined elements of the equipment of the pump station with attraction of the analyzer of the range.

Next important directions in making a decision on the set task is a definition of prevailing ways of vibration spreading from sources of springy oscillation.

Based on the given classification of sources of production vibration (fig.2), it is possible to make a conclusion that main directions of prevailing spreading of vibration is the base and

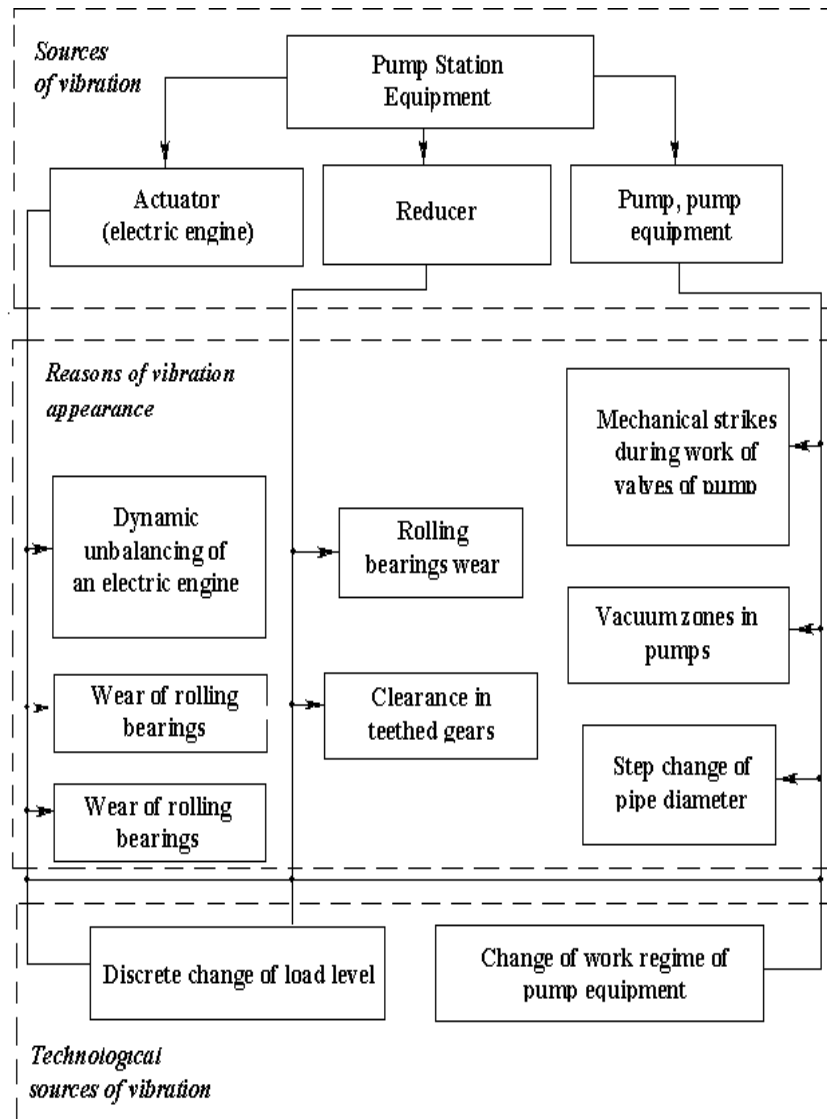


Fig.2. - Classification of sources of production vibration at pump stations of systems of water supply and sewage construction of production facility, as well as hydraulic systems of water supply [4]. Let us consider briefly the main moments of this issue.

1 – vibration, caused by reasons of mechanical character and is a derivative from work of an electric engine, a reducer, pump equipment. Such vibration is transferred mainly to the base of a building.

Thus, this type of vibration can be referred to a structural type. Movement of the maximum of vibration levels towards low frequencies usually characterizes such a type of vibration and due to this, it can be transmitted on big distances.

After that, depending on formation of constructive specifics of this way of spreading, the vibration can be transformed into sound oscillation and transmitted by air. There is also possible an increase of resulting level of noise both in production facilities and in the development zone.

2 – vibration of hydraulic system. This type of vibration is transmitted through liquid, transported through pipelines. It might be result of appearance of air hollows at pumps, at stage

measures of the diameter of pipes due to mechanical strikes during valve work of pumps of equipment.

The considered type of vibration influences mainly the personnel who maintain pump stations. This type of vibration, where noise is its derivative, is characterized by higher level of spectral compounds in the range of oscillation of middle and high frequency.

Thus, the considered objects such as sources of vibration are characterized by significant list of sources of springy oscillation, various on spectral and acoustic characteristics, that reveals itself both through harmful production factor and in a negative factor, which influences the development land.

Considering particularities of the named above sources of vibration, it means that to reduce harmful influence of pump stations of water and sewage systems both on personnel and on development land of settlements, it is necessary to reduce a level of structural and hydraulic vibration.

The following directions of safety measures can help to solve this task: - measures that provide the decrease of the level of produced noise in the very source of acoustic oscillations; - measures that provide the decrease of noise in channels of its transfer to the environment; - measures that are based on the effect of compensation of emitted acoustic oscillations [1].

Depending on production conditions, these measures can be applied simultaneously or separately.

To decrease vibration, transmitted by pump equipment and systems of pipelines through constructive elements, with anti-vibration pedestal and padding are advised to be used on the floor of production areas.

Usually, it is possible to use elastic vibration isolators from any material for pumps of medium capacity that will be placed at the places where technological equipment touches elements of a building.

For the equipment of medium capacity, the vibration of a hydraulic system of the pump equipment is determined by its construction and characteristics of pump equipment.

The solution of a task to decrease this type of noise is more complicated, as emitting of vibration by hydraulic systems of pump stations is a complicated non-stationary process.

A number of methods is known, theoretical prerequisites and practical realization of which give positive result.

Out of them, it is worth mentioning the usage of special vibration and noise isolation of elements of hydraulic system, as well as measures, that are efficient, but not completely used in practice, they are based on main phenomena, that follow the process of spreading of acoustic oscillations in the air environment.

The suggested approach to setting and solution of a complex task to decrease production vibration is tested at pump stations of the water supply system in the city of Izum, Kharkiv region.

The results of such implementation of the developed project enabled to suggest several concrete organizational and technical solutions that provide significant technical effect.

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