NEW METHODS FOR DIAGNOSING PUMPS HYDROTECHNICAL SYSTEMS

F.A. Bekchanov
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers,
Tashkent 100187, Uzbekistan

Abstract: *the article discusses modern methods of diagnosing and technical diagnostics of irrigation pumping units to ensure reliability during their operation. The use of new designs of pumping power equipment and the development of new operating modes provides for improving the mode of pumps based on improved diagnostics, which provides significant savings in operating costs.*

Key Words: *technical diagnostics, irrigation pumping units, operation, new designs, pumping power equipment, savings in operating costs.*

1. INTRODUCTION:

The purpose of the pump diagnostics is to increase the reliability, durability and efficiency of operation. New diagnostic methods suggest:

- study of the behavior and state of pumps in the past, including an analysis of the previous technology of operation (failures, accidents);
- study of the technical condition of pumps at the present time, including the study of characteristic parameters and their evaluation;
- prediction of the technical state in which the pumps will be in the future, including the definition of the resource according to the technical condition at present [1,2].

The focus was on the head pumping station (PS) of the Karshi Main Canal (KMC). The main pumps installed on it with four impellers operated in unfavorable conditions due to low water levels in the avancamera, insufficient pump penetration depending on low water horizons in the Amudarya River. The pumps operated in cavitation mode, which repeatedly led to failure. This was especially noted on the extreme aggregates.

In recent years, the PS-1 has been reconstructed. Based on the actual mode of operation of the PS (3 new units of different supply to stabilize the water levels of the lower and upper pools (DWL and HL)), two new units of type 300VO-37/26C (Pump № 1.3) and one operating unit were selected for testing type OPV11-260 (Pump № 6).

At the same time, the non-identical operation of the extreme and medium pumps is established. The unevenness of the approach of water to the extreme aggregates created the reverse currents of water in the suction pipes, the work of the aggregates with vibrations and in modes close to cavitation (Table 1).

Table 1 - Results of a comparative measurement of vibration (micron) of PS-1 KMC aggregates

Pump	No filters	On the reverse frequency	At the pole frequency	V mm/s	notes
Impeller chamber: vertical vibration					
Extreme 6	35…40	25…35	8	2,2…3,5	P=8,2 mW
Average 4	17…20	13…20	4	1,5…2,2	8,5
Horizontal					
6	60…70	26…35	24	2,7…3,2	
4	62…68	17…24	21	2,8…3,2	Siphon not charged
Upper motor spider, vertical vibration					
6	26..35	15…16	3	1…1,3	
4	10…13	2…3	1	0,5	
Horizontal					
6	76…83	61…71	4	1…1,4	
4	22…23	17…18	3	0,1	

Vibration measurements of the OP 11-260 EG were also carried out in the event of a pump malfunction caused by an uneven air gap between the stator and the rotor, as well as after the elimination of this malfunction. In both cases, vibration measurements were performed at idle pump operation. The air gaps on the diagnosed unit before and after moving the stator are shown in table 2.

Table 2 - Air gaps between the stator and the rotor on a faulty and serviceable unit

Measurement location	Average air gap stator-rotor	
	before offset	after offset
Upper reach (UR)	12,5	13,5
Right Bank (RB)	16,5	10,5
Lower pool (LP)	12	11
Left Bank (LB)	4	11,5

The results of measurements of vibration accelerations in non-stationary modes on the pumps before and after elimination of the non-uniformity of the stator-rotor air gap are shown in table 3.

Table 3 - General and 1/3 –octave vibration levels of the unit before and after repair

Vibration direction	The name of the frequency range, Hz	Vibration parameter			
		acceleration, dB		speed, dB	
		faulty	serviceable	before repair	after repair
Radial	joint	62	56	111	96
	100	57	51		
	1000	57	37		
Tangential	joint	68	61	112	95
	100	63	58		
	1000	60	46		
Vertical	joint	55	52	108	96
	100	48	46		
	1000	46	39		

It follows from the table that the overall vibration levels in the horizontal direction after moving the stator of the unit decreased by equal values: acceleration by 6 dB, speed by 25 dB. In the vertical direction, the reduction in the general level of vibration acceleration was 3 dB, and in terms of vibration velocity 12 dB. A reduction in vibration accelerations in the 1/3-octave band of 100 Hz in all directions corresponds to a reduction in overall vibration levels. The component at the average geometric frequency of 100 Hz significantly (20 dB) decreased in the radial direction, by 14 dB in the tangential and by 7 dB in the vertical directions. These measurements show that an excessive vibration change is recorded in the tangential direction, both in the general level and in the frequency band of 100 Hz (Table 3). Diagnosing the offset of the stator axis relative to the rotor axis should be done by measuring the vibration of the upper cross of the engine in the horizontal direction along the general vibration level and levels in 1/3-octave bands of 100 and 1000 Hz, where the vibration change is 6...20 dB.

Based on the results of diagnostics, the list of the investigated priority issues of the reconstruction of pumping stations was clarified:

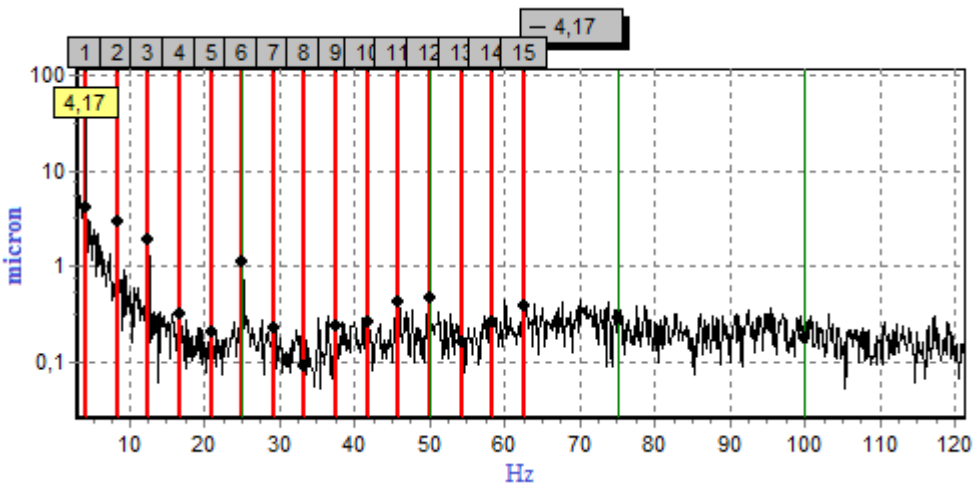
1. Improving the anti-cavitation properties of the flow-through part of the OPV-260 EG pumps and the development of methods and means for the vibration diagnosis of the onset of cavitation;

2. Development of devices for signaling friction blades on the impeller chamber, bearing assemblies, pump rectifiers [3,4].

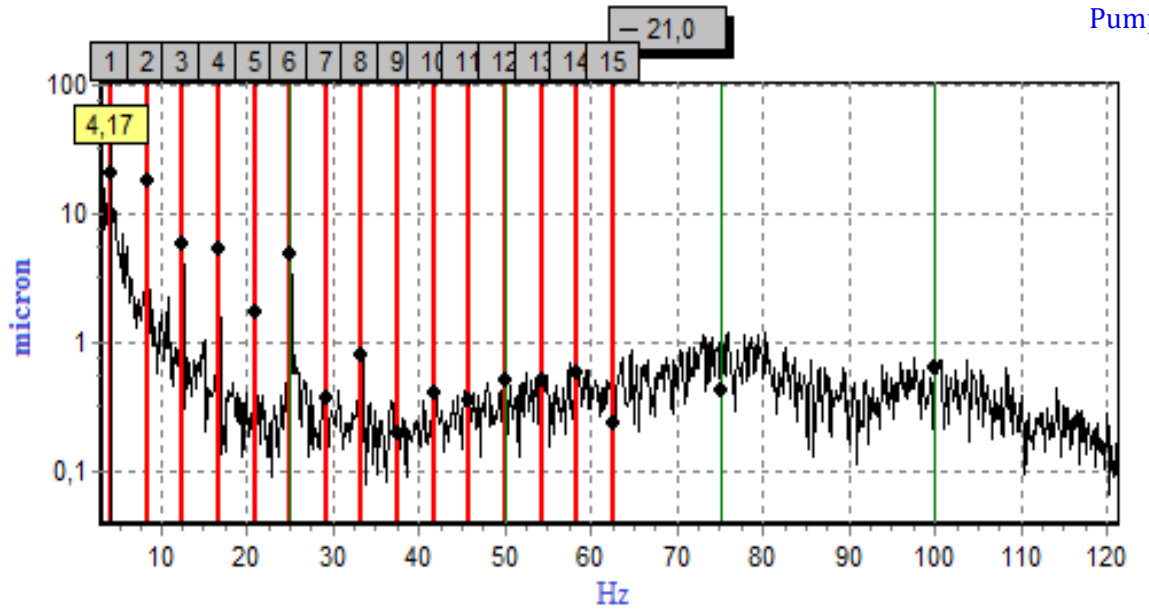
For this, the results of vibration diagnostics of the PS-1 impeller chamber of the extreme and middle pumps are analyzed (Picture 1)

Radial direction

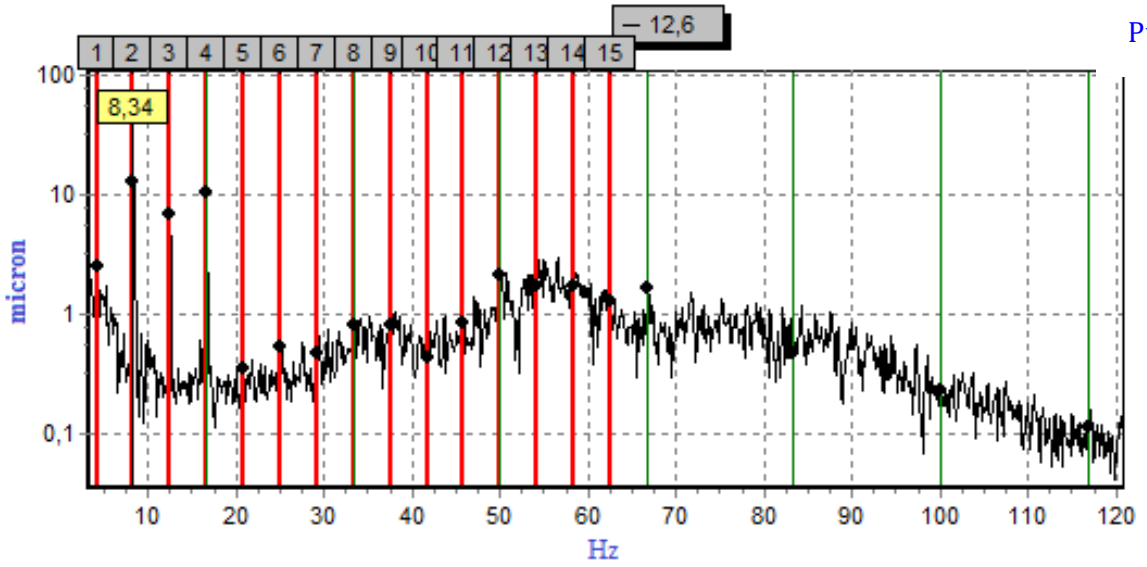
Pump № 1



Pump № 3

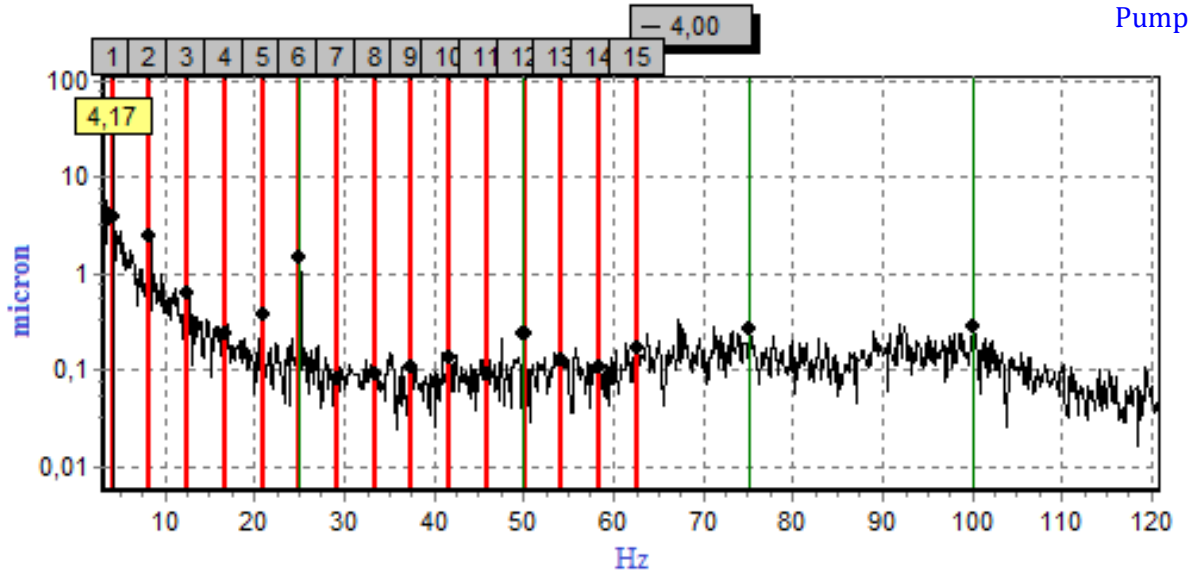


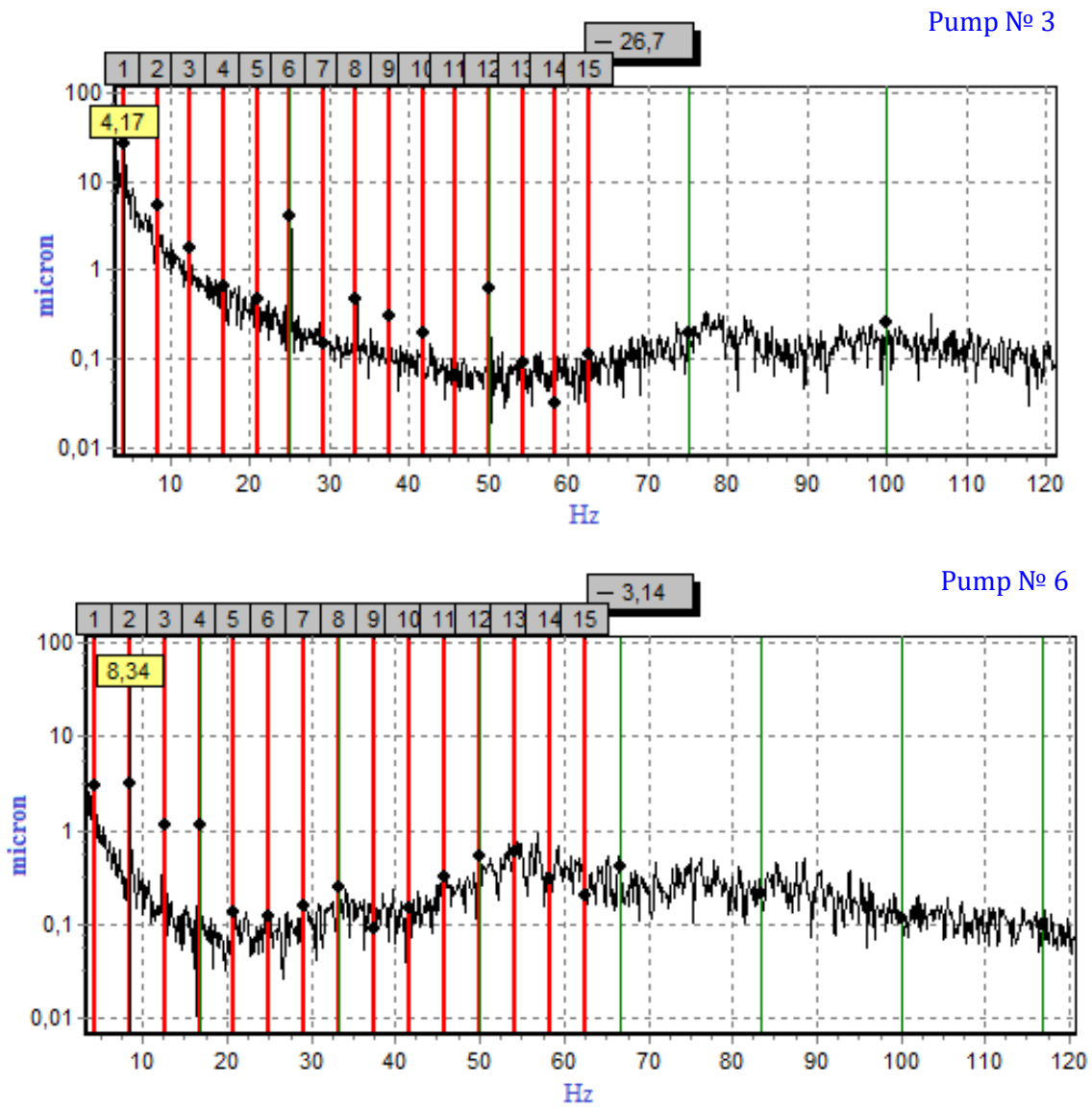
Pump № 6



Vertical direction

Pump № 1

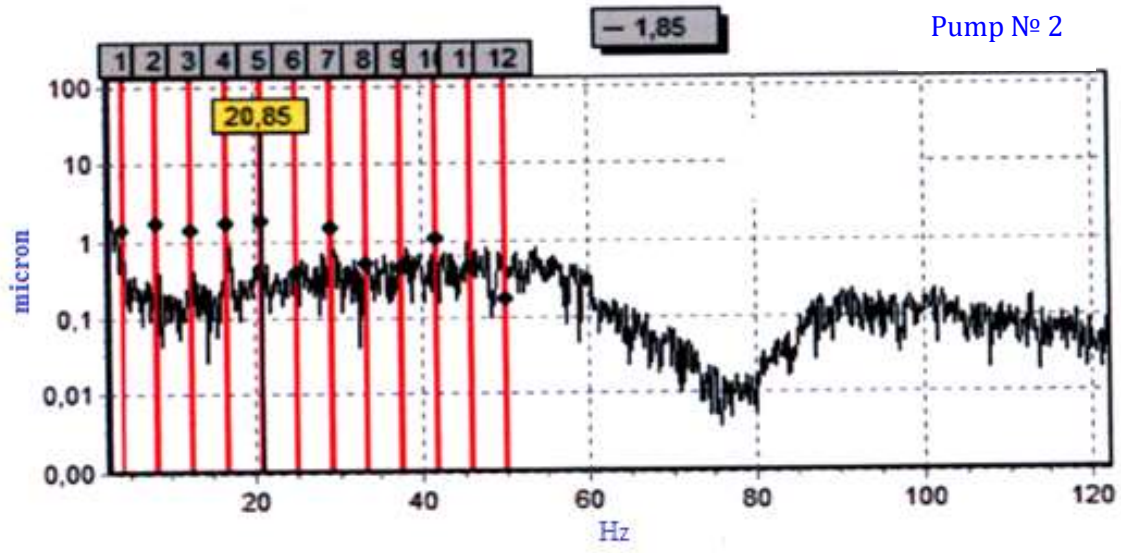


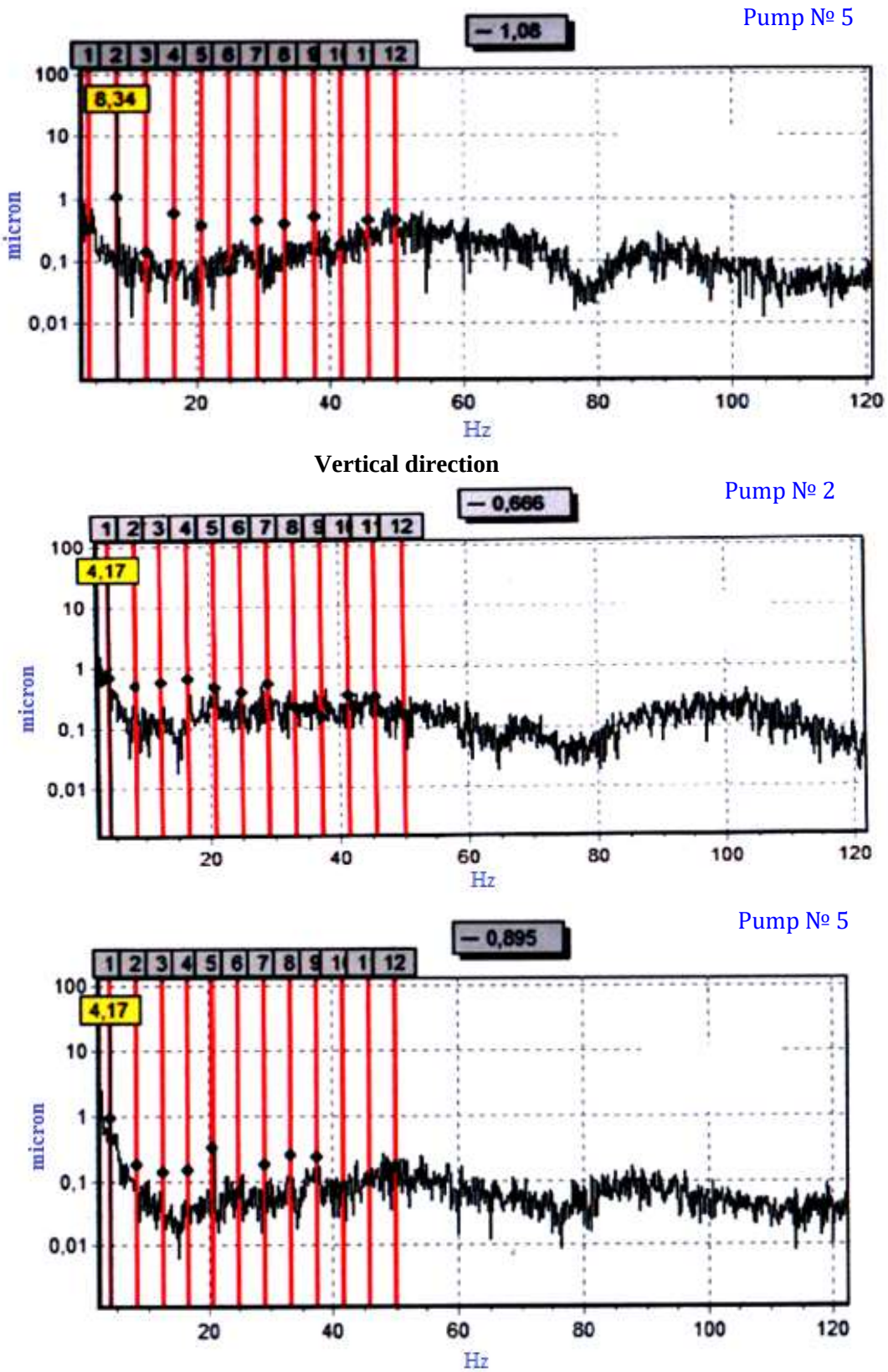


Picture 1- Spectrum of the amplitude of the vibratory displacement on the camera impeller of pumps PS-1 KMC, micron

Studies have shown unsatisfactory performance of pumping units № 2 and № 5 with an exhausted resource caused by uneven wear of the impeller and hydrodynamic instability (Picture 2)

Radial direction





Picture 2- Spectrum of the amplitude of the vibration displacement on the upper bearing of the engine PS-1 KMC, micron

2. FINDINGS:

1. With the participation of the author, new complex diagnostic methods based on vibro-measurements are being developed, which make it possible to increase the reliability of pump operation by predicting the technical condition and accuracy of measuring the vibration of pump assemblies.

2. Diagnosing irrigation pumps allowed to justify proposals for the modernization of their main components and operating modes. When periodically monitored, it may be obvious that the pump, due to the state of components, wear, deformation, malfunction, and beating, considers it necessary to fix the pump failure.

REFERENCES:

1. F.A. Bekchanov, R.R. Ergashev, O.R. Ochilov, N.R. Nasyrova. Diagnostics of large vertical pumps // Materials of the republican scientific-practical conference «Problems of improving the security and quality of water resources of the Republic of Uzbekistan» - T., 2013. pp. 58-62.
2. Glovatsky O.Ya., Nasyrova NR, Ergashev RR, Bekchanov F.A. Analysis of diagnosis of pumping units of Jizzakh head pumping station // Irrigation and melioration number 3 (9), 2017, pp. 32-35.
3. Glovatsky O.Ya., Nasyrova NR, Bekchanov F.A. Improving the efficiency of operation of pumping stations of irrigation systems // Scientific and practical journal "Ways to improve the efficiency of irrigated agriculture" - Novocherkassk, №4 (68), 2017. -54-58 p.
4. O.Ya.Glovatsky, R.R.Ergashev, N.R. Nasyrova Improving the operational reliability of pumping stations with diagnostic methods // Journal “Hydraulic Engineering” No. 12, Moscow, 2017, p. 27-30.
5. Shaymanov N.O., Muradov R.A. Design of land leveling work on irrigated land, Tashkent.-2017 “Irrigation and Land Reclamation” Journal 4 (10) volume, 24 p. (in Uzbek)
6. Shaymanov N.O., Muradov R.A. Land leveling work design. Agroilm Journal, Tashkent -2017, 1 (45) volume, 73 p. (in Uzbek)
7. Shamanov N.O., Muradov R.A. Certificate №DGU 05057 for the software product: Determination of field slopes with a quadrangular grid for the minimum amount of earthworks. Tashkent - 2018. (in Uzbek)
8. Shamanov N.O., Muradov R.A. Certificate №DGU 06421 for the software product: Determination of the quality coefficient of irrigated field leveling. Tashkent - 2018. (in Uzbek)
9. Rickman J.F. Manual for Laser Land Leveling. Rice-Wheat Consortium for the Indo-Gangetic Plains, New Delhi 110 012, India, 2002
10. Bratishko V.I. Technology and technical means of designing irrigated land planning: PhD dissertation. - Novocherkassk: 2007. - 19 p. (in Russian)
11. Karimov N.R. Development of a method of operational planning of irrigated land using laser technology in the cotton growing area: PhD dissertation. - Tashkent, TIIAME. 1993. - 24 p. (in Russian)
12. Yefremov A.N. On the importance of land leveling for surface irrigation of agricultural crops // Resource-saving and energy-efficient technologies and equipment in irrigated agriculture: Sat. scientific report - Kolomna: "Raduga", 2003. Part 1. - pp. 117-121. (in Russian)
13. Muradov, R. A. (2010). Water use in conditions of deficit of irrigation water. Bulletin of the Tashkent State Technical University, (1-2), 164-168.
14. Muradov, R. A. (2014). Some issues of effective land use in the WUA in case of water resources shortage. In: Agrarian Science for Agriculture. Proceeding IX international. scientific-practical conference. Barnaul, Altai State University, 460-462. (in Russian).
15. Muradov, R. A., & Khozhiev, A. A. (2017). Optimal solution of washing norms in case of deficit of irrigation water. Agro ilm, (5), 83-84.
16. www.fao.org/laser-leveling_manual/part2.pdf
17. Umurzakov, U.P., Ibragimov, A.G., Durmanov, A.S. Development of the organizational-economic mechanism and development of scientific, methodological and theoretical foundations for improving the efficiency of the rice growing industry to ensure the country's food security // Science and Practice Bulletin. Electron. journals 2017. №11 (24). P. 103-118. Access mode: http://www.bulletennauki.com/umurzakov. DOI: 10.5281 / zenodo.1048318
18. Umarov, S. R. (2017). Innovative development and main directions of water management. Economy and Innovative Technologies, (1). Available at: https://goo.gl/eEHSJK. (in Uzbek).
19. Durmanov, A. (2018). Cooperation as a basis for increasing the economic efficiency in protected cultivation of vegetables. Bulletin of Science and Practice, 4(8), 113-122.
20. Durmanov, A., & Umarov, S. (2018). Economic-mathematical modeling of optimization production of agricultural production. Asia Pacific Journal of Research in Business Management, 9(6), 10-21.
21. Durmanov, A. Sh., & Yakhyaev, M. M. (2017). Measures to increase the volume of exports of fruit and vegetables. Herald of the Caspian, (4).
22. Tulaboev, A., (2013). Blended learning approach with web 2.0 tools," 2013 International Conference on Research and Innovation in Information Systems (ICRIIS), Kuala Lumpur, pp. 118-122. doi: 10.1109/ICRIIS.2013.6716695
23. Tulaboev, A., & Oxley, A. (2012). A case study on using web 2.0 social networking tools in higher education. In Computer & Information Science (ICCIS), 2012 International Conference on (1). 84-88.

24. Tulaboev, A., & Oxley, A. (2010). A pilot study in using web 2.0 to aid academic writing skills. In Open Systems (ICOS), 45-50.
25. Ibragimov, A. G., & Durmanov, A. S. (2017). Issues of the development of competitiveness and the prospects of specialization in rice farms. SAARJ Journal on Banking & Insurance Research, 6(5), 14-19. doi:10.5958/2319-1422.2017.00021.2.
26. Durmanov, A. Sh., & Khidirova, M. H. (2017). Measures to increase the volume of exports of fruit and vegetable products. Economics, (9), 30-34. (in Russian).