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S形下卧式轴伸贯流泵装置的振动特性分析

Analysis on vibration characteristics of S-shaped shaft-extension tubular pumping system

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中文摘要:

为分析S形下卧式轴伸贯流泵装置的振动特性，该文通过物理模型试验，研究了5个叶片安放角时S形下卧式轴伸贯流泵装置的能量性能，在导叶体进口处布置2个振
点，采用EN900数据采集分析仪和振动速度传感器VS-080对叶片安放角为+4°与?4°时各工况的泵装置模型进行振动测试和分析。测试结果表明：在叶片安放角?2°时，
下卧式轴伸贯流泵装置的最高效率达83.55%，此时流量为289.28 L/s，装置扬程为4.438 m。在相同叶片安放角时，泵装置在径向的振幅峰峰值Ap-p高于铅垂方向。随泵
扬程的增大，径向振幅峰峰值呈先减小后增大的趋势，泵装置的不平衡振动频率与转频成倍数函数关系。在扬程相同时，在叶片安放角为+4°时泵装置在径向的振幅
值较大，不同叶片安放角时泵装置铅垂方向的振幅峰峰值差异性较小。研究结果可为该泵装置的安全稳定运行及同类型泵装置的振动分析提供参考。

英文摘要:

Abstract: A physical model test was adopted to study the energy performance of an S-shaped shaft-extension tubular pumping system at 5 blade angles (θ=-4°, -2°, 0°, +2
+4°) by energy tests in the hydrodynamic engineering laboratory of Jiangsu Province, of which total uncertainty is ±0.39%. A signal collecting analyzer EN900 and a vibration
velocity transducer VS-080 made by Schenck Process GmbH were used to study the vibration characteristics of model pumping system at blade angle +4° and -4° based on diff
pumping system operating conditions with the pumping system head range from 0.0 m to 7.0 m at the same rotating speed. Two measuring points P1 and P2 were arranged in the i
of the guide vane. The X direction indicates the radial direction measured by P1; the Y direction indicates the vertical direction which measured by P2. The test results show that t
highest hydraulic efficiency of the pumping system is 83.55% at blade angle -2°, the flow rate is 289.58 L/s and the pumping system head is 4.438 m. Compared with the hydraulic
efficiency of traditional shaft tubular pumping system, that of the new S-shaped shaft-extension tubular improves by about 5%. Compared with the highest hydraulic efficiency of
hydraulic model TJ04-ZL-23 in the range of blade angle -4°-+4°, the maximum decrease in the maximum efficiency is 5.22% at a blade angle of +4°, and the minimum decrease is
2.47% at a blade angle of +2°. At the same blade angle, the amplitude Ap-p of the X direction is higher than that of the Y direction, but the dominant frequency of both has the sa
value in any operating conditions. With increasing pumping system head, the amplitude Ap-p of the X direction decreases first then increases. At the same value of pumping syst
head, the amplitude Ap-p of the X direction at a positive blade angle is higher than that at a negative blade angle. There is little difference between the amplitude Ap-p of the Y
direction at different blade angles. The maximum amplitude Ap-p of the X direction is 74.526 μm and that of Y direction is 27.679 μm in different testing conditions, both of which a
less than the maximum allowable value (or, alternatively, "tolerance"). The dominant vibration frequency is 22.5Hz for monitoring points P1 and P2 at blade angle +4°, which is th
same as rotation frequency, while the dominant vibration frequency is 45 Hz for monitoring points P1 and P2, which is different from both the rotation frequency and the blade
frequency. The rotation frequency is the main influence on the frequency of the pumping system vibration at blade angle +4°. An expression was established for the functional
relation between the unbalanced vibration frequency and the rotation frequency and blade number. The dominant frequency of unbalanced vibration at monitoring points P1 and
equal to the product of one third of the blade number and the rotating frequency at blade angle +4°, while at blade angle -4° the dominant frequency of unbalanced vibration at
monitoring points P1 and P2 is equal to the product of two thirds of the blade number and the rotating frequency. The dominant vibration frequency is therefore a different functic
rotation frequency and blade frequency for different blade angles. The study can be a reference for type selection and design of a pumping system.