

1.8.5. APPLICATION OF VIBRATION DIAGNOSTICS IN EVALUATING INDUSTRIAL SAFETY OF COMPRESSORS

Zhukov R.V., Davydov V.M., Grib V.V., Korolkov M.V.,
RLS “NNP Mekhanik”, Moscow, Russia

Operation of hazardous industrial facilities requires special attention to the issues of safety. In modern conditions, equipment safety review is one of the ways to ensure its operational safety. Dynamic equipment is subject to the impact of a whole range of factors resulting in degradation of its technical condition: corrosion and mechanical wear, multiple-cycle fatigue produced by variable loads caused by the operation, and vibrational impact.

Dynamics of any device is a source of vibration for the entire machine. Therefore, its change primarily impacts oscillating processes' parameters. A malfunction of the device leads to anomalies of the “vibration picture”. These may be new vibration responses or a change in the frequency of vibration responses, amplitude or phase, the value of the latter being dependent on the degree of fault maturity.

Computer simulation of the mechanical system behavior facilitates greatly in decoding of vibroacoustic signals and detecting faults during machine diagnostics. The authors have developed a mathematical model of the piston compressor dynamics which allows identifying diagnostic signs of wear based on time and frequency criteria, taking into consideration movable joint clearances.

Vibrodiagnostics is one of major phases of the industrial safety review which makes it possible to get information about technical condition of machine joints. Based on the example of several air compressors and pumps inspected by RLS “NNP Mekhanik” as part of the safety review, the report contains a few cases where vibrational diagnostics findings facilitated making specific decisions to ensure operational safety. The majority of the identified faults were confirmed by other methods of non-destructive testing after the machine disassembly. It should be noted that a production plant is not always capable of repairing the machine. Therefore, if the vibration is within the limiting vibration value, the machine may be allowed to operate for a limited period of time, and the safety review opinion will provide for regular vibrational inspection of the fault maturity.

It should be noted that the current regulatory documents do not fully reflect the specifics of piston compressors in the context of vibration rating. Given the reciprocating motion of machine parts and the associated cycle of piston forces and low rotation frequencies, which are often below 600 rounds per minute, the marginal vibration parameters should be higher than those for rotor machines. Using the results of vibrational diagnostics, compressor trouble shooting and ISO 10816-6:1995 recommendations, the employees of RLS “NNP Mekhanik” calculated rates of the root mean square value of vibration speed and displacement. These rates were included in the techniques of piston compressor diagnostics drawn up by RLS “NNP Mekhanik” and approved by Rostekhnadsor (Russian Technical Supervisory Authority).

Special emphasis should be placed on the expert review of compressors where a vessel under pressure is used as a support frame. As a rule, such structural configuration is used for screw-type ammonia compressors and less frequently for piston compressors. Also, it is applied for mobile air piston compressors. In this case, the vessel is subject to cyclical stresses caused by the compressor and engine vibration. The action of high inertial forces results in cyclical vessel deformations in the locations where supports are

welded thus facilitating development of cracks there and reducing rigidity of the compressor-engine system. It entails a faster misalignment of shaft axes and earlier breakdown of the drive roller bearings. Therefore, the compressor and the vessel at such facilities should be subjected to industrial security review in totality.