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Vibration Diagnostics of Gas Pipelines Technological Equipment Using Wavelet Analysis

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Abstract

This paper dwells upon the methods for diagnosing ground gas pipelines as a part of gas-compressor station equipment. Such methods were used in accordance with normative certification documents. A supposition was made that the design of such pipelines had several faults. This paper is devoted to the methods of diagnosing entire gas pipelines or parts thereof for such faults during expert inspection and certification protocol registration. The analysis of all defects allows determining the time-between-repairs so as to develop some operations for the purpose of avoiding these faults, evaluating the repair operation quality and reducing failure probability.

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Keywords: vibration diagnosis; gas pipelines; modal analysis; Fouierier analysis; wavelet analysis

1. Introduction

The operation expenditures in the field of petroleum and gas transportation constitute a fifth of the ultimate production cost and are quite comparable to profits. Maintaining appropriate technical conditions is crucial for the reduction of operating expenditures. It is recommended to diagnose new faults of a compressor station, the entire ground gas pipeline or parts thereof by expert inspection in accordance with normative certification documents. Detecting excess vibration allows to reduce maintenance efforts and prolong service life. Identification of its cause by expert inspection helps prevent equipment damage. The frequency analysis helps identify faults and allows to determine the "between-repairs interval", to develop methods for prevention of faults, to evaluate the quality of

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repair technology. This considerably reduces the probability of unexpected damage. It is therefore possible to determine the condition of equipment and carry out maintenance by increasing some parameters while inspecting such equipment to register the approved protocol. Equipping the maintenance service facilities with vibration control systems has a number of advantages:

- Data collected during operation allows to plan and implement maintenance service and repair without stopping the equipment;
- Equipment downtime for maintenance and repair cost are reduced thanks to timely identification of faults;:
- Statistically, 2 to 10 percent of new parts have manufacturing faults; therefore, high quality repair and equipment installation requires immediate post-repair vibration tests;
- Timely repair per operating specifications allows to avoid stopping the operating cycle and reduce unplanned expenditures;
- The labor protection indexes are improved, while enterprises avoid violating terms and conditions of use;
- Vibration increases are avoided, helping save the resources;

The documented parameters of equipment vibration during operation provide evidence for arbitration in case the designer, the manufacturer(s), the assembler(s) and maintenance worker(s) express their dissatisfaction.

2. Dynamic model

As an instance of equipment maintenance based on the technical status of efficiency evaluation using the vibration methods for certification and result registration, we can analyze some faults of ground GFP pipelines (Fig. 1). The effects of damage on dynamic loads have been calculated with the help of computer program STARDYNE. This software uses the finite-element method and allows to carry out experimental modal analysis of the system [1-3]. The finite-element model of the output pipelines is shown in Fig. 2. Some of the vibration parameters are usually used as a criterion for the technical evaluation of gas pipelines and their supports when developing operational standard monitoring. Some of faults result in an incalculable pattern, changes in the rigidity values that can be amalgamated in a value like equivalent rigidity. The selection of support rigidity is characterized by breaking the non-linear response to pipeline vibrations and aerodynamic pulsations. The vibrations frequency exceeds tolerance values for such faults. In our case, all supports of output pipelines were 2-4 times the tolerable levels (Tables 1 & 2).

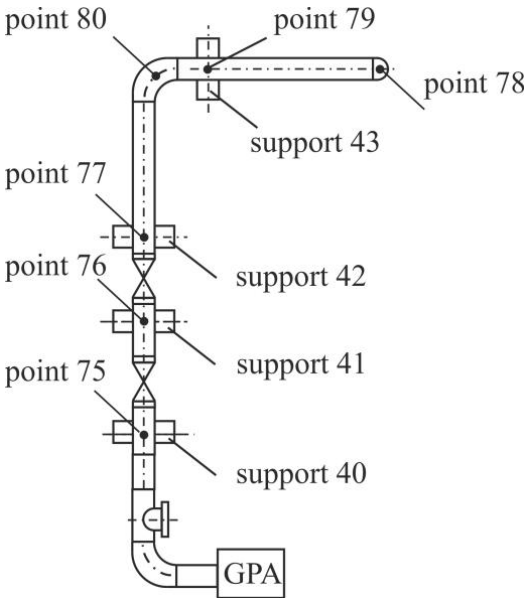

Fig. 1. Output pipeline