1.11.10. NEW METHOD FOR NON-DESTRUCTIVE EVALUATION OF IMPACT STRENGTH OF STEEL PIPELINES

Tatsakovych N., Karpash O., Karpash M., Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine

There is extensive network of oil and gas pipelines on the territory of Ukraine that numbers more than 40 thousand kilometers. Around 30% of pipelines are operated over their service life and yet more are close to lifetime exhaustion. Nonreversible damages accumulate stepwise in pipes through long-term effect of operation loads and environmental conditions. In addition, even in the metal of pipe that has not been in service are defects. All that leads to different kinds of failures and sometimes major leaks, and in return cause not only system breakdowns but injure environment also. That is why the reliability and the safety of pipeline system are definitive requirements for its operation.

Basically for the stress calculation of pipelines the yield limit is used. Thus, by the yield limit allowable stresses are defined. At the same time numerous researches indicate that strength factors may change ambiguously after a long-term operation: strength either remains changeless or increases insignificantly. Obviously that completion phase of pipeline destruction is preceded by mechanical properties changes which ensured pipeline working efficiency at the beginning of operation. Therefore for degraded metal estimation the characteristics that uniquely would decrease with operating life increasing and would be maximally sensible to the metal changes need to be used. Such characteristic of metal is Charpy impact toughness.

The Charpy impact toughness change versus operating time relationship is defined by two characteristic intervals. During the first interval impact toughness changes are little, during second – there is its more considerable degradation. The transition between the first and second interval in most cases depends on material and operation conditions that is why it is specific for a separate pipeline. However, irrefutable is the fact that the Charpy impact toughness decrease takes place and the degradation degree may come up to 30 – 40% after 20 – 25 years of operation. It is necessary to point out that impact toughness is the mechanical property of metal, minimum values of which, depending on nominal diameter and operating pressure, are regulated by normative documents on pipelines, in particular SNIP 2.05.06–85.

Performance of standard Charpy impact test is complicated since requires manufacturing of test coupons of pipeline that is in service. Taking this into account, the development of new method for non-destructive evaluation of Charpy impact toughness is of current interest as allows quickly obtaining information about technical state of pipeline without technological process interruption.

Developed method for non-destructive evaluation based on interconnections of Charpy impact toughness and electromagnetic informative parameter i. Informative parameter i was measured by means of experimental setup I-2, which operating principle is based on experimentally defined relation of electromagnetic oscillations of changer induction circuit to phase-structural components and metal constructions materials mechanical conditions. The main elements of experimental unit are induction changer, self-oscillation generator, microprocessor, induction unit, power unit.

The outcome of performed investigations show that the usage of informative parameter, measured by experimental unit I-2, in the set of income parameters for Charpy impact toughness evaluation gives high results (average error normalized to the range

value is among 3.47 – 4.11%). From the point of the best results and minimal quantity of technical means the optimal combination of income parameters is hardness – informative parameter (average error normalized to the range is about 3.90%).

Thus, it is possible to draw conclusion that developed non-destructive method will allow to solve the problem of the quickly obtaining of real values of Charpy impact toughness as the characteristic of the actual technical state of steel pipelines and will become an instrument for the performance of the permanent monitoring of the pipelines.