1.13.8. CALCULATION OF STRESS-DEFORMED STATE OF TANK WALL HAVING DEFECTS: NEW INSPECTION REQUIREMENTS

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Oil and oil products storage vertical steel tanks are hazardous industrial facilities. In accordance with the ruling documents of Rostekhnadzor they have to be periodically inspected in the course of operation and the defects found to be eliminated.

The existing regulations establish criteria of permissible defects: considering wall dents as well as vertical deviations of vertical steel tanks (VST), for wall irregularity etc. However, based on calculations performed by expert organization it is allowed to operate VST having wall defects.

In order to stipulate well-founded operation conditions for VST having defects, methods of stress-deformed state calculation of VST have been developed. They allow imitate behavior of tanks considering real operation parameters: wind and snow loads, interaction of VST structures, actual defect parameters.

The existing regulation documents specify measurement of only maximum dent tongue which is insufficient to develop its model. In order to perform stress-deformed state calculation additional requirements have to be placed on results of defects measurement. The present work is based on a series of calculations. It contains recommendations on number and frequency of dent tongue measurement during tank inspection.

Storage tank VST-5000 has been selected as a subject of research (test subject). It is a vertical steel tank having capacity of 5000 m^3. There are hundreds of such tanks available with various oil and gas producing and transporting companies. Therefore stress-deformed state calculations of VST wall are crucial for assessment of resource to operate them safely.

Study of grid step dent measurement influence on stress-deformed state value has been performed for dents having linear dimensions (length and width) from 0.75 up to 4.5 m. During the study measurements of dent tongue have been performed with a step of 5 cm. There have been 3600 points of dent tongue measured all in all. It is evident that creation of such a dense measurement grid during inspection is extremely time-taking. Therefore in order to determine minimum required grid step for dent tongue measurement study of dependence of stress-deformed state of tank wall having dent on measurement pitch. In the course of the study 24 model tanks having dents measured with pitch of 5, 10, 20, 30, 40, 50 cm have been created.

As a result of calculations load distribution and radial movements of the wall in dent area depending on grid step have been determined. It has been found that the maximum allowable measurement grid step to ensure the required calculation accuracy of 5% for dents having linear dimensions shall be:

- up to 0.75 m – 100×100 mm;
- from 0.75 up to 1.5 m – 200×200 mm;
- from 1.5 m up to 3.0 m – 200×200 mm;
- from 3.0 m up to 4.5 m – 300×300 mm;
- more than 4.5 m – 300×300 mm.