Analysis of Methods of Protection of Inner Surface of Welds of Field Pipelines

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Abstract. In order to increase corrosion resistance, different types of insulation of the inner surface of pipes are used, but corrosion in this case often occurs on the inner surface of pipes in the zone of annular welded joints, where there is no insulation. There is no doubt that protection of the internal weld joint is an urgent task, the purpose of which is to increase the reliability of pipeline transport systems. There is a problem of insulation of the area of welded joints of pipes. In areas of welded joints of pipelines, effective corrosion protection shall be provided. A variety of methods have been used to protect internal coated welded joints from corrosion. Protective bushings are the most common method of protection of welded joints of field pipelines with internal coating.

1. Introduction

Currently, more than 350 thousand km of field pipelines are operated in Russia, accordingly, the relevance of pipe production for the oil and gas industry is beyond doubt. Every year in Russia, up to 70 thousand pipeline transport accidents occur in fisheries, 90% of which are the result of corrosion damage [1-8]. Of the total number of accidents, hydrocarbon collection systems account for about 55%. Currently, 42% of new steel pipes during operation in oil fields do not withstand 5 years of operation, and 17% are operated before the start of gusts for less than 2 years. More than 8 thousand km of pipes are spent on the annual replacement of field networks, which is about 400-500 thousand tons of steel. Therefore, pipelines with internal coating or pipes made of corrosion-resistant materials are increasingly used in the country's fisheries in the construction and reconstruction of field pipelines [2,5,7].

In order to increase corrosion resistance, various types of insulation of the inner surface of pipes are used, but corrosion in this case often occurs on the inner surface of pipes in the zone of annular welded joints, where there is no insulation [9-14]. There is no doubt that protection of the internal weld joint is an urgent task, the purpose of which is to increase the reliability of pipeline transport systems. Main methods used to protect welded joints of pipelines:

- dross;
- protector;
- installation of lining rings;
- metallization of pipe ends with corrosion-resistant metals and alloys;
- coating the inner surface of pipe joints after welding;
- installation of protective bushings.
All these methods of protection described above have their advantages and disadvantages and whatever method of protection of welded joints is used, it must satisfy the following conditions: The method of protection of welded joints should be applicable in both factory and field conditions [9,15-20]; pipeline welds shall be guaranteed to be protected against corrosion for a period close to the service life of the main coated pipeline; If there are any devices in the weld area, the hydraulic resistance of the pipeline shall not increase significantly; protective devices in the weld area shall not prevent the passage of ODS; protective devices in the weld area shall not increase the allowable bending radius of the pipeline when laid in the ground; Protective devices in the weld area shall not be displaced from the various horizontal loads - flow or ODS movement; protection of the weld shall not affect its strength and purity; method of protection of welded joints shall have minimal impact on pipeline installation technology.

2. Experimental procedures
The object of the investigation is the bushings of internal protection of the weld seam, shown in Figure 1, 2.

![Figure 1. Test specimen before bushing installation.](image1)

![Figure 2. Test specimen after bushing installation.](image2)
Figures 1, 2 show the following elements in numerals:
1,2. welded pipe elements;
3. weld seam;
4. internal coating of the pipeline;
5. bushing;
6. adhesive layer of bushing.

It should be noted that the installation of the bushing consists of the following main operations:
incoming inspection of the bushing; preparation of bushing for installation (cleaning of internal cavity of pipes in the area of dust and other contaminants ends; degreasing of internal pipe cavity in the end face area); installation of the bushing into the pipe (bushing entry into the pipe up to stops; if there is a gap between the bushing and the pipe more than 1 mm, it is required to center the bushing; to ensure longitudinal stability of the bushing, attach all stops of the bushing to the pipe; start the second pipe on the bushing; align the axes of the connected pipes with the help of the external centralizer, providing the required clearance; tack the pipes to be connected and remove the centralizer).

The final step is to weld the pipe joint:
- welding of the root seam. The height of the return roller shall not exceed 1 mm;
- after welding the seam root, grind the seam and fill the seam;
- after filling the seam, grind the seam and weld the lining seam.
- prevent stopping of welding works before application of at least the 3rd layer.
- if single defects of weld seam are detected, repair of weld seam is allowed without removal of bushing installed earlier.

3. The results of studies and their discussion

The protective bushing is a metal ring shown in Figure 3. During its installation, insulation of the annulus is achieved using epoxy mastic or thermally expanding materials. Despite the disadvantages, it is the installation of bushings to protect internal welds that is currently used most massively, and in the foreseeable future has every chance to maintain its leading position.

Specialists of one of the manufacturers of protective bushings together with specialists of the organizations operating pipelines conducted a number of bench tests of the pipeline with bushings of internal protection of the weld for axial shear and hydraulic tightness. As a result of bench tests for axial shear, the following values are recorded: - bushing of internal protection of welded joint of type 114x8 - 29 200 kg; - bushing of internal protection of welded joint of type 325x8 - 30 200 kg.

The following values are recorded as a result of bench leak tests:
- bushing of internal protection of welded joint of type 114x8 - 0.4 MPa;
- bushing of internal protection of welded joint of size 325x8-0.8 MPa.

Bench tests of pipelines with bushings for internal protection of the weld for axial shear and hydraulic tightness were found to be satisfactory, and the results of leak tests were found to be unsatisfactory. These results require a more in-depth study of the processes occurring in the internal cavities between the pipeline and the sleeve during the assembly and welding of the joint.

4. Conclusions

Protective bushings are the most common method of protection of welded joints of field pipeline lines with internal coating. At the same time, despite the progressive figures for the production and implementation of this method of protection of pipelines against internal corrosion, the installation technology of protective weld joints bushings has not been sufficiently studied, methods for welding bushings depending on the diameter and thickness of pipelines have not been developed, and additional research and development of installation methods are required.

5. References

[1] Zaripov M Z, Fairushin A M and Karetnikov D V 2019 Materials Science Forum 946 883-8
[2] Rizvanov R G, Mulikov D Sh, Karetnikov D V, Fairushin A M and Tokarev A S 2018 IOP Conf. Ser.: Mater. Sci. Eng. 317 012077
[3] Nasibullina O A and Tyusenkov A S 2020 IOP Conf. Ser.: Mater. Sci. Eng. 862 022007
[4] Yakhin A V, Karetnikov D V, Cherepashkin S E and Rizvanov R G 2019 Chemical and Petroleum Engineering 55(7-8) 681-6
[5] Nasibullina O A and Rizvanov R G 2020 Materials Science Forum 989 28-2
[6] Yakhin A V, Karetnikov D V, Rizvanov R G, Abakacheva E M and Gareev A G 2019 Chemical and Petroleum Engineering 54(11-12) 801-5
[7] Nasibullina O A, Gareev A G and Rizvanov R G 2018 Solid State Phenomena 284 1302-6
[8] Tyusenkov A S, Rubtsov A V and Tlyasheva R R 2017 Solid State Phenomena 265 868-72
[9] Nasibullina O A and Gareev A G 2019 Materials Science Forum 946 20-4
[10] Karetnikov D V, Rizvanov R G, Fairushin A M and Kolokhov K S 2013 Welding International 27 (7) 557-60
[11] Tyusenkov A S and Nasibullina O A 2019 IOP Conf. Ser.: Mater. Sci. Eng. 687 066016
[12] Nasibullina O A and Tyusenkov A S 2019 IOP Conf. Ser.: Mater. Sci. Eng. 537 022023
[13] Kuzeev I R, Ibragimov I G, Bayazitov M I, Davydov S N and Khairudinov I R 1985 Chem. and Technology of Fuels and Oils 22(3) 111-3
[14] Gaysin E Sh, Frolov Y A and Nasibullina O A 2020 IOP Conf. Ser.: Earth and Environ. Sci. 459 032055
[15] Rizvanov R G, Mulikov D Sh, Karetnikov D V, Cherepashkin S E and Shirgazina R F 2017 Nanotechnologies in Construction 9(4) 97-15
[16] Nasibullina O A and Rizvanov R G 2020 Materials Science Forum 992 695-9
[17] Zharinova N V and Vakulenko M V 2020 IOP Conf. Ser.: Mater. Sci. Eng. 862 032014
[18] Tyusenkov A S 2016 Steel 2 53-7
[19] Mirkhaydarova K A, Tyusenkov A S and Rizvanov R G 2018 Solid State Phenomena 284 1297-301
[20] Vakulenko M V and Zharinova N V 2020 IOP Conf. Ser.: Mater. Sci. Eng. 862 062022