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Розроблення і впровадження нових технологій

Development and Introduction of the Newest Technologies

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Monitoring the technical condition of the fuel storage facility at the Ukrainian Antarctic Akademik Vernadsky station

Abstract. The paper examines the technical condition of metal structures of the fuel storage facility and pipelines at the Ukrainian Antarctic Akademik Vernadsky station, the development and implementation of measures to increase the reliability of their work, and the organization of their regular annual monitoring. At the preparatory stage, the analysis of design and operational documentation for fuel storage facility VST-200 was performed, technical inspection methods were selected (ultrasonic thickness measurement, tightness control, visual and eddy current control, level and theodolite surveys, and others), equipment and auxiliary equipment were selected for performing diagnostic work by non-destructive testing methods (flaw-detectors, thickness gauge, leak detector, level, theodolite, and others). An instrumental inspection of the condition of metal structures of the double-skinned fuel storage tank VST-200 and pipelines was carried out using non-destructive testing methods to detect defects and damage in structural elements and welded joints, as well as inspection of the condition of the foundation and base of the tank. Anti-corrosion work was carried out on the bottom of the station's fuel tank VST-200, and pipelines with corrosion damage were replaced. All elements (foundations, walls, bottoms, and roofs of the external and internal reservoirs) are in working technical condition. They meet the norms and standards for design, manufacture, and operation. The static strength of the walls of both reservoirs is adequate for the project and current regulations. Thanks to the anti-corrosion work on the bottom of the internal tank, it is possible to continue its operation until 2029 by providing the rules of the technical operation of the fuel storage facilities and the organization of annual monitoring of the technical condition of the tank and technological equipment. The old decommissioned fuel storage tank HST-150 is modified into a dry solid materials store.

Keywords: damage, defect, fuel tank, non-destructive testing methods, pipeline

1 Introduction

Reservoirs for storing petroleum products and diesel power plants have become the basis of life support for Antarctic research stations. Today, Antarctic stations operate mainly two types of reservoirs: horizontal steel tanks (HST) and vertical steel tanks (VST). For example, reservoirs of the HST type operate at Eduardo Frei, King Sejong, and Bellingshausen stations, with 20—150 cubic meters volume. Reservoirs of the VST type have been installed, for example, at Palmer, Rothera, and Arctowski stations, with a volume of 200—2000 cubic meters.

Currently, the diesel fuel double-skinned steel tank VST-200 (Fig. 1), installed in 2007 at the

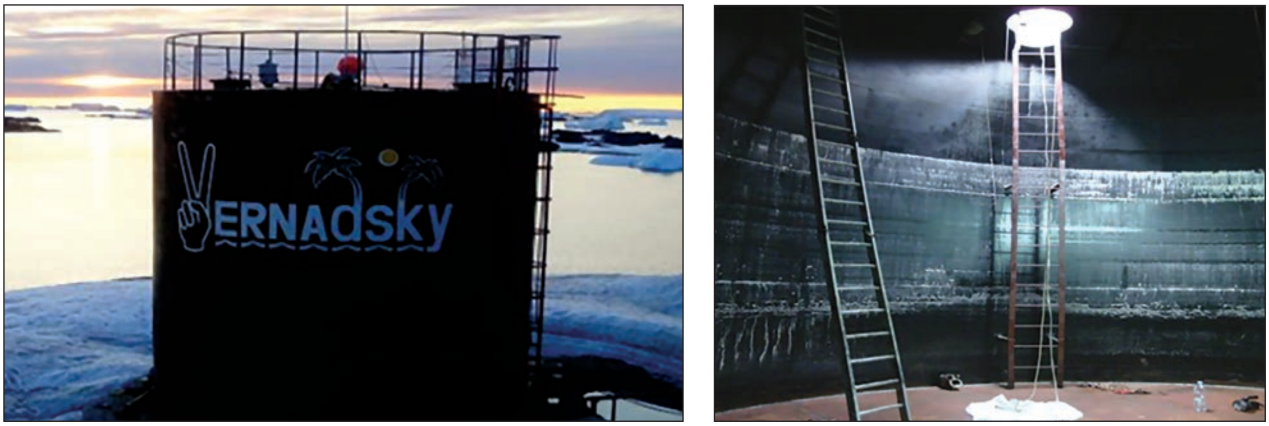

Figure 1. The fuel tank VST-200, outside and inside view

Figure 2. The decommissioned old fuel tank HST-150, outside and inside view

Ukrainian Antarctic Akademik Vernadsky station (from now on – Vernadsky station), is in operation. Additionally, two small process tanks with a volume of about six cubic meters are in operation inside the generator shed to prepare fuel before its supply to diesel generators and boilers for water heating of the station's premises. The VST-200 tank has been installed to replace the old fuel tank HST-150 (Fig. 2), built in 1978–1979. The old fuel tank HST-150 was taken out of service following the 1995 Memorandum of Understanding between the British Antarctic Survey and the Ukrainian Antarctic Centre on transferring the British Faraday base to Ukraine, with the subsequent new name of the station – Akademik Vernadsky (ATCM, 2007). In 2016, work on monitoring the technical condition and preventive maintenance of the fuel storage facility at the Vernadsky station was started and continued in 2019–2023.

Tanks for storing fuel products are considered objects of increased danger (Law of Ukraine, 2001)[1]. Therefore, their periodic technical diagnostics is a mandatory type of control, which, together with constant monitoring of the technical condition, ensures trouble-free and safe operation. At the same time, accident-free operation of tanks in Antarctic conditions is of great importance from the point

[1] Verkhovna Rada of Ukraine. (2001a). Zakon Ukrainy. Pro obiekty pidvyshchenoi nebezpeky 2245-III [Law of Ukraine. On Extremely Dangerous Objects No 2245-III]. *The Official Bulletin of the Verkhovna Rada of Ukraine (BVR),* 15, 73. https://zakon.rada.gov.ua/laws/show/2245-14?lang=en#Text

of view of environmental protection, environmental, man-made, and fire safety. Ukraine joined the Antarctic Treaty in 1992 (Resolution of the Verkhovna Rada of Ukraine, 1992)[2], and the Protocol on Environmental Protection to the Antarctic Treaty in 2001 (Law of Ukraine, 2001)[3]. Since 1996, it has been conducting research at the Vernadsky station. The Antarctic Treaty Parties are subject to strict environmental protection requirements (COMNAP, 2016).

International Antarctic organizations have developed several documents that regulate measures to ensure environmental safety at Antarctic stations. In these documents, special attention is paid to the storage and use of oil products and measures to localize accidents and eliminate their consequences. It is possible to ensure the fulfillment of these requirements only under the trouble-free operation of tanks and pipelines. The basis of the requirements of international and national standards concerning tanks for the storage of petroleum products are regulatory provisions on ensuring the operational reliability of (API, 2014; European Committee..., 2004; Goskomitet..., 1988; Ukrnaftoprodukt, 1997; 1998; VBN..., 1994; DBN... 2009; DSTU B V.2.6-183, 2012[4]). At different stages of the "life cycle" of tanks, they are reduced to the following:

1. At the design stage – the provision of a reserve of bearing capacity of structures due to the selection of materials, technology of welding joints, shape, and geometric dimensions.

2. At the stage of factory production of elements and construction – ensuring the conditions of high-quality delivery, assembly, and installation of tank structures.

3. At the stage of operation – periodic technical diagnostics of metal structures, constant monitoring of the technical condition, timely preventive repairs, and implementation of anti-corrosion measures.

In this paper, we investigate the technical conditions of the metal structures of the fuel storage facility and pipelines at the Vernadsky station. The non-destructive testing methods of fuel tank elements and instruments for the test are described in Section 2. Section 3 discusses the results of checking the welded joints of the VST-200 fuel tank, measurements of the horizontality of the bottom and the verticality of the wall, checking the tightness of the bottom, applying an anti-corrosion coating to the bottom, and calculating the strength of the wall, as well as given the historical description of the decommissioned old tank HST-150 state, followed by conclusions in Section 4.

2 Methods and instruments for fuel tank diagnostics

The program of technical diagnostics of fuel tanks is determined by the requirements of the standard (DSTU, 2009)[5], so we performed the following works using instrumental non-destructive testing:

• visual control of metal structures and welded joints (viewing and measuring magnifiers, calipers,

[2] Verkhovna Rada of Ukraine. (1992). Pro pryiednannia Ukrainy do Dohovoru pro Antarktyku 1959 roku, No. 2609-XI dated 17.09.92 [Resolution of the Verkhovna Rada of Ukraine on Ukraine's Accession to the Antarctic Treaty 1959, No. 2609-XI dated 17.09.92]. *The Official Bulletin of the Verkhovna Rada of Ukraine (BVR)*, 41, 602. https://zakon.rada.gov.ua/laws/card/en/2609-12

[3] Verkhovna Rada of Ukraine. (2001b). Zakon Ukrainy. Pro pryiednannia Ukrainy do Protokolu pro okhoronu navkolyshnoho seredovyshcha do Dohovoru pro Antarktyku [Law of Ukraine. On Ukraine's Accession to the Protocol on Environmental Protection to the Antarctic Treaty No 2284-III]. *The Official Bulletin of the Verkhovna Rada of Ukraine* (*BVR*), 16, 78. https://zakon.rada.gov.ua/laws/show/2284-14?lang=en#Text

[4] DP «UKRMETRTESTSTANDART». (2012). *DSTU B V.2.6-183:2011 Rezervuary vertykalni tsylindrychni stalevi dlia nafty ta naftoproduktiv. Zahalni tekhnichni umovy* [*DSTU B V.2.6-183:2011. Vertical cylindrical steel tanks for oil and oil products. General technical conditions*]. Ministry of Infrastructure of Ukraine.

[5] DP «UKRMETRTESTSTANDART». (2009). *DSTU NBA.3.1-10:2008 Upravlinnia, orhanizatsiia i tekhnolohiia. Nastanova z provedennia tekhnichnoho diahnostuvannia vertykalnykh stalevykh rezervuariv* [*DSTU NBA.3.1-10:2008. Management, organization and technology. Guidelines for carrying out technical diagnostics of vertical steel tanks*]. Ministry of Infrastructure of Ukraine.

rulers, weld templates, metal cleaning products, and lighting equipment);

- ultrasonic control of the thickness of the bottom and wall sheets (ultrasonic thickness gauges with piezoelectric transducers and control samples);
- measuring the horizontality of the bottom (level SL60-2);
- measuring the verticality of the wall (theodolite T2);
- measuring the internal dimensions of the tank (laser and tape measures);
- control of tightness of welded joints of the bottom (straight and angular overhead vacuum chambers NK-175 with vacuum gauges, vacuum pump 2NVR-1D);
- eddy current control of welded joints (flaw detectors VD3-71);
- recording of visual information on digital media using the VK/TVA-1 device and its archiving for subsequent decoding;
- photo and video recording of technological processes of bottom preparation for control and repair operations;
- estimated examination of the condition of the tank structures based on the results of the instrumental survey;
- analysis of the results obtained from the tank survey and preparation of the expert opinion.

In addition, the tools for preparing the bottom for applying an anti-corrosion coating (sandblast cleaner, air compressor, vacuum cleaner), anti-corrosion coating thickness gauge, and methods of its application were used. The results of the stages of fuel tanks' technical diagnostics are presented in papers (Posypaiko, 2016a; 2016b; 2017; Zhuk et al., 2017) and technical reports stored at the State Institution National Antarctic Scientific Center.

3 Results

3.1 General characteristics and technical conditions of the VST-200 fuel tank

The VST-200 fuel tank was built at the Vernadsky station in 2007 under the project of the Ukrainian V. M. Szymanovsky Institute of Steel Construction and the Institute of Oil Transport. The tank construction is a double-walled vertical cylinder with two bottoms and two roofs, according to the "glass-in-glass" principle. Two hermetic shells of the tank prevent leakage of the oil product into the natural environment and ensure reliable operation of the tank in the conditions of the ecologically vulnerable Antarctic. The fuel tank was built in the conditions of the Antarctic summer, characterized by winds, rain, snow, and an air temperature of 0 ± 5 °C.

For the external tank tank, the height of the wall is 6.58 m, the diameter is 6.96 m, the thickness of the wall sheets is 5 mm, the thickness of the bottom sheets is 8 mm. The internal's height of the wall is 5.96 m, the internal diameter is 6.63 m, the thickness of the wall and bottom sheets is 5 mm, the bottom area is 34.5 m^2. The distance between the walls of the inner and outer tanks is 0.16 m. The tank roof comprises two metal shields connected by an overlay welded joint. The thickness of the roof sheet is 4 mm.

The tank's foundation consists of seven parallel reinforced concrete strips $8300 \times 460 \times 650$ mm. The foundation strips are fixed to the rock base by holes and steel rods. Fifteen steel I-beams with a height of 140 mm are laid along the foundation tapes, perpendicular to their length, fixed by welding to the foundation plates. These beams are the basis of the bottom of the tank. The tank's walls are assembled from individual sheets of 3000×1500 mm, 5 mm thick, and joined by manual arc welding on both sides at the assembly site. All welded joints are butt joints.

Visual control of the walls of the tank showed that there are no rolling defects on the surface of the metal sheets — cracks, delamination, dips, burrs, shells. Corrosion of the metal surface under the protective coating is insignificant at the level of rolling scale. The protective paint coating of the wall is mostly in good condition. The exception is some areas in the zone of the secondary seam, where the paint coating has peeled off due to corrosion processes.

Welded joints of the tank generally meet the requirements of standards (VBN..., 1994; DSTU, 2012[4]). The width of seam reinforcement rollers is

12–14 mm (vertical seams) and 10–12 mm (horizontal seams), height is 1–2.5 mm. The legs of the corner seam of the wall and the bottom are 6–8 mm. In the seams, there are no unacceptable defects of welded joints (surface cracks, pores, undercuts, voids, unwelded craters) that exceed the dimensions allowed by the standards. However, there are some deviations in the seam reinforcement roller's shape, which cannot affect the operational characteristics of the welded joint. In the welded joints, the following was found: linear displacements of the edges up to 1 mm (4–5% of the length of the seam), excess convexity of the weld seam (4–5% of the length), splashes of metal (10–15 pcs m^{-1}), undercuts (up to 0.5 mm) of the upper edge of horizontal seams (10–15% of the length).

Measurements of the horizontality of the bottom and the verticality of the wall were made by a leveller SL 60-2 and a theodolite T2, which were installed around the fuel tank on snowdrifts due to the absence during the measurements of an open rock surface. All indicators of the bottom's horizontality and the walls' verticality are within the limits of current regulations. The maximum deviation of the fuel tank from the vertical on the outside is 22 mm, and in the middle, it is 26 mm. The maximum difference in the levelling points of the bottom contour is 6 mm. The verticality of the wall of the inner tank was measured using a hanger fixed under the roof with a U-shaped magnet. The maximum deviation of the building wall from the vertical on the outside is 38 mm, and in the middle, 31 mm. The maximum difference in the levelling points of the bottom contour is 6 mm.

The strength of steel tanks in operation is assessed based on the results of their technical examination using the general scheme for calculating building structures according to limit states (Ukrnaftoprodukt, 1997). In general, the strength condition for any structural element is written as follows:

$$\sigma \le \gamma \cdot R, \qquad (1)$$

where σ is the estimated (maximum possible) stress value in the structural element, determined by the corresponding calculation; R is the permissible stress value for the structural element. For fuel tank wall belts made of the St3ps steel, the R value is 240.3 MPa; γ is the coefficient of working conditions, determined by regulatory documents. According to (VBN..., 1994), $\gamma = 0.6$ and 0.7 for the wall's first and second belts, respectively.

The calculation of the value of the ring stress in the first and second belts of the cylindrical wall of the tank, based on the actual thickness of the metal sheets and under the condition of maximum filling of the tank, was performed according to the methodology proposed in (Ukrnaftoprodukt, 1997; Posypaiko, 2016a).

The maximum possible ring stress in the first (σ_1) and second (σ_2) belts of the wall are $\sigma_1 = 44.3$ MPa, $\sigma_2 = 34.1$ MPa with permissible values of 144.2 MPa and 168.2 MPa, respectively. Thus, the strength condition (1) is fulfilled with a significant margin.

According to the results of levelling the outer contour of the bottom, the parameter ΔU_k, which characterizes the unevenness of the settlement, and Θ_k, which characterizes the general roll of the tank, were determined (Ukrnaftoprodukt, 1997). The calculation of these parameters is given in (Posypaiko, 2016a). The value of the parameter ΔU_i and uneven bottom subsidence for the VST-200 tank meets the requirements (VBN..., 1994) and is 4, and its permissible value is 40. The value of the parameter Θ_k of the total roll for the tank meets the requirements (VBN..., 1994) and is 0.0004, and its permissible value is 0.006.

The bottom of the internal tank is made of steel sheets of 5.0 mm to 5.2 mm thickness. The sheets are assembled into strips by butt-welded joints, and the strips are joined together in an overlay. External inspection and visual control of the bottom of the tank showed that the surface of the metal sheets and welded joints were affected by pitting corrosion up to 2.0 mm deep. Corrosion ulcers of different depths are grouped in areas of 20–40 cm^2 and scattered over the sheets, mainly along the welded joints. The characteristic corrosion impressions of the bottom sheets are shown in the photo in Figure 3.

Figure 3. General view of corrosion damage at the tank's bottom

Welded joints generally meet the requirements of regulatory documents (Goskomitet..., 1988; VBN..., 1994; Ukrnaftoprodukt, 1997; 1998). There were no unacceptable surface defects of welded joints in the seams — cracks, undercuts, voids, unwelded craters, pores of industrial origin, and critical corrosion ulcers. The width of the reinforcement rollers of the butt-welded joints is 10—12 mm, and the height is 1—2.5 mm. In overlay welded joints, the size of the seam legs is 5—7 mm. The transition of welded seam metal to sheet metal is only sometimes smooth.

Separate corrosion ulcers with a depth of up to 2.0 mm were also found in the weld seams. There are splashes of metal along the seams. The general appearance of corrosion damage to the bottom welded joints is shown in the photo in Figure 4.

Controlling the tightness of the bottom's welded joints was carried out to detect cross-cutting damage or leaks. The vacuum method carried out airtightness control (Ukrnaftoprodukt, 1998). At the same time, overhead vacuum chambers were developed and manufactured by the E.O. Paton Electric Welding Institute (project NK-175) and vacuum pump 2NVR-1D. No leaks were detected in the welds. In addition, control of the tightness of welded joints of the bottom and walls as a whole is performed by checking the presence of fuel in the space between the two bottoms of the tank. An outlet pipe with a valve is installed in the outer bottom of the tank. Fuel stored in the internal tank can enter the space between the walls and bottoms only if there are leaks in welded joints or metal sheets of industrial or corrosion origin.

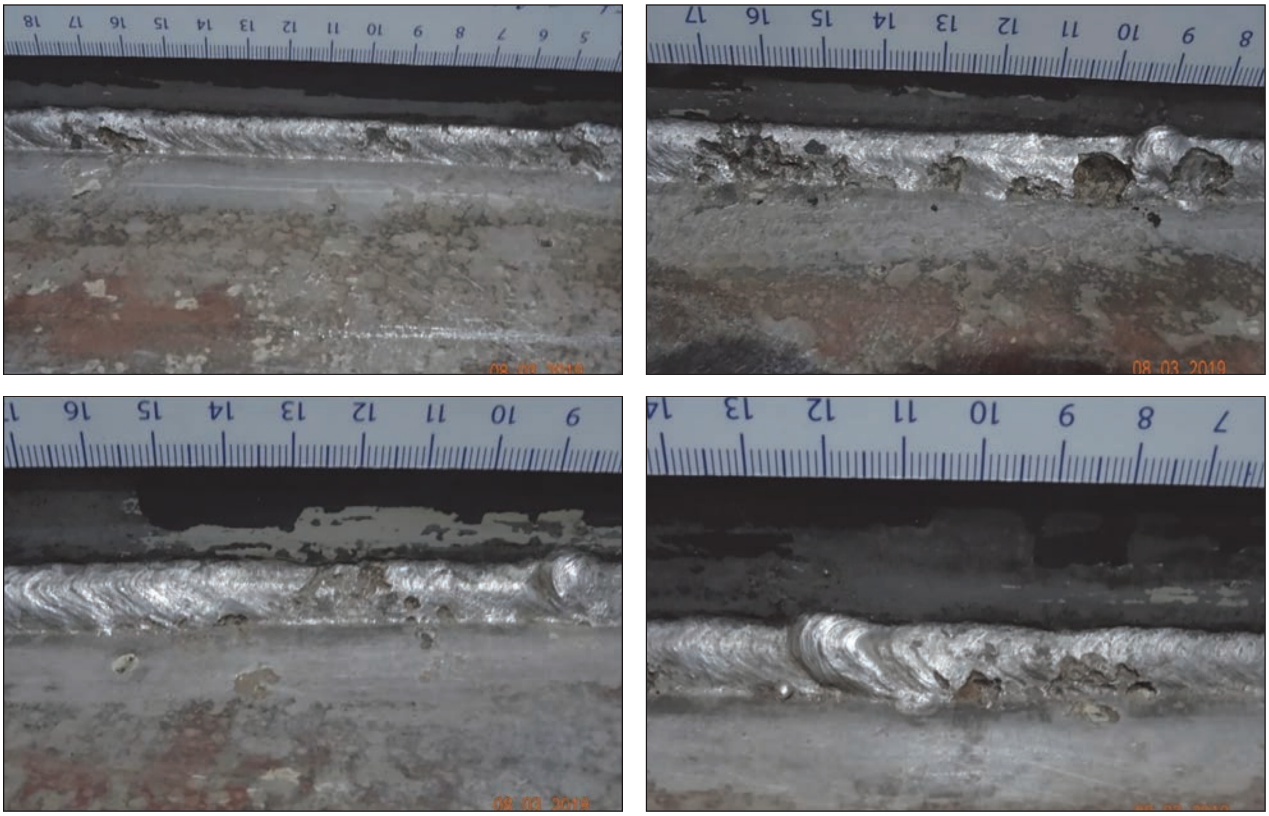

Figure 4. General view of corrosion damage of welded joints at the tank's bottom

By opening the valve of the outlet pipe at the bottom of the external tank, it is possible to ensure the presence or absence of fuel in the space between the two bottoms. Performing this operation showed that there was no fuel inside. That means there is no leakage in the internal tank.

During the examination of the tank's bottom, a test of the VK/TVA-1 visual information recording device was carried out, as shown in Figure 5. The VK/TVA-1 device is equipped with a video camera and a unit for wireless transmission of information to a smartphone. The device allows the examination of the welded joints of tanks and recording visual information about their condition. This information can be transmitted over communication lines to Ukraine to specialists in non-destructive testing for professional analysis using computer equipment in laboratory conditions.

One of the main conclusions of tank diagnostics was the need for priority anti-corrosion protection of the bottom of the internal tank. Anti-corrosion coating of the bottom was installed in 2019.

3.2 Anti-corrosion coating on the tank's bottom

Preparation of the bottom for the application of an anti-corrosion coating included several stages of its cleaning: collection of fuel residues and sediment, cleaning of the bottom with spatulas from paint residues, sandblasting of welded joints, near-seam zone and areas of metal affected by pitting corrosion, degreasing of the bottom surface with acetone.

Today, many anti-corrosion materials are applied to the inner surface of fuel storage tanks. In order to select modern anti-corrosion materials

Figure 5. Testing of the VK/TVA-1 visual information recording device on the welded joints at the bottom of the VST-200 tank

and rational technology for their use in Antarctic conditions, studies were conducted on samples with the participation of leading companies performing anti-corrosion work in tanks during 2016—2017. As a result of research and analysis, preference was given to a combined coating, the first layer of which is a suspension of flaky metal non-oxidized zinc in a system of polymer binders, the so-called "cold galvanizing" with LiquidZinc material. The next three layers are two-component liquid ceramic coating ZingaMetall CeramCoatCN1-N.

The LiquidZinc material forms a stable chemical bond with the cleaned steel surface. The percentage content of zinc in the material is 88—92%. The specific gravity of the material is 2.90—2.95 g cm^{-3}. The two-component liquid ceramic coating ZingaMetall CeramCoatCN1-N forms a dense elastic layer, providing metal protection and water in an aggressive environment. It can be applied in several layers. The time of complete drying is seven days. The solvent is acetone.

Adhesion of the LiquidZinc material layer was tested by the "knife scraping" method. The inspection showed that the material is not removed in a layer, remains on the metal, and is scraped off only in the form of zinc powder. Adhesion of the ZingaMetall CeramCoatCN1-N coating was tested on reference samples. When applied to the bottom, each layer's thickness was measured with a thickness gauge.

3.3 The state of the decommissioned HST-150 tank

In our work, we also studied the state of the decommissioned HST-150 tank, which has a historical value for knowledge of the durability of these tank type. The HST-150 fuel tank was built in 1978—1979 using the "Braithwaite" technology, which involves assembling a wall from steel stamped elements of a square shape measuring 1220 × 1220 mm, with diagonal stiffeners with a height of 40 mm. This technology allows the assembly of containers of different volumes without welding and lifting mechanisms. Steel square elements are fastened together with screws using elastic sealing gaskets and sealant. The thickness of the metal sheet, from which such elements are made by hot stamping, is 5 mm. In 1986, an inner hermetic shell made of corrosion-resistant steel sheets with a thickness of 3 mm was assembled and welded in the tank.

The HST-150 tank is divided in half by a hermetic partition into two containers of the same volume, connected by an external pipeline with a diameter of 80 mm. A 2.5-inch valve is installed at the outlet of each container. The tank has the shape of a parallelepiped, and its dimensions are 7340 × 7340 × 3660 mm. Internal dimensions of containers: 7250 × 3570 × 3660 (±10) mm. Limit height of pouring: 3600 mm. The structural strength of the tank is provided by internal oblique and transverse rods made of 70 × 70 mm angle. The roof of the tank is made of sheets measuring 1220 × 1220 × × 4 mm, which are connected with screws and installed on arched beams resting on the walls. The height of arched beams is 300 mm. The metal structures of the tank are made in the UK.

The tank's foundation is seven mutually parallel reinforced concrete strips measuring 8000 × × 600 × 800 mm. The foundation was built in 1978 on a rock foundation. The deviation of the surface of the foundation tapes from the horizontal plane was measured using an SL 60-2 level. Leveling points are selected at the corners of the tank. Measurements showed that the horizontal plane of the foundation is inclined along the longitudinal axis by 110 mm. Such an inclination of the foundation was included in its design to incline the tank towards the drain pipes.

The metal surface of the square-shaped steel stamped elements that make up the outer shell of the tank walls is uniformly smooth, painted, and has no rolling, stamping, or shape deviation defects. There are no traces of fuel leaks on the surface.

The inner shell of the HST-150 tank's walls and bottom are assembled and welded from sheets of anti-corrosion steel measuring 2000 × 1300 mm with a thickness of 3 mm. The sheets are connected by overlay seams and to the steel elements of the outer shell by "slit" seams. Thus, all welds are angular with legs of 3 mm to 4 mm. No unacceptable defects in welded joints and metal were found. The most common drawback of welded joints is the uneven shape of the seam reinforcement, which, however, cannot affect the operational characteristics of the joint. No corrosive damage to metal and seams was detected.

The verticality of the tank walls is measured in eight directions. The starting points for measurements are chosen near the corners of the tank. The deviation of the tank walls from the vertical line corresponds to the slope of the foundation: the front wall is inclined to the middle of the tank (−67÷−70) mm, and the back wall is inclined to the outside (+55÷+70) mm. The side walls slightly differ from the vertical up to 20 mm.

The tank bottom design is similar to the design of the walls. Square-shaped steel elements rest with their edges on 180-mm-high I-beams located on foundation tapes. The surface of the metal, which can be inspected between the concrete strips of the foundation, is uniformly covered with atmospheric corrosion, and there are traces of ancient painting. No rolling, stamping, or shape deviation defects were found on it. There are no traces of fuel leaks on the surface.

The roof of the tank is made of flat steel sheets, 1220 × 1220 × 4 mm in size, connected by screws, and installed on arched beams resting on the walls. The thickness of the metal sheets is 4 mm. The height of arched beams is 300 mm. The surface of the metal is uniformly smooth and painted and has no rolling, stamping, or shape deviations.

In response to the 2008 Agreement for Bilateral Cooperation in Antarctica between the State Institution National Antarctic Scientific Center and the British Antarctic Survey, the old fuel tank HST-150 was taken out of service. The waste fuel and sludge were carefully removed in a special container without causing pollution from the Antarctic Treaty Area and then utilized properly following the provisions of the Protocol on Environmental Protection to the Antarctic Treaty, as well as recommendations of the inspections carried out under the Antarctic Treaty (ATCM, 1999; 2005). Due to financial and technical difficulties in demolishing and removing the old fuel storage facility, the decommissioned fuel tank HST-150 is modified to a dry solid materials store by fitting a door in a side wall, as it has already been done with another smaller old fuel storage tank with a capacity of 33 m^3 (ATCM, 2008).

4 Conclusions

As a result of the inspection of the technical condition of the fuel tank at Vernadsky station, the preventive repair of the bottom of the VST-200 tank was accomplished, and conclusions were drawn about its state.

All elements (foundations, walls, bottoms, and roofs of external and internal tanks) are in working technical condition and comply with current norms and standards for design, manufacture, and operation. The static strength of the wall of the external and internal tanks corresponds to the project and current regulations.

Thanks to anti-corrosion work on the bottom of the internal tank of the VST-200, it is possible to continue its operation until April 1, 2029, in provisions of the rules for the technical operation of the tanks and the organization of annual monitoring of the technical condition of the tanks with appropriate technological equipment. Every year, it is necessary to clean the tank from sediment and inspect the condition of the anti-corrosion coating of the bottom, considering that in the existing operating conditions of the tank (lack of cathodic protection, close location of power generators, presence of sediment-forming substances in the fuel, use of general-purpose St3ps steel), corrosion processes cannot be avoided. It is necessary to identify the places of violation of the anti-corrosion coating at each inspection of the bottom and restore it.

The pipeline connections between the VST-200 fuel tank and the diesel power plant were replaced with new ones and tested for tightness and strength before commissioning. The technical condition of fuel tank and pipelines should be monitored annually during seasonal maintenance, and inspection of potential fuel leakage sites should be done daily. The old decommissioned fuel storage tank HST-150 has been cleaned and modified to a dry solid materials store.

Author contribution. Yu.P.: conceptualization, methodology, research, performance of works, writing — original and draft. A.A.: anti-corrosion protection methodology, performance of works.

Conflict of Interest. The authors declare that they have no conflict of interest.

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Моніторинг технічного стану паливного резервуару на Українській антарктичній станції «Академік Вернадський»

Реферат. В статті розглянуто діагностування технічного стану металевих конструкцій резервуару та трубопроводів на станції «Академік Вернадський», розробку та реалізацію заходів з підвищення надійності їх роботи, організацію їх регулярного щорічного моніторингу. На підготовчому етапі виконано аналіз проєктної та експлуатаційної документації на резервуар РВС-200, обрано методи технічного обстеження (ультразвукова товщинометрія, контроль герметичності, візуальний та вихрострумовий контроль, нівелірна та теодолітна зйомки тощо), підібрано обладнання та допоміжне приладдя для виконання діагностичних робіт методами неруйнівного контролю (дефектоскопи, товщиномір, течошукач, нівелір, теодоліт тощо). Виконано інструментальне обстеження стану металоконструкцій резервуару та трубопроводів методами неруйнівного контролю з метою виявлення дефектів та пошкоджень у конструкційних елементах та зварних з'єднаннях, обстеження стану фундаменту та основи резервуара. Виконано протикорозійні роботи на днищі паливного резервуара станції РВС-200 та замінено трубопроводи, що мали недопустимі корозійні пошкодження. Всі елементи резервуарів (фундаменти, стінки, днища та покрівлі зовнішнього і внутрішнього резервуарів) мають робочий технічний стан і відповідають чинним нормам і стандартам на проєктування, виготовлення і експлуатацію. Статична міцність стінки зовнішнього та внутрішнього резервуарів відповідає проєкту та діючим нормативам. Завдяки проведенню антикорозійних робіт на днищі внутрішнього резервуара РВС-200 можна продовжити його експлуатацію до 2029 року за умови виконання правил технічної експлуатації резервуарів та організації щорічного моніторингу технічного стану резервуарів і технологічного обладнання. У свою чергу, старий виведений з експлуатації резервуар РГС-150 переобладнується для зберігання сухих твердих матеріалів.

Ключові слова: дефект, метод неруйнівного контролю, пошкодження, резервуар, трубопровід