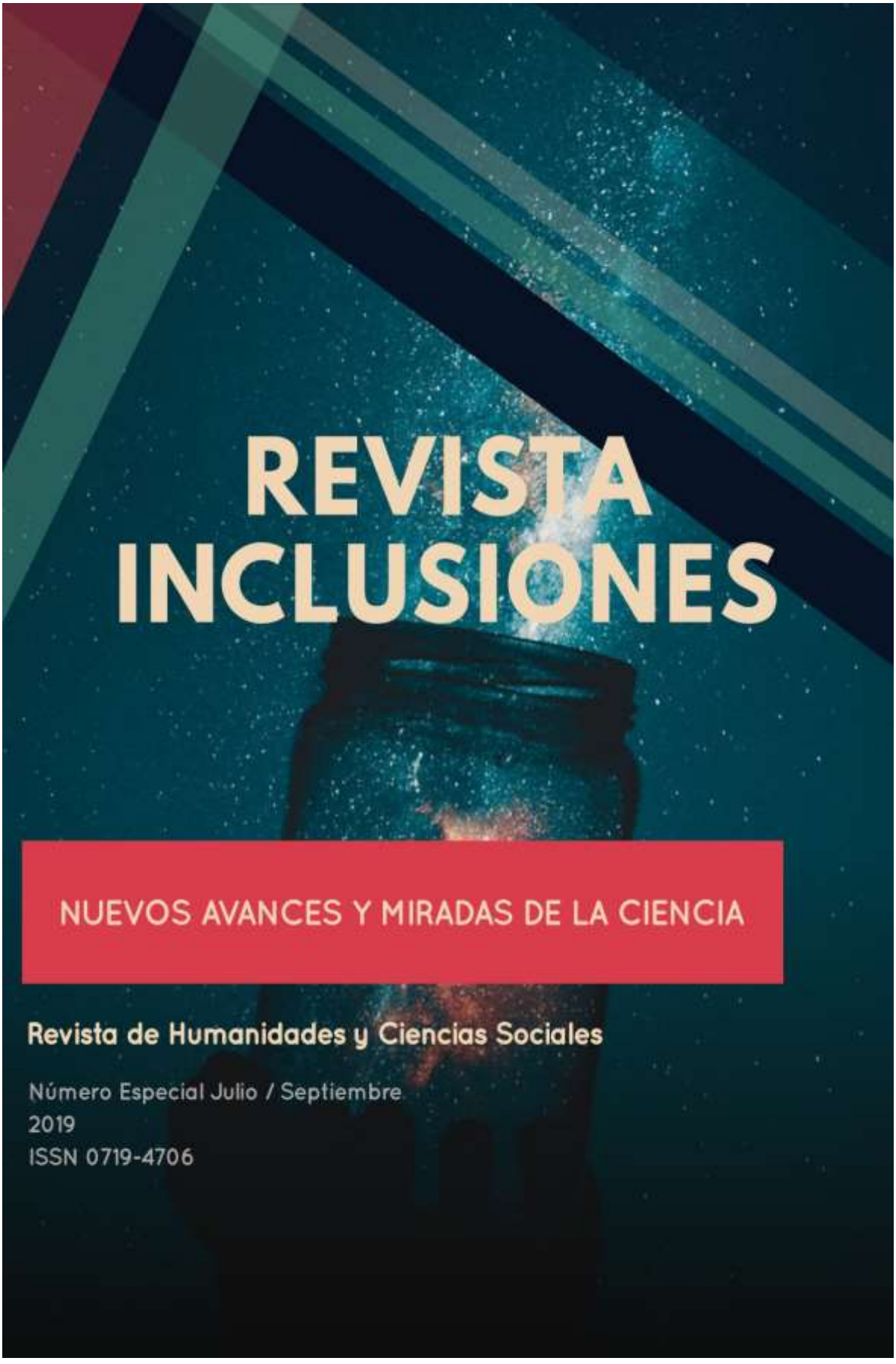

REVISTA INCLUSIONES

NUEVOS AVANCES Y MIRADAS DE LA CIENCIA

Revista de Humanidades y Ciencias Sociales

Número Especial Julio / Septiembre
2019
ISSN 0719-4706

REVISTA INCLUSIONES
REVISTA DE HUMANIDADES Y CIENCIAS SOCIALES

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REVISTA INCLUSIONES
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CUADERNOS DE SOFÍA EDITORIAL

ISSN 0719-4706 - Volumen 6 / Número Especial / Julio – Septiembre 2019 pp. 157-164

METHODS OF MEASUREMENT OF OIL QUANTITY IN TANKS

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Fecha de Recepción: 19 de marzo de 2019 – **Fecha Revisión**: 28 de abril de 2019

Fecha de Aceptación: 21 de junio de 2019 – **Fecha de Publicación**: 01 de julio de 2019

Abstract

In this article problems of accounting for the amount of oil in reservoirs are considered. Various types of oil storage tanks are analyzed, as well as devices for controlling its amount. Based on the studies conducted, the most appropriate level indicators were identified for their use in oil reservoirs of different types.

Keywords

Reservoir park – Reservoir – Counting quantity – Leveler – RAPTOR – System TRL / 2

Para Citar este Artículo:

Fokeeva, Liya H. y Zainyllina, Vilena. Methods of measurement of oil quantity in tanks. Revista Inclusiones Vol: 6 num Esp Jul-Sep (2019): 157-164.

Introduction

To date, the control of oil levels in reservoirs is very important. Without this data, it is impossible to take into account the amount of oil in the reservoir. The amount of oil in the reservoirs is determined by the volume consumed by it in the reservoir. Toto quickly and accurately determines the volume of oil depending on its level (elevation), pre-made gauge tables are used for each type of reservoir. The reservoirs are calibrated in various ways: using measuring vessels, bulk and drain pre-measured volumes of water (for small tanks); with the help of volume counters, measuring the amount of poured water while simultaneously measuring the height of the level in a calibrated tank, and measuring the geometric dimensions of the tank. The method is chosen to take into account the volume of reservoirs and the required precision.

In connection with this, various oil control systems in the reservoirs used today are considered, the best option is chosen. Also, the types of reservoirs for the placement and storage of oil are considered.

Methods

The reservoir park is a group (groups) of reservoirs intended for receiving, storing and pumping oil and located on the territory bounded by perimeter overturning or enclosing wall with ground tanks and roads or fire fences - in underground tanks.

A reservoir is a tank where petroleum products are stored. Reservoirs are one of the main structures of petroleum storage facilities and are intended for the storage of petroleum products and the production of certain technological operations.

The purpose of the tanks is to receive, store and dispose of various liquid (such as water, oil, butter, gasoline, kerosene, etc.) and gaseous media.

Tanks can be classified according to different features, for example: concerning the level of the earth; by the magnitude of excess pressure; on technological operations; by design.

Concerning the level of the land, tanks can be:

- underground;
- ground-based.

By excessive pressure:

- low-pressure tanks, in which the excess pressure is slightly different from atmospheric (Rn <0.002 MPa)
- tanks of high pressure (Rn> 0.002 MPa);

For technological operations:

- Tanks for storage of low viscosity oil and petroleum products;
- Tanks for storing high-viscosity oil and petroleum products;

- reservoirs-settlers;
- Tanks of special constructions for storage of oil and oil products with high pressure of saturated vapors;

By design:

- steel tanks vertical cylindrical with conical and spherical roofs, horizontal cylindrical with flat and spatial bottoms, drop-shaped, ball-shaped;
- reinforced concrete tanks (vertical and horizontal cylindrical, rectangular and trench).

The vertical reservoir (VER) is a construction (Fig. 1), usually steel, in the form of a cylinder with a bottom and a roof (therefore they are called cylindrical reservoirs). Different equipment is installed on the roof of the reservoir: breathing valves, hatches - light and measuring, leveling and lightning dampers. In the lower part pipelines are connected, and hatches are installed. To prevent the accidental spill of the product, the tanks are guarded by an earth shaft (clogging). For service convenience, the reservoir is equipped with fencing areas and an external steel staircase. All designs necessarily have anti-corrosion coating (two layers of soil GF-021 and enamel coating PF-115)[1].

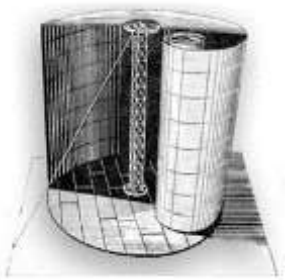

Fig. 1
VER

Fig. 2
HST

[1] R. Gost, Reservoirs vertical cylindrical steel for oil and petroleum products. 2008.

Fig. 3
Soft Tanks

Horizontal steel tanks (HST) are intended for stationary storage of liquids - water, oil, petroleum products, as well as technological mixtures and other liquids with a density of up to 1.3 t / m^3.

The HST is a steel cylindrical structure with two flat, conical or spherical bottoms (Fig. 2). To give the tank greater strength, the sidewalls are reinforced with rigid rings. The bottoms, as well as the walls, can be strengthened by ribs of stiffness[2].

Ball tanks are spherical shaped tanks. They are designed for storage at elevated pressure (more than 0,25 MPa) of liquefied hydrocarbon gases and petroleum products.

The main element of the ball tanks is the shell, collected from the petals of a double steepness. It is manufactured in factory conditions. Petals are welded automatically with the help of welding manipulators, which ensures the most mechanization of the process of manufacturing ball tanks, achieving high-quality welds and high installation performance. The shell of the ball tanks rests on several columns, welded directly to the body, which transmits pressure to the concrete foundation. For greater stiffness, columns can be joined by a system of stretch marks[3].

In the drop-shaped tanks, there is no support ring and stiffeners within the reservoir, and the shell lies in the zone of the equator on 20 supports (columns), which are mounted on the reinforced concrete support ring. The droplet shell has a thickness above the equator of 5 mm, below 6 mm[4].

There are also soft tanks (Fig. 3). This is a fairly new product that is becoming increasingly popular. Their application is actually in various branches of industry and production both in small and large enterprises, as well as in private individuals, the army, special services during emergency rescue operations. Their advantage is that they are not subject to corrosion under the influence of aggressive substances.

[2] V. V. Shalya ands Yu. P. Makushev, Designing, and operation of oil and gas stations. Study allowance (Omsk: Publishing house of OmSTU, 2010).
[3] A. Yu Zhukov, “Algorithms for measuring the level of liquid in a closed reservoir”, Bulletin of the Ural State University, num 23 (2012): 175-177.
[4] I. V. Komarov, Fundamentals of the theory of radar systems with continuous radiation of frequency-modulated oscillations (Moscú: Hot Line-Telecom, 2010).

Soft tanks are used to temporarily store virtually any liquids - petroleum products, water, sludge, alcohol, and other liquids. They are made in the form of pillows[5]. They have high tightness, which is guaranteed by the high quality of the joints of the polymeric material.

However, as in other cases, there are problems with their exploitation.

- To achieve the maximum capacity of the tank and at the same time reduce the risk of spills and overflows, a comprehensive introduction of new technological solutions for measuring and controlling the level of the product is necessary.
- To improve the quality of the measurement of the product level in the tanks, specialists need to apply various methods that improve the quality of the indications. Quite widely used were contactless or waveguide radars.

Methods

- Integrated technologies
- Vibration level alarms
- Wireless connection
- Anti-theft system (SPZ)

Results

Application of modern liquids measurement and control technologies - reliable protection from emergencies. Accurate measurement of the liquid level in the reservoirs plays a significant role in inventory management and environmental protection.

For level measurement in reservoirs, enterprise engineers widely use contactless or waveguide radars. The principle of their operation makes it possible to increase the accuracy and reliability of measurements while reducing maintenance costs. It is based on the propagation of a microvolume nanosecond radar pulse down the probe. When the radar pulse reaches the surface of the measured medium, part of the energy is reflected in the opposite direction.

The level meter allows you to measure the time it takes for the impulse to reach the surface of the medium and to reflect in the opposite direction, after which the built-in microprocessor accurately calculates the distance to the surface of the medium by time-resolution reflection technology.

The newest measuring instruments meet all of these requirements, increase reliability and accuracy of measurements, announce their technical condition, and allow previously impossible measurements.

[5] V. I. Tereshin, “Design principles of radiofrequency single-probe-based devices for multi-parameter and disturbance-independent technological measurements. Proc. of the Int'l Symposium on Instrumentation Science and Technology (ISIST'2004). Xi'an, China. 2004.

The TRL / 2 system is intended for commodity accounting of oil and petroleum products and continuous monitoring of the state of the reservoir park[6].

The TRL / 2 system provides:

1) measurement of the level, temperature, pressure of the product;
2) measurement of the height of the level of sub-commodity water;
3) signaling of the limit levels when pouring, product leaks during storage;
4) calculation of the specified volume, required density and mass of the product in the reservoir based on the results of measurements of the product parameters with an error that meets the requirements of GOST R 8.595-2002.

The existing Raptor information and measurement system for commercial inventory and management of tank farms is a further development of the TankRadarL / 2 system.

The Raptor system is a flexible system with the ability to simply change its configuration based on the use of standard communication protocols. This system provides full control not only for the status of tank farms, but also for the parameters of the product in tanks, as well as the calculation of the volume and mass of oil and petroleum products in reservoirs of all types: under pressure and without excess pressure, with a fixed or floating roof, in vertical or horizontal cylindrical and spherical reservoirs.

Radar level meters

The RAPTOR radar gauges provide level measurement with the highest accuracy and reliability because they do not have moving parts, although there is only an antenna or a small sensing element inside the tank.

The Raptor system provides measurement and calculation of product parameters in tanks for the following operations:

- control over the general condition of the tank park;
- calculating the volume and weight of the product in the tank itself;
- control over the conduct and execution of acceptance and shipment operations;
- detection of possible product leaks from different types of reservoirs;
- prevention of overflow of the permissible level of reservoirs;
- operational control of the presence or absence of products in tanks.

The Raptor system can be completed and configured to measure the following product parameters in tanks:

- level, speed of level measurement;
- multi-point temperature measurements for calculating the average temperature;

[6] V. I. Tereshin, “Measurement of the amount of liquefied petroleum gas in a tank by radiofrequency techniques”, IEEE Transactions on Instrumentation and Measurement. Vol: 53 num 4 (2004): 1255-1261.

- the hydrostatic pressure of the product and excess pressure in the gas space;
- the level of substandard water.

The TRL / 2 system uses TankRadar REX radar transducers, TankRadar PRO with different types of antennas, depending on the measurement conditions. Levels continuously emit frequency-modulated high-frequency oscillations and have the highest measurement accuracy.

Radar level meters can be used in reservoirs of various designation and type of structures.

1. PRO Series Levels are designed for process tanks with internal constructions or stirrers.
2. The RTG3900REX series is designed for commercial reservoirs requiring product level measurement with extremely high precision.
3. The RTG3930REX level gauges with a parabolic antenna are used on fixed roof tanks for measuring the level of oil and petroleum products.
4. The RTG3950REX level gauges are installed in guide pipes in tanks with a pontoon or floating roof.
5. RTG3960REX level gauges are installed on pressurized liquefied gas tanks. These gauges are equipped with a ball valve and a verification device that automatically allows for the change in the signal propagation rate in the gas space of the tank, depending on the product type.

RNL / RNT level alarms are used to protect tanks from overflow. The advantage of these level meters is the availability of automatic monitoring of their performance [JIG-1. 2008. 2005, Varghese, 2016].

Conclusions

Depending on the method of storage, the specifics of operations of loading and unloading of oil and petroleum products and their properties, it is possible to apply various methods of accounting for quantities, which is defined in the instructions on the procedure for receipt, storage, hire an account of oil and petroleum products at oil depots, filling stations and petrol stations of the system. The article deals with the problems that exist to date and mentions the modernization of radar level meters.

At present, little studied, however, remains the problem of assessing the reliability of oil reservoirs both at different stages of their life cycle and in the process of exploitation.

When evaluating the level of reliability of the operation of the tanks, the expression of this value is most effective through the indicator of their service quality. For a comprehensive study of the problem of maintaining and maintaining the reliability and safety of reservoirs, it is necessary to develop models and methods by which it is possible to identify and assess with a sufficient degree of precision methods for ensuring the reliability of reservoirs at different stages of their life cycle.

Acknowledgments

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University

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