Differential draft the bottoms of vertical reservoirs, operating in Arctic conditions

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***Abstract*— The analysis of differential draft the bottoms of vertical welded reservoirs operating in Arctic conditions. As a result of leveling and plumb, it was found that there is a significant excess of standards deviations reservoirs horizontally and vertically, which can cause an accident. The results of investigation of fracture and damage to reservoirs.**

***Keywords*— Reservoir, bottom draft, fracture, accident.**

I. INTRODUCTION

The storage depots of the Arctic regions of Russia operated reservoirs, spent more than 20-40 years, thus many reservoirs almost exhausted their service life. One of the stages of the problem solving is the expertise of industrial safety with complex observation the technical condition of the reservoir NDT methods [1, 2].

Climate conditions in the Arctic, is characterized by low temperatures and a large temperature difference in summer and winter, territories with permafrost soil.

In this paper the differential draft the bottoms of vertical steel welded reservoirs operating in the Arctic region of Russia - Yakutia. Analysis about the case according to the expertise of industrial safety and technical diagnostics more than one hundred reservoirs with a capacity of up to 5,000 cubic meters.

II. DRAFT OF RESERVOIRS

Regulatory documents in the oil and gas industry of Russia does not contain specific requirements for the base of reservoir bottom on permafrost soil. Therefore, most of the reservoirs in the Arctic have a base arranged bedding of inert materials such as snd-gravel mix, sand, loam, with concreting of the blind area and a square, without the ventilated basement [3].

Based on results of leveling and plumb, it was found that the feature observed reservoirs is - significant exceeding the standards deviations of outer contour of the bottom of the reservoirs from the horizontal (the maximum deviation of 600 mm, the allowable 100 mm) and forming the walls of the reservoir from the vertical (the maximum deviation of 575 mm, the allowable 160 mm) [4].

According to analysis, found (Figure 1):
On the territory of Yakutia: deviation reservoirs horizontally within norms - 46%, deviation reservoirs horizontally above rules - 54%, including deviation from 100 to 200 mm - 22%, from 200 to 300 mm - 19%, by 300 to 400 mm - 9% or more than 400 mm - 4%;

On the territory of Southern Yakutia: deviation reservoirs horizontally within the rules - 58%, deviation reservoirs horizontally above rules - 42%, including deviation from 100 to 200 mm - 25%, from 200 to 300 mm - 17%;

On the territory of Central Yakutia: deviation reservoirs horizontally within the rules - 73 %, deviation reservoirs horizontally above rules - 27%, including deviation from 100 to 200 mm - 18%, from 200 to 300 mm - 9%;

On the territory *of Western Yakutia:* deviation reservoirs horizontally within the rules - 29%, deviation reservoirs horizontally above the norm - 71%, including deviations from 100 to 200 mm - 24%, from 200 to 300 mm - 24 %, from 300 to 400 mm - 16% and more than 400 mm - 7%.

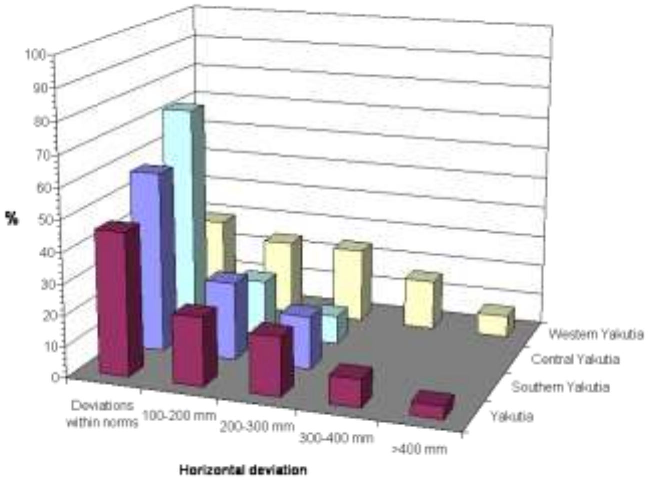

Figure 1. Draft of reservoirs.

Based on the available data base under the reservoirs on permafrost soils should be designed on pile foundations with a highly placed raft or bedding of coarse material [5]. Storing frozen soil state is achieved by the device ventilated space between the soil surface and the bottom of reservoir with a year-round natural ventilation. This type is the best reason in the Arctic that show technical observations reservoirs installed on the ventilated foundations, which were found unacceptable draft reservoir bottoms volume of 5000 m3, operated more than 30 years.

III. Fracture of reservoirs

These deviations have appeared in the course of operation are a greater threat of accident reservoir. Thus, in 2002-2003 years, there were 2 cases of accident RVS-700 due to differential draft bottom. The reservoirs were put into operation in the 1976-1982 years, the passport stamp steel - 09G2S. In the first case of an accident due to differential draft bottom of the reservoir RVS-700 was climbing central pillar of the reservoir which eventually led to the separation of the roof from the wall at the joints (Figure 2). This fracture occurred in sub-zero temperatures and filled reservoir, although not brought to the emergency filling fuel but has led to the exit of the exploitation of the reservoir.

Figure 2. Wall of RVS-700.

In the second case, due to differential draft reservoir bottom RVS-700 occurred in the form of local deformation folds (buckling) of the wall at the junction of the bottom plates, which resulted in formation of the through hole (Figure 3). In this case, there was no emergency fuel filling was carry out the county and pumping the fuel, but the reservoir was also decommissioned.

Figure 3. Wall deformation RVS-700.

In another case, in 2004 year there was a break of the bottom of the filled reservoir RVS-1000, which resulted in the leak fuel. This reservoir was operated since 1968 and was used for storage of light oil products. By marking sheets wall - reservoir made of steel St3ps. After the elimination of the accident during the observation it was discovered by the leveling the maximum deviation from the horizontal was 242 mm. During the investigation, on the side of the maximum gradient in the bottom of the reservoir was detected hole diameter of about 15 mm, formed by the gap of the steel bottom plate (the direction of the gap - upward). The hole was formed due to the following reasons:

Invalid differential draft of the reservoir with a maximum draft in the area of the hole to 240 mm, which resulted in a break of the bottom sheet (hole formation), and the deformation of the outer side of the reservoir bottom;

In place of the gap according to a decrease in the thickness measurement of sheet thickness from 4 mm to 2.9 mm, and had a small bulge the size of 40*20 mm and a height of 3.5 mm, which indicates the possible presence a solid object on the base under the bottom of the reservoir.

IV. Conclusions

Thus, this and our previous work shows [6], reservoirs operates 30-40 years in the Arctic, practically exhausted service life. It is shown that one of the most dangerous types of defects is - differential draft of tank bottom, which can lead to fracture of the reservoir. Based on these data, necessary to tighten the requirements for the building of the base under the reservoir in areas permafrost soils and conduct periodic observation of the technical state of reservoirs.

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