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THE TASK OF OPTIMIZING OIL LOADING IN TANKERS

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ABSTRACT

The paper discusses the task of optimizing oil loading into tankers, using the Baku-Sufsi oil pipeline as an example. The goal is to develop an algorithm for building an optimization method for a tanker from an oil terminal, which represents the cost from the pipeline as a Fourier series. The problem of the hydraulic differential equation for loading oil flow from the terminal to the tankers is discussed. After integration, the equation does not have an obvious solution and must be solved approximately by an iterative or graphical method. As a result, factors and regularities are identified, which are combined with real oil parameters. Therefore, for the first time in Georgia, an original methodology for building an optimization algorithm for oil loading from a terminal to a tanker was developed.

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Introduction.

Consider the task of optimizing the loading of oil into tankers, using the Baku-Sufsi oil pipeline as an example (pic. 1). From the commissioning of the Baku-Sufsi oil pipeline to November 2021, 700 million barrels of oil have been transported. As of November 30, 2021, 1,000 tankers have been loaded [1, 2, 3].

In this regard, we will discuss the construction of an optimization algorithm (method) from an oil terminal to a tanker. This problem is not new, however, we decided to improve the process in the oil sector, which is characterized by certain approaches. Our goal is to use the algorithm we have developed to build an optimization methodology for a tanker from an oil terminal, which represents the cost from the pipeline as a Fourier series.

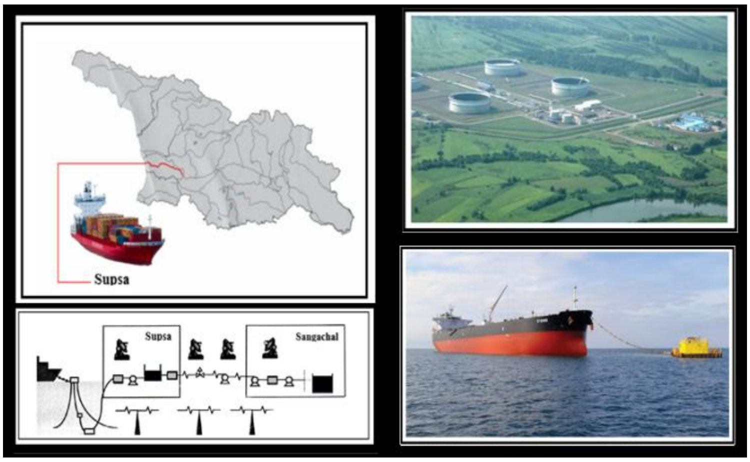

Fig. 1. Scheme of Sangachali-Supsa main oil pipeline and view of Supsa oil terminal.

According to the last five years, the amount of crude oil entering the main oil pipeline "Baku-Sufsa" is about 4.2 mln.

Consider the task of loading oil into tankers from the terminal, the scheme of which is given in pic. at 2 [4].

Q* - the constant charge coming from the mains, obtained by means of the Fourier series; q(t)- the cost of loading into a tanker, the graph of which changes over time is shown in Fig. 2 H_0 and Ω are reservoir height and cross-sectional area. It is implied that the time interval between the arrival of tankers is T_1, part of which t_0 is used for loading. Lets determine the time during which the depth in the reservoir will change from H_0 - to 0, i.e. then, it is impossible to continue the process of pouring oil into tankers.

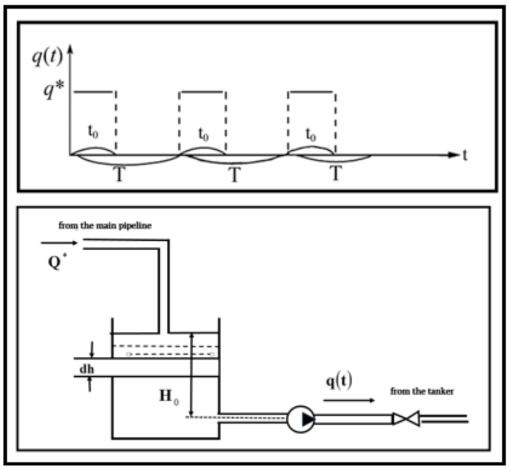

Fig. 2. Top - chart of loading oil from the terminal into a tanker.
Bottom - graph of changes in cost of loading oil into a tanker.

Let's say that in *dt* time, the depth in the reservoir has changed over time by *dt* and *dh*. (as the level in the reservoir decreases q* > Q*). Then the volume balance equation will have the following form [11]: (1)

Where q(t) - Fourier series expansion is obtained.

$$\mathbf{q}(\mathbf{t}) = \frac{4\mathbf{q}^*}{\pi}\sum_{\mathbf{n}=1}^{\infty}\frac{1}{\mathbf{n}}\sin^2\frac{\mathbf{n}\pi\mathbf{t}_0}{2\mathbf{T}}\sin\frac{\mathbf{n}\pi\mathbf{t}}{\mathbf{T}}, \qquad (2)$$

Where q*=const

Therefore, we will have

$$\left[\mathbf{Q}^* - \frac{4\mathbf{q}^*}{\pi}\sum_{\mathbf{n}=1}^{\infty}\frac{1}{\mathbf{n}}\sin^2\frac{\mathbf{n}\pi\mathbf{t}_0}{2\mathbf{T}}\sin\frac{\mathbf{n}\pi\mathbf{t}}{\mathbf{T}}\right]\mathbf{dt} = \Omega\mathbf{dh} \qquad (3)$$

After integration, we finally get the equation:

$$\frac{8\mathbf{q}^*\mathbf{T}}{\pi^2}\sum_{\mathbf{n}=1}^{\infty}\frac{1}{\mathbf{n}^2}\sin^2\left(\cos\frac{\mathbf{n}\pi\mathbf{t}}{\mathbf{T}} - 1\right) = \mathbf{Q}^*\mathbf{t} + \mathbf{W}_0 \qquad (4)$$

Where W_0 - is the Volume of the reservoir.

(4) The equation does not have an obvious solution and it must be solved approximately by an iterative or graphical method. Let's consider the following parameters: *T=200hr; t_0=40hr; q*=500m^3/hr; Q*=1000/hr; W_0=140000m^3.*

The graphical result of the calculation performed on the computer is shown in pic. at 3.

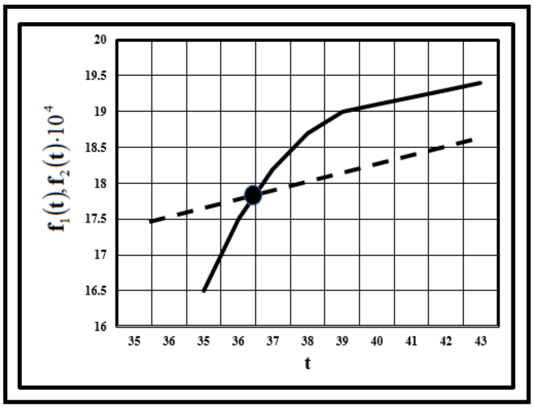

Fig. 3. Graphical solution of the equation.

Therefore, the received result $t \equiv 37hr$. shows us that, the parameters for the process are chosen incorrectly and for the proper function we need to increase T. After choosing specific values for T and conducting above-mentioned processes, we can come to an optimal Value for T.

Actually, the terminal consists of several reservoirs. In such a case, the solution scheme does not change, only W_0 does, the total volume of all four reservoirs.

The given scheme of the solution is fair even in the case when different water tankers arrive at different time intervals, only in this case, it is necessary to (1) change the image with the appropriate Fourier expansion of the process.

Thus, factors and regularities are identified, which are combined with real oil parameters. Therefore, for the first time in Georgia, an original methodology for building an optimization algorithm for oil loading from a terminal to a tanker was developed.

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