Improvement of equipment for top loading of petroleum products

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Abstract. Transportation of oil and petroleum products is a priority for the development of the country's economy, therefore, the development of fuel-filling equipment that allows to increase the safety of the operator who controls this equipment, as well as the driver of the tank car who works on the tank--opens (closes) filling hatches, and also manually orients the fuel-filling pipe and lowering (lifting) its in the hatch opening of a tanker truck, is an important task. The article offers a description of a new design of fuel-filling equipment for tankers, which allows automating the process of projecting a filling pipe relative to the hatch of a tanker truck when top-loading petroleum products into tankers and increasing measures to protect the driver and operator. This is achieved by introducing additional hydraulic cylinders into the prototype design, which allow moving the filling pipe in the transverse plane of the hatch, as well as lowering (lifting) the filling pipe into the hatch opening for filling petroleum products. Automation of the process is carried out through the use of a video camera, the image from which is transmitted to the operator's control panel. The image comes from a video camera in real time, and in addition to the transverse movement of the pipe, the depth of movement is controlled by the operator on the monitor.

1 Introduction

Transportation of oil and petroleum products on the territory of the Russian Federation is one of the priority areas that have a significant impact on the economic development of the country. Transportation is carried out by all types of transport, starting from pipeline, railway, etc., ending with automobile [1-3].

It is necessary to ensure safety at each stage of transportation of petroleum products, because spills often lead to ignition or explosion. The consequences of such emergencies lead to a large number of victims, damage to the environment, loss of dangerous cargo. Consequently, issues related to the transportation of oil and petroleum products still remain relevant.

For the transportation of oil and petroleum products on the territory of the Russian Federation, the international rules for the transportation of dangerous goods, which have received the abbreviation ADR, apply. In accordance with the requirements of ADR, the
transportation of oil and petroleum products belongs to the third class of hazards – the transportation of flammable liquids in tankers. According to ADR, all operations related to the transportation of such liquids are strictly regulated: starting with the choice of a vehicle for their transportation, loading dangerous cargo into a tanker (filling), transportation along a pre-agreed route with the Traffic Police of the Ministry of Internal Affairs of the Russian Federation and the Ministry of Transport of the Russian Federation, and its unloading at the point of arrival.

Auxiliary equipment plays a special role in this process, ensuring safety when filling oil and petroleum products into tankers, as well as draining into stationary tanks.

2 Materials and Methods

In this paper, automation of the process of top loading of petroleum products into tankers and improvement of measures for labor protection of the driver and operator are proposed.

The proposed system for the top filling of petroleum products in tankers has the following design.

Figure 1 shows a platform equipped for the top filling of petroleum products. The figures in Figure 1 indicate:

- Tanker truck 1 with an upper hatch 2;
- Equipment 3 for the top filling of petroleum products with a block of pumping stations 4;
- Operator room 5;
- Guiding curb stone 6;
- Traffic light 7.

Fig. 1. Orientation of the tanker truck at the site equipped for top loading of petroleum products
3 Results and Discussion

The composition of the equipment for the top filling of petroleum products is shown in Figure 2. The figures in Figure 2 indicate: a vertical support stand 8, to which the console 9 is attached, reinforced with a stop 10. The guide 16 of the pipeline for pumping petroleum products is installed on the console 9. The connection of the detachable parts of the pipeline 14 and its connection to the flexible pipe 15 is carried out by couplings 11. Pumping of petroleum products is carried out by pumping station 12 (PS1), the drive of hydraulic cylinders 18 and 25 by pumping station 13 (PS2).

With the help of the hydraulic cylinder 18, the hydraulic cylinder 25 is moved along the console 9 to accurately hit the filling pipe 17 into the hatch opening 2 of the tanker 1 [10-13].

With the help of a hydraulic cylinder 25, the filling pipe 17 is lowered into the hatch opening 2 of the tanker 1 to prevent the spraying of petroleum products during filling.

In order to obtain an image to correct the movement of the filling pipe 17, a video camera 14 is installed in its lower part, the signal from which is transmitted to a monitor located in the operator's room. A fuel level monitoring sensor 20 is installed at the end of the filling pipe 17.

To prevent the ignition of petroleum products from a spark, the tanker 1 is connected to earthing devices 21 using an automatic grounding control device 22 with an intrinsically safe contact device.

Figure 3 shows the principle of moving the hydraulic cylinder 25 in the transverse plane of the tanker 1 along the hatch opening 2.

Along the upper part of the console 9, the hydraulic cylinder 25 moves with the rod of the two-way hydraulic cylinder 18. Axles 23 are fixed to its body, bearings 24 are mounted on it.
Figure 3 shows the movement of the hydraulic cylinder in the transverse plane of the tanker along the hatch opening. Figure 4 shows the design of the hydraulic cylinder 25. The numbers indicate: a flexible pipe 15 connected to the filling pipe 17 by a coupling that performs the function of the piston of the hydraulic cylinder 25. Oil products are poured inside pipes 15 and 14. The hydraulic cylinder 25 is controlled by the block 26.

The hydraulic circuit of the hydraulic cylinder 25 is shown in Figure 5. The pump shown in Figure 5, located in the pumping station PS2 13 (Figure 2), supplies the working fluid to the main line under pressure controlled by a pressure valve. With the help of a hydraulic distributor, the filling pipe 17 is lowered down or raised up [14-16].
Fig. 6 shows a hydraulic scheme for pumping petroleum products.

The numbers indicate: tank 27, pump 29, filter 28, main 30, pressure gauge 31, pressure valve 32, flow meter 33, fuel level sensor 20.

The system for the top filling of petroleum products in tankers works as follows. The driver of the tanker truck 1 (Figure 1) drives up to the site where the equipment 3 for the top filling of petroleum products is installed. A traffic light 7 is installed in front of the platform, which is controlled by an operator located in the operator room 5.

The driver, moving at a low speed of up to 10 km/h along the guide curb 6 and as close as possible to it, stops the tanker 1 when the red signal lights up at the traffic light 7. The operator turns on the red signal after hatch 2 appears on the monitor. The image on the monitor comes from a video camera 14 (Figure 2) mounted on a filling pipe 17.

After stopping the tanker 1, the driver opens the hatch 2, connects the tanker to the earthing devices 21 using the automatic grounding control device 22 with an intrinsically safe contact device [17, 18].

To accurately get the filling pipe 17 into the hatch opening 2 of the tanker 1, the operator moves it back and forth in the transverse plane of the tanker along the hole. The movement is carried out along the guides along the upper part of the console 9 by the rod of the two-way hydraulic cylinder 18. To remove the load from the hydraulic cylinder rod 18, the axes 23 are attached to the hydraulic cylinder body 25 (Figure 3), at the ends of which the inner rings of the bearings 24 are pressed. The outer rings of the bearings 24 move along the guides along the upper part of the console 9.

The hydraulic scheme of the hydraulic cylinder 18 is shown in Figure 7.
When the operator turns on the PS2 pump located in the pumping station 13, the oil from the hydraulic system tank enters the main line, and is discharged back into the tank through the pressure valve. The operator, having chosen the right direction, connects the desired cavity of the hydraulic cylinder 18 to the main line, and moves the hydraulic cylinder 25 to the center of the hatch opening 2. The process is controlled by the image on the monitor coming from the video camera 19 in real time. When the hydraulic cylinder reaches the center of the hatch opening 2, the pump turns off.

To prevent the spraying of petroleum products during their upper filling into the tanker with the help of a hydraulic cylinder 25, the filling pipe 17, which is essentially a rod, moves down into the hatch opening. The depth of movement is controlled by the operator on the monitor, which receives the image from the video camera 19 in real time.

To compensate for the distance traveled by the filling pipe into the opening of the hatch 2, the upper rod is made of a flexible pipe 15, and has a certain margin in length. The hydraulic cylinder 25 (Figure 4) is a double-sided hollow rod inside which petroleum products are pumped, consisting of a flexible pipe 15 connected by a coupling that performs the function of a piston with a filling pipe 17. A video camera 19 and a fuel level sensor 20 are installed at the end of the filling pipe.

The operation of the hydraulic cylinder 25 is controlled by the operator through the control unit 26. The hydraulic scheme of the hydraulic cylinder 25 is shown in Figure 6, and its principle of operation is similar to the operation of the hydraulic cylinder 18.

Having lowered the filling pipe to the desired depth, the operator turns off the hydraulic cylinder pump 25 located in the pumping station HC2 13 (Figure 2). After that, the operator proceeds to refuel the tanker 1 with petroleum products by turning on the pump 29 located in the pumping station HC2 12 (Figure 2). Oil products from the storage tank 27 (Figure 6) after switching on the pump 29 enter through the filter 28 into the trunk 30 through pipelines 14 and 15, interconnected by couplings 11. The pressure in the pipeline is controlled by a pressure gauge 31, the readings of which are displayed on the monitor in the control room in real time, and regulated by a pressure valve 32.

The volume of pumped petroleum products is set by the operator and controlled by the flow meter 33. To protect against the overflow of petroleum products from the tanker 1, a fuel level sensor 20 is attached to the flange of the filling pipe 17 (Figure 2).
4 Conclusion

The technical result of this utility model consists in automating the process of top loading of petroleum products into tankers and improving measures to protect the driver and operator. The paper describes the design of the proposed system for the top filling of petroleum products in tankers and its principle of operation.

References


