Use of collapsible pipelines for joint work with main oil product pipelines

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Abstract. The paper describes development stages for dismountable pipelines to work together with the major oil pipeline. Dismountable pipelines are used for transporting refined oil volumes over great distances in any climatic and geographical conditions. A dismountable construction provides technological pipeline schemes for rapid transportation and distribution of refined oil products to storage tanks. Subsequently, these products from containers can be utilized for various purposes.

1. Introduction
Dismountable pipelines were developed for the country’s armed forces with a view to transporting fuel for military equipment.

Integrated experience of using dismountable pipelines in various situations over the years has allowed for a definite system of views to be shaped towards their possible applications in various fields.

2. Materials and methods
The scope of dismountable pipelines can be very wide. They have long been used for transporting water and oil for the needs of the national economy [1-4].

The main indicators of dismountable pipelines encompass a deployment rate and pumping capacity. The deployment rate depends on the type of pipeline, availability of forces and means, proficiency of specialists, adopted task execution plan, climatic conditions and the terrain. Table 1 presents the main characteristics of dismountable pipelines.

The deployment rate is defined in kilometers of the pipeline installed and filled within a day and may amount to:
- DFP-150 using mechanical devices – up to 60 km/day (without mechanical devices – 25-30 km/day);
- DFP-100 using mechanical devices – 70-80 km/day (without mechanical devices – 35-40 km/day).

The idea behind the special exercises was to master the procedures of stocking oil products through dismountable pipelines.

The main objectives of the exercises were:
- working out possible ways to connect dismountable pipelines to MOP;
- organizing documentation procedure to ensure product supplies from MOP to a dismountable pipeline for further transportation;
- elaborating the procedure for determining the quantity and quality control of products accepted from MOP;
- mastering skills required to ensure the deployment, operation and reeling-up of dismountable pipelines;
- shipping oil through a pipeline from a transfer terminal to a MOP (OTT–MOP) to a stocking site with a capacity of 600 m³;
- organizing documentation procedure to ensure product transfers from a dismountable pipeline to a stocking site;
- product transfers to road transport through a mass delivery section;
- organizing documentation procedure to ensure product transfers from the stocking site to road transport.

To ensure compliance with the plan, special exercises were deployed:
- 10 km section of a dismountable pipeline;
- stocking site with a capacity of 600 m³;
- mass delivery section for road transport.

Table 1. Main characteristics of dismountable pipelines

| Indicator                      | DFP-100  | DFP-150  |
|--------------------------------|----------|----------|
| Pumping capacity, t/day        | 1200     | 3000     |
| Working pressure, MPa (kgf/cm²)| 6.0 (60) |          |
| Test pressure, MPa (kgf/cm²)   | 7.5 (75) |          |
| Pipeline arrangements          | Mechanic using MST-100 and manual | Mechanic using PLC-150V and manual |
| Pipe connection                | “Bell”   |          |
| Conventional pipe length, m    | 6.0      |          |
| Conventional pipe diameter, mm | 100      | 150      |
| Pipe weight, kg                | 36.2     | 80.9     |
| Pipe material                  | Steel 16GS |          |
| Angular mobility in joints, degrees | 1.5 – 2.0 |          |
| Longitudinal mobility, mm      | up to 5  |          |

An upstream end of the dismountable pipeline was a MOP junction point. The dismountable pipeline was connected to the MOP via an oil transfer terminal [5-7]. OTT–MOP was performed in two options: through a “hot tapping” method and through an access manhole (AM) of the dismountable pipeline (DP) to MOP (Figure 1).

Figure 1. Connection of a dismountable pipeline to OTT–MOPL
OTT–MOP was developed and manufactured by Transneft PJSC together with the specialists of the Armed Forces fuel service. The main specifications and characteristics of OTT–MOP are given in Table 2 [8-11].

Table 2. OTT–MOP specifications and characteristics

| Indicator | Specifications |
|-----------|----------------|
| Type of the pipeline connected to OTT–MOP | DFP-150 high-capacity field pipeline (DFP-100) |
| Diameter, mm | 150 (100) |
| Supply, m³/h, at least | 90 |
| Delivery rate, m³/day, at least | 1800 |
| Working pressure, MPa (kgf/cm²) | до 6.3 (63) |
| Test pressure, MPa (kgf/cm²) | 1.25 Pₜₚₜₜwork |
| Type of junction to the pipeline | Bell joint |
| Type of junction to MOP | Flanged or welded joint |
| Working substance | Oil products |
| Filtration fineness, mm, at least | 4 |
| Relative error of mass measurements in the flow range from 10% of the nominal flow to the nominal, % (of the volume), at least | ±0.25 |
| Measurement equipment error, % (from the upper limit of measurements) | 1.5 |
| Time to put OTT–MOPL, mounted on the pipeline as AM, into operation (to the delivery of oil products), h | 1.0 |
| Time to put OTT–MOPL, mounted on the pipeline via hot tapping devices shortly before the delivery of oil products, into operation (to the delivery of oil products), h | 24.0 |

The dismountable pipeline was connected to the OTT–MOP using an MPT-15.4 – Bell adapter that came with a junction point and was stored in an AM. The adapter was directly connected to a Flange – MPT-15.4 quick-disconnect joint installed directly in the AM.

The dismountable pipeline was installed based on linear and auxiliary equipment that came with the DFP-100 and DFP-150 kits, and on linear prototypes for a metal composite DP-MC-100 pipeline. The dismountable pipeline was assembled in one line (Figure 2).

![Figure 2. Section of DP-MC-100 pipeline](image-url)
The dismountable pipeline was used during special exercises within four stages:
- deployment preparation;
- pipeline deployment;
- pipeline operation;
- pipeline reeling-up.

Deployment preparation involved a series of activities to select and verify the availability of linear and auxiliary equipment, shutoff and control valves enclosed in the DFP-100 and DFP-150 kits, prototypes for the DP-MC-100 metal composite pipeline, mobile pumping units (MPU), air compressor station (ACS). The said components were also delivered to the region to host special exercises.

Pipeline deployment encompassed the following activities:
- loading and removal of linear and auxiliary equipment, shutoff and control valves enclosed in the DFP-100 and DFP-150 kits and DP-MC-100 kits to the pipeline deployment site;
- transporting MPU, ACS to the pipeline deployment site;
- assembling a linear part of the pipeline;
- assembling a process piping of the pumping station, consisting of two MPUs and technological units on the pipeline;
- filling the pipeline with a test working medium (water);
- hydraulic testing of the pipeline;
- emptying the pipeline from the test working medium.

Pipeline operation involved the following activities:
- filling the pipeline with a product;
- shipping the product through the pipeline;
- simulating an emergency situation on the pipeline and taking measures to handle it by the patrol and emergency team (Figure 3).

Pipeline reeling-up involved the following activities:
- emptying the pipeline from the product;
- dismantling the pipeline;
- dismantling the process piping of the MPU pumping station;
- loading and delivery of linear and auxiliary equipment, shutoff and control valves enclosed in the DFP-100 and DFP-150 kits, linear prototypes for the DP-MC-100, MPU, ACS to permanent storage.

The linear prototypes for the DP-MC-100, equipment enclosed in the DFP-100 and DFP-150 kits were delivered by the following means of transport:
- from storage to the load station – by road;
- from the load station to the delivery station – by rail;
- from the delivery station to the pipeline deployment site – by road.

KamAZ-6350 cars were used as motor vehicles.

DFPL was assembled using an installation tool coming bundled with the DFP-100 and DFP-150 kits.

Transferring the product at the upstream and delivery ends of the pipeline required universal samplers to be mounted from the DFP-150 kit [12].

At the upstream end of the pipeline there were:
- product sampling terminal;
- ACS connection unit;
- process piping of the pumping station, consisting of two MPUs;
- separator trigger.

| Table 3. Technical specifications of MPU-100/200K |
|------------------------------- |------------------- |
| **Parameter**                  | **MPU-100/200K**   |
| Overall dimensions, mm:        |                   |
| - length                       | 5750              |
| - width                        | 1890              |
| - travel height                | 2275              |
| Travel mass, kg                | 3860              |
| Carrier – trailer              | 2-PN-2            |
| Engine: type                   | Four-stroke eight-cylinder diesel |
| - brand                        | YaMZ-238G         |
| Operational shaft rotation frequency, rpm: | |
| - engine                       | 1700              |
| - pump                         | 4330              |
| Engine operating power, kW     | 125               |
| Engine: type                   | Centrifugal two-stage |
| - brand                        | H6x2M4            |
| - feed, m³/h                   | 130               |
| Pressure, MPa:                 |                   |
| - outlet                       | Up to 6.0         |
| - inlet                        | 0.1-3.0           |
| Capacity, l:                   |                   |
| - fuel tank                    | 140               |
| - engine lubrication           | 33.5              |
| - engine cooling systems       | 40                |
| Fuel consumption, kg/h         | 27                |
| Oil consumption, kg/h          | 0.3               |
| Crew, person                   | 1                 |
| Deployment time from traveling to working (from working to traveling), min | 60 (20) |

The sampling terminal is designed for sampling and measuring the density of the shipped product.

The ACS connection unit is designed to connect an air compressor station to a DFPL section and supply compressed air in order to clean it from foreign objects, as well as to displace from it the test medium and product.

The separator trigger is designed for performing technological operations to start a separator during filling, sequential pumping of the product and emptying the dismountable pipeline.

The process piping of the pumping station is designed to perform technological operations for filling and shipping the product through the dismountable pipeline.

At the delivery end of the pipeline there were:
- separator receiving unit;
- sampling unit;
- block valve stations.

The separator receiving unit is designed to receive the separator in the process of emptying the dismountable pipeline from the test medium and product.

The block valve station is designed for tight separation of adjacent sections of the dismountable pipeline.

The product was shipped through the pipeline using mobile pumping units MPU-100/200K.

Technical specifications of MPU-100/200K are given in Table 3.

In order to ensure stable shipping of the product, the pumping station consisting of two MPU-100/200K, main and reserve (Figure 4), was located at the upstream end of the pipeline.

![Figure 4. Pumping station at the upstream end of the pipeline](image)

At the delivery end of the pipeline, a stocking site was constructed with a capacity of 600 m³ (Figure 5).

The stocking site is designed to keep oil stocks, as well as receiving and delivering them to various means of transport. The main technical characteristics of the site are given in Table 4.

### Table 4. Main technical characteristics of the site for oil stocks

| Characteristic                  | Indices             |
|---------------------------------|---------------------|
| Tank module capacity, m³, at least | 600                 |
| Tank capacity, m³               | 50                  |
| Operating temperature range, °C | from minus 60 to plus 60 |
| Tank Material                   | thermoplastic polyurethane |
| Deployment time, h              | 15                  |
| Crew, person                    | 8                   |
| Cargo turnover, m³/day          | 1,000               |

The site included:
- manifold block with fittings and sleeves (Figure 6);
- elastic tanks (Figure 7);
- pumping and transfer module (container);
- quality control laboratory (container);
- warehouse of materials and spare parts (container);
- reactive lightning protection;
- lighting kit;
- camouflage nets;
- diesel generator (stand-alone);
- loader;
- a site for mass distribution of the product to vehicles (Figure 8);
- fire kit.

Figure 5. Development of stocking site

Figure 6. Manifold block with fittings and sleeves
From the terminal, the product was shipped through the mass delivery section to road transport. The total volume of product shipped through the pipeline during the exercise was 600 m$^3$ [13].

3. Conclusion
The joint special exercises resulted in:
- ways to connect a dismountable pipeline to MOP;
- documentation procedure to ensure product supplies from Transneft PJSC;
- procedure for determining the quantity and quality control of products accepted from MOP;
- sampling procedure at the upstream and delivery ends of the pipeline;
- activities towards the deployment, operation and reeling-up of dismountable pipelines;
- actions of pipefitters when the product is shipped through the pipeline from MOP to the stocking site;
- documentation procedure to ensure product transfers from the dismountable pipeline to the stocking site;
- actions of the crew responsible for the delivery of the product to road transport;
- documentation procedure to ensure product transfers from the stocking site to road transport.

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