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ANALYSIS OF THE RESULTS OF THE EXPERIMENTAL VOYAGE ON PACKAGE "TANKER LOADING SYSTEMS"

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ABSTRACT

The greatest portion of the lay time (82.5%) was taken by the cargo handling operations, as such, and raising their rate will result in the most considerable reduction in the duration of stay. To raise the loading rate capacity of the storage tanks, diameter of the pipeline and pumping rates of the supply pumps shall be increased.

In the secondary operations, the ice and hose connection loading operations comprised approximately equal proportions. In the ice operations, about 80% of the time was taken by the icebreaker operation to provide arrival and departure of the tanker, while in the hose connection loading secondary operations the hose connection operations and repair work on the shore pipeline were the most prolonged.

The quantity of cargo loaded in Sabeta settlement during the ARCDEV (Arctic Demonstration Voyage) experimental voyage corresponds to the capacity of the storage tanks available but not to the cargo-carrying capacity of the tanker.

Under the conditions where the gas condensate is transported in quantity less than 150000 t per year that is, where ships arrive at the loading point less than once per month, use may be made of temporary hoses to be placed on the ice in winter and afloat in summer.

Exportation of 300-600 ths.t per year will require 1-2 tankers of 15000 t cargo carrying capacity, making two-four calls at Sabeta settlement per month to accept the condensate for carriage. With such exported volumes it would be expedient to lay an underwater pipeline and arrange the SBAM (Sea Bed Anchor Mooring) single point berth.

INTRODUCTION

The experimental voyage to the Ob Bay under the European Union's ARCDEV project was made from 25 April to 14 May 1998.

To transport gas condensate use was made of the tanker "Uikku" owned by the Finnish company NEMARK and assigned the highest ice class 1 A Super according to the Finnish and Swedish Rules. The tanker is equipped with a driving-propulsion unit "Azipod" used for the first time on an ice-going transport shop.

For escorting the "Uikku" with Consideration for passage to the ob Bay the Russian diesel-electric icebreaker "Kapitan Dranitsyn" with a restricted draft was choosen. Escorting of "Uikku" through ice in the Kara Sea was effected by the icebreaker "Rossiya", one of the "Arktika" class icebreakers available on the Northern Sea Route. In the fast ice of the Ob Bay

the channel was broken out by the nuclear icebreaker "Vaigach" (of "Taimyr" class) involved in escorting ships on the Yenisei stretch of the route: Murmanck-Dudinka.

1. ANALYSIS OF THE RESULTS OF THE EXPERIMENTAL VOYAGE

Gas condensate is delivered from the field to the tank form located on the riverside of Ob, at a distance of several km from Sabeta. At the tank form the condensate is accumulated in tanks each of abt. 2000 cu.m in capacity. The total capacity of the storage tanks is abt. 14000 cu.m. To deliver gas condensate aboard the tanker two pipelines were laid over the river ice. The diameter of one pipeline is 146 mm, the diameter of the other is 114 mm. Scheme of pipeline installation on the ice near Sabeta is shown in Fig.1.

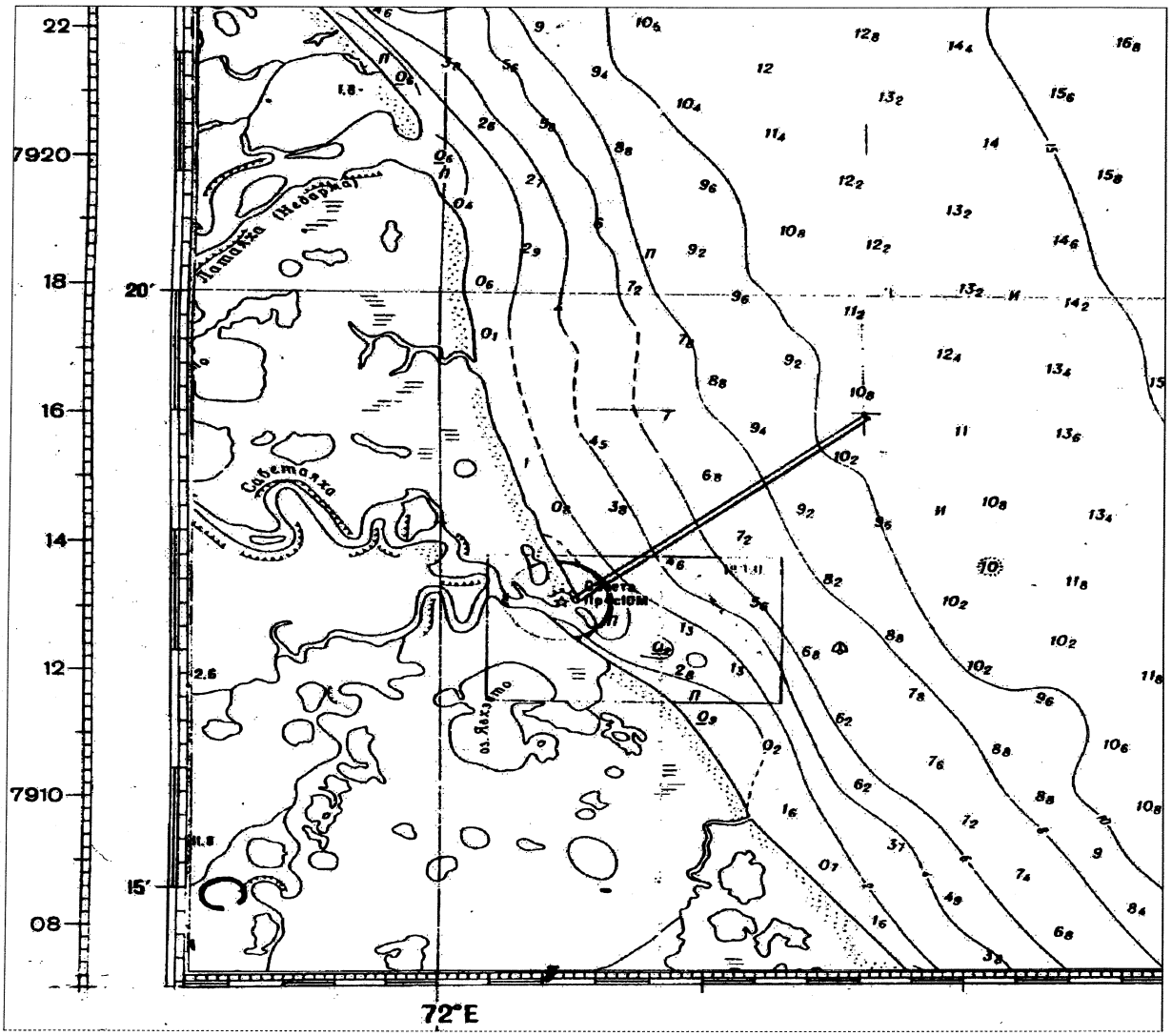

Fig. 1 Sabeta of Pipeline Installation over the Ice Near Sabeta Settlement in the Ob Bay.

The length of the pipelines is 4100 m.

The pipelines were assembled of 25 m pipes used for drilling wells and welded together to form lines of abt.150 m long, joined by means of flanges. A winter road destined for movement of tractors, trucks, buses, tank truck, crawler-type cross-country vehicle, truck crane was laid along the pipeline.

The gas condensate is delivered by pumps installed at the tank farm in individual sheds. Both pumps are diesel-driven. One pump is of reciprocating type with a capacity of 150 cu.m/hr at 20 kg/sq.cm, the another is of axial type with a capacity of 90 cu.m/hr at 10 kg/sq.m. The pipeline ends are fitted with shut-off valves, connecting flanges and reducers placed over a drip tray.

The icebreaker prepares an ice berth at a distance of abt. 15 m from the pipeline ends.

A scheme of the ice berth for boading gas concentrate near Sabeta Settlement is shown in Fig.2.

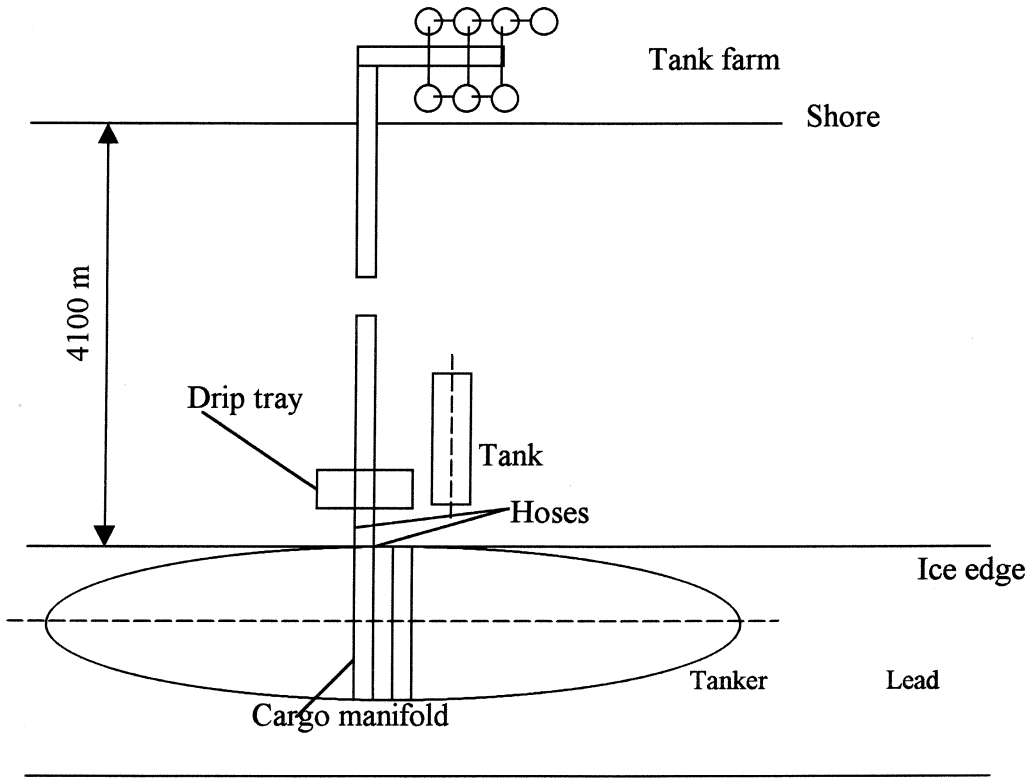

Fig. 2 Scheme of Ice Berth.

The ice conditions in way of the ice berth were complicated. The ice thickness near the ice berth was abt. 2 m with the snow cover being of abt. 20 cm thick, while in channel, on the approach to the berth the thickness of the ice cover was abt. 1.5 m with the snow cover being abt. 20 cm. The ice berth, as such, was situated on 10 m of isobath. The ice conditions made

the arrival/departure of the ship considerably more difficult, called for a prolonged operation of the icebreaker and led to increased lay time.

Fig. 3 displays the tanker "Uikku" in the ice berth.

Fig. 3 The Tanker «Uikku» in the Ice Berth.

The lay time budget is given in Table 1.

At the time of stay 10656 t of gas concentrate were loaded. The greatest loading rate amounted to 250 cu.m/hr. The net loading rate was 10556 t/3.35 days = 3180 t/day while the gross loading rate was 10656 t/4.06 days = 2625 t/day.

It follows from the Table 2 that the greatest portion of the lay time (82.5%) was taken by the cargo handling operations, as such, and raising their rate will result in the most considerable reduction in the duration of stay. The average loading rate was 132 t/hr, whereas the tanker was designed to load 2800 t/hr. To raise the loading rate capacity of the storage tanks, diameter of the pipeline and pumping rates of the supply pumps shall be increased.

In the secondary operations, the ice and hose connection loading operations comprised approximately equal proportions. In the ice operations, about 80% of the time was taken by the icebreaker operation to provide arrival and departure of the tanker, while in the hose connection loading secondary operations the hose connection operations and repair work on the shore pipeline were the most prolonged.

Table 1

Lay Time Budget of the Tanker "UIKKU" Being Loaded in the Ice Berth (Sabeta Settlement)

n_{OS}	Description of operation	Operation period	Time spent for the operation, hr.	Cargo loaded, m^3	Overage loading rate, m^3/hr
1	Proceeding of the i/b "K. Dranitsyn" from the channel broken out by the i/b "Vaigach" to the loading point of the tanker, preparation of the ice berth	04.05 10.37-14.15	3hrs.38min.		
2	The i/b "K. Dranitsyn " leaving of its own channel	04.05 14.15-15.30	1 hr.15 min.		
3	Proceeding of the tanker to the ice berth	04.05 15.30-16.00	0 hr.30 min.		
4	Tanker berthing	04.05 16.00-16.45	0 hr.45 min.		
5	Hose connection operations	04.05 16.45-18.45	2 hrs. 00 min.		
6	Removal of failed valve	04.05 18.45-21.30	2 hrs. 45 min.		
7	Loading 4.05.98	04.05 21.30-24.00	2 hrs. 30 min.	200	80
8	Loading 5.05.98	05.05 0.00-24.00	24 hrs. 00 min.	4590	191
9	Loading 6.05.98	06.05 0.00-24.00	24 hr. 00 min.	4786	199
10	Installation of the valve and re-connection of hoses	06.05 9.00-11.00	2 hrs. 00 min.	4483	235
11	Loading 7.05.98	07.05 0.00-19.00	19 hrs. 00 min.	33	1,7
12	Loading with the shore tanks being stripped and shore pipelines blown out	07.05 19.00-24.00 08.05 0.00-8.00	13 hrs. 00 min.		
13	Diconnection of hoses	08.05 8.00-8.20	0 hr.20 min.		
14	Issuance of documents	08.05	During other operations		
15	Unberthing and breaking down of ice by the icebreaker near the tanker	08.05 8.20-9.30	1 hr.10 min.		
16	Entering the channel with manoeuvring under the assistance of the icebreaker	08.05 9.30-12.10	2hrs. 40 min.		

Table 2

Analysis of the Lay Time when Loading Gas Condensate in the Ice Berth near Sabeta Settlement on 04 – 08.05.98.

Operation group №	Operation № as per Table 2	Description of operation	Time spent, hrs.	%		
				Of secondary operation time	Of secondary operation group time	Of lay time
1.		Secondary operations	17hrs.3min. (17,05 hrs.)	100		17,5
1.1.		Secondary ice operations	9 hrs.58min. (9,97 hrs.)	58,5	100	10,2
	1.	Proceeding of the i/b "K. Dranitsyn" from the channel broken out by the i/b "Vaigach" to the loading point of the tanker, preparation of the ice berth	3 hrs.38min. (3,63 hrs.)		36,5	3,7
	2.	The i/b "K. Dranitsyn " leaving of its own channel	1 hr.15min. (1,25 hrs.)		12,5	1,3
	3.	Proceeding of the tanker to the ice berth	0 hrs.30min. (0,5 hrs.)		5,0	0,5
	4.	Tanker berthing	0 hrs.45min. (0,75 hrs.)		7,5	0,8
	15	Unberthing and breaking down of ice by the icebreaker near the tanker	1 hr.10min. (1,17 hrs.)		11,7	1,2
	16	Entering the channel with manoeuvring under the assistance of the icebreaker	2 hrs.40min. (2,67 hrs.)		26,8	2,7
1.2.		Secondary loading operations	7 hrs.5min.(7,08 hrs.)	41,5	100	7,3
	5.	Hose connection operations	2 hrs.		28,3	2,1
	6.	Removal of failed valve	2 hrs.45min. (2,75 hrs.)		38,7	2,7
	10.	Installation of the valve and re-connection of hoses	2 hrs.		28,3	2,1
	13.	Diconnection of hoses	0 hrs.20min. (0,33 hrs.)		4,7	0,3
	7, 8, 9, 11, 12.	Loading	3days8 hrs.30min. (80,5 hrs.)			82,5
Total lay time			4days1 hr.33min. (97,55 hrs.)			100

2. RECOMENDATION FOR THE TANKER LOADING SYSTEM

The quantity of cargo loaded in Sabeta Settlement during the ARCDEV experimental voyage corresponds to the capacity of the storage tanks available but not to the cargo-carrying capacity of the tanker, even though the water depths in way of the ice berth permit full utilization of the draft, cargo-carrying capacity of the tankers which deadweight is abt. 15000 t, such as the tanker "Uikku".

In this connection, first of all it will be necessary to increase the total capacity of the storage tanks up to abt. 15000 t in view of the fact that the full utilization of the ship's cargo-carrying capacity makes the most significant impact on reduction of the transportation costs.

With the supposition of steadiness in the gas condensate exportation, which is associated with steady production and limited capacity of the storage tanks, the export schedule and tonnage requirements are defined by the voyage turn-around of ships in winter. It follows from the results of the ARCDEV experimental voyage that in winter one tanker can made 2 voyages per month or 24 voyages per year.

Gas condensate can be exported from Sabeta by a tanker of abt. 15000 t dwt with a draft of 9 m. Thus, one tanker of 18000 cu.m in cargo arrying capacity can transport within one year abt. 305000 t of gas condensate with mass density of 0.74 t/cu.m.

Under the conditions where the gas condensate is transported in quantity less than 150000 t per year that is, where ships arrive at the loading point less than once per month, use may be made of temporary hoses to be placed on the ice in winter and afloat in summer.

To raise the loading rates it is necessary to increase the size of tanks up to 20000-28000 cu.m, fit a special tank stripping pump in order to have an opportunity to carry out stripping coincidentally with loading.

The hoses shall be reinforced, have an internal diameter of abt. 180 mm, be designed to a pressure up to 15 ata. The condensate shall be loaded through two pipelines by means of pumps each of 250 m/hr in capacity at a head of 120 mm W.G.

With such equipment loading will take abt. 40hrs and the whole stay - 2 to 2.5 days.

With the exported volume of condensate being abt. 150000 t per year, installation of such an equipment would be expedient since it will reduce significantly the condensate transportation costs, improve utilization of the ship's cargo-carrying capacity by 30%, reduce the lay time by one half and the voyage turnaround by 20%.

Exportation of 300-600 ths.t per year will require 1-2 tankers of 15000 t cargo carrying capacity, making two-four calls at Sabeta settlement per month to accept the condensate for carriage. With such exported volumes it would be expedient to lay an underwater pipeline and arrange the SBAM single point berth.

With the exported volumes of 1 m t and more, as it follows from the Institute's studies it would be expedient to prepare a berth near the Kamenny cape where tankers of abt. 43000 t dwt can be used. Carrying capacity of one such ship will be abt. 960 ths.t per year with 2 voyages per month. To load these ships consideration may be given to the version of on underwater pipeline with the SBAM or island type single point berth and the version of an pipeline laid on the scaffold bridge with the single point or permanent berth.

CONCLUTIONS

An analysis of the time budget of the experimental voyage has shown that the stay for loading took about 20% of the voyage duration and that the considerable portion of the ship's operation cost depended on this stay time.

The greatest portion of the duration of stay for loading was accounted for by the cargo handling operations, as such, which took abt. 80% of the total lay time.

In this connection, considering that raising of the cargo handling rates may increase substatially efficiency of the gas condensate transportation, studies proposed to be pursued at a later time, aimed at developing promising loading systems which will make it possible to reduce significantly the transportation costs and provide the required environmental protection. These studies shall include:

1. Proceeding from the given variety of possible exported volumes to select the loading point and size of the tanker for transportation of the gas condensate.

2. To determine the required capacity of storage tanks, loading rates and pump types for the exported volumes under consideration.

3. To select type and characteristics of the pipeline and berth:

- pipeline: underwater, afloat, on scaffold bridge, diameter, design pressure;
- berth: ice, buoy, single point (SBAM, island type), permanent.

4. Considering low cost, absence of continuous interaction with the ice cover, ease of hose connection operations and communication with shore, to work out proposals for use and improvement of the TECHNOMARE System, underwater pipeline with the SBAM type berth,including the following additional studies:

- analysis of possible damages to the underwater pipeline in the recommended installation sites;
- functioning of thick ice cover
- development of various modifications of the SBAM System consistent with concrete conditions of the loading point location.