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THE OPTIMIZING OF THE HYDROCABONS CAPACITY ON THE DISCHARGE OF OIL TANKS

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Abstract: *The transport activity of hydrocarbons from the extraction site to the purification zone has known a significant increase in the last decade and, therefore to increase the efficiency of this activity we have to keep in mind the processing duration which should provide a short time spent by the ship at the oil terminal, also the energy capacities during the discharge process. This essay has the purpose to analyze the account between the heating temperature of the cargo and the hydraulic losses on the transportation pipe thus the energy capacity on liquid cargo transportation to be reduced to minimum.*
Keywords: *optimizing, discharge, oil, RMH 45.*

1. INTRODUCTION

In the last decades, as a consequence of the fast growth of the energy supply necessities and the consumption of oil fabricated products the transport activity of liquid hydrocarbons has became essential for economic and industrial development of the entire human kind. Depending on the extraction, processing and consumption needs, the transport of the liquid hydrocarbons continues to develop, constantly rising new issues the need solving keeping in mind the newest achievements in this domain. The oil extraction, transport and storage and the products obtained by processing oil has became a highly important industrial activity that supplies raw materials to refineries and petrochemical plants. The main way of liquid hydrocarbons transportation from the ship to the terminal is represented by pipes.

In this kind of system, the main spot is represented by the transport with its specific matters(the functionality of the safety system) which needs careful examination in order to find the best technical and economical solutions.

2. SPECIFIC ISSUES REGARDING THE TRANSPORT OF CRUDE OIL THROUGH PIPE LINES

An important part on the way of pumping in the cargo transfer from the tank-ship to the oil terminal is played by the temperature variation in the pipe. Thus, the viscosity of liquids varies inversely proportional to the temperature and a significant temperature decrease can cause an important viscosity increase.

The issue raised by the fluctuant temperature in the pipeline frequently occurs at the transfer of light crude oils. These have a certain content of paraffin which can be found completely dissolved in oil when the temperature is high enough. If the temperature goes down in value the paraffin can transform in small crystals that separate from the oil product. In the situation of the continuously decrease of this temperature the crystals can bound between them forming a net or a paraffin network. In these conditions the crude oil doesn’t act like a normal newtonian liquid, but as a colloidal solution, in which the crude oil represents the continuous phase and the paraffin represents the dispersed phase. Thus, the congealing phenomenon of crude oil consists, in fact, in the separation of paraffin and even if the oil remains in liquid state it is distributed uniform in the paraffin network forming an assembly named gel. This compound has a structure that can disturbed by excitation but it is reestablished in idle.

Knowing the temperature value that doesn’t allow the crude oil to flow through the pipeline is very important to assure the safe transportation (it is called the freezing point). The determination of this value is very difficult because the known methods result different values which depend on the thermal treatment applied before on the oil specimen.

Depending on the paraffin content the crude oil divides in three large categories, the main criteria being the freezing point of the oil fraction that has cinematic viscosity at the 323,15^{0}K temperature. When the freezing point of this fraction is between 258,15^{0}K and 293,15^{0}K or below this value the crude oil is considered less paraffin-base oil. When the freezing point is between 258,15^{0}K and 293,15^{0}K the crude oil is paraffin-base and finally, if this value is above 293,15^{0}K, the oil is highly paraffin-base.

So, it is very important to determine de annual variation temperature curve to establish the most favorable case.

For the transportation of highly paraffin-base oil other methods can be used(besides increasing the temperature), some of them used frequently, the difficulties that occur during pipeline transfer could be this way eliminated if the crude oil is being pumped using a thinner mixture that increase the flowing proprieties of the oil. The main thinners that can be used are: gasoline, the lamp gas, diesel oil, condenser, a light crude-oil, etc.

3. THE LOADING-DISCHARGING INSTALLATION

The loading-discharging installation has cargo pumps and one strip pump, submersible pumps placed on the double bottom sealing (fig. 2). Because of the multiple advantages in the last period the submersible centrifugal pumps are used as cargo pumps, type FRAMO, the excitation motor being a hydraulic motor and the excitation being made directly.

The pressing pipeline of the cargo tanks pumps drill the main deck through a special hole which offers the possibility of inserting or discharging air while loading/unloading as well as the possibility of connecting the compressed air pipelines to ensure the normal functioning of the strip pump; through the same hole made in the main deck the excitation ax of the cargo pump is being introduced and it is equipped with luting elements.

The pressing pipeline of the pumps that serve nearby tanks are united in one single pipeline that makes the link with the intake manifold, that’s why it is necessary to transport the same type of material in nearby tanks.

The storage system offers the possibility of cargo segregation for each pair of tanks, the handling and conditioning systems being independent.

The installation is equipped with measurement and control elements in the purpose of monitoring and maintaining the installation parameters (the pipeline pressure, the pipeline flow, the cargo handling temperature, the pressure or depressurization in the cargo tank) at the established values for each type of product.

The loading/unloading installation has to be designed with emergency stopping systems of pumps in the scenario of one of the parameters exceeding the normal value or in case of a system failure. By correct valve handling the following circuits can be established:

- loading the cargo using the manifold intake and sending them in the cargo tanks;
- unloading the cargo through aspiration pipe and sending it to the manifold using cargo pumps;
- heating or cooling the cargo by recirculation using a cargo pump through the heat exchanger placed on the main deck.

The fuel analysis card has to contain the numerical value of viscosity at several temperatures as it was measured.

This fact can be visualized in the viscosity-temperature diagram (Tab. 1) which show that the viscosity drops when the temperature increases.

Table 1. Viscosity estimated at a 100^{0}C temperature measured viscosity

Kinematic viscosity [mm^2/s^2]				
Measured at 100 [^{0}C]	40 [^{o}C]	50 [^{o}C]	80 [^{o}C]	130 [^{o}C]
10,0	80	50	17	5,5
15,0	170	100	28	7,5
25,0	425	225	50	11,0
35,0	780	390	75	14,5
45,0	1240	585	105	17,5
55,0	1790	810	130	20,5

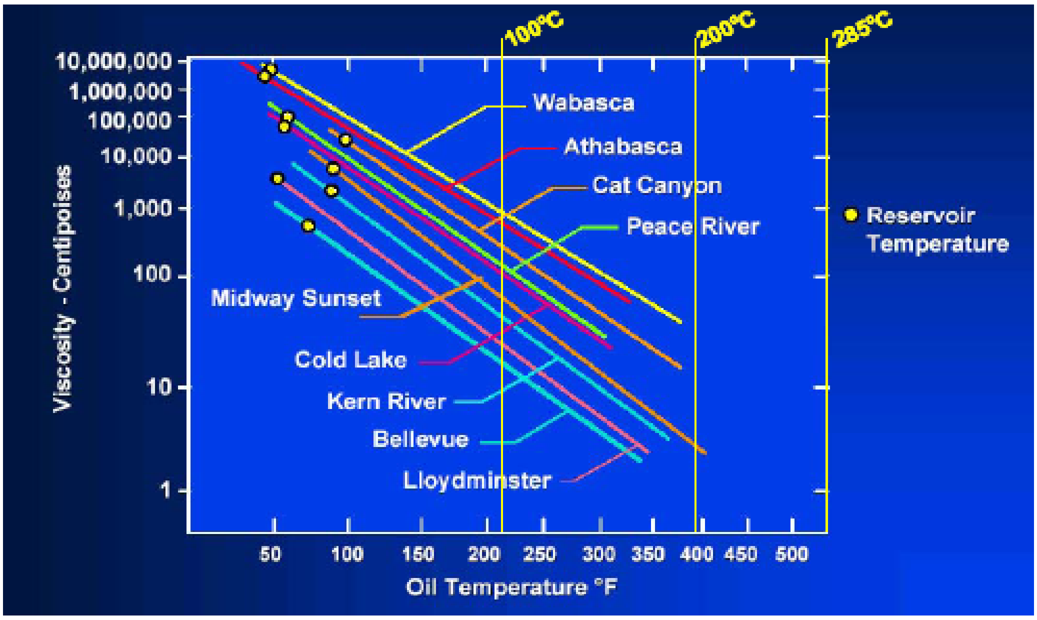

Fig. 1 The relation between the temperature and viscosity for crude oil extrased form different zones

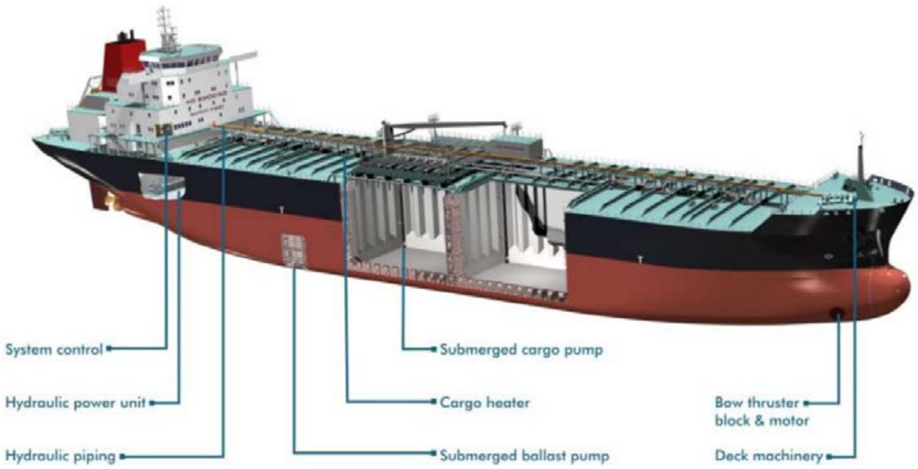

Fig.2. The FRAMO pumping system

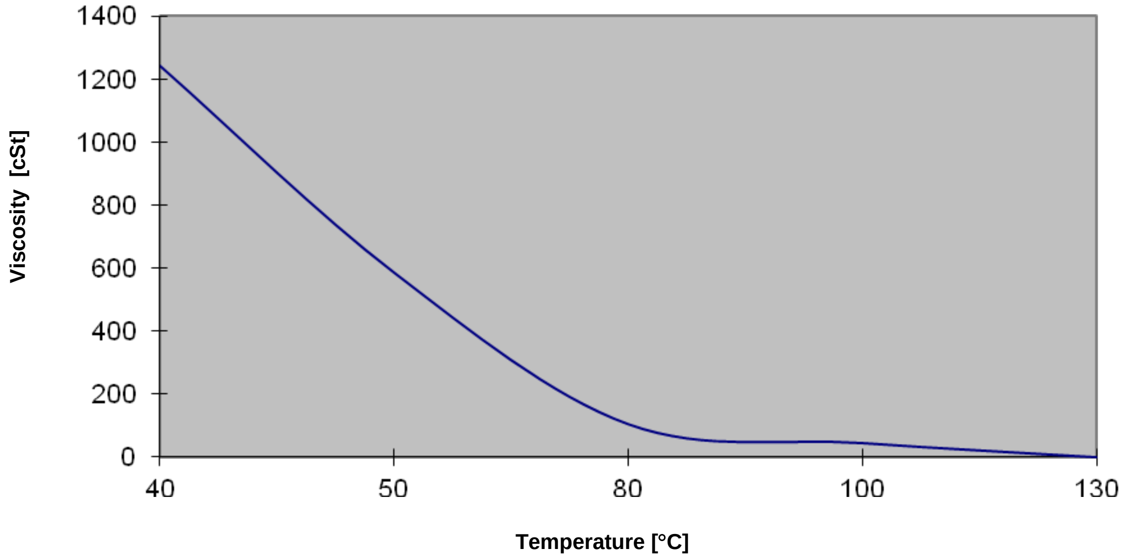

Fig. 3 The $\upsilon_{(T)}$ variation, for a residual product (black oil) RMH 45

4. OPTIMAL CARGO VISCOSITY DETERMINATION FOR ENSURING A MINIMUM TRANSFER ENERGY CONSUMPTION

Taking in consideration the local pressure losses as being constants depending on the viscosity and if the flow is maintained constant, in order to respect the operating time, we have to determine the same kinematic viscosity at which the consumed energy for the cargo pumps excitation to remain at a minimum value.

The local losses can be determined using the following formula:

$$h = \lambda_{(\mathrm{Re},\varepsilon)} \cdot \frac{l}{d} \cdot \frac{\rho \cdot v^2}{2}$$

λ - linear hydrodynamic friction coefficient (dimensionless);

ς – local losses coefficient caused by existence of corners, section jumps, armors, diaphragms, etc,(dimensionless).

l – the pipeline length in which the fluid travels [m];

v – the fluid speed [m/s];

ρ – the fluid density [kg/m^3];

The linear hydrodynamic friction coefficient λ can be analytic or graphic calculated, being a function depending on the dimensionless number Re and the relative roughness ξ, , where Re is also calculated depending on the kinematic viscosity υ.

For the laminar flow at slow flowing speeds, as in the case of crude oil, the linear hydrodynamic friction coefficient λ is determined using the Stokes formula:

$$\lambda = 64 / \mathrm{Re} \quad (2)$$

Where the Reynolds number is calculated using the formula:

$$\mathrm{Re} = \frac{v_{rec} d_{STAS}}{\nu} \quad (3)$$

The hydraulic losses for 100m transfer pipeline will be represented in several values of the kinematic viscosity υ. The calculus was made in a tabular method:

T [°C]	40 [°C]	50 [°C]	80 [°C]	100 [°C]	130 [°C]
υ[cSt]	1240	585	105	45	17,5
Re	254.0323	538.4615	3000	7000	18000
λ	0.251937	0.118857	0.021333	0.009143	0.003556
h [N/m^2]	65065.34	30696.15	5509.565	2361.242	918.2609

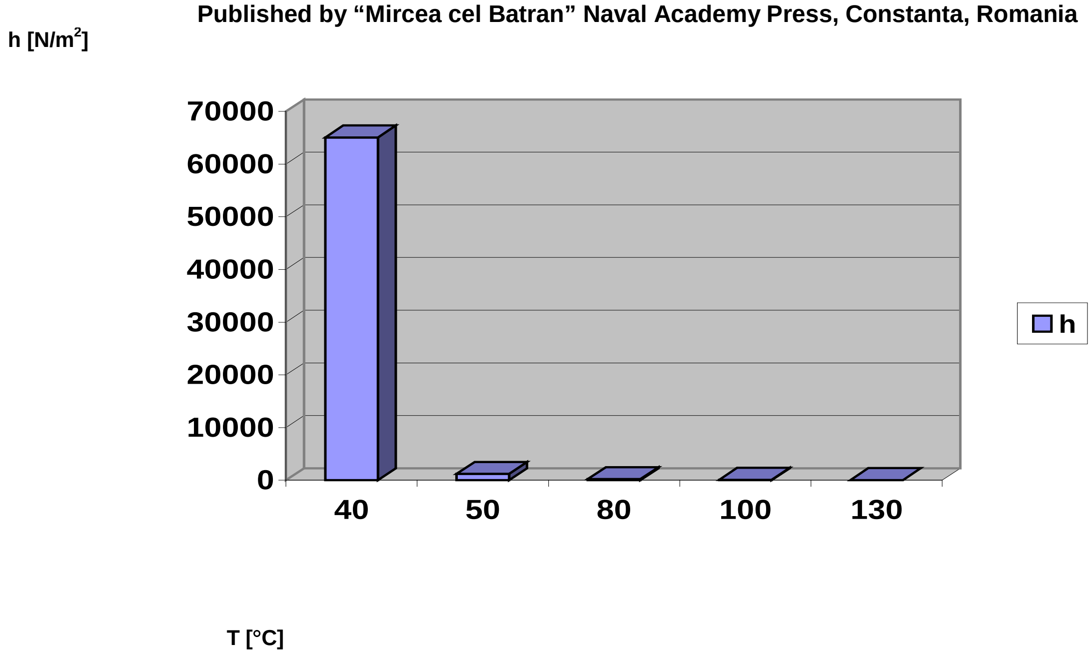

Fig. 4. The variation of hydraulic losses for a 100m depending on the cargo temperature

The consumed energy by the cargo pumps to overcome the linear hydraulic losses caused by the cargo friction with the pipeline will have the in initial conditions generated by the constant flow the same variation form.

The issue is represented by the determination of the energy needed to heat up the cargo from the transfer temperature equal with 20^0C up to 130^0C. Those two energies will be summed and where the sum variation will have a minimal point, that point represents the optimal transfer temperature (fig. 5).

We have to consider a pump with a usual flow equal with 1200 m^3/h at discharging hydrocarbons, conversed in 0,333 m^3/s, meaning that the energy quantite will be determined for an hour in Joules.

T [°C]	40 [^{o}C]	50 [^{o}C]	80 [^{o}C]	100 [^{o}C]	130 [^{o}C]
υ[cSt]	1240	585	105	45	17,5
h [N/m^2]	65065.34	30696.15	5509.565	2361.242	918.2609
Q_{tr} [MJ]	77.29763	36.46703	6.545363	2.805156	1.090894
$Q_{înc}$ [MJ]	49.2156	73.8234	147.6468	196.8624	282.9897
Qtot [MJ]	126.5132	110.2904	154.1922	199.6676	284.0806

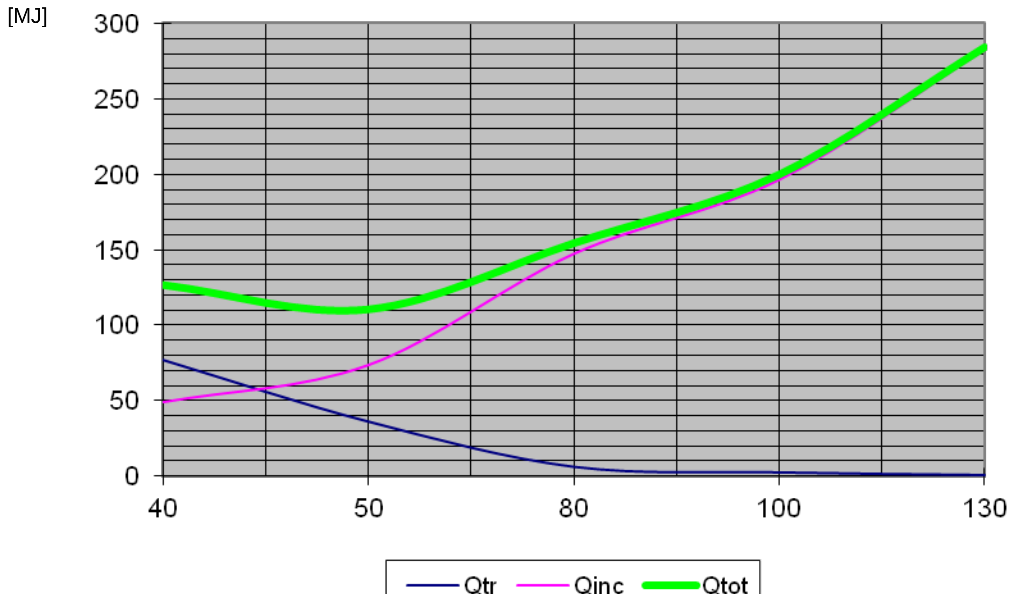

Fig. 5 The energy variation diagram used for pumping and heating the cargo.

CONCLUSIONS

The analysis of the diagrams drawn in the 5th figure leads to the conclusion that for the kind of cargo chosen, the residual fuel RMH45 has its optimal transfer temperature around 50⁰C, the point where the sum of energies needed for heating and transferring the cargo to the oil terminal presents a minimum value point. The kind of calculus can be done for several types of cargo this way being able to determine the optimal temperatures for unloading installation functioning with substantial energy savings.

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