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STUDIES AND RESEARCHES ABOUT VARIATION OF THERMO- PHYSICAL PROPERTIES OF THE LIQUEFIED PETROLEUM GAS WITHIN STORAGE TANKS

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Abstract: *This paperwork presents the theoretically and experimentally researches achieved on special stands provided with storage tanks used in domestic equipments of LPG, regarding the variation of thermo-physical properties of this kind of gas, depending on surrounding temperature and the loading grade of the tank.As conclusions the paper presents the usage mode of storage tanks in different situations of acting*

Key words *Liquefied Petroleum Gas, vaporization process, thermo-physical properties.*

1. Introduction

Through the theoretic study and the resolution of the equations system that describe the heating and mass transfer within the vaporization process of the Liquefied Petroleum Gas [1-2] a number of values developing theoretic charts, may be obtained. The theoretic values may deviate very much from the real values; values that can be obtained only by experimental researches on test stands. Through the theoretic researches [5], [3] some important measures could not be appointed such as the real values of some coefficients used for designing the LPG plant.

2. The Experimental Researches

The Stand [1], presented in figure 1, was realised through a 1 tank of LPG heaving 1750 litres, usually used for the LPG plant, by the company S.C. Sistemgas Timisoara, with two independent routes of gas pipes, a route realised by rolled steel for pipes, and another route by a copper pipe.

Fig.1. *The experimental stand.*

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[2] S.C. SISTEMGAS Timisoara
[3] TermoServ Deva

The stand is equipped with flow gauge, diaphragms, thermometers, thermocouples for the interior of the tank, manometers etc. In essence it was meant to answer to many more questions like:

-what is the real gas flow continuously supplied by the tanks without vaporizers in the climate of our country and the parameters that influence this flow?.

-which are the real values of some parameters and coefficients used for designing the LPG plant?

- what is the effect of different types of routes over the supplied gas pressure and gas flow ?

The entire vaporization process of the LPG into the tanks even in the case of a constant temperature of the environment and the reduced speed of wind made that all the measurements occur into a thermodynamic steady system. In this situation, for short periods, the identification of some quasi-stationary measures was intended to be made in order to create different charts. In order to enlarge the number of points on the charts, in case of some important parameters (considered for the design) we followed the reiteration of the measurements in appropriate conditions and with similar quantities of LPG into the tank (by refilling the tank).

3. The Results of the Experimental Researches

In figure 2 we presented the variation of temperatures within the tank of 1750 litres and the environment in two situations: a) into the tank the quantity of liquid is at the beginning of the attempts 55% and the temperature of the environment of –14 ^{o}C, and the gas flow is maximal, of 19kg/h,

b) into the tank the quantity of liquid is at the beginning of the attempts 35% and the temperature of the environment is of –19 ^{o}C, and the gas flow is 19kg/h.

In both situations the temperature within the tank, at the beginning of the attempts, was close to the temperature of the environment, and then the temperature of the environment was rising. For the first case the figure 3 represented the variation in time of the main measured quantities from the 1750 litre tank.

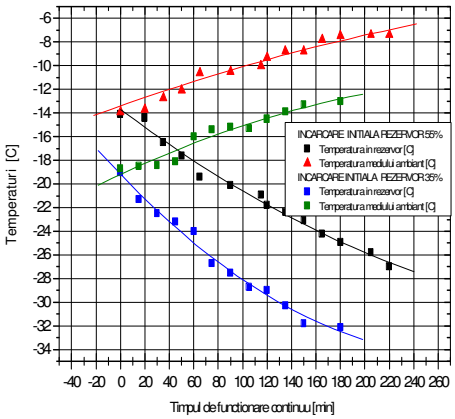

Fig. 2 *The variation of the temperatures from the tank*

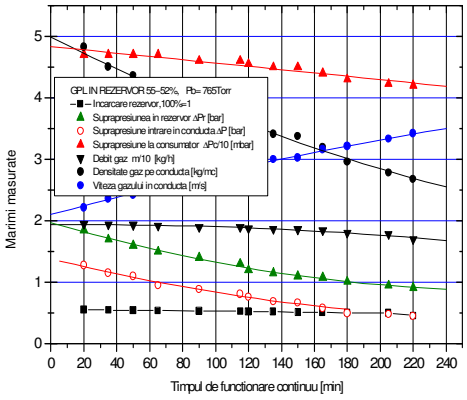

Fig. 3. *The variation in time of the main measured sizes*

During the experiments the temperature of the environment floats as it results from figure 4 or 5, temperature that can be expressed through the following equation:

$$t_{ex} = -14.4 + 2.997\tau - 0.273 \cdot \tau^2 \qquad (1)$$

where τ [h]- is the functioning time

In figure 4 it was represented the variation in time of the pressure from the tank and in figure 5 it was represented the variation in time of the temperatures from the tank and the variation of the temperature in the environment the testing day; the load with liquid is of 55% , the temperature of the environment varies from –14 °C to –6 °C.

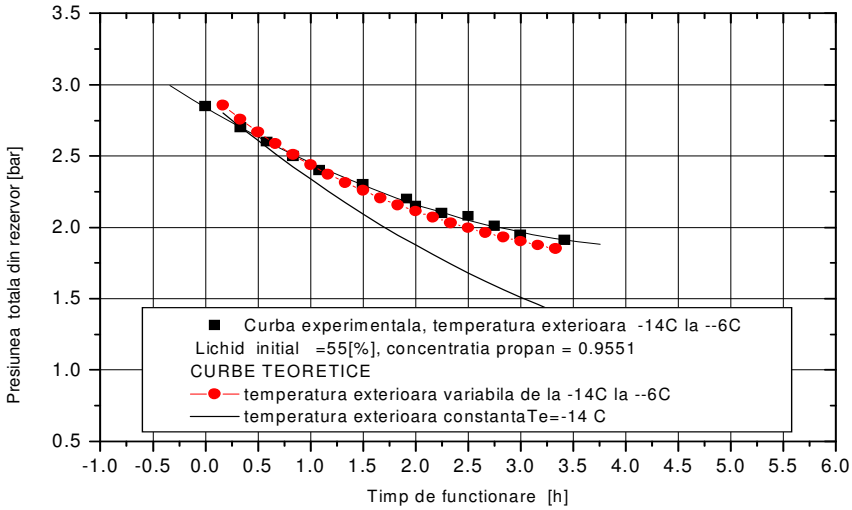

Fig. 4. *The pressure from the tank*

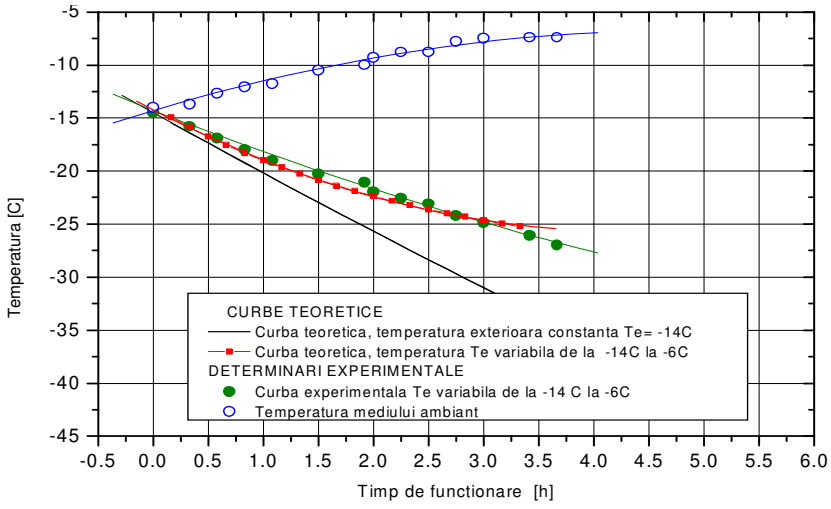

Fig. 5. *The temperature of the liquid*

4. Conclusions

The gas flow at the beginning (approximate the first two hours) remains constant, then it has a small decrease that is accentuated because of the temperature fall of the liquid from the tank and because of the diminution of the contact surface liquid-tank- environment. It is remarkable the fact that this decrease could have been

more accentuated if the temperature of the environment has remained constant, but this temperature increased and the effect of the gas cooling was diminished.

The additional dimension from the tank decreases strongly; after 4 hours it tends to reach the critical level 0.5 bar (the minimal overpressure of design, necessary for a correct functioning of the devices consuming the LPG). This is the reason why it is recommended to use the tanks of 1750 litres to the installations with a more reduced scheduled consumption.

We ascertain the fact that the pressure after the regulator of high pressure is, in this case, rather high, this thing can be explained through the fact the outside temperature (of the environment) increased and the temperature of the liquid mixture propane- butane is relatively high.

The pressure of the consumer hardly decreases together with the decrease of the pressure into the tank. The LPG plant without the vaporizer is a plant where the consumers need, at the entrance, a pressure 30….40mbar. By analysing the chart from fig.6.5 we discover that these values can be also realised for the installations with very long pipes, as long as inside the tank the overpressure does not decrease under 0,5 bar. We must take into account not only the temperature of the environment but also the quantity of liquid from the tank, which under 20% filling contains less propane (the mixture used for testing contains in this situation between 95..90% propane).

From the above mentioned analyses it results the fact that the most important parameters for the exploitation of the autonomic systems with LPG, without vaporizers are:

- the variation in time of the pressure into the tank; the pressure that ensures the transmission of the gas through the plant and the pressure necessary for the combustion ;
- the friction coefficients from different types of pipes;
- the gas flow is continuously delivered by the tank at low temperatures ($-15\ ^{o}C$).

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