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Simulator for Natural Gas Transport and Distribution

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Abstract

As on real natural gas transport and distribution system it is practically impossible to conduct experiments, it was considered necessary to make an experimental device in the laboratory to simulate and experimentally study situations that occur in the natural gas transport and distribution systems. The paper shows the design, construction and testing of this natural gas transport and distribution system.

Key words: *gas, transport, distribution, simulation*

Introduction

Natural gas reach the users from the production area by means of transport pipeline systems, in which gas pressure is higher than 20 ÷ 40 bar and distribution systems in which gas pressure is low 2.5 ÷ 5 bar for average pressure systems and 40 ÷ 150 mbar for low pressure systems.

Phenomena that occur within the natural gas transport and distribution systems are complex and in order to study them, more than suitable numerical models, experiments have to be conducted on the transport and distribution systems.

As real transport and distribution systems are very expensive to build and their exploitation is done in restrictive juridical conditions to assure safety it is impossible to conduct experiments on real transport and distribution pipeline systems. That is why we considered as very useful making in the laboratory an experimental device for natural gas transport and distribution, as situations occurring in the natural gas transport and distribution systems cab be simulated and experimentally studied on such a device.

Design and Building of the Natural Gas Transport and Distribution Stand

The natural gas transport and distribution stand has been thought to comprise a natural gas transport area, made up of the pipeline 1-2, ring 2-3-4-2-, branch 3-5 and branch 4-6-8-9. In order to conduct relevant experiments our purpose was to design, build and test a natural gas transport and distribution system. Generally speaking, it needs to have a gas supply unit, a transport pipeline, a distribution ring with two branches to which consumers are connected.

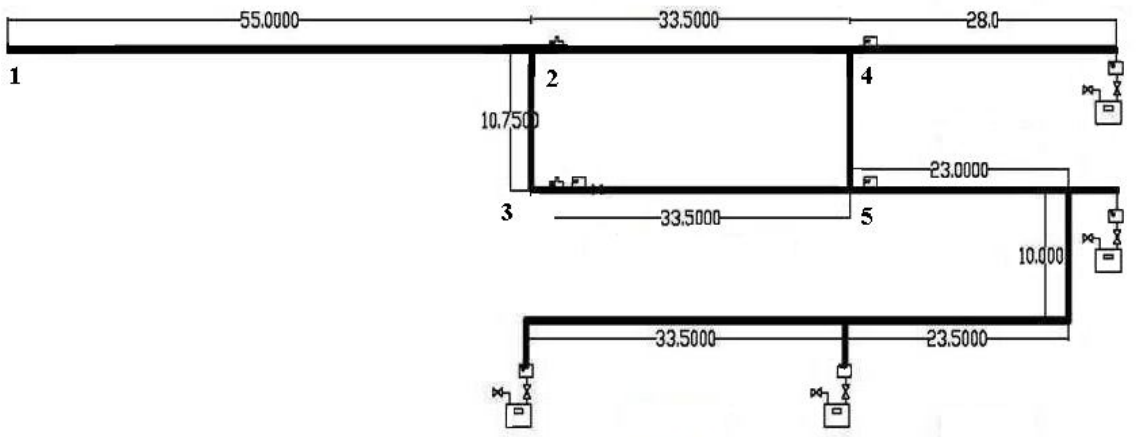

Fig. 1. Scheme of the stand

The placement of the pipelines with emphasis on the transport pipeline is shown in figure 2.

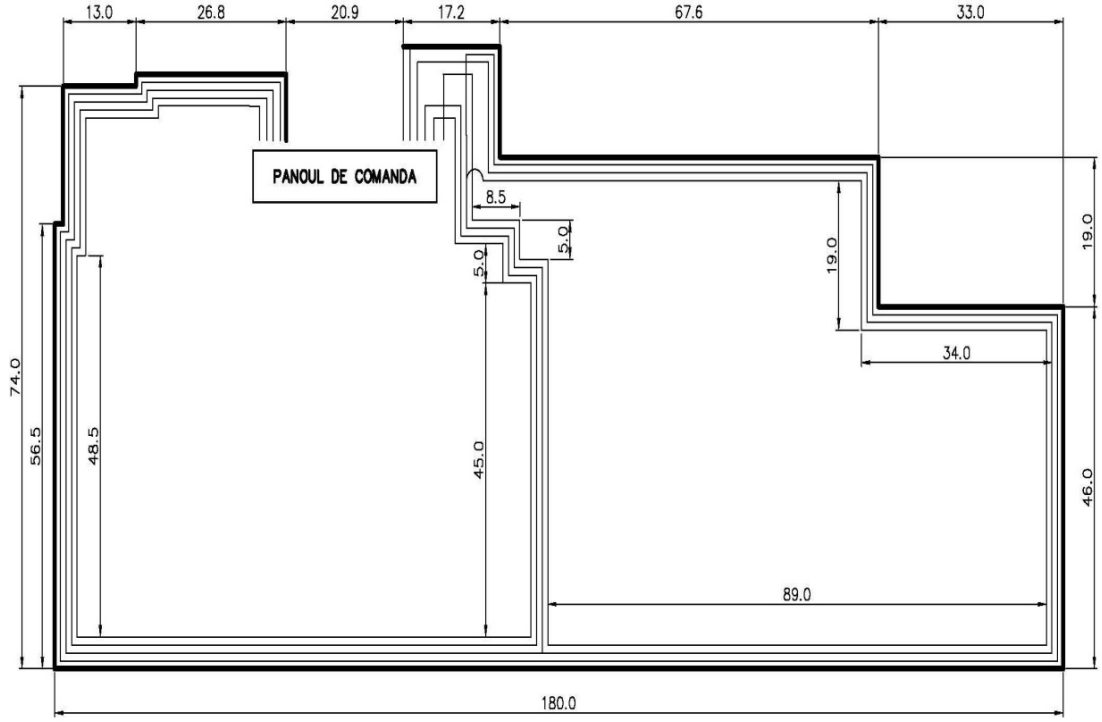

Fig. 2. Transport pipeline 1-2

The control panel standAns" of the transport and distribution system is shown in figure 3.

The transport and distribution system was made of copper pipe fitted on stands, the joints being connected with tin. The system is supplied by a compressor with a 100 l bottle.

The consumers were simulated by means of calibrated nozzles, able to discharge a constant gas flow from the system, but also to maintain the pressure in the low pressure system.

Fig. 3. Control panel

The calculation program for pipelines' design

For making the design calculations, a calculation program was drawn up, that includes a data base with the pipeline and local resistance parameters, for bent pipes, branch pipes, valves etc. Figure 4 shows the interface of this program.

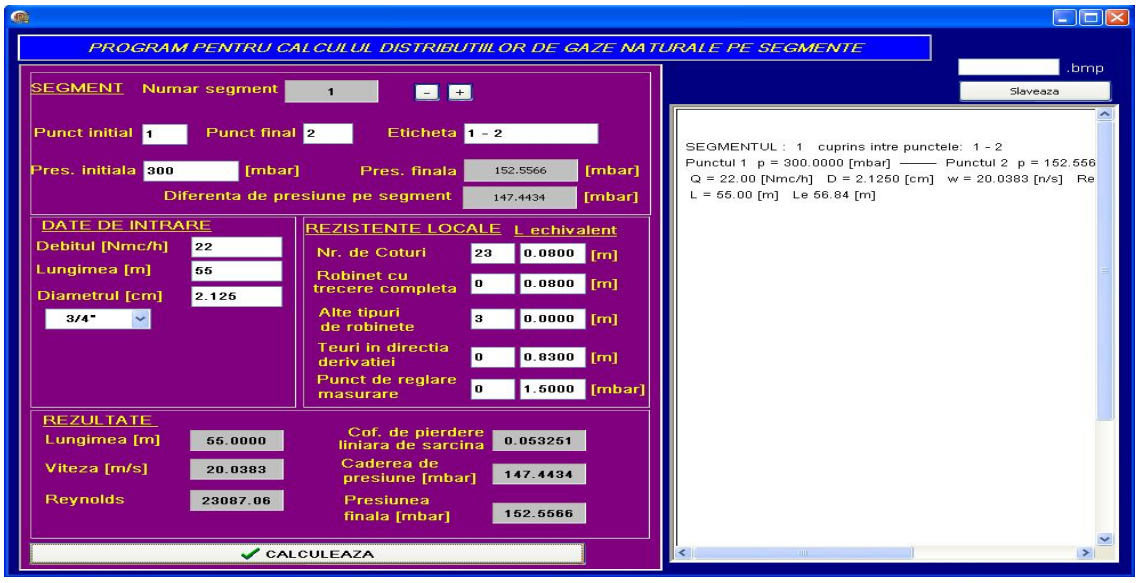

Fig. 4. Interface of the calculation program

The upper part contains a panel where the calculation segments and their succession can be defined. The left part contains a panel where the pipeline diameter can be defined.

The program only allows introducing the standardized diameters. The panel on the right side contains the equivalent lengths for various local resistances that can occur in pipeline systems.

The user has to specify only the number and the type of the local resistance on the respective segment. By pressing the "CALCULATE" key, the program makes the calculation, showing the results for the corresponding segment on the panel on the right side, and the report for the calculated segment(s) is shown on the sheet on the right. The program may save the report containing the calculated results.

Measure, command and control equipment used on the stand

The transport and distribution system is monitored by means of the following elements assembled within the system:

- *Decoders* – the following types of decoders have been used:
  - 8 relative pressure decoders 0 ÷ 5 bar – this patented type of decoder combines advanced design techniques of micro-machines, metallization in thin layer and bipolar processing in order to obtain an accurate output signal which is proportional to the process pressure.
  - Relative pressure decoders 0 ÷ 70 mbar;
  - 4 flow decoders. Weber, vent-captor type 3202.30 & 3205.30 - Weber vent captor decoder is an air flow – meter with the following characteristics: it is simply to install, it is a sensor for all measurement and control applications, it is compact, it has a linear variation of output electricity 4-20 mA and it has four measurement scales up to 5 m/s, 10 m/s, 20 m/s and 30 m/s continuously adjustable.
- *Volumetric meters* – flows consumed by gas users in the low pressure system are measured with 4 volumetric meters, changed so that they can be automatically read.
- *Electro-valves* – the control of gas flow through is done with 4 electro-valves of 1" – normally shut- that can be controlled from distance.
- *Automat programmable TWIDO 24 DRF* – is the element that makes possible the integration of signals and controls the whole stand.
- *PLC-s (programmable logic controller)* – are minicomputers that are usually placed close to the controlled process. They are equipped with input/output devices, so that the decoders that measure the process parameters and the execution elements can be directly connected to PLC. Also they have communication modules to communicate between them and with the central control system. PLC-s are used to control and setup a process in real time. This is done by means of the software with which the controller is programmed. The software application is specific to each process.

Results

After making the stand it has been tested. In order to do this the transport site was supplied with 1.5 bar pressure and the consumption branches:

- The branch with one consumer is supplied with 40 mbar pressure;
- The branch with 3 consumers is supplied with 70 mbar pressure.

Experimental determinations aimed at calculating the flows for the given situation. Keeping the flows constant the pressure falls on the branches of the transport and distribution system have been calculated. The results are shown in the graph below. The measured values are shown in comparison with the calculated values.

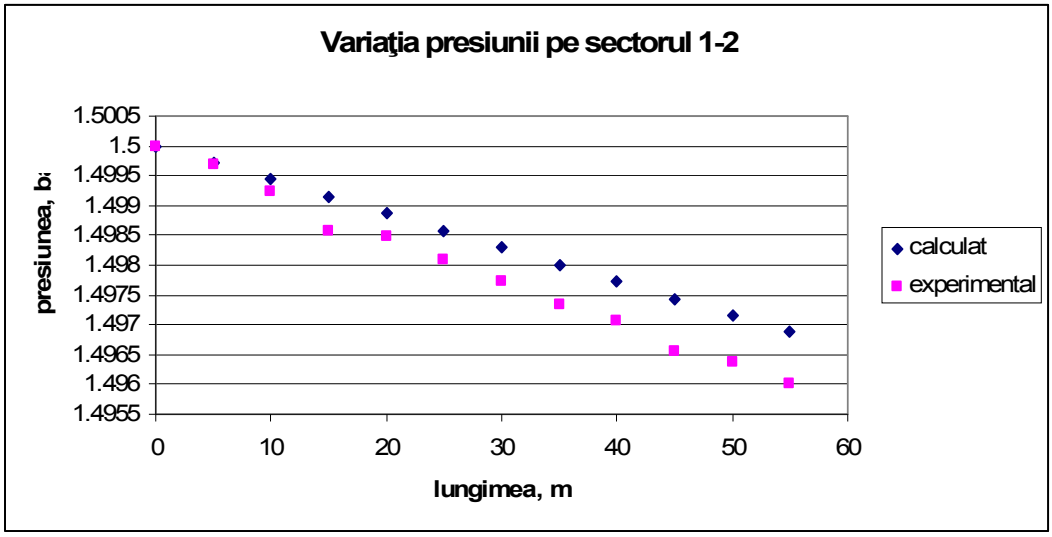

Fig. 5. Pressure variation on the pipeline 1-2 length

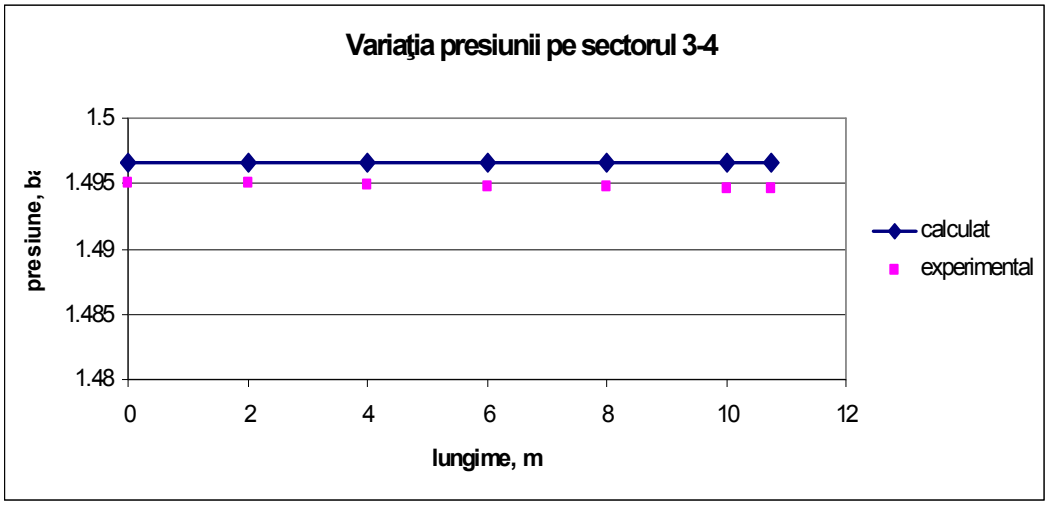

Fig. 6. Pressure variation on the pipeline 3-4 length

Conclusions

The stand for gas transport and distribution design in the laboratory is a useful instrument as it allows analyzing phenomena occurring in gas networks.

The complex system of data acquisition and control through electro-valves allows simulation and studying unsteady phenomena in transport and distribution systems.

The transport and distribution system allows defining operating states and training of specialists in the gas field.

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Simulator pentru transportul si distribuţia gazelor naturale

Rezumat

Deoarece pe sistemele reale de transport şi distribuţie a gazelor naturale este practic exclus realizarea de experimente, s-a considerat necesar realizarea în laborator a unui dispozitiv experimental pentru a se putea simula şi studia experimental situaţii ce apar în sistemele de transport şi distribuţie gaze naturale. Lucrarea prezintă proiectarea, construirea şi testarea acestui sistem de transport şi distribuţie pentru gazele naturale.