REDUCING THE IMPACT OF PERFORMANCE OF MAINTENACE ACTIVITIES ON THE OZON LAYER

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1. Background

Methane is the second most important greenhouse gas in the enhanced greenhouse effect is the methane (CH4). Since the beginning of the Industrial Revolution, atmospheric methane concentrations have doubled and contributed about 20% to the intensification of greenhouse effect. In industrialized countries, the proportion of methane in the greenhouse gas emissions is 15%.

Methane is created by bacteria that feed on organic material without oxygen access. Methane occurs in a variety of natural and human-influenced sources, while the man-made emissions account for the majority. Methane in the atmosphere traps the heat and is 23-times more effective than CO2. But its life is shorter - 10 to 15 years.

Gas system is a place where you can reduce the methane emissions in completely new approach to the performance of maintenance activities. One of the fundamental objectives of eustream company is environmental protection, which is considered one of the pillars of its operation. Therefore, it pays much attention to methane emissions and does not approach their assessment only in terms of achieving the lowest operating costs. However, it tries to identify all aspects of decisions relating to minimizing losses and find the optimal approach.

One of the environmental and technology policy is also pursuit of as little as possible discharge of gas into the atmosphere. This is carried out with the help of mobile re-pumping compressors.

Fig. No.1. The use of three mobile compressors for gas re-pumping.

Mobile compressor allows repumping the gas from a closed section to other pipeline or to adjacent section of the same pipeline behind the closed section . Eustream, a.s. owns two such compressors and has extensive experience with their use (Fig. No.1.).

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2. Aims

Our company as the first launched the initiative to pump out the gas from pipeline systems to zero pressure what is impossible in case of existing mobile compressors. Technically this is feasible with the help of additional compressor - booster. This serves in order to achieve an acceptable suction pressure for a mobile compressor. Eustream as the first comes with the idea of deployment of mobile booster (Fig. No.2.) where the suction pressure is from 0,1MPa to 4,0 MPa and the booster is in pre-pressurizing position.

	KOA2 – older type	CFA34 – new type
Gas engine	CATERPILLAR CAT 3412	CATERPILLARCAT G3412 TA 130
Fuel consumption (gas)	75 Nm3/hod.,	150 Nm3/hod.,
Compressor	DRESSER RAND USA RVM KOA2	CAMERON USA C-FORCE 34
Technical design	two-stage, double-acting	two-stage, double-acting
Working pistons	1 x 5,25“ a 1 x 7“,	2 x 3,75“ a 2 x 4,125“
Suction pressure	0,7 – 7 MPa	0,5 – 7,3 MPa
Max. discharge pressure	7,24 MPa	7,3 MPa
Power output	2500 – 24000 Nm3/h	2500 – 38000 Nm3/h
Chassis	40 t FLOOR	40 t SVAN

Table 2.1: Basic parameters of repumping compressors

Fig. No. 2. Booster in working position

An advantage of repumping compressor is its high flexibility - compressor can be connected to the pipeline by means of optional flange with minimal diameter DN80, to which pressure hoses will be fitted. It means that also installation is very quick (not more than 5 hours). Other advantage is relative low price of this solution. For explanation of procedures and configurations in paper, the compressors are marked as *KOA* and *CFA* according to table 2.1.

The new approach to the performance of maintenance activities in piping systems, in which the depressurization is inevitable, combines the possibilities of both types of compressors. In terms of time, it is clear that the deployment of booster for the operator represents about 10 to 20% of the total pumping time, thereby it seems at first glance that its usefulness is very low with respect to the acquisition cost. And just this time deployment of the booster represents the key stimulus for initiative within the Central European gas companies to exert on repumping the whole volume of gas in the pipeline. In recent years, some gas companies have changed the policies of gas discharging that they carried out in the following manner:

- discharging into air
- partial repumping
- combustion during gas discharge

Each of these methods has an impact on the environment but also economic efficiency. It is essential that there was a balanced state between these two elements.

Our company by using the system of economic - technical calculations elaborated a system for deploying the mobile compressors according to market availability. The situation of mobile compressors especially as for their number, especially in Central Europe, has changed and now four to five of these units are available. Not all are continuously busy so the new technical - economic model relies on the deployment of two to four compressors. The model considers all the technical operating parameters of the transmission network and various kinds of mobile compressors.

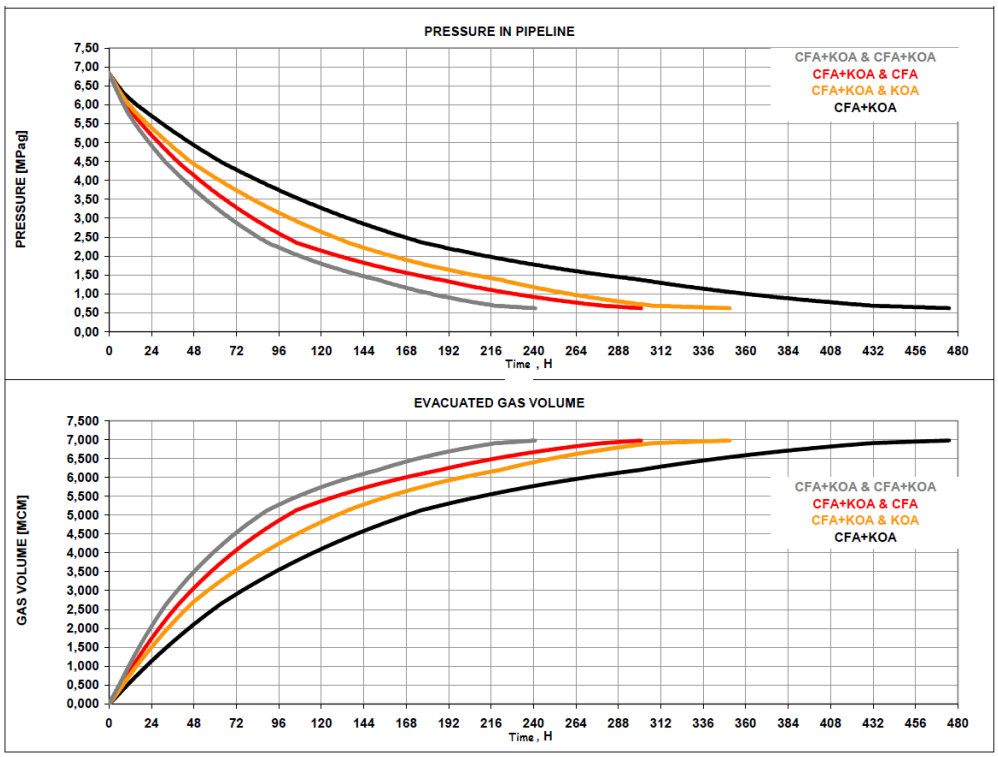


Fig. No.3 Calculation of configuration options of deploying the mobile compressors without booster

By deployment of compressors we can reduce the repumping time up to half, which creates an ample space in the compressor deployment – booster thus allowing to exhaust line to zero pressure.

As already mentioned, our company has developed a technical specification of compressor - booster, with it that it must be a mobile unit of standard type as a mobile compressor. It's the first piece of this kind to our knowledge developed for the given purpose in the world. Its ability to move flexibly, not only within the Slovak Republic as well as beyond its borders, predetermines it for flexible functionality in several gas companies.

We propose a joint coordination of the performance of maintenance activities, which leads to pumping out the gas so that within its availability the individual gas companies around the Slovak Republic will be enable to use the economic and environmental potential in repumping.

3. Methods

Feasibility of this technical plan in deployment of several compressors has been tested in our company and technical solutions have been simulated for the pumping process with both types of compressor. Technical schematic solution is presented in the functional diagram (Fig. No.4.). In the upper part of the scheme there is a general diagram of piping interconnection of compressors and system of valves.

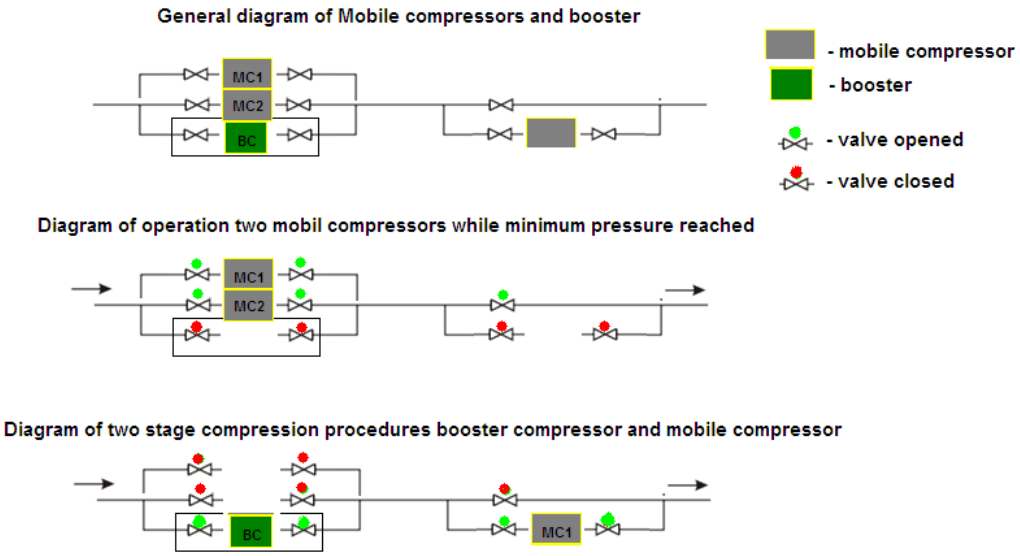


Fig. No. 4. Individual phases of connection of a mobile compressor and booster in the functional diagram

Technical connection of compressors in two phases are crucial for the given activity:

Phase 1 - Middle diagram

This is a standard connection of two mobile compressors. Open valves indicate the possibility of repumping the gas flow. In the diagram the two compressors are shown, but their number can be various depending on the operating conditions of the operator. This scheme is functional until the minimum pressure is reached, when a mobile compressor can

repump the gas. Diagram of process of pressures for the section with the length of 24 km of pipeline with a diameter of DN 1200 serves as an example of time process (Fig. No.5.).

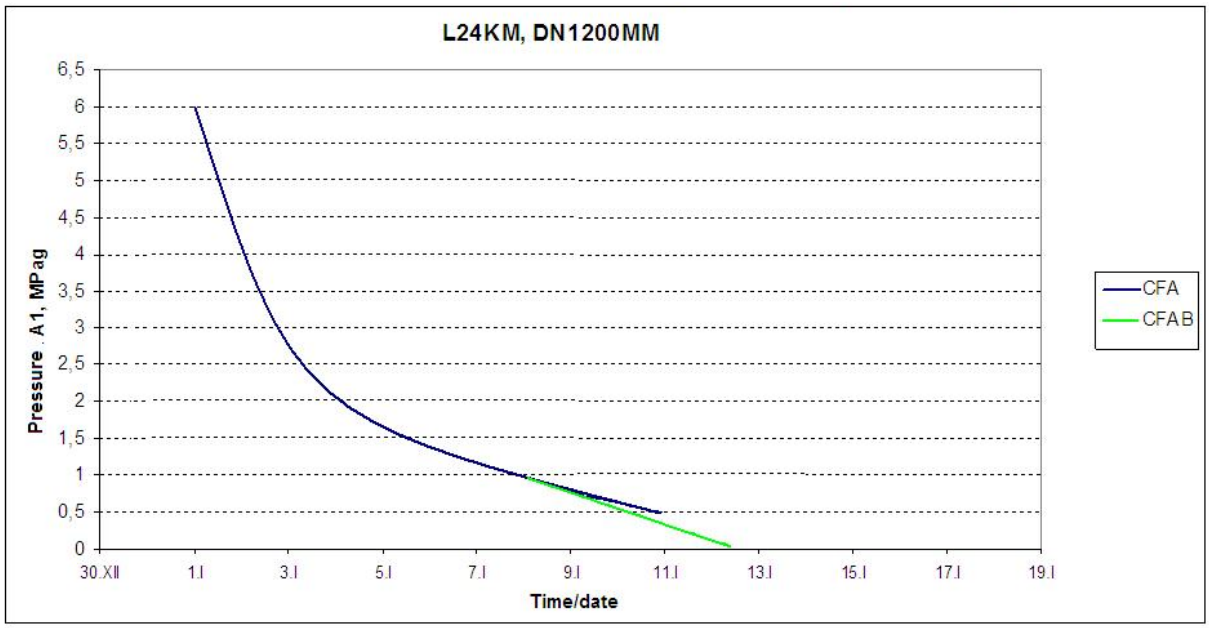


Fig. No.5. Theoretical time process of repumping up to „the zero pressure“

Just before reaching 1 MPa comes the booster and the whole scheme passes into the second phase.

Phase 2 - the inclusion of the booster into operation

From the technical point of view there is obviously the less potential flow during the repumping, which is given by the technical parameters of the booster, therefore the deployment and integration of compressors into series will be carried out under the scheme diagram below. The booster included in this way will compress the pressure in the pipeline, which is in the range from 0 to 1 MPa to the desired value necessary for a mobile compressor to push the gas into the operating pipelines. Such serial inclusion of two different compressors is as for our operating practices necessary for a period of 10 to 20% of the total intended repumping time.

Here it is created the potential for deployment of the booster in the surrounding gas companies operatively and its deployment is possible within 48 hours from the operator´s request.

But such intention would require an integrated technical solution of connecting the pipelines and valves in the companies potentially interested in repumping the gas to zero pressure. Partially this is a technical solution provided by unification of technical standards across the Europe.

4.Results

During the technical - economic calculations the pressure curve during repumping of the selected sections with the deployment of various types of compressors have been processed. Clearly from the first moment our company proceeded to the variable deployment of three mobile compressors, where two of them in our possession were used and one according to a contractual partner. Comparison of theoretical and practical results can be

presented in the graph where the theoretical options are processed that confront the real process of repumping shown by green curve .

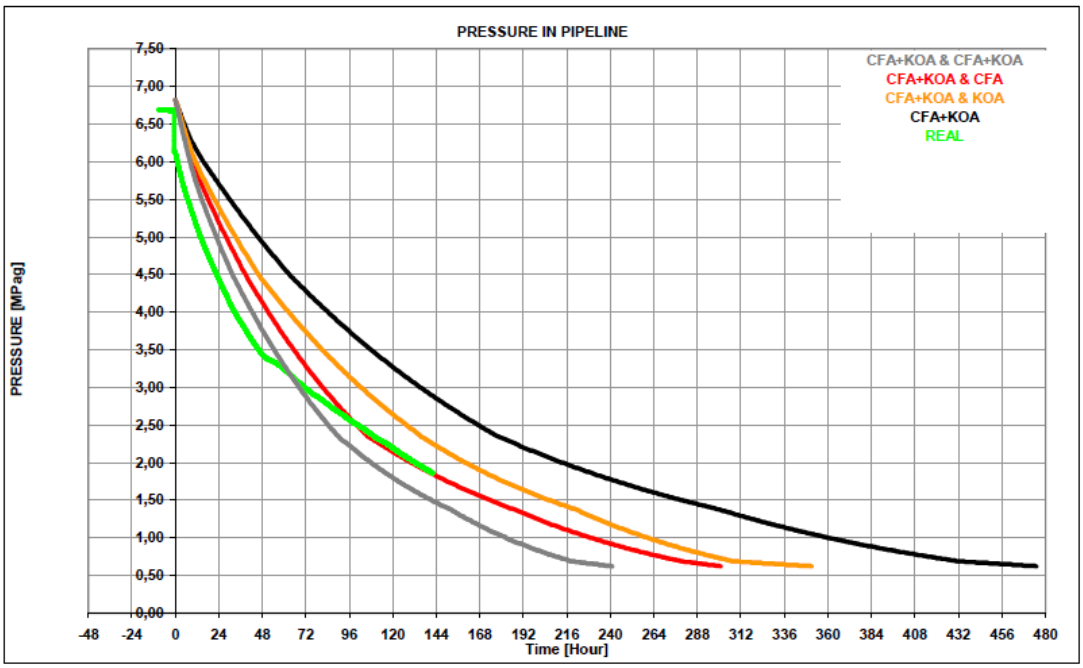


Fig. No.6.Comparison of theoretical calculations and real process of pressure drop in repumping

From the illustration (Fig. No.6), it is clear that the repumping time in different connection diagrams can be reduced up to the half, resulting in several positive aspects:

- time space for deployment and the inclusion of booster for the purpose of complete pumping out the gas, thereby we help to reduce the impact of methane emissions on the ozone layer

- to reduce the need for additional compressor work for alternative routes of gas that is inevitable in order to ensure its uninterrupted.supplies. The additional compressor work causes an increase of CO and NOx emissions of the production facilities. In addition, there is an increase of operating hours of the turbo-set what is necessary to consider in the technical - economic parameters. Considering only the difference in fuel gas consumption must include also this fact.

- reducing the amount of overtime work since the shutdowns of this kind are technically complicated operational actions usually performed during the days and nights

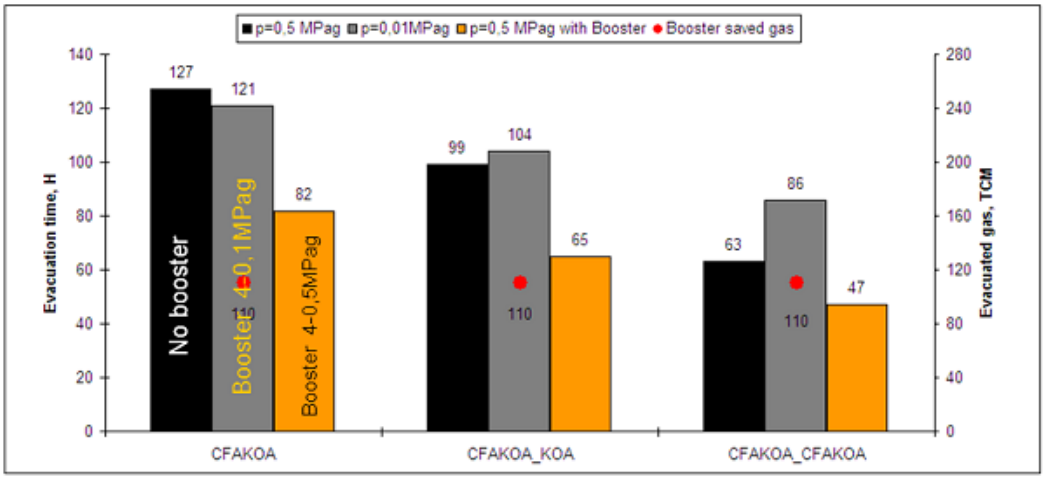
- Reducing the operating restrictions of gas systems that are necessary from a business point of view

The results of all theoretical calculations, tests and site feedback are in the decision table and diagram (Fig. No. 7.). Table represents basic data necessary for calculation as are: Size of the pipeline, temperature of gas and soil, pressure at start of evacuation.

In the table are different configuration labeled in left part. “B” is mentioned booster and compressors are labeled according to Table.2.1. The decision of operator depends of many factors, like a requested time, financial issues from saved gas, etc..

DN, mm	1200
long, km	20
gas temperature, °C	20
soil temperature, °C	15
start accumulation, TCM	1 594

	Pressure, MPag		Time, H		final accumulation, TCM	Evacuated gas, TCM		booster gas, TCM
	start	finish	final	0.5 MPag		final	0.5 MPag	
CFAKOA	6.3	0.5	127	127	135	1 459	1 459	0
CFAKOA_KOA	6.3	0.5	99	99	135	1 459	1 459	0
CFAKOA_CFAKOA	6.3	0.5	63	63	135	1 459	1 459	0
CFAKOA_B	6.3	0.01	121	82	25	1 569	1 459	110
CFAKOA_KOA_B	6.3	0.01	104	65	25	1 569	1 459	110
CFAKOA_CFAKOA_B	6.3	0.01	86	47	25	1 569	1 459	110



	Pressure, MPag		Time, H		final accumulation, TCM	Evacuated gas, TCM		booster gas, TCM
	start	finish	final	1 MPag		final	1 MPag	
CFAKOA	6.3	1	79	79	251	1 343	1 343	0
CFAKOA_KOA	6.3	1	57	57	251	1 343	1 343	0
CFAKOA_CFAKOA	6.3	1	40	40	251	1 343	1 343	0
CFAKOA_B	6.3	0.01	121	64	25	1 569	1 343	226
CFAKOA_KOA_B	6.3	0.01	104	49	25	1 569	1 343	226
CFAKOA_CFAKOA_B	6.3	0.01	86	34	25	1 569	1 343	226

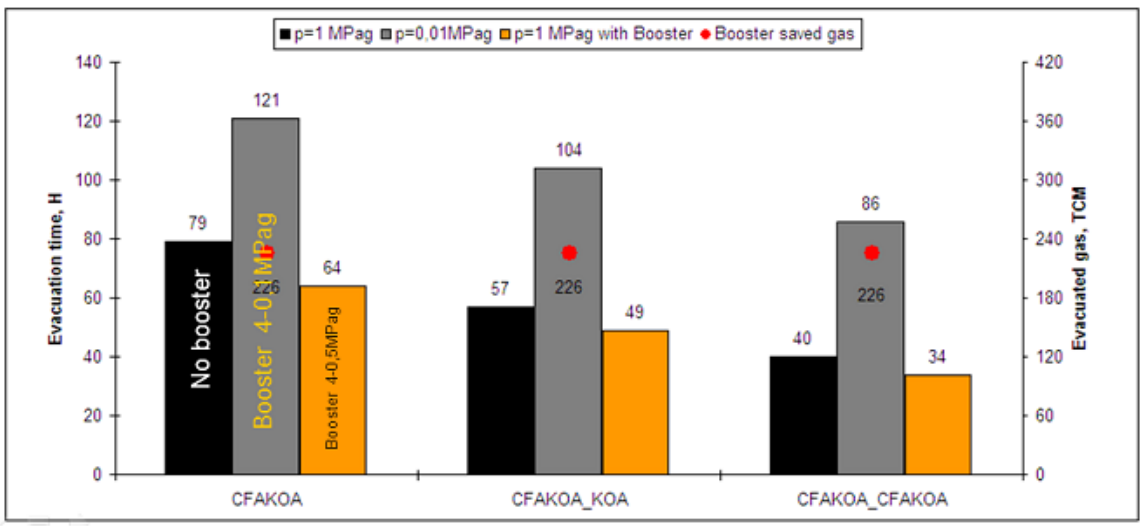


Fig. No.7. Decision table for „sample pipeline section“

The table and graphs represent the history of gas evacuating technologies in eustream and here are visible the milestones.

The first milestone is in 1997 when first idea about gas evacuation is implemented if form of new KOA gas evacuating compressor. Few year later new CFA compressor unit came. The milestone is clearly visible on **black bar** at the the top of Fig. No.7. and says:

- Evacuation procedure lasts for 127 hours
- Our final pressure in the pipeline is 0,5MPa
- We have to vent to the air 135 TCM of gas

We started to think about pre-pumping compressor – "booster" and we prepared the technical idea for supplier.

Second milestone is in 2010 and spring of 2011 and represents extending of the fleet of compressors to achieve shorter time for gas evacuating procedures. On the market we can find service companies for gas evacuation and the results represents set of configurations of different type of compressors. For the same conditions as in first milestone we need 2/3 of former configuration, and for doubled fleet we are at ½ time. But still there is the rest gas at 0,5 MPa which has to vented out to the atmosphere.

But the third milestone move us to new operational excellent position thanks to newly developed booster implemented in autumn 2011 in operation.

Finally the section with configuration 3+1 (it means 3 compressor + 1 booster) we saving all gas from the pipeline at pressure level 0,01 MPa and it takes ½ time compared to 1-st milestone.

Difference is very visible on the red point, which represent the amount of saved gas in TCM.

5.Summary

New technical - economic approach in repumping the gas of the company Eustream and putting into operation the additional compressor - booster provides a new step in protecting the ozone layer and effects of the impact of the operated facilities on the environment.

The advantage of new technique bring to us:

- Methane emission reduction
- Finance saving in various forms
- Reduction of repumping time of natural gas
- Reduction of overtime work
- Reduction of the amount of operated gas evacuating compressor hours
- Extension of interval between general overhauls
- Option to provide services out of eustream, a.s.
- Revaluation of gas emitting also within short sections, pipe yards of compressor stations or main sections of distribution systems
- Reduction of number of forced operating hours of major compressor technology allocated at compressor station due to temporary bottleneck created during maintenance activities on pipeline network.

It is essential that the gas companies mutually coordinate the selected maintenance activities and utilize the given approach. Mutual communication that takes place between the individual gas companies within the Slovakia represents the high potential for such initiative and policy changes.