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THE TECHNICAL MANAGEMENT OF THE UNDERGROUND GAS STORAGES OF MEDIUM CAPACITY IN TRANSYLVANIAN BASIN (ROMANIA)

1. INTRODUCTION

The present worldwide energetic crisis represented by the natural decline of the gas fields associated with a very increased requirement for the new reserves discoveries claims for a more accurate approach of the whole technical and economical strategy.

The dependence of natural gas sources located in even more remote areas and the necessity to satisfy the romanian market demand all through the year, have been determined the intensifying of the efforts in order to create new underground gas storages for seasonal peaks consumption supply.

In creating of the underground gas storages of high capacity, "Romgaz" has a long history, starting many years ago, the first storages being developed to cover the seasonal fluctuations in highly industrial areas like: Sibiu, Bucuresti-Ploiesti and Turda-Cluj, due to the local insufficient sources to cover the consumption peaks during cold season.

We have to mention that the first experiment for building underground storages has been performed in 1959 and included more wells of Pliocen age reservoir from one field located in extracarpathian – zone, but the receptivity tests have been interrupted due to the improper completion of the injection wells, which determined the appearance of some gas emanations behind the casing.

This first experiment was followed by an effective development of some underground gas storages created in extra-carpathian area and also in the north-western part of the Transylvanian Basin in 1960, 1979, 1983 and 1992. All these achievements had an essential contribution for reducing the impact upon the consumers of the great fluctuations derived from the gas production domain.

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2. THE WAY WE DESIGNED AN UNDERGROUND GAS STORAGE OF MEDIUM CAPACITY

Recently, a new strategy related to this concept has been successfully implemented in development of some underground gas storages of medium capacity. An interesting case study is represented by Cetatea de Balta gas field, a half-depleted reservoir, located in Transylvanian Basin and converted in underground gas storage few time ago.

Our intention is to present some details regarding the technical management for building an underground storage in this gas field.

The design included a very rigorous analysis, taking into account a lot of criterions in terms of geological and physical model of the reservoir, surface facilities, capacity of connection to the national gas transport system and consumption market and the final result was the selecting of the best candidate horizon for the gas storage.

The fundamental elements which have been defined this analysis were the following :

- the existence of an accurate geological model of the reservoir;
- a considerable volume of the porous – permeable zone, attractive from underground storage point of view;
- high permeability values of the reservoir;
- an optimum depth of the reservoir, which could assure the proper sealing to the upper reservoirs and to the surface layers;
- the reservoir should be not so deep, due to the high pressure drops recorded during withdrawal-injection cycles;
- actual values of static pressures, which could assure the obtaining of the requested rates during the withdrawal cycle, without creating of a great cushion gas;
- a representative number of active or inactive wells in order to retrieve to the desired horizon;
- the existence in that area of some surface facilities and one compression station with proper parameters (suction and discharge pressures) for working in withdrawal-injection cycles, the presence of one complex gathering and transport system.

The most interesting horizon related to the above mentioned issues was Sarmatian III, considered to be the best candidate for converting in an underground gas storage.

The geological and physical parameters which characterizes the volume and the reservoir conditions have the below presented values:

- the lithology is represented mostly by permeable sandstones;
- the average depth of the reservoir about 550 m;
- the net pay about 30 m;
- the effective porosity 20–25%;
- the gas saturation 70–80%;
- the average reservoir pressure:
  - initial 57 bar,
  - actual 14 bar,
- the effective permeability 40–60 mD.

In order to establish the underground storage capacities, which could be created in this horizon, more process simulations have been performed with gas volumes belonging to the range of values between 200 and 250 mil. cm /cycle.

Some restrictions have also been taken into account in simulations elaborating:

– maximum discharge pressure from compression station;
– an optimum number of wells, which can assure a low interference effect;
– a maximum reducing of the pressure drops during the withdrawal cycle.

For establishing the flowing equation in the average well, in order to estimate the gas transmissibility in the whole reservoir, the history of the dynamic wellhead parameters and the hydrodynamic tests performed in the last period have been analyzed. To simulate the behaviour of the reservoir in the underground storage process, the average values for laminar and turbulence coefficients were taken into consideration. In order to support these values, a theoretical computation has also been made and the final results were very closed to the previous ones.

Among all the elaborated scenarios, it was selected fesable those one with an underground storage capacity of 250 mil. cm/cycle and gas cushion of 100 mil. cm /cycle.

For obtaining a low interference effect, it was estimated that a maximum number of sixteen wells will assure a significant increasing of the gas flow rates in the withdrawal cycle. In this context, to those three existing producing wells from Sarmatian III, seven wells have been retrieved from lower horizons and six new drilled wells have been added (Fig. 1).

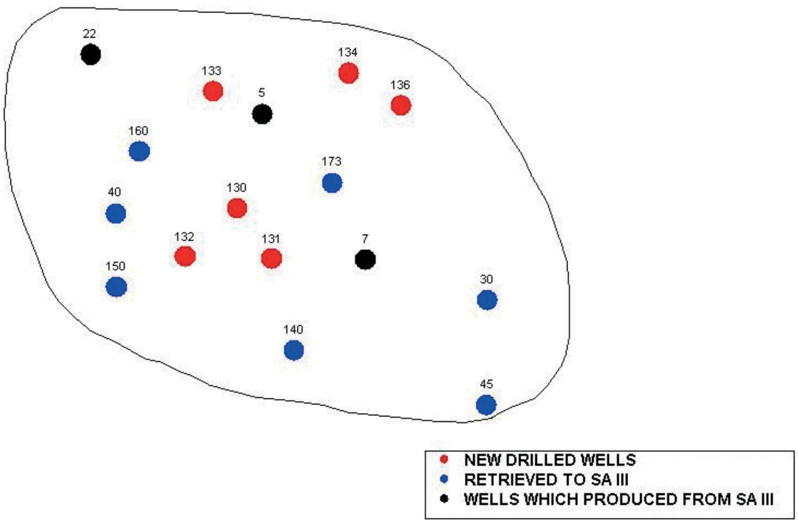

Fig. 1. Sarmatian III – the wells from underground storage

The new wells completion was also specially designed with a 7 inch production casing and 4 inch production string, with a safety valve located about 20 m from the surface.

The reology of the drilling fluids has taken into account the depletion degree of the reservoir, being used the low density fluids of maximum 1.10 kg/dm^3.

After peforating with Dyna Star deep penetration guns (3 3/8 inch or 4 inch), the wells were completed with retrievable production packers set above the perforated intervals, established based on the petrophysical interpretation of the special open hole logs, which included resistivity and porosity logs.

The Sarmatian III horizon is located in one porous-permeable medium defined mostly by sequences of sandstones interbedded with thin layers of clays and silty clays (Fig. 2).

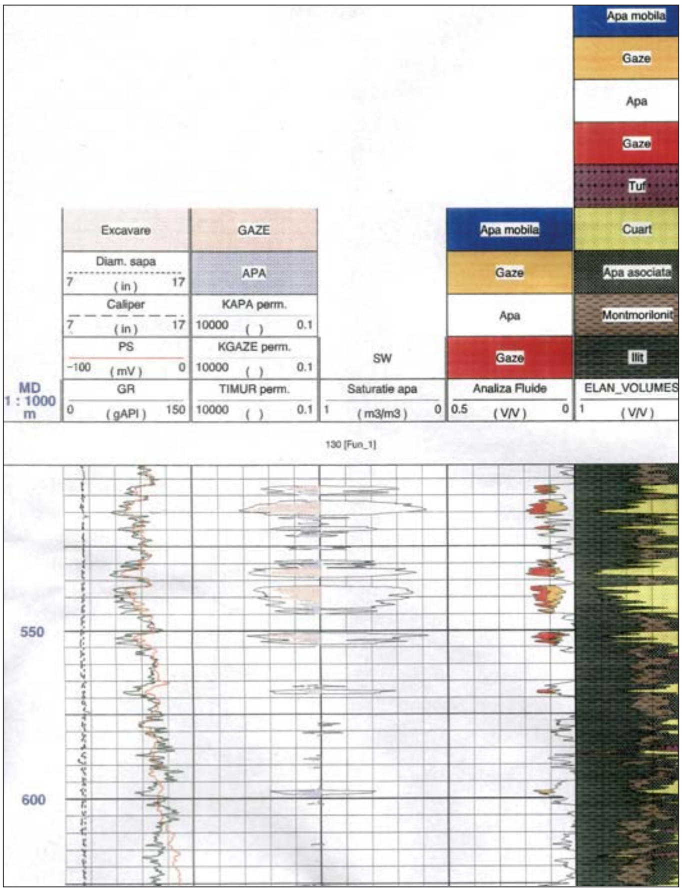

Fig. 2. Cetatea de Balta new drilled well – processed log example

The physical parameters obtained from the petrophysical interpretation are an effective porosity of about 20% and a maximum gas saturation of 70–80%.

Initially, the withdrawal-injection process started in April 2002, in eight wells, further being added the rest of eight wells until June 2004. The underground storage capacity has been performed gradually, during injection cycles, so in 2006 will be realize a maximum capacity of 250 mil. cm, from which 150 mil. cm will be represented by active stock and 100 mil. cm by inactive stock (cushion gas) (Tab. 1).

Table 1

The underground gas storage capacity

	[mil cm]					
CETATEA DE BALTA	ACTIVE STOCK 2002	ACTIVE STOCK 2003	ACTIVE STOCK 2004	ACTIVE STOCK 2005	ACTIVE STOCK 2006	INACTIVE STOCK 2006
	50	101	104	116	150	100

The injected and withdrawn gas quantities in each cycle correlated with the reservoir pressures evolution, presented in Table 2, emphasize the gas quantity of 13 mil. cm/bar, as volume of the porous space.

Table 2

Injected, withdrawn quantities and reservoir pressures

Injected and withdrawn gas quantities [mil. cm]							
Injection 2002	Withdrawal 2002–2003	Injection 2003	Withdrawal 2003–2004	Injection 2004	Withdrawal 2004–2005	Injection 2005	Withdrawal 2005–2006
50	16	67	25	28	37	49	16
Reservoir pressures [bar]							
20.27	15.28	22.83	17.27	21.31	18.50	23.16	19.50

The maximum designed underground gas storage capacity will be realized at the end of 2006 injection cycle, Figure 3 showing the way in which the yearly stocks were created, based on the injected and withdrawn gas quantities.

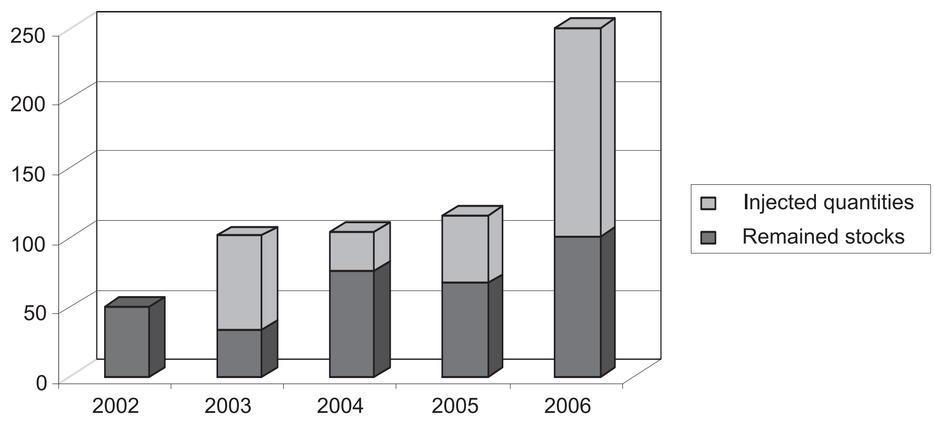

Fig. 3. Creating the maximum designed storage capacity

3. CONCLUSIONS

Based on this last experiment and involving an accurate technical management, "Romgaz" will extrapolate the possibility to build other new underground gas storages of medium capacity in the same area, in order to create a network of storages.

All of these storages will represent a real gas stock, which undertake the seasonal consumption peaks and will reduce the impact of great fluctuations of the gas production upon the consumers.

Although in the last period the underground capacity has known an ascending trend, the "Romgaz" strategy assumes two major coordinates, in terms of intensifying the efforts in development of the existing gas storages and also in creating the new ones, in order to increase the security coefficient of the internal gas market requirements.

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