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Dávid Szabó*, Ján Pinka*, Ľuboš Fedorko**

UGS WELLS IN DEPLETED FIELDS

1. INTRODUCTION

While gas consumption in Slovakia is increasing, domestic gas production is declining and gas imports are on the rise. Therefore Slovakia is eager to secure additional gas imports from the former Soviet Union to cover the seasonal gas demand, and prevent the supply shortages. To get the stability in the energy sector, every country needs a huge amount of hydrocarbons from its own resources other than from import. Most of the leading oil and gas companies have to make an effort to ensure the stability of the country with 2 ways, firstly increasing the production/import of hydrocarbons (crude oil and gas), secondly, to expand the storage capacity of the country to get over the natural gas crisis from the last years [1, 4].

2. UNDERGROUND GAS STORAGE

The idea of storing natural gas in underground reservoirs during low consumption seasons to be for later use in high-demand seasons and to meet the peak rates has found worldwide application since 1950 s.

UGS has not only been found interesting as a solution to overcome the energy shortage during winter, but also to keep the gas production capacity from processing units and refineries in the summer [2].

UGS represents a complex system of surface and subsurface equipment and technology also known as downstrean & upstream technology (Fig. 1). Both technologies play an important role in the proper functioning of the UGS complex.

* Faculty of Mining, Ecology, Process Control and Geotechnologies Technical University in Kosice, F BERG, Slovakia,
** E.ON IT Slovakia spol. s.r.o, Slovakia

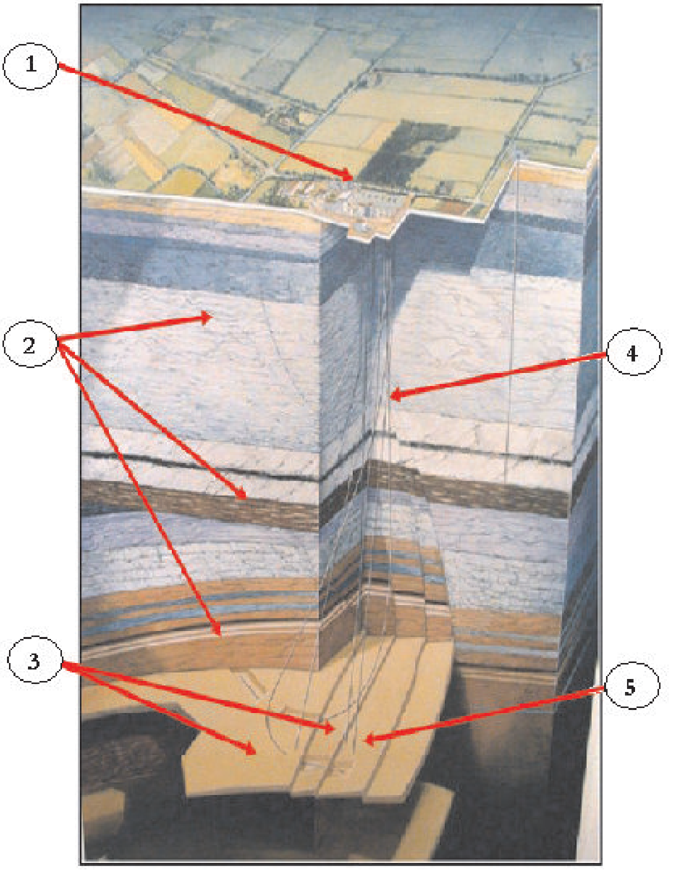

Fig. 1. Typical layout capabilities of UGS [7]. 1 – Upstream technology, 2 – Overlaying formations, 3 – UGS – depleted oil/gas reservoirs, 4 – Sand/sandstone reservoir with high porosity and permeability

3. DRILLING FLUIDS USED FOR DRILLING UGS WELLS

Proper selection of the drilling fluid/additives is the most difficult in relation with the reservoir behaviour. Non-damaging drilling fluids are preferred for better stabilization of the reservoir formation. Under domestic conditions (well known reservoir behaviours), Ultradrill mud system from MI-SWACO company represents a good treatment with additives to fight against mud loss, plus also enjoys the benefit of non-damaging nature. Ultradrill mud system reduces the torque and drag in horizontal wellbores and prevents sticking [5]. Other drilling contractors, e.g. OMV have extensive experience with oil base drilling fluids used in the closed loop system. Special permission and rig equipment is required to manage the oil base fluids. Oil base drilling fluids can be used for drilling in hydrocarbon reservoirs or when using horizontal wells to help minimizing the torque and drag (Fig. 2) [3].

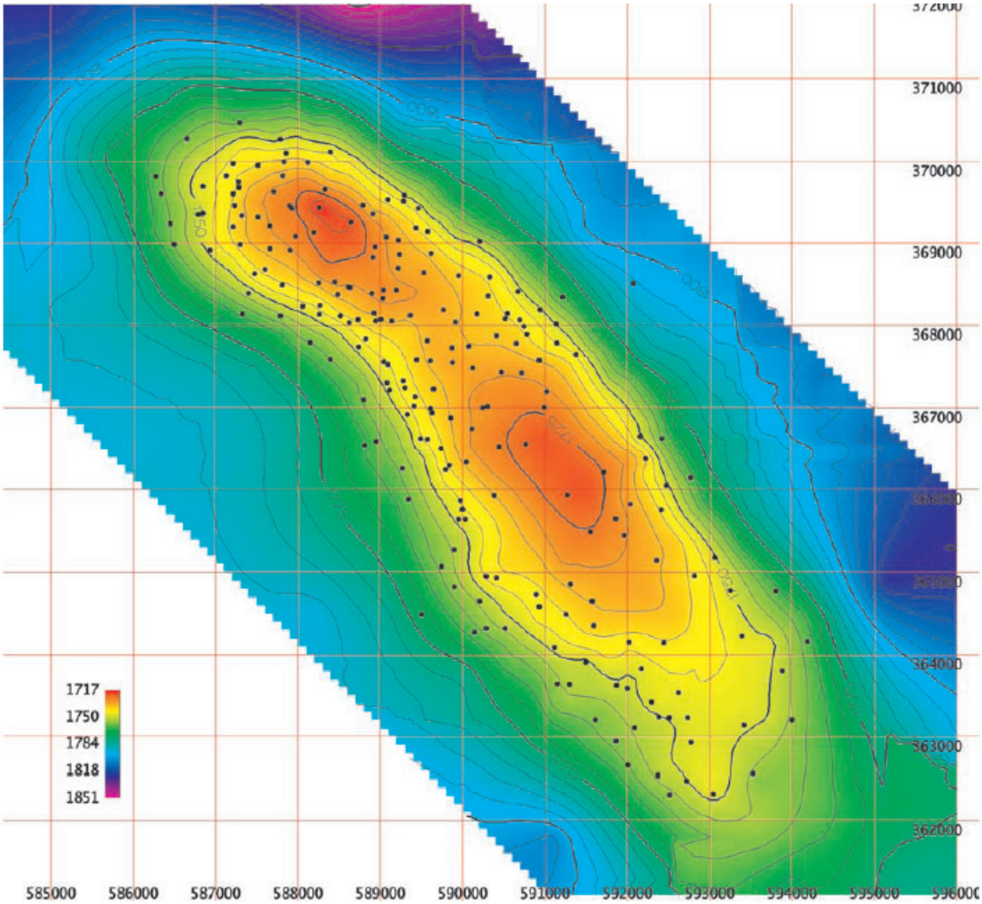

Fig. 2. Main reservoir characteristics – Top Map [3]

4. UGS WELL DRILLING

Casing drilling technology (CDT) can be applied for drilling for UGS development: CDT helps minimizing the losses by cutting behind the casing, yet its disadvantage is that Open Hole Logging isn't feasible during casing drilling.

Underbalanced drilling is also an option how to to drill in depleted reservoirs, however, it is very expensive – approximately twice as much as the conventional drilling [3].

5. UGS WELL CEMENTING

Many case studies recommend using the lightweight slurries 0.48–2.2 kg/l for the cementing jobs. Advantages of the lightweight slurries such as the foam cement with N_2 is allow “expansion” approximately 2–3% of the slurry volume behind the casing and reduce the possibility of cement failures acting forces like pressure and temperature cyles during the operation of the UGS wells. Economically competetive, combats annular gas invasion and it is suitable for high temperature cementing up to 315 ^{o}C. Other advantages are excellent strenght to density ratio – reduction of filtrate loss (Fig. 3) [8].

Some case studies recommend using the latex based Schlumberger´s cementing system FLEX Stone (Fig. 4). Cement slurry with fibres is also one of the options to combat losses during cementing.

Fig. 3. Preparation of foam cement with N_2

Fig. 4. Foam cement with N_2

6. UGS WELL COMPLETION

The proper selection of the UGS well construction helps reduce the risks and elongate the operating life of the well without the necessity of work over operations, but in most of the cases it depends on the reservoir behaviors [6, 7]. A practice of using a pre-drilled liner in the highly deviated or horizontal UGS wells may represent an advanced well construction of the present techniques. Another example is shown below (Fig. 5).

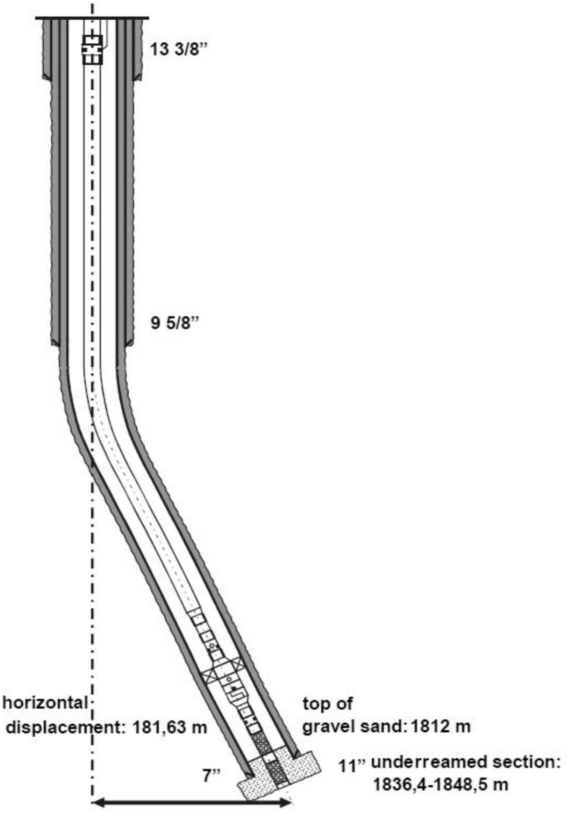

Fig. 5. Advanced UGS well construction [3]

Table 1

Well completion [6, 7]

Description (from the top)	Diameter Ø
NE™ Tubing-SCSSV	4½"
SSD, X-nipple profile	3½"
Retrievable sand control packer	7"
STAB AC MCS closing sleeve	5 13/32"
EGF ceramic flapper valve	4 13/16"
Safety joint	4"
OTIS®X® nipple	3½"
Telltale screen 10ft 8gg	3½"
Production screen 29ft 8gg	3½"
Bull plug	3½"

7. SANDING PROBLEMS

Causes of sanding problems: during operation of the UGS: the well temperature and pressure are substantially changing. The pressure factor is mostly shown in a force which may be the cause of moving the formation components (sand in the sandstone reservoirs) induced by the flow of natural gas. The factors are stronger than the forces that hold the sand grains in place. To put in simple, the downhole stress (pressure cycles) around the wellbore causes the sand production during the UGS operation. Other factors that might influence the sand production : compaction, radial differential pressure, fluid inertia, fluid drag, saturation changes.

8. METHODS OF SAND EXCLUSION

Sand control or sand managing also known as the procedure to maintain (reduce) the minimum amount of sand production during operation of the UGS. Among the well-known methods for sand exclusion are: Velocity control, underreaming, Perforation technology (charge type, shot density). An interesting solution for the sand managing is the In-situ chemical consolidation (grain to grain cementation by chemicals). The well is completed by a sandscreen or perforated liner without gravel pack. To achieve better results a combination of chemical and mechanical sand control may be applied (Fig. 6).

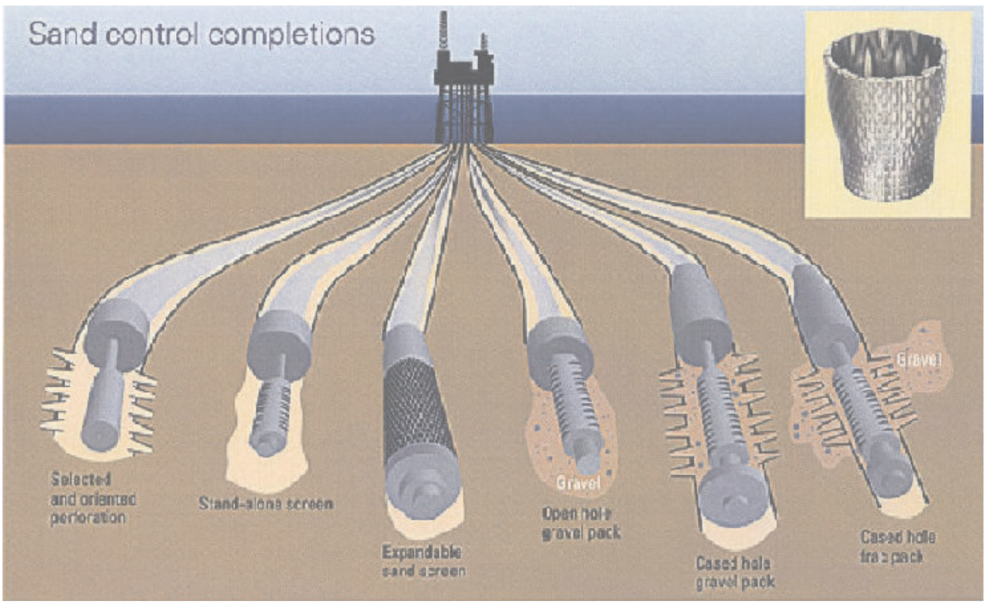

Fig. 6. Sand control completions [6]

9. CONCLUSION

Assessment procedures concerning the drilling, well completion and sanding problems in place differs between the individual companies, involves parameters such as well age, depht, cement quality,completion (packer, safety valve, sandscreen) and also leakage monitoring (behind the casing) – based on the assessment (Logging, Work over and Wire-line operations).

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