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PROBLEMS OF HERMETICALITY OF WELLS FOR LEACHING IN "TETIMA" MASSIF AND REPAIRING CONSTRUCTION IN CASE OF UNHERMETICAL COLUMN PIPES $9^{5}/_{8}$"

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ABSTRACT

As it is known, the extraction of rock salt from deposit "Tetima", Majevica, performed is by controlled leaching in the underground chambers positioned diply in the salt deposit. The connection between the underground chamber, that represents the basic production unit in the primary salt production and technological installations on the surface, is through a deep wellbore, which is an integral part of the leaching system.

Keywords: *hermeticality of wells, construction of wells, procedures of repairing, "Tetima" massif*

INTRODUCTION

The extraction of rock salt from deposit "Tetima", Majevica, performed is by controlled leaching in the underground chambers positioned diply in the salt deposit. The connection between the underground chamber, that represents the basic production unit in the primary salt production and technological installations on the surface, is through a deep wellbore, which is an integral part of the leaching system.

The controlled leaching is characterized by safe control of the fluid flows (and balance) moving through the well and chamber during the leaching. When a unhermetic well must be used, one needs the repairing methods to restore lost hermeticality. In this case, we apply the repair method, which should enable the exploitation of the rock salt within the projected dimensions of the chamber.

PROBLEMS OF WELLS HERMETICALITY

Physical position and orientation of the well defined [1]:

- The coordinates x, y and z,
- Zenithal angle (θ) which is the angle between the vertical plane and the axis of the borehole, Azimuth (β) and horizontal angle between the projected direction of drilling and astronomical North,

- Angle decreases (α), which represents the angle between the axis of the bore and horizontal planes, which can be positive (drilling upward, above the horizontal plane) and negative (drilling down below the horizontal plane) and
- Deviation wells or horizontal distance between the mouth and the bottom of the borehole.

Rock drilling can be carried out using mechanical, thermal, physical - chemical, electric arch, the explosive and other methods. In the industry, however, have found the widest practical application of the methods are introduced in action mechanical disintegration of destroying rocks [2].

The borehole is made by stringing the following operations [3]:

- Connecting the drill string and chisel,
- Stringing drill string and dropping chisel to the bottom of the borehole,
- The work of chisels or crowns on the bottom wells (drilling) while taking fragments destroyed rocks,
- Adding the drill string to chisel progresses in depth,
- Removing tools from the wells (eg for replacement of worn-out bits)

The construction of the well casing, for the appropriate method of controlled leaching of salt deposits, must meet the requirements of a number of very strict criteria, of which the most important are the following: incontroverstible physical stability of the wellbore in its projected exploitation (and post exploitation) period; solid tightness, isolation of the wellbore and the future chamber against the influx of unwanted fluids from the massif; comfortable space to accommodate PIPING to perform the technological process of leaching according to the selected method, and selected characteristics of the cladding tubes must allow the safe and rational exploitation of brine.

In the phase of drilling the borehole is a classic casing exploration structure through which it is possible to collect detailed information about the spatial location and other characteristics of salt body, its roof and bottom, hydro-geological characteristics of the drilled interval and a lot of other information, all of which significantly influence the selection of technologies and methods for leaching and how to adjust and construct casing.

Among these criteria, an extremely important role has the nearby massif, because of very complex and difficult hydro-geological conditions prevailing in parts of “Tetima” massif on which we here present a few notes, to be considered to achieve hermeticality wells and future exploitation chambers.
The complex hydro-geological picture of evaporites is produced partly by natural factors from the time of postgenetic shaping of the deposit when strong tectonic movements resulted to the levying and concentration of initially thin salt layer, but also much later, under the influence of other technogenic factors when, in the period of primitive exploitation, accelerated circulation of groundwater water and increased saturation have significantly undermined the primary hermetical massif. All these natural and technogenic factors together have created serious hydro-geological conditions in the massif, and the deposit.

Among the several hydro-geological units whose waters have subartesian and / or artesian character, for the mining operations the most dangerous waters are situated in the immediate salt roof (predominantly of subartesian character) and those located in the bottom of the salt body, whose mechanism is not sufficiently studied.

The most complex and most difficult drillhole interval necessary to achieve the required hermeticality, is located in lower Tornton breccias which are positioned immediately above the salt body, under whose overlying protective thickness ranging to ~20 meters, will be developed the future exploitation chamber to a final diameter of 70 meters. Mentioned breccias usually represent a separate entity with the worst engineering geological characteristics in the entire lithostratigraphic deposit column, in which, as we noted above, a subartesian ground water exist, which must be insulated by cementation from the future chamber.

If during the drilling in this interval, we do not pay special attention and do not exercise adequate technical procedures when making the wellbore, it is certain that this "vulnerable" structure, that is in the primary condition unfavorable for mining activity will be exacerbated. This statement can be easily proved: by definition, subartesian ground water released in breccias must have a hydrostatic gradient of less than 0.01 MPa / m for which the application of standard bentonite mud or salt mud with usual density of 12 kN/m^3 with the gradient of 0.012 MPa/m will cause the injection into breccias and these under this pressure will be fractured. The same negative effect will be achieved in the case of directional drilling with the use of turbodrill, correction of deviated well, due to the fact that the optimal operation of the turbodrill is achieved at a maximum pressure of mud.

However, the major damage to this area happens in the works when the primary cementing slurry (densities 18 to 19.5 kN/m^3) are pressed by considerable pressures (up to 6 MPa/m) where the gradient of lithostatic overlying rock sediments is exceeded and breccias fracture.

This can be proved by a simple example: during primary cementing technical column 9 $^5/_8$", which is built on the depth of 468.5 m, cement slurry is pressed in the borehole mud density of 12 kN/m^3, under the pressure of 6 MPa at its head. For these conditions, the total pressure at the bottom of the well, at the end of the displacement of cement slurry will be [4]:

$$P_{uk} = 6000\ (kN/m^2) + 12\ (kN/m^3) \times 468{,}5\ m = 11622\ (kN/m^2)$$

which is the heel column 9$^5/_8$" pressure matching 11622/468,5 = 24,81 kN/m^3, or 0.02481 MPa/m', which is greater than lithostatic gradient in "Tetima" which is 0.0242 MPa/m', the breccia will be. In some wells, such as the wells B-86, instead of the recommended test pressure gradient of 0.017 MPa/m hermetic cementation was tested with gradient 0.0229 MPa/m, and the tested cementation gradient was only 0.0209 MPa/m 48 hours after cementing, what will, in terms of insufficiently hardened cement slurry and its possible damage from vibration of bit when drilling non-return valve, undermine the homogeneity of the cementation mantle and fracture breccia.

CONSTRUCTION OF WELL FOR PRIMARY AND REPAIRING METHOD OF LEACHING

For the simplest way to gain additional insight into this complex problem we will show, shortly, construction of the casing well for the basic method of leaching in "Tetima", and then, necessarily to change that construction in case of loss of hermeticality in the column 9$^5/_8$". Lateral leaching method (or so called. "close pipe bottoms") requires the use of five serious "casing" pipes of different diameters as follows [5]:

$$20" \times 13^3/_8" \times 9^5/_8" \times 7" \times 4^1/_2"$$

of which the first three series are cemented and the other two free hanging, hinged in boreholes head on the surface. The main task of these sequences is as follows:

- The conductor ϕ 508 mm (20 "), is installed in a dry to a depth of ~20 m and cemented and has the task of protecting the mouth of the well, and allows the circulation of drilling fluid over the vibrator during the development of channels for the opening column (Figure 1 - Phase A)
- The surface string ϕ 340 mm (13$^3/_8$")[1], covering the pannonian unstable formations, and the directed at drilling and the curved wellbore channel in order to avoid the creation of so called "The keyhole". It installed to depths of 60 -150 m and cemented to the surface (Figure 1-Phase B)

[1] On this column, if necessary, install preventer

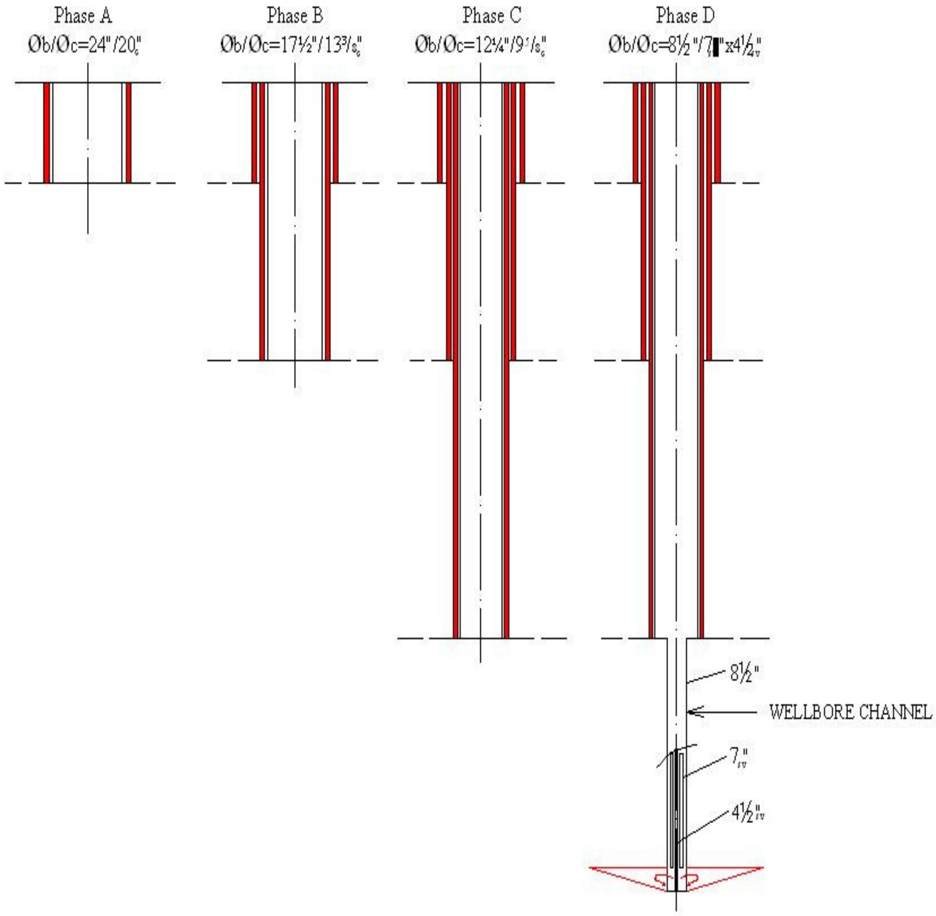

Figure 1. Phased development of the construction of wells for the method of "close pipe bottom".[2]
Phase A, B and C: drilling, installation and cementation column: 20 ", $13^3/_8$" and $9^5/_8$ ".
Phase D: equipping hermetic chamber with movable columns 7" and $4^1/_2$ "

- The technical string ϕ 245 mm ($9^5/_8$"), must be hermetically separated from the cap rock and salt deposits. Installation depth of this column depends on the spatial position and salt body whose depth from the surface varies from 400 - 900 meters. Lower installation position of the column (or so called "heel" of the column) is ~ 20 m in the salt body. This is the most important column, which, except the role of technology, has a crucial role in the realization of hermetical of the underground chamber to the surrounding massif (Figure 1 - Phase C). Because of technological reasons nature, after installing technical columns and its successful cementation, through salt body of well with diameter of $8^1/_2$" is made in which the descending moving column is lowered

- Exploitation string ϕ 178 mm (7"), ϕ 114 ($4^1/_2$"), is free hanging column, and hanging in wellhead is used for flow of technological water and installation depth of the tube is not essential for the physiognomy of this paper (Figure 1 - Phase D).

The presented construction of wells meets the criteria of controlled leaching only when the effectively controlled are the flows (and balance) of all three fluids which characterize the basic method: technological water, saturated or under-saturated salt water (in relation to the preparation or exploitation phase of chamber) and isolating fluid which specifically blocks the leaching of some areas in the chamber (eg. Top of hydro notch or chamber).

[2] Øb/Øc: Øb – wells diameter, Øc –chisel diameter. For example, for Phase A that means that the wells are drilled with chisel diameter 24" installed pipe diameter is the subscript for 20". The pipe can be c or sv, which means that they are or cemented or free hanging.

Anyway, that is why these methods of exploitation add an attribute to the controlled leaching. Otherwise, in case of loss of the hermetical, the term controlled would be relatively quickly transformed into uncontrolled leaching, whose catastrophic consequences are seen in the town of Tuzla.

Otherwise, it is necessary to find appropriate solutions that will restore the disrupted hermeticality and allow the excavation of salt reserves within dimensions of the designed chamber. According to previous experiences the most frequent loss of the wells hermetical wells happens in the area between the upper zone of salt layer (belt of the overlying safety plate of lower torton breccia where because of the above described, but also of other reasons can succumb fracturing (Figure 2 - Phase E).

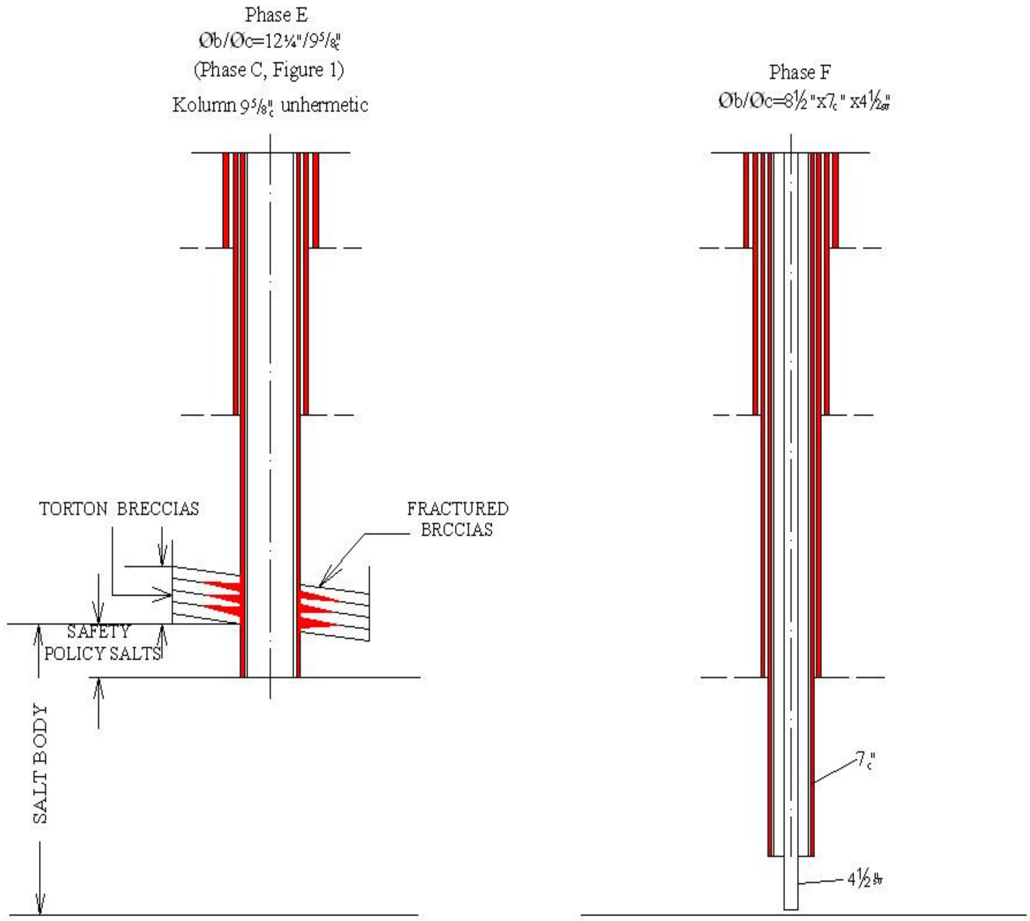

Figure 2. Construction repairing wells with not realized hermeticality.
Phase E: failed encapsulation of column $9^5/_8$ "because of fractured breccia.
Phase F: lowered and cemented a reparing column 7", and then lowered freely hanging column $4^1/_2$"

In the described case, we will continue to drill the wells with chisel of diameter $8^1/_2$" and in the wellbore install column tube with diameter of 7" at the proper depth for the application of alternative leaching methods with cemented column tube, after which the column 7" is cemented (Figure 2 - Phase F) and column of $4^1/_2$" down near to the bottom salt.

This is a method for the side-top leaching lower part of chamber and top exploitation of the chamber in bands with cutting cemented column 7".

Exploitation of salt by an alternative method using the repair construction is less productive but, for now, there is no other rational alternative [6,7,8].

CONCLUSION

The controlled leaching is characterized by safe control of the fluid flows (and balance) moving through the well and chamber during the leaching. When a unhermetic well must be used, one needs the repairing methods to restore lost hermeticality. In this case, we apply the repair method, as described in this work, which should enable the exploitation of the rock salt within the projected dimensions of the chamber.

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