CONSTRUCTION EXPERIENCES OF DEWATERING EQUIPMENT IN THE THOREZ MINE

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SUMMARY

Thorez mine of the Mátraalja Coalmining Company is the first modern high-capacity open-pit coal mine in Hungary. Its hydrogeology is greatly affected by sandy aquifers among coal seams. Consequently, aquifers in the advancing front line of the mine must be dewatered in order to assure the safety of mining machinery and slopes. In addition, piezometric head in the underlying layer must be reduced in order to prevent greater seepage flow and hydraulic soil failure. Large-scale dewatering activity has been going on over this area for some 20 years. The mining company has endeavoured to develop simple, minimum-cost and maximum-reliability dewatering system and the necessary equipment. Experiences on the construction of such equipment are briefly described.

INTRODUCTION

After hydrogeological exploration had been completed within the opening pit of the Thorez mine, dewatering started immediately and exploration continued outside the opening pit. That time /in the early sixties/, both exploration and dewatering were performed by contractors. However, by 1968, the company established its own drilling section; the number of its workers was about the same as now. From that time on, drilling, construction and repair of wells, and naturally dewatering itself have been performed by the company.

Intermediate dewatering as applied in the mine requires three kinds of wells: pumping well, intermediate well and observation well.

The construction of wells includes a number of special working phases, worth describing owing to geological conditions.

THE APPLIED DRILLING EQUIPMENT

G-100 - made in Hungary, self-propelled, applicable as deep as 100 m. Guaranteed initial drilling diameter is 175 mm and the final one is 86 mm. However, within the given depth limit drilling has been performed with an initial diameter of 317 mm and a final one of 295 mm. The equipment was used for drilling observation wells and intermediate wells, but as the drilling depth demand became greater than 100 m, only two sets of equipment were kept for changing submersible pumps and for well repair.

R-200 - made in Hungary, self-propelled, applicable as deep as 200 m. Gurarenteed initial and final drilling diameters are 335 and 145 mm resp. but within the depth limit of 150 mm drillings with initial and final diameters of 380 mm and 295 mm have been executed. The equipment is used for the drilling of observation wells, intermediate wells and well maintenance. The company has 6 such sets of equipment.

FA-12 - made in Rumania, non self-propelled but can be hauled, applicable as deep as 300 m. In contrast to the above equipment it has a converted flushing system. Guaranteed initial and final drilling diameters are 1016 and 444,5 mm resp. However, within a depth limit of 150 m, drillings with initial and final diameters of 1100 and 762 mm have been performed. Principally, this equipment is used for sinking pumped wells. Further availabe capacity is applied to drill intermediate wells.

THE SOLUTION OF DRILLING TECHNOLOGICAL PROBLEMS

From the beginning, it has been a serious problem how to drill through the andezite rubble of 2-10 m deep since rubble diameter has reached 300 mm and the average has been as high as 50-150 mm. Equipment G-100 and R-200 have been used with the following experiences:

-double core-barrel with geared bit: small diameter and small advancement, frequent rupture, borehole distortion;
-brace spoon bit: small advancement, frequent rupture;
- manual shaft sinking: small advancement, skilled labour requirement, accident hazard;
-three-wing bit with flushing: small advancement, frequent rupture;
- roller bit: advancement still small, /3-5 m/day/ due to small bottom loading, but less ruptures;
- roller bit with directly fitted short weighting rod according to depth: advancement three times higher, greater equipment survival time, more uniform borehole, decrease of failures.

Drilling equipment F-12 had to "combat" also in penetrating the rubble.

There was endeavour without success using the original step drill with left-side flushing.

Manual shaft sinking became necessary: slow and expensive.

An innovation resulted in introducing drum drillers of ø 1100 and 820 mm, with 2 and 4 edges, equipped with excavator teeth. Advancement became quite good in wet rubble layers.

An other innovation, the earth auger with 1 and 2 edges led to very good performance in dry clayey gravel.

The drum drill is connected with flange joint to the FA-rod, and has a guide spiral in its lower centre.

It is more advantageous to use larger, 2 edge drum drill in greater rubbles.

Drum drill of ø 419 mm can be used in equipment R-200 /ø 368 mm/ too in order to penetrate the dried-out fly-ash slurry.

Drum drill needs a shaft of about 0,5-0,7 m deep to keep space for it during lifting.

There is a plate under the installed drum drill for cuttings removal.

Earth auger is fitted with flange joint, also with a guide spiral in its centre.

A drawback of the single-edge drill is that the torsional load is unsymmetric and may lead to the distortion of the borehole.

Earth auger does not require any shaft due to the small height. It is cleaned above a plate located under it.

Rollers of the roller bit and cutters and excavator teeth of the drum drill and the earth auger have a hard-metal cover made earlier with Triamant, now with Diadur and Citadur.

It often happens over the area Keleti I that a clay layer with limestone rubble is located in depths 6-13 m under the rubble. As an effect of the mud, the lime is decomposing and the borehole starts to collapse. Often, it was impossible to drill as deep as 25-30 m, in front of the second pipe column, since borehole collapsed around 20 m.

As a result of technological changes every borehole could be drilled without disturbances.

Plan of drilling and tubing:

drill ø 1100, before tube ø 1000 under 6 m
drill ø 950, before tube ø 820 under 15 m
drill ø 762, before tube ø 720 under 30 m
drill ø 609 as deep as the bottom.

Penetration of soft bentonite clays by jumbo drill has often caused problems, since the drill sticks and reuqires new installation.

This problem was solved by so-called slip piping.

The innovation is the wing drill with several steps and 4 edges: good advancement, and sampling, sticking is minimal.

Collapsing of the rubble may cause also problems if there is no sufficient closing layer under the shoe of the standpipe.

Its principle is a fix ø 820 mm standpipe of 6-7 m, containing a ø 720 slip pipe of 6-7 m by giving a loose part of 5 m to strands.

During drill, the ø 720 pipe may slip as deep as 11-12 m, or as long as it sits on the top of a layer suitable to shoe placing.

As a result, the possibility of rubble collapsing behind the standpipe is eliminated since no cavern can be formed there.

Such a mud-technology has been sought which minimizes the pollution of the aquifers and still assures borehole stability. Simple and low-cost solutions were required. The mud-technology developed according to experiences is the simplest possible since no mud-forming material is used for right-flushing drilling equipment; drill starts using pure water. As a consequence of the upper clayey layers /20-30 m/, water becomes so muddy that must be exchanged. In left-flushing equipment, flushing water flows down along borehole wall and breaks it. Consequently, weak mud bentonite and clay is used for the upper 20-30 m, then the standpipe is placed and clean water is applied further on. Borehole stability depends on time: drilling time of a 150 m deep borehole is about 2 days. There is no borehole collapsing during that period under the above technology.

WELL CONSTRUCTION TECHNOLOGY

Well construction technology utilized, evidently, the general practice of water well sinking but the main differences between the functions of the wells had to be accounted for.

A water-supply well aims at yielding a safe uniform flow for a long time. Design flow is generally some 60 % of the total discharge.

Our dewatering wells aim at the dewatering of a given area with maximum drawdown, during the shortest time using the smallest number of wells /min.-cost/.

A relatively early decision was possible on well materials:
- within the mining area, PVC pipes /removable during mining/, outside of it, steel pipes are used;
- filtered pipe has 20 % of perforation made by drilling machine in the workshop;
- screening cloth and gravel fill are jointly applied;
- screening cloth is made of perlone, sieve size depends on soil particle sizes /0,58/0,3; 0,63/0,3; 0,8/0,4; 1,25/0,5, where the first number is the mesh spacing and the second one is fiber thickness in mm/;
- particle size of the filter gravel is 4-8 mm.

After well drilling immediately, geophysical measurements are performed in order to determine well structure in-situ and to make mining production exploration.

The first step of well construction is to install filter section. Steel pipes are join by in-situ welding, the ends of PVC pipes are bulged in the workshop and fixed together in-situ by 4 screws.

In the second step, muddy water from the borehole and some mud from the wall is removed.

Drilling with right-side and left-side flushing is performed in different ways:

- In case of right-side flushing, installed filter is washed with clean water from up to down by the help of the generally known washing-head. If this reaches the bottom, graveling starts, and simultaneously, washing is continued from down to up and arrives to the surface when graveling is terminated.

- In case of left-side flushing, pipes for both producing and air are built into the filter section and clean water is directed into the borehole. Mammoth pumping is performed by a discharge corresponding to clean water supply.

This method doesn't prevent wall collapsing. The operation terminates when clean water can be found where earlier mud was located. Then, graveling is performed from the bottom to the surface.

This simple method of graveling has been preceded by a number of experiences on other methods known from literature.

The next step of well construction is cleaning pumping by mammoth pump. Producing pipe is located always 0,5-1,0 m above the bottom. Air pipe is placed to a depth corresponding to 1,5 times of water depth. Then, both producing and air pipes are lifted by 6-8 m and the compressor is started. After the start, both pipes are gradually returned to their original place.

After cleaning, air pipes are extended according to the pipe length of 6 m. The degree of this extension depends on compressor capacity. Pumping is drastically effected: frequent starting and stopping. As a consequence, greater operational discharge can be attained in the wells by the help of submergible pumps, than the maximum discharge of cleaning pumping. There are wells still in operation where the above figures are 1,5 m^3/min and 0,6 m^3/min resp.

During cleaning pumping, drilling equipment is not located on the well. After building-in producing and air pipes, and initiating the first step of pumping, drilling equipment starts another drilling. A special auxiliary machine performs air pipe joints and the installation of producing and air pipes.

The efficiency of well construction and maintenance has been increased by a number of special tools and processes developed by the workers of the company.

In addition to the above experiences on well construction and maintenance, operation experiences are also available.

The following experiences have been observed during the steady operation of dewatering wells located along the mining boundary of the Thorez mine.

There is smaller discharge of wells located subsequently in the depression zone of pumped wells constructed about simultaneously and operated for several years, as compared to the discharge of steadily operated wells. This phenomena can be observed at the double well rows along the western boundary of pit K-1. The distance between these two rows, K-17 and K-18, is 30-60 m. Well spacing within the rows is 80 m, on the average. Due to technological reasons, a new well 17/30 A was sunk with a discharge 120 l/min as compared to the average 340 l/min.

Originally, a well row K-19 of 90 m spacing protected the North-East boundary of pit K-I. As a consequence of geo-hydrological anomalies over one part of this mining area it became necessary to build a parallel row of wells between wells 19-25. The distance between these two rows was 90 m and the discharge of wells from the new row was only 60 % of the original wells.

These experiences are reflected in the following specific discharge data.

Specific discharge of rows of wells
1/min/well

Year	K-17	K-18	K-19	K-19/A
1978	323	225	-	-
1979	343	338	1	85
1980	338	337	127	84
1981	353	366	149	98
Average:	340	344	157	90

The above data show that specific discharges of rows K-17 and K-18 simultaneously constructed and parallel operated are similar with small changes. Considerably smaller discharges have been observed in wells K-19, K-19/A, built several years later.

The possible explanation is that the flow net developed in the aquifers during several years of operation, subsequently cannot be locally changed.

Another observation is that new cleaning pumping is necessary in wells not operating for a longer period /0,5-1 year/ after well construction and cleaning. If there is no subsequent cleaning pumping, the steady discharge will be lower than expected, or high sediment inflow may result in frequent change of submergible pumps.

This phenomena was observed at the western terminal row of wells, K-59 of mining pit K-II. These wells were constructed in the third part of 1979, and operation started in the first part of 1980. Though all wells were cleaned after construction by the same technology, one part of the wells had to be cleaned again before operation.

This phenomena may be caused by the great variability of local hydrogeological conditions, and the secondary change of aquifer structure due to cleaning pumping.

Further operational experiences of dewatering activity could be mentioned here, only the most significant ones were described. These experiences may not say much for others, but it is of high importance for us to work by utilizing practical observations in order to perform dewatering efficiently, under minimum ocst.