DEVELOPMENT AND OPTIMISATION OF THE TECHNOLOGY FOR THE VELENJE COAL MINE DEWATERING SYSTEM

ŽELJKO VUKELIČ, Podjetje za geotehnična dela, Letališka 27, 1000 Ljubljana, Slovenia

ABSTRACT

In coal extraction, we encounter problems associated with safe and economical excavation under water-bearing strata. Appropriate technologic arrangements of dewatering, either surface-based or pit-based, can decisively contribute to both of the above aspects. Today, dewatering schemes employing surface dewatering facilities - wells, solve effectively the problems of safe excavation of coal under water-bearing strata. The construction of surface wells is relatively simple and does not require any special technological procedures.

In the area of dewatering the water-bearing strata above the coal layer, we are witnessing the ascent of popularity of the technology of construction of vertical or inclined impress filters from inside the mining pit. The impress filters are drilled into the shaft ceiling or floor. The impress filters are designated either as the primary dewatering facilities, secondary facilities (dewatering of specific segments of the water-bearing strata), or as the observation wells - piezometers. The construction of impress filters starting from the mining shafts is considerably cheaper than the construction of the surface-based wells, since the impress filters are much shorter. However, the construction of impress filters requires special technological procedures in the cases of drilling through strata under high porous pressure (exceeding 20 bar). The paper thus primarily discusses the technology of the construction of impress filters. The accurate and reliable construction of impress filters in the pit of the Velenje coal mine, in association with the surface wells, provides the optimum method of dewatering of the water-bearing strata above the coal layer.

INTRODUCTION

My research work thus far, in the framework of research projects in Slovene coal mines, has been focused primarily on devising optimal novel solutions in the area of the technology of drilling and equipping of impress filters, to function either as primary, secondary or observation dewatering facilities. The technologies known to date in drilling and equipping of impress filters have failed to ensure the absolutely safe and effective construction of impress filters in all cases where the drilling is performed through water-bearing strata exhibiting high porous pressure. In the Velenje coal mine, I have developed a method of drilling and equipping of impress filters which guarantees absolutely reliable and safe construction. The technology so developed, is based on:

- drilling with technical columns, which are then cemented;
- drilling with the filter structure itself.

MECHANICAL AND HYDROGEOLOGICAL CHARACTERISTICS OF THE VELENJE COAL MINE STRATA

In the Velenje coal mine, the lignite layer is covered with Pliocene sediments, of which a layer of marl, clay or clay-stone is directly in contact with the lignite, while the strata higher above comprises water-bearing sands of various permeabilities. The clay layer is called the insulation layer, since it protects pit cavities, and most of all, excavation cavities, from the influx of water from the sands in the hanging walls.

In the north-western and the central part of the Preloge pit, as well as in the prevailing part of the Šoštanj pit, the thickness of the insulation layer ranges from 3 m to 20 m. In addition to the hanging wall sands, water-bearing sands of low permeability are found in the lignite layer at the extreme western tip of the north-western section of the Preloge pit. The water pressure in the latter layers may reach 40 bar. These sands are inter-layer sands. And, in some sections of the Šoštanj pit, sandy materials are also found in the foot wall strata.

Towards the foot wall, the coal gradually changes to low grade coal, further on, inserts of tailings begin to emerge, in the main, clay, silt-stones and clay-stones, green or grey types, with sand inserts. The direct foot wall layer is composed of green clay, silt and sand, and only occasionally, sand-stone or conglomerates are encountered.

In the north-western part of the Škale pit, the lignite layer lies, in part, directly in contact with the Triassic dolomite water-bearing layer. The dolomite is characterised by crack-based and carstic porosity. As a result of tectonic activities, dolomite is, in spots, cracked and crushed. The cracks are usually filled with grey clay and carbonate inserts.

As regards drilling, the Velenje coal mine strata are mechanically easy to smash. The geological cross-section of the coal-bearing strata of the Velenje coal mine is presented in Figure 1.

Water-bearing sands, suitable for dewatering, are of relatively low permeability, both in the hanging and the foot walls. The coefficient of permeability is $k = 10^{-6}$ to 10^{-7} m/s. From the point of view of hydrogeology, these sands are considered as semi-permeable, which means that they belong to the lower limit class of materials capable of gravitational dewatering.

In the hanging wall water-bearing sands pressures of up to 20 bar may be expected in the locations of planned impress filters due to the dewatering by means of hanging filters (wells). Higher pressures may be encountered, in exceptional cases, in the sand sections, which are not part of the Velenje coal mine dewatering system. Separation of the CO_2 and CH_4 gases also takes place from the hanging strata waters, but not to the extent of provoking gas eruptions.

In the initial phase, prior to their partial dewatering, a maximum hydrostatic pressure of 45 bar may be expected in inter-layer sands. Also, the separation of CO_2 and CH_4 is more agile in these layers. A similar situation is encountered in the foot wall water-bearing strata of the Šoštanj pit.

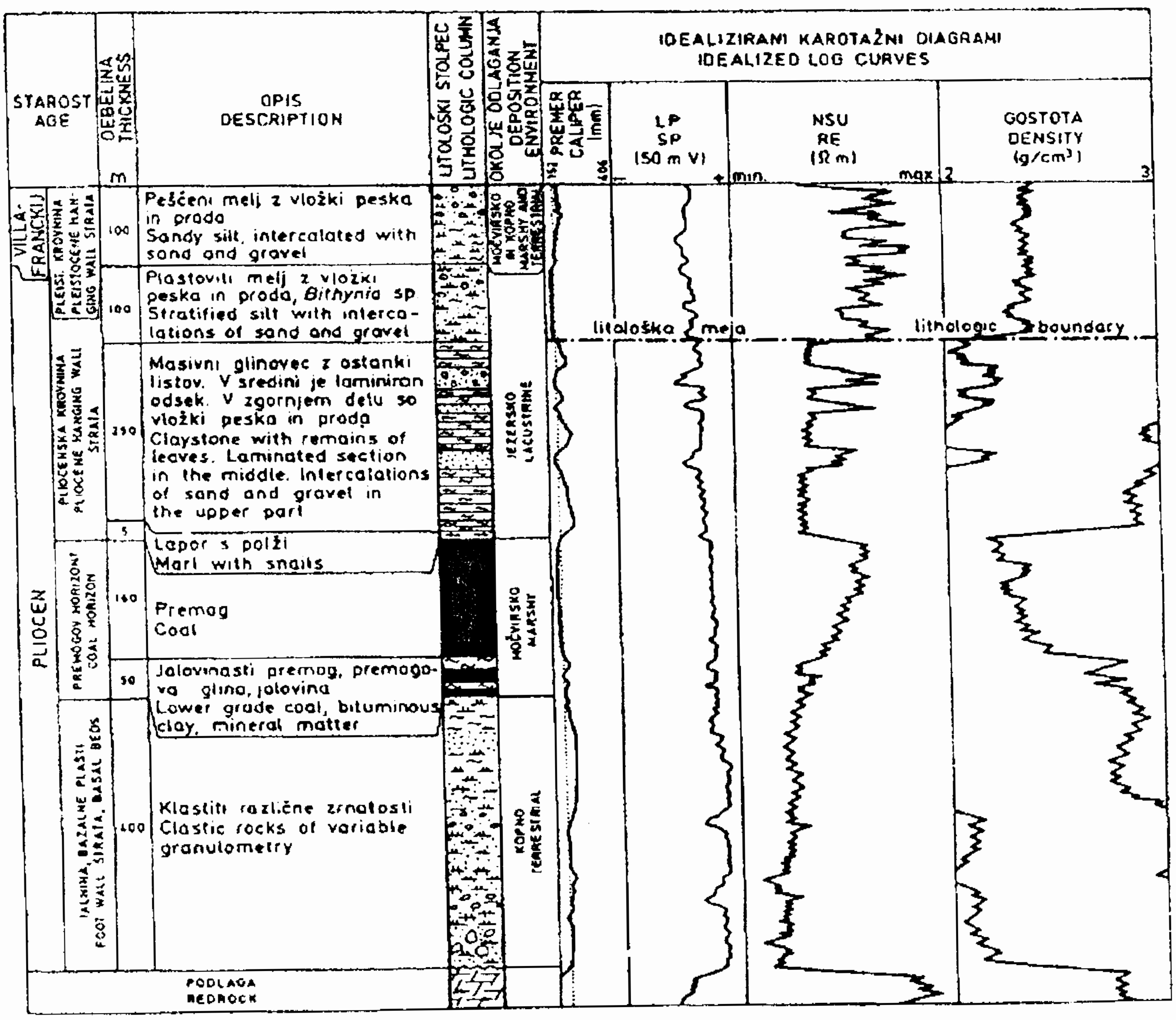
In the foot wall strata of the Škale pit, which are hydraulically connected to a partially dewatered triadic foundation, one can expect pressures below 10 bar, small quantities of water, and negligible CO_2 and CH_4 water content. However, one has to be aware of the presence of H_2S.

Figure 1. Geological column of the Velenje coal-bearing strata

TECHNOLOGY OF IMPRESS FILTER CONSTRUCTION IN THE WATER-BEARING STRATA EXHIBITING HIGH POROUS PRESSURE

The conventional methods of construction of impress filters, whereas, initially, a bore is drilled, and subsequently, the filter structure is embedded, do not ensure reliable construction of the impress filter in strata exhibiting high porous pressures. Frequently, drill pipes or the filter structure become stuck

Figure 1. Geological column of the Velenje coal-bearing strata



within the bore. Let me point out, once again, that the technology of the construction of an impress filter, which I have developed is based, primarily, on:

- drilling with technical columns, which are then cemented;
- drilling with the filter structure itself.

The drilling of the bore lid is performed with a chisel of a 76 mm diameter, and a drill bit of a 360 mm diameter. We drill to a depth of 0.5 m. In this manner, we ensure adequate space to accommodate the bore lid equipment, which, in turn, ensures safety and efficiency of work in the subsequent phases of impress filter construction.

After completing the drilling of the bore lid, we start drilling for the initial column of protection pipes, to a depth of approximately 12 m. Depending on the mineralogical and geological conditions drilling can be performed employing one of the following three methods:

1. drilling with a 76 mm diameter chisel, followed by reaming with a 163 mm diameter drill bit;
2. drilling with a 76 mm diameter chisel and a 163 mm diameter drill bit; or
3. drilling with the initial column of a 143 mm diameter (drill bit of diameter 163 mm).

Table 1. Methods of drilling for the initial column of protection pipes

DRILLING METHOD	∅ drilling (mm)	∅ reaming (mm)	∅ piping (mm)
1	76	163	143
2	76/163		143
3	163		143

A polymer rinsing medium is applied during drilling. Upon completing the drilling to the set depth, we install the initial column of protective pipes into the bore. In the first and second method of construction, we equip the initial column with the flange and the seal, and then perform the cementing, applying cement milk or a suitable injection medium. After cementing, we perform a pressure check of the initial column of protective pipes. If the pressure check results indicate that the criteria of safe operation will not be met, the cementing procedure is repeated.

In case of the third method of construction, we begin cementing immediately upon attaining the set depth of drilling, since the protective pipes are already in the bore. Cementing is performed in the same manner as in the above two cases.

Prior to drilling for the technical column of protective pipes, we have to equip the initial column of protective pipes (i.e., the bore lid) with the technical column brake, gate valve, ball valve and drain. The bore lid so equipped guarantees absolute safety of subsequent operations. During drilling, the rinsing medium can be injected directly through the technical column, or, alternatively, indirectly, alongside the technical column, depending on conditions within the bore.

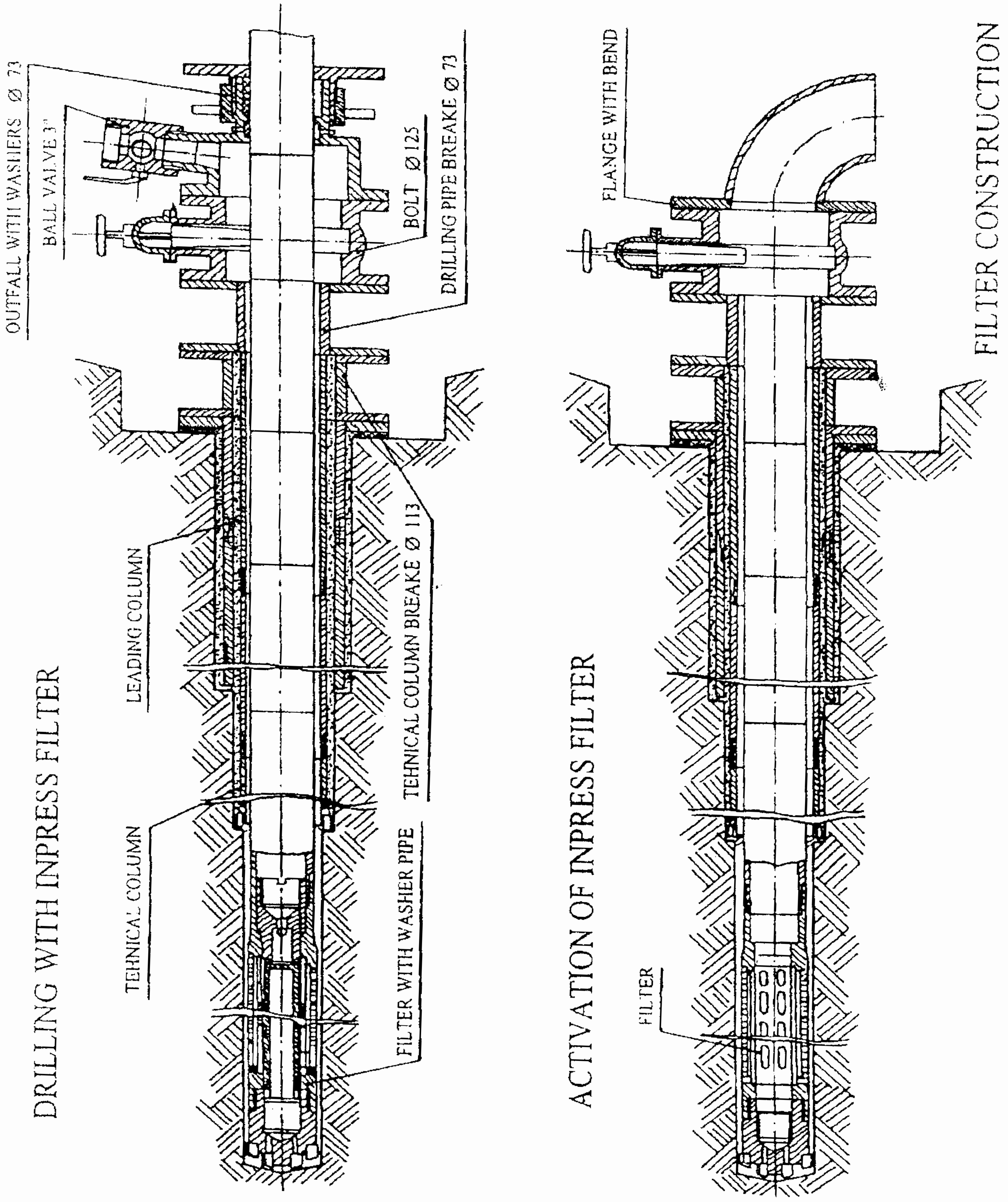
The drilling is performed employing a 116/113 mm diameter extended profile drill bit, and a 96 mm diameter chisel, which is retracted from the bore after the drilling is finished. In this case, the diameter of the technical column of protective pipes is 113 mm. This method of drilling ensures high reliability, since the protective pipes are employed for drilling. In the contrary, i.e., when the drill pipes are employed, the bore is lost if the drill pipes get stuck in it, since the drill pipes cannot be retracted from it. On the contrary, when employing protective pipes for drilling the bore is not necessarily lost when the drill pipes are stuck. We retract the 96 mm chisel from the bore and proceed drilling, either with a technical column of a smaller diameter, or, with the filter structure. If, during drilling, we penetrate a water-bearing stratum with the technical column, outflow of water is controlled since the bore lid is suitably equipped.

Upon reaching the desired depth of drilling with the technical column of protective pipes, we retract the 96 mm diameter chisel and start cementing the technical column. The cementing is performed either with cement milk or with a suitable injection medium. When the cementing is finished, the bore is ready for drilling with the filter structure.

Prior to drilling with the impress filter, we equip the bore lid with the drill pipe brake, gate valve, ball valve and drain. The diameter of the filter structure is 73 mm, while the diameter of the drill bit is 76 mm. The filter, 1.5 m in length, is equipped with an internal sealing tube, which prevents the leakage of the rinsing medium through the filter (Figure 2). Thus, the rinsing medium flows directly through the drill bit, and in this way provides effective rinsing of the bore and the overcoming of high porous pressures in the water-bearing stratum. During drilling with the filter structure, the rinsing medium pressure slightly exceeds the porous pressure in the environment stratum, so as to ensure efficient filter penetration through the water-bearing strata.

When the filter reaches the desired depth, we retract the sealing internal tube from it, by means of special pipes, and activate the filter. If required, the filter part can be chemically treated with an acid, to decompose the remaining polymer rinsing medium.

Figure 2. The impress filter design



CONCLUSION

All the impress filters constructed thus far in the Velenje coal mine, have been installed in a perfectly safe manner, and did not pose any technological problems during construction. The impress filters have been installed in the upward vertical direction into water-bearing sands. The lengths of the impress filters range from 30 module to 70 m, and the flow rates even reach 300 l/min. The maximum porous pressures are 40 bar. Thus, I feel confident to state that significant technological progress has been accomplished in the construction of this type of dewatering facility. As an addition to the method of dewatering of water-bearing sands above the coal layer by draining wells, already in place in the Velenje coal mine, a reliable technology of constructing impress filters clearly represents a contribution to the optimisation of dewatering, both in terms of technology and cost.

The currently available capacity of drilling equipment supports the construction of impress filters up to a depth of 100 m in the upward vertical direction.

REFERENCES

1. Veselič M. Vtisni filter za odvodnjevanje vodonosnih plasti v jamah Rudnika lignita Velenje. Št. proj.: RP-382/87. Jamomersko-hidrogeološka služba RLV. Velenje (1987).
2. Brezigar A. Premogova plast Rudnika lignita Velenje. Geologija-razprave in poročila 28/29. knjiga. 319-336 (1987).
3. Fletcher G. Groundwater and wells. Johnson Division. St. Paul. Minesota (1986).