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WATER: ONE OF MANKIND'S MOST VALUABLE COMMODITIES

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WATER - ONE OF LIFE'S ESSENTIALS

There are three basic essentials for human life:

- o Water
- o Food
- o Oxygen

Some purists would add clothing to the list but the natives of Southern Patagonia, who were hunted to extinction, survived in a cold climate without any clothing other than a liberal coating of dirt!

Most of us take for granted that we should have copious quantities of potable water freely available to meet our needs.

Water as a basic essential for life was brought home to me in the mid-sixties while working at a mine in the Sinai desert. At the end of the working shift underground, where water for dust suppression was a luxury no one dare even suggest, one was

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invariably black from head to foot with coal dust. During the early stages of the project we were rationed to two pints of water for bathing. The contortions required to cover one's body with lather and rinse down are too intricate to briefly describe. Suffice to say that taking a bath on monthly visits to Cairo was a luxury greatly looked forward too. On one occasion I stayed overnight at the Desert Reclamation Institute guest house at El Arish. My first act was to step under a shower covering myself from head to foot with luxuriant lather. The water supply then failed. After spending the next 13 hours in account of dried soap suds I began to appreciate the essential role of water to mankind.

At the same mine one of the exploratory boreholes started to outflow with air. Once the drilling mud had been washed out bright clear water flowed. The source of water was quite deep and was unlikely to be contaminated with any harmful bacteria. To create confidence in the use of this water and to show it potable I drank a glassful in front of an audience of our Upper Nile miners. All were experienced desert men. Not unexpectedly it was slightly saline since most desert waters contain mineral salts. Drinking the water was greeted with great hilarity by the miners, so I drank a second and third glassful to show I was in earnest. The next day I discovered the reason for hilarity. The water contained magnesium salts, sold by pharmacists as "Epsom Salts"! We decided to restrict the use of this water to supplying showers. A lather could just be obtained by using sea water soap and one's hair literally stood on end after washing.

THE PROBLEMS OF MINING ENGINEERS

To the mining engineer water invariably means increased cost and possibly danger. The western outcrop of the Durham coalfield, possibly the site of Britain's earliest worked coal mines, had many depleted areas long before accurate abandonment plans were a statutory requirement. In later years inundations were not infrequent, often involving serious loss of life. I have in my possession a gold medal presented to my grandfather, then a colliery overman, inscribed "R. Atkinson, Sacristan Inundation, 16 November 1903". This incident caused tragic loss of life and many acts of great bravery occurred. The colliery however was saved and my grandfather, my father and I were able to earn our living there.

Management of water inflow to mines and the avoidance of inundation is a vital duty of mine managers. In years gone by it was said that mining men from West Durham were born with webbed feet. This may be an exaggeration but certainly mining engineers have an acute awareness of the serious threat that water poses to the lives of those from whom we are responsible and their economic well-being. The presence of water creates a range of problems from lowering of the worker's morale to enforced abandonment of the whole of a mine with serious loss of life.

Inundation by water or other fluid material into mine workings has in the past been responsible for a large number of deaths and is a major mining hazard. It is relevant to list a few incidents of inundations:

West Driefontain Gold Mine, South Africa

26 October, 1968. No lives lost. The inundation was preceded by the occurrence of a number of large "sinkholes" caused by the dewatering of cavernous dolomite due to the pumping from the mine. In December 1962 much of the surface installation at West Driefontein disappeared into a huge sinkhole with the loss of 29 lives. On 26 October 1968 an inundation demonstrated the terrible power of water. The rush of water down the shafts sucked the air out of some workings to create vacuums. Fierce air currents over 200 km/h followed as the vacuums were filled. There were no casualties, but water continued to flow at up to 100 million gallons per day. The inrush occurred after workings penetrated an impervious vertical dyke of 50 m thickness. The water table in the "compartment" on the other side of the dyke was considerably higher than in the mined area which had been continuously pumped. Inrush was effectively stopped off by dams constructed on two levels. An estimated inflow of 386000 cubic metres per day had to be dealt with. In human terms it was an epic of courage, skill and endurance. Man faced danger every minute of the protracted struggle as they worked., often waist deep in water, moving materials through the fast flowing water to where they were needed. That there was no loss of life is testimony to the professionalism of all concerned.

Ridding Colliery Falkirk, Stirlingshire

25th September, 1923. 40 Lives lost. The inundation occurred due to failure of a dyke which had previously being considered impervious. Old workings on the other side of the dyke had been full of water since about 1873 and the abandonment plans did not accurately reflect the situation in the vicinity of the dyke. Apart from drowning, some men were suffocated by black damp from the old workings.

Montagu Colliery, Scotswood, Northumberland

30th of March, 1925. 38 lives lost. Many years previously a neighbouring colliery had encroached on the Montagu take. Montagu colliery workings were 86 m from the boundary and they were proposing to leave a 37 m barrier, when the inundation occurred. The miners complained about the smell of the water prior to inundation and again some men suffocated from black damp.

Lofthouse Colliery, Yorkshire

21st March 1973 7 lives lost. Previously unknown old workings were intersected resulting in violent inundation. The violence of inrush was due to the pressure head caused by old shafts. Again miners complained of the smell of the water prior to inundation.

Ackton Hall, Yorkshire

7th April 1968 (Sunday). 1 Life lost. Inflow of shaft backfill, described as mud accrued. It flowed through stoppings at several inset levels into the workings. Four men were trapped in the pit bottom office, the surviving by holding their heads above the inflow material. The use of granular fill for shaft fill, which subsequently becomes saturated with water, produces a higher pressure on stoppings than a column of water of the same height.

Knockshinnoch Castle Colliery, Ayrshire

7th September, 1950. 13 lives lost. 116 rescued three days later. An inrush of peat or moss occurred from the surface into a heading rasing at 1 in 2 to the surface. The inundation cut off the two egress routes and a spectacular rescue was achieved through gas contaminated roadway of a neighbouring mine using breathing apparatus. The initiation of the inrush was through a rock fall following heavy rain. Geological data had not been transferred onto the mine plan and unchecked, inaccurate surveying had accrued.

Mufulira Copper Mine Zambia

25th September, 1970. 89 Lives lost. Caving over stopped areas produced a sink hole of 320 m diameter by 15 m deep on the surface under a tailings dump which caused an inrush of material at a point 500 m below the surface. This caused all parts of the mine below the 700 m level to be flooded. The estimated inflow was 708000 cubic metres of which 225000 cubic metres was unaccounted for. Much of the mine was recovered and restored to production.

This is a limited list of inundations but it illustrates the potential hazard of water to mining operations.

WATER MANAGEMENTS IN MINES

Water managements is of vital importance to the mining engineer. Flexibility in the operation of pumping systems is mandatory. Such systems seek to provide:

1- Adequate spare pumping capacity

2- Several Main sumps

3- Depleted workings to the dip, which in conjunction with two may provide temporary effective safeguard in the event of an inrush

4- The use of 2 and 3 to utilise the economic benefits of off-peak power (although this is becoming increasingly difficult with modern mining systems.

5- Spare pumping capacity can be expensive in capital cost and the facilities for rapid installation of suitable pump s in the event of an emergency may be advantageous. This could include arrangements for lowering multi-stage submersible pumps into shafts used as sumps.

The pipe reticulation in mine pumping systems invariably costs more than the pump installation. The major savings can be made by optimization of the total installation rather than considering different items in isolation. This is an aspect of pumps and pumping that is somewhat is neglected.

The speed and violence of occurrence of water inrushes usually prevents any corrective action being taken in the immediate vicinity of the inrush. Without carefully planned precautions the task of retrieval can be formidable. Each station is likely to be different but generally the following procedures are essential:

1- Put into operation a previously prepared emergency plan. The first step is to establish the nature of the incident and the lives at risk

2- To withdraw personnel from the other districts likely to be affected.

3- To ensure all the installed pumping capacity is operating effectively and to formulate rescue plans if some men are trapped.

4 - Install additional pumping capacity as quickly as possible and arrange for increased power supplies.

5- Attempt to determine the source and nature of the inrush, its capacity and driving head, and draw up immediate and long term plans to retrieve the situation.

6- After this point each incident will probably be very different in detail but two main courses of action must be considered, (i) to attempt to restrict the inflow at the source by pumping from adjacent mines, from large diameter surface boreholes, etc usually involving heavy spending or (ii) at suitable locations construct permanent underground dams to seal the inflow. This usually involves placing puffer dams with by-pass drain pipes up-flow from the site of the permanent dam suite and pressure grouting the rock surrounding the dam.

The risk of water inrush to lives and property in underground mining is self-evident but it is equally self-evident that good mining practice can eliminate disastrous occurrences.

WATER IN SURFACE MINING

It is not just in underground mining that water management is important. Obviously surface run-off due to precipitation can reduce surface mining efficiency but groundwater can pose greater problems. Some of the open-cut, brown coal mines of the Rhineland pump 70 tonnes of water for every tonne of brown coal produced. This is required to drain the overburden so that mining operations can proceed efficiently.

At the Neyveli lignite mine in South India we had a lesser problem with only 33 tonnes of water to be pumped for every tonne of lignite produced. The requirement was not that of lowering the surface of the water table to drain the overburden but to lower the piezometric surface of a confined sub-artesian aquifer beneath the lignite seam. The aquifer is prolific and extensive, its recharge area being some 130 km away in the Western Ghats. It is recovery rate is such that in the event of the submersible borehole pumps stopping due to a power failure the mine would flood within 35 minutes. A total of 314182 tonnes of water per day (48000 gallons per minute) must be continuously pumped on a 24 hour/day, 365 day/year basis. The pumping system must advance as the mining advances. A new pump well for a 1000 gallon/min pump must be drilled, developed, equipped and fitted while a redundant well must be stripped., the casing and screen withdraw, every four weeks. Automatically started, stand-by, diesel driven, electric power supplies of 8 MW capacity must be available at all times. Overall the water management system is a sophisticated engineering operation requiring the highest levels of managerial and technical skills. It is the major cost centre in the mine operation.

In the early days it was thought that this would be a water-disposal problem but with the development of a large thermal power station, fertiliser and carbonization plants, a ceramics units utilizing kaolin from the overburden, and a town of 40000 inhabitants, the management now complain that the pumping system (designed to protect the mine) is inadequate for the industrial complex!.

CONCLUSIONS

Water can mean many different things to different people. As an essential of life it is taken for granted., but to the mining engineer it can be a serious hazard a costly item in production. We can not afford to take it granted. It must involve us in fundamental engineering/economic studies to achieve optimal operations and is an area we can not afford to neglect.