Problems Encountered in Dewatering a Nigerian Coal Mine

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ABSTRACT

The only functional underground Coal Mine in Nigeria is located in Enugu in Anambra State. For some years now the mine has been beset with a perenial problem of flooding. This has hampered production and some time ago the mine was abandoned. Recently money and equipment were made available to reactivate the mine. Attempts are now made to increase production as it is very much below demand. However, there are problems as the mine is below the water table under some major rivers and any advance exposes men and equipment to water surge. The paper traces the different attempts made to dewater the mine and the problems encountered in producing coal in this mine.

INTRODUCTION

Coal was discovered in Nigeria in 1909 by a team of European explorers on their way down the Nsukka-Enugu-Awgu-Okigwe escarpment (1). The first drift was opened in 1919 at Obwetti-Enugu under the then Nigeria Collieries. The history of early coal mining in Nigeria is replete with accounts of crudeness of operation. Initially the Coal Industry and the Nigerian Railways were jointly managed. In 1950 the government instituted an ordinance empowering the Nigerian Coal Corporation to win Coal in the Country.

NIGERIAN COAL CORPORATION UNDERGROUND OUTPUT

The early coal production was by pick and axe. In 1916 production was 24,000 tonnes. As a result of demand in coal by the power plants and the Nigerian Railway Corporation production increased to over one million tonnes by 1950. This boom did not continue because of the change from coal to deisel by the Nigerian Railway Corporation and to oil by power plants. The collieries were shut down between 1967 and 1970 during the Nigerian Crisis. When hostilities ceased in 1970, the mines were reactivated and production started. Annual production rate from 1973 to 1984 is shown in Table 1. Production has declined since 1973 and in an attempt to boost production the Nigerian Government asked a Polish firm KOPEX to mechanise the coal faces in Enugu.

TABLE 1: ANNUAL PRODUCTION FROM ENUGU MINES (2)

Year	Production (metric Tones)	Year	Production (Metric Tones)
1973	323,000	1979	162,000
1974	250,769	1980	153,005
1975	257,832	1981	114,875
1976	249,446	1982	48,916
1977	246,190	1983	49,488
1978	188,806	1984	85,606

The impact of mechanization since 1978 has not been felt as flooding has made it impossible for management to meet the initial objective of increased production. The mechanized longwall face has been abandoned and the area sealed off. The objective of this paper is to highlight the methods used in dewatering the mine.

GEOLOGY OF NIGERIAN COAL

The Nigerian Coal field covers an extensive area of the Eastern and Northern parts of the country. The coal was probably formed during the Cretaceous Era about one hundred and twenty million years ago by the action of heat and pressure on decayed vegetation. For many years plants grew and died, fell into shallow waters thus preserved against complete decay. The plant debris called "peat" accumulated in some places until it was many metres thick.

Clays, sands and mud containing sea shells were then deposited upon this organic matter. The sediments became the shales, sandstones and limestones that are above the coal seams. The peat was compacted which during metamorphosis became dense and gradually was converted to coal. Most of the coal formed is bituminous.

There are three important formations in the Nigerian coal field. These are: Lower coal measures, False-bedded sandstone and Upper coal measures (3). The Lower Coal measures is the oldest formation in the coal fields, the False-bedded sandstones is the next and is the main aquifer in Onyeama mine and contributes nearly all the groundwater entering the Enugu coal mines. The material here is unconsolidated. The upper coal measures lie above the second formation. The rocks consist of an alternating successions of sandstone, dark shale and sandy shale with coal seams of various horizons.

In the Nigerian coal fields the seams are numbered for identification purposes from 1 - 5 counting from the bottom.

The Coal seam, No 3 is the thickest, the thickness varies from one metre to two metres This is the one currently exploited and it occurs in the Lower coal measures. Other seams Nos 2 to 4 are also known to be in this Formation. The Nigerian Coal is mined at a depth of about 100m to 150metres below ground level.

CAUSES OF FLOODING IN ONYEAMA MINE

Water encountered in Enugu coal mine comes from different sources. These are discussed below:

1. Climate

Onyeama mine is in Enugu located in the Southern part of the country. This is in the Forest Region and the rains are heavy (about 189.5cm) during the rainy season from March to October. The heavy rains flood the rivers and streams where the mine is located. This invariably enters the mine through the weak strata overlaying the mine. Evaporation is about 72.4cm which is lower than the rate in the North. The accumulated water from rainfall is noticeable as the mine is heavily flooded during this time. Also during the rainy season water enters directly through the tunnel.

2. Location of Mine below Groundwater Table

Enugu coal mine is below the water table. The initial tunnel driven here is below the water table. Figures I and II show the relative position of the mine to the rivers and hills in the area.

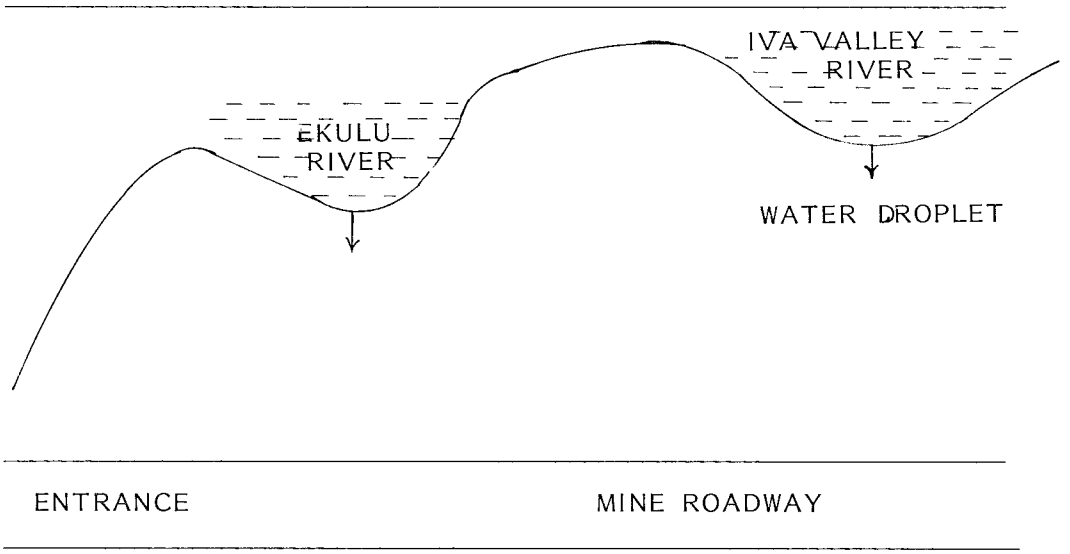

FIGURE 1: RELATIVE POSITION OF ONYEAMA MINE TO EKULU IVA - VALLEY RIVERS

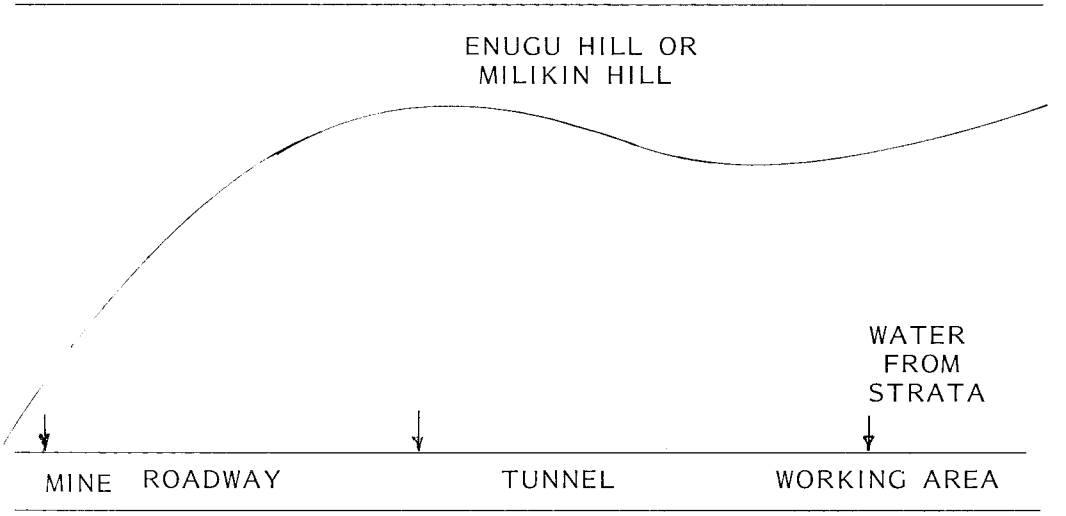

FIGURE 2: RELATIVE POSITION OF ONYEAMA MINE TO ENUGU HILL

Water enters the mine through structural discontinuities such as faults and fractures. The mechanized Onyeama mine occupies the Iva-Valley and Ekulu Rivers. The drainage area of the two Rivers is about 40 square kilometers. Ekulu River is fed by several small youthful tributaries like the Iyiofie and Iyiaku rising from the face of the escarpment and the flow is eastward where there is a meeting point with the Nyaba River.

3. Other Sources of Water

Water sometimes finds its way into the mine from adjoining workings by seeping underneath the barrier pillars or workings. When a new area is exploited and broken, large quantities of water contained in the overlaying strata and surface springs are released. The released water is difficult to pump out or contend with.

The whole strata above the coal seam at Enugu is saturated with water. As the coal is exploited the shale above the coal allows flow of water easily. Since the rocks are porous the rate of permeability is very high. If the rate is not checked flooding of the face is often the case. Other sources are from broken pipes and pumps, and from the faults in the vicinity of the mine. In one instance it was found that water was literally raining down from the roof of the mine at a rate estimated to be about 25,000 gpd.

DEWATERING PRACTICE IN ONYEAMA MINE

Pumping of water in Onyeama mine is via pipes. The choice of pumps in dealing with the water is viewed as follows: (a) Pumps that can handle the acidic water of the mine to avoid corrosion (b) Pumps that can handle the large quantity of water in the mine and (c) Pumps that can handle variable heads of water versus large quantity of water. It is not possible to adhere to the above because of financial and technical conditions.

The different pumps currently in use are:

Mono Pumps

These pumps are used to pump mouldy and contaminated water. The normal speeds of rotation adopted are 960 and 1450 rev/min. Depending on the stages of the pumps they are suitable for heads up to 150ft. For higher, the rotor and starter lengths are increased. Thus a two stage mono pump is suitable for heads up to 300ft. Capacities of the different models available vary from 500 to 1,000 gal/min. requiring horse power of 15 to 30 respectively with 30 to 65ft heads.

Flight Pumps

These are light and portable rotodynamic pumps and are electrically driven. They are designed mainly for draining the faces where they are actually used in Onyeama mine. Such pumps are used for pumping water which is either clear or with very little impurities. Flight pumps are submersible with 50 HP and delivery capacity of about 50 to 100 gal/min.

Dewatering Pump Room

Water is pumped from the working faces either by the flight pumps or from the natural inflows into the auxillary dewatering pump rooms (usually temporal sumps), which are always designed for two pumps. From here the water is delivered to the main pump house where there are large pumps of high head and capacity. The main sump of the Onyeama mine is located in the 1 North lateral and the pump house is designed to have a total pumping capacity of 21.6m^3/min while the auxillary sumps are planned to handle 4.05m^3/min. The capacity of each is about 720m^3 and is served by three pumps.

Centrifugal Pumps

These are the main pumps used in Onyeama mine. They are used for three stages. They handle large quantities of water that are contaminated and corrosive. The centrifugal pumps used have been very helpful to the mine as they operate in extreme difficult conditions.

PROBLEM ENCOUNTERED IN THE PRESENT DEWATERING METHOD

To date the dewatering system in Onyeama mine has proved unsatisfactory. The mechanized longwall face has since been abandoned and a new area is currently producing coal. All the equipment were submerged by water and for safety of men that area has been sealed off though not forgotten.

Some of the reasons for this inefficiency include:

(i) The rate of outflow of water was not at pace with rate of inflow.
(ii) Some of the pumps were over-utilized while some were under-utilized
(iii) A major cause of inefficiency in the dewatering system is inability of management to supply power for pumping. (4)

In most cases there is power shortage because NEPA is overworked as it supplies electricity to the whole country. The stand by generator is not efficient as a result of lack of spare parts and can not be relied upon.

(iv) Water is lost during pumping operations through joint leakage which is due to absence of rubber packing seal.
(v) Some of the pipings and fittings do not comply with condition necessary for maximum efficiency in pumping and discharge lines. Friction loss is very high and
(vi) Life span of some of the pumps is very low. Some of the pumps and pipes are corroded because of acid mine water. This results in large turnover and replacement is not usually available.

The parts for replacement are not stocked and it is even worse now than when the face was abandoned a few years back. As a result of the economic crunch it takes a long time to get spares from abroad. This is the major problem with many of the industries that are dependent on equipment and materials from the west. The only solution is to fabricate some parts locally. Even in such a situation there used to be no incentive in the past. Since the government does not want the only underground coal mine to collapse it is now ready to dole out money to reactivate the mine.

CON CLUSION

The present rate of pumping is estimated to be 300 gpm ie.0.432Mgd It was mentioned earlier that the longwall face was abandoned some years ago because of the inability to pump enough water out of the face. Most of the pumps have broken down or buried in water. In order to pump out water in the flooded area of the mine and recover the equipment submerged in water the number of major pumps have to be increased to six. It must be mentioned that these pumps have a capacity of 1000 gpm.

The six pumps anticipated would give 8.64 Mgd After allowing for pumps changing time and power failures, the quantity of water to be pumped could be about 6 million gallons per day. This is the bearest minimum for draining the mine. It will cost management about ₦ 400,000 per year (£1 = ₦ 7.5). This represents about eight percent to the present production cost.

Extensive pumping of the underground water in Onyeama mine will on the long run result in the lowering of the level of saturation for a certain distance around the mine area where pumping takes place. The local lowering of the water table takes the form of a cone known as the cone of depression or exhaustion.

It was mentioned earlier that the cost of dewatering is estimated to be ₦ 400,000, another serious effect is the general water supply of the district. Enugu and the environ, depend on wells and springs within the cone of depression for water supply. The withdrawal of large quantities of water, may result in cracking of rocks or formations. It is likely this would have surface effect on buildings and farm land on top of the mine.

Finally the menance caused by flooding can be solved and the problems reduced if management makes available money to purchase additional pumps and spare parts.

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