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The Story of Coal: Amazing Transformation in Its Extraction Technology and Uses

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Abstract: Coal has come to be known from the fourth Century. This is regarded as chief source of energy in many countries in the world. And it occupies a place of pride in mineral industry today .Coal mining technology in the last two to three decades coal have been undergoing amazing transformation in the area of its extractions using novel methods for instance, hydraulic mining ,underground gasification ,retorting and ocean mining for the coal deposit seated beneath the sea water. The article describes briefly the chemistry of coal, its novel methods of extraction and its modern applications which has greatly advanced the standard of living.

Keywords:hydraulic mining, gasification of coal, underground retorting, benzoyl, ocean mining

Introduction

Coal is stratified carbonized remain s of plant materials. From the Earth`s history, the earlier period of coal formation appears in Carboniferous andPermian periods. The coal seams of all high rank, particularly of North America and Europe belong to Carboniferous age and those of Australia, Eastern Asia and Siberia, India, to Permian age.

Before the 20th century mines were filled with people and animals, working .But mines of today may not have a single person hewing the coal face or any other operation underground and scores of men are replaced by a single man at a control panel. The Chemists have revolutionized its uses for the modern world and has greatly improved the standard of living. Apart from its use in generating electricity, it has several other applications in the chemical industries to have great variety of products, such as drugs, disinfectants, perfumes, fertilizers, plastics to make nylon, dyes, and explosives.Recently,petrol from coal been manufactured which is in use in the motor car and aircraft. From the earth's history, the first coal mining began in New Brunswick, Canada in the early 1600 and the first School of Mines in the world was established in Czech Republic (formerly called Czecszlowvikia in 1716 (approximately three hundred years ago).

***Posthumous**

How Coal is Formed

From the earth's history, the earliest period of coal formation appears in Carboniferous and Permian periods. The coal seams – all of high rank – of Northern hemisphere, particularly of North America and Europe belong to Carboniferous age and those of Siberia, East Asia, India and Australia to Permian age. The second period of formation appears to be during upper Certance-to which belong the brown coals of Italy, Austria, Hungary, Yugoslavia, Japan, Indonesia and India. The third period is the Quaternary period when all peat deposits of the world appear to have been formed.

Theories propounded explained the origin of coal postulate that the coal seams of the world have their origin either in swamps (according to insitu theory) or in brackish or fresh water basins where vegetable debris from the swamps floated out (drift theory). In the swamps huge forests grew and assisted by bacteria, the plant material decayed and decomposed in the same area. With slow subsidence of the area, the vegetable debris got submerged supporting another vegetable growth. This slow sinking must have continued till the thickness of vegetable debris was built up to a quale sizable proportion. With sudden increase in sinking the vegetable matter must have been covered by other sediments giving rise to sandstones and shales. The cycle of slow and rapid subsidence must have repeated, thus producing a succession of plant debris, clay and sand deposits (refer to Figure 1) below.

Figure 1.Formation of Coal (a) Insitu method (b)Drift method

It is usually believed that the plant debris got converted into coal in two stages, (1) by biochemical process or humiliation process which converted the debris into peat and (2) by geochemical or coalification process by which peat was transformed into higher rank coal. The plant debris consisting of ligneous, celluloses, proteins, resins, undergoes transformation into a porous, fibrous and friable mass, called peat by the activity of micro-organisms which thrive in swampy environments. This process is called mummification and all coals are believed to have gone through it. Under the blanketing of newer strata, with pressure and earth movements, peat got converted into lignite, with more pressure and rising temperature, progressive dewatering, loss of CO_2, H_2 CH_4 and amalgamation of acidic and basic humid bodies, influence of intensive earth movements to anthracite. This sequence of development from wood to anthracite is reflected in changes in chemical composition; there is a steady increase of carbon and decrease of oxygen in the material as it undergoes transformation from one stage to another,Before the

Christian era (BC), perhaps in the fourth century, coal came to be regarded as a chief source of energy in many countries in the world.

From the earth's history, the first coal mining began in New Brunswick, Canada in the early 1600. Coal is still regarded as a chief source of energy in many countries.

The coal bearing formations consist of sedimentary strata containing a number of coal seams at some interval. These deposits extend over areas and have sometimes enormous thickness

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The following equations describe the change of wood (cellulose) to lignite (or bituminous coal. .

5 ($C_6H_{10}O_5$ = C_{20} H_{20} 0_4 + $3CH_4$ + $8H_2O$(Eq. 1)

6 ($C_6H_{10}O_5$) = $C_{22}H_2O$ 03 + 5 CH_4 + 10 H_2O + $8CO_2$ + CO (Eq.2)

These equations show how carbon was enriched over the original project changes. However, this should not be taken literally as representing the exact changes.

Extraction of Coal by Special (Novel) Methods:Hydraulic mining; Underground Gasification of coal; Retorting of oil shale (kerosene) And Ocean mining

Hydraulic mining which includes breaking of rocks and minerals is transporting from the working face to the pit bottom and finally hosting of material in the form slurry. This uses kinetic energy of fluid (generally water unless the mineral is likely to react with it) for breaking and to form slurry for its transportation. Although it is back dated to 125 years (1891), however, the first commercial publication began in 1957 in Utah and Colorado (USA) for transporting essonite to a distance of 116km through a pipe. Following this, ores of copper, gold, iron, limestone and phosphonate. The longest to date pipe is 435km for transporting coal in Arizona.

Principle of Working

Hydraulic mining utilizes kinetic energy of water jet breaking rock. The effectiveness of cutting rate depends upon nozzle of water jet, flow rate of water, pressure force and power (Fowlessetal, 1968). Other important operating factors are the distance of water jet and the rock on which it is being applied, the rectangle

which the water jet stream impacts on the face and jet travel rate (Jeremia,1979). The effects of several nozzle parameters are shown in Figure 1. In general, high flows of water associated with low pressure are most suitable for the breaking of soft minerals (Wood, 1980). Research by Wood shows that the breaking rate is directly proportional to both pressureand flow rate'Successful hydraulic mining requires that the threshold nozzle pressure must be greater than the rock compressive strength which the design parameters for operational hydraulic mining, should be as suggested in Table 1

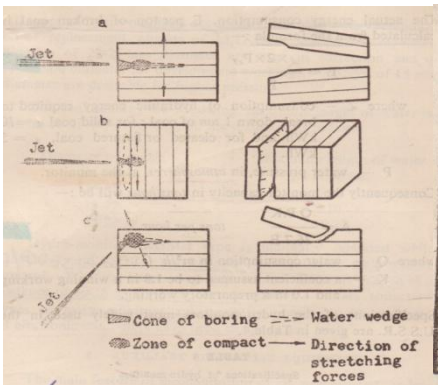
Table 1. Design parameters for nozzle and water flow rate

Material	Nozzle		Flow rate of water m3/sec
	Diameter (mm)	Pressure (Mpa)	
Soil	38 - 152	0.7	0.16
Bituminous coal	15 - 30	11.7	0.08
Soft sandstone	16.0	34.5	0.02
Anthracite	10- 12	6.9	0.03
Hard rock	05 – 2.5	170	0.01

Source: Wood 1980

Figure 2(b) shows a simple layout showing sublevel caving.With hydro monitor It is important that the wall rocks must remain stable for the period of mining of the mineral. The face length may be over 60 – 125m depending upon geological and geotechnical factors of the host rock.

Hydraulic mining is adaptable to several extraction methods among which room and pillar mining, sublevel caving are most popular. However, for the success of hydraulic mining it is important to consider gradient of the mineral which should be in excess of more than 5^0(to facilitate its movement), thickness (not less than 0.75m or more).



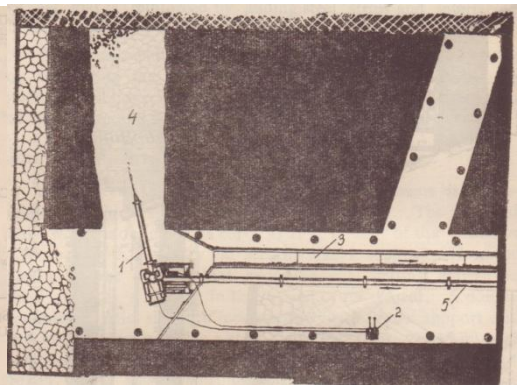


Figure 2(a)direction of water jet pressureFigure 2(b). Sublevel caving

Determination of Hardness Factor of Rock/Mineral

It is necessary to determine hardness factor of the rock/mineral to determine capacity of hydro monitor. The Research Institute VNII Gidrougolm the CIS (former USSR) has developed an empirical relationship for determining the required capacity of hydro monitor in terms of strength of coal. The minimum water pressure for effective breaking of coal is given by an empirical formula.

Pef = 50.f atmosphere (1 atm.= 1.07kpa)

Where Pef = minimum effective of water p and

F = Protodykonov pressure index of hardness

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Underground Gasification of Coal

Underground gasification of coal involves the partial combustion of coal in place, generally through boreholes, with the collection of gaseous by-products at the surface. The objective is to extract thermal energy from the coal seam in the form of fuel gases to avoid conventional mining. Analternative, shown in Figure3 (a),is to use the gases as feedstock for the production

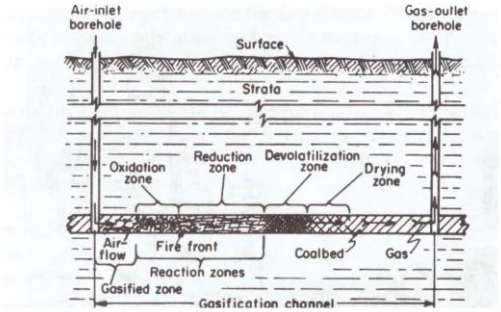
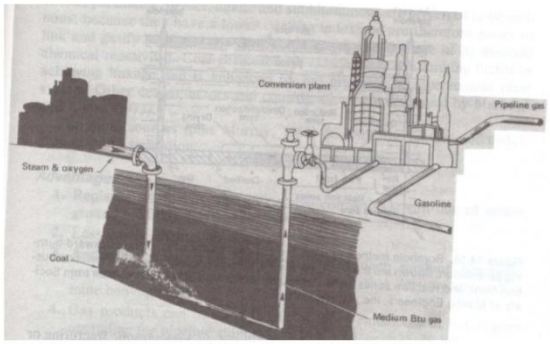


Fig 3(a)



Fig,3 (b)

Figure 3(a) Borehole method of underground coal gasification and 3 (b) conceptual diagram of underground coal gasification coupled with surface.

The above method has many advantages for instance, less environmental impact, applicable to low grade coal, gas products can be used without enhancement very good health and safety conditions etc.

Undergroung Retorting

Certain natural hydrocarbon deposits such as oil shale and tar sand, occur in the solid state. Kerogen is found in oil shale and bitumen in tar sand. The unique nature of these solid is that when heat is applied it get fluidized.

Mineralogical and petrographic ally, oil shale is a fine-grained marlstone containing insoluble organic substance called kerogen. Whenheated to 480-510 degree delicious, kerogen decompose to oil, gas, and carbonaceous residue .This process of pyrolysis or cracking kerogen is known as retorting. Figure 4 shows a simple and mostly used method of retorting.

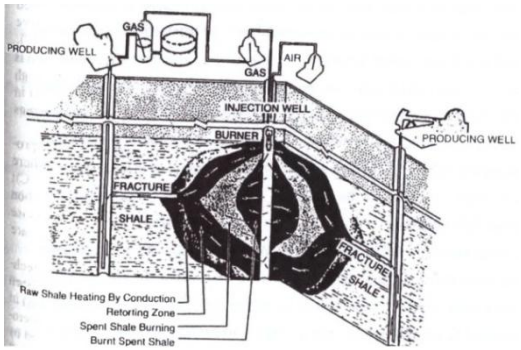


Figure 4 conceptual diagram showing injection and production wells underground

The advantage of this method isthat it is much cheaper compared to traditional mining with minimal environmental damage.

Ocean Mining

An Ocean-mining system consists of three components which are platform, coupling and hoist and excavating unit. In this method both mechanical and hydraulic units are utilized. A continuous materials-handling system is either hydraulic or air lift. It has been found that hydraulic system is both technologically and economically superior to a mechanical one. Especially at great depth, greater than 3 km. or more

The features of Ocean mining are that the minerals excavated are of high grade, environmental impact of mining small and recovery of mineral deposits is 100 per cent.

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Uses of Coal

The Chinese used coal in 1100 BC.In the 1705, ThomasSavory andThomstems pump and the improved made by James Watt made it possible to keep the mine free of water and so to drive them deeper. Steam engine used coal as their source of power and they were soon been employed in the mills and factories There are over thousands of applications of coal as its by-products and some of them are shown in Figure 5. .

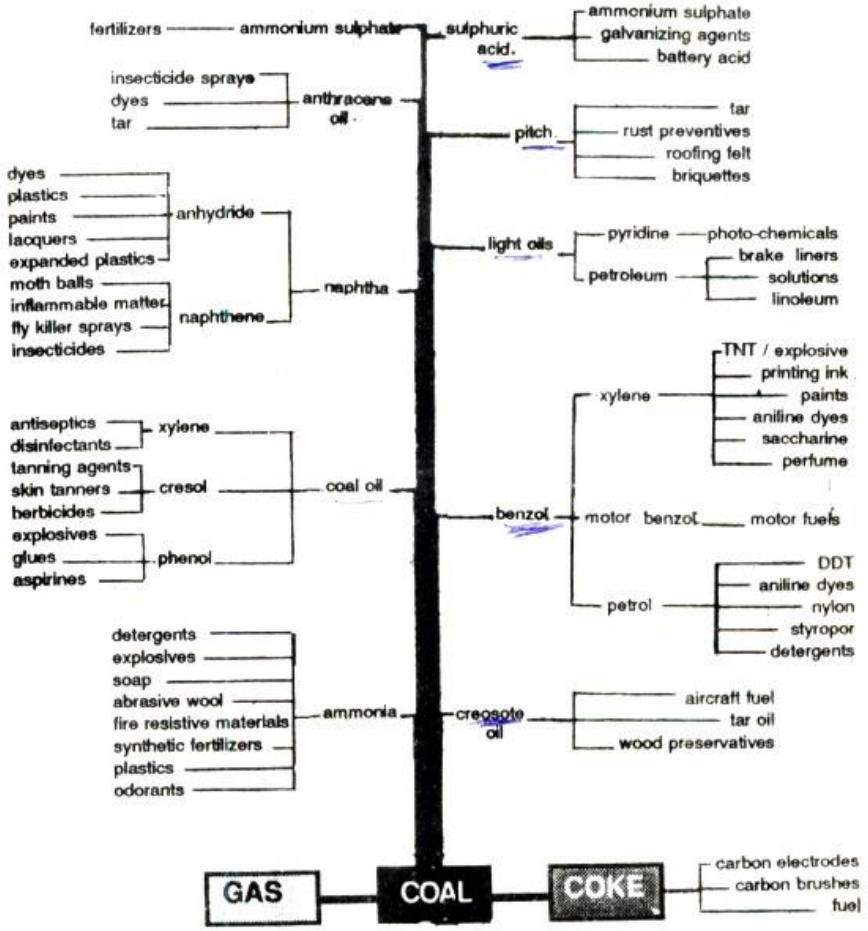

Figure 5.Bird`s eye view 0f uses of coal (after Deshmukh, 1991)

Concluding Remarks

Hydraulic mining is a comparatively new mining technology and the most suitable for soft rock mining that includes precious stones such as diamond, emerald, and amethyst. tanzanite etc. It is a productive economic and safe technology. It has a vast scope of improvement in terms of developing appropriate hydro monitor capable of breaking even harder rock and to match with this, a more powerful high pressure pumps which are already in the process of development. No doubt, hydraulic mining has a great future.

Coal mining technology has undergone amazing transformation in the past two, three decades in the field of its safe, economic and healthy method ofextraction andits over thousands of applications.

Currently, there are novel methods of mining of coal are in use for instance hydraulic mining, underground gasification, retorting of oil shale and ocean mining to extract from under the sea bed. This is likely to meet the fuel shortage in the growing demand of energy.

In general, underground hydraulic mining can be successfully applied for mining coal of thickness of any range, (0,5-150 m) and gradient exceeding 15 % degrees. However, it should be noted that Protodykonov strength number for coal should be around 2 or less.

For better performance of hydraulic mining improvements are required in the design of coal pumps and feeders for mining from deep levels.

Developments of hydro-monitor for breaking strong coal is under research throughout the world and also to make to be operated automatically.

Other forms of energy (such as nuclear power, water power, and petroleum) have gained in importance recently. But coal will remain a vital fuel for many years to come

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