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Impact of the Coal Industry on Environment

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Abstract: ***Coal has been used as an energy resource, primarily burned for the production of electricity and/or heat, and is also used for industrial purposes. A fossil fuel, coal forms when dead plant matter is converted into peat, which in turn is converted into lignite, then sub-bituminous coal, after that bituminous coal, and lastly anthracite. This involves biological and geological processes that take place in millions of years. The firm coal reserve of coal on earth is not estimated. It may be between 860 GegaTonnes to 18 000 Gega Tonnes.***

Coal is the largest source of energy for generation of electricity worldwide, as well as one of the largest worldwide anthropogenic sources of carbon dioxide releases. In 1999, the gross carbon dioxide emissions from coal usage were 8,666 million tonnes in the world. In 2011, world gross emissions from coal usage were 14,416 million tonnes. Coal-fired electric power generation emits around 910 Kgs of carbon dioxide for every megawatt-hour generated, which is almost double the approximately 500 pounds of carbon dioxide released by a natural gas-fired electric plant per megawatt-hour generated. Coal not only affects the environment during burning only but it also impacts badly, while mining, transporting, disposal of ash etc for a longer period.

The environmental impact of the coal industry includes the consideration of issues such as land use, waste management, and water, air, noise, thermal, visual pollution caused by the coal mining, processing and the use of its products. In addition to atmospheric pollution, coal burning produces hundreds of millions of tons of solid waste products annually, including fly ash, bottom ash, and flue-gas desulfurization sludge, that contain mercury, uranium, thorium, arsenic, and other heavy metals.

Key Words: Fossil fuel, Underground mine, Opencast mine, Green house gases, Pollution.

I. INTRODUCTION

Coal is extracted from the ground by coal mining, either underground by shaft / incline mining, or at ground level by open pit / opencast mining extraction. Since 1983 the world's top coal producer has been China. In 2011 China produced 3,520 million tonnes of coal – 49.5% of 7,695 million tonnes world coal production. In 2011 other large producers were United States (993 million tonnes), India (589MT), European Union (576MT) and Australia (416MT). In 2010 the largest exporters were Australia with 328 million tonnes (27.1% of world coal export) and Indonesia with 316 million tonnes (26.1%), while the largest importers were Japan with 207 million tonnes (17.5% of world coal import), China with 195 million tonnes (16.6%) and South Korea with 126 million tonnes (10.7%). There are severe health effects caused by burning coal. According to the reports issued by the World Health Organization(WHO) in 2008 and by environmental groups in 2004, coal particulates pollution are estimated to shorten approximately 1,000,000 lives annually worldwide. Coal mining generates significant additional independent adverse environmental health impacts, among them the polluted water flowing from mountaintop removal mining. Historically, coal mining has been a very dangerous activity and the list of historical coal mining disasters is a long one. Underground mining hazards include suffocation, gas poisoning, roof collapse and gas explosions. Open cut hazards are principally mine wall failures and vehicle collisions.

Coal mining has significant impact on environment, some of the land related impact are: Loss of biodiversity, Economic loss or loss of livelihood due to displacement and encroachment of agricultural land and Impact on water resource (in term of water availability and quality). Open cast mine has significant impact on land as compared to underground mine

II. Disasters in Coal Mining, Oil & Gas Exploration

Coal Mining: Historically, coal mining has been a very dangerous activity and the list of historical coal mining disasters is a long one. In the US alone, more than 100,000 coal miners were killed in accidents over the past century, with more than 3,200 dying in 1907 alone. Open cut hazards are principally mine wall failures and vehicle collisions; underground mining hazards include suffocation, gas poisoning, roof collapse and gas explosions. The mining activity is basically against the nature and its ill effects are seen worldwide. In history of Indian coal mining there are two horrible accidents occurred. Chasanala mining disaster was a disaster that happened on 27 December 1975 in an underground coal mine in Chasanala near Dhanbad in the state of Jharkhand. An explosion in the mine followed by flooding killed 372 miners. When a roof of coal caved in, 32,000 m3 of water per minute flooded into the mine. The miners were trapped under a mountain of debris and drowned when the water surged into the mine. Although this accident was caused by explosion and subsequently flooding of water, still it gives the idea of unforeseen events which could occur in mines. The 1965 Dhanbad coal mine disaster occurred on May 28,1965, in a coal mine near Dhanbad. On the fateful day, there was an explosion in Dhori colliery near Dhanbad, which led to fire in the mines. The fire killed 268 miners.

Oil Exploration: Oil spill forcing the worst of the environmental risk associated with offshore. Recent research suggests that transporting the oil poses greater threats than the drilling process itself. Oil spills are always a possibility when drilling for oil in the ocean. Oil spills can poison not only to sea animals, but also animals that eat them.

Natural Gas: The biggest mud volcano in the world is observed due to the blowout of a natural gas well drilled by PT Lapindo Brantas in the subdistrict of Porong, Sidoarjo in East Java, Indonesia that has been in eruption since May 2006, although some scientists and company officials contend it was caused by a distant earthquake. At its peak Lusi spewed up to 180,000 m^3 of mud per day. By mid-August 2011, mud was being discharged at a rate of 10,000 m^3 per day, with 15 bubbles around its gushing point. This was a significant decline from the previous year, when mud was being discharged at a rate of 100,000 cubic meters per day with 320 bubbles around its gushing point. It is expected that the flow will continue for the next 25 to 30 years.

III. Coal as Power Plant Fuel: Advantages & Disadvantages

In spite of above disasters, one cannot think of energy scenario without Fossil fuels which are indeed the top fuels used all over the world for generating power and electricity. Coal, gas, and oil are the fossil fuels responsible for most of the world's electricity and energy demands. Coal, which is readily available in most of the developing and developed countries, has been used as a major source of fuel. It was used in ancient human civilizations and also found its use in historic steam engines at the dawn of the industrial revolution.

3.1 Advantages of Coal as Power Plant Fuel: Coal has improved living conditions with its current role in meeting man's fuel needs. Coal has been used extensively in power generation where better technology is employed to ensure that there is a balance between ecology and economics in producing sustainable and affordable energy. But ***affordability*** and ***sustainability of coal,*** as an energy source is to be examined on following points i.e. the advantages- and disadvantages- of coal & fired plants. Some of its advantages are enumerated as follows:

(i) Reliability: One of the greatest advantages of coal fired plants is reliability. Coal's ability to supply power during peak power demand either as base power or as off-peak power is greatly valued as a power plant fuel.

(ii) Affordability: Energy produced from coal fired plants is cheaper & affordable than other energy sources. Coal is low priced compared to other energy sources & is cheap to produce power.

(iii) Abundance: There are approximately over 300 years of economic coal deposits still accessible. Hence coal fired plants can be continuously fueled in many years to come.

(iv) Known technologies: The production and uses of coal as a fuel are well understood, and the technology required in producing it is constantly advancing & it ensures constant supply.

(v) Safety: A coal power plants are safer & its failure is certainly not likely to cause catastrophic events such as a nuclear meltdown would.

3.2 Disadvantages of Coal-Fired Power Plants: On the other hand, there are also some significant disadvantages of coal fired plants:

(i) Greenhouse gas emissions: Coal leaves behind harmful byproducts upon combustion & it cause a lot of pollution and contribute to global warming. The increased carbon emissions brought about by coal fired plants has led to further global warming which results in climate changes.

(ii) Mining destruction: Mining of coal not only results in the destruction of habitat and scenery, but it also displaces humans as well. Places near coal mines are unsafe for human.

(iii) Generation of millions of tons of waste: Millions of tons of waste products generated from coal fired plants can no longer be reused. Moreover, these waste products contribute to its disposal problems, which also contain harmful substances.

(iv) Emission of harmful substances: Thermal coal plants emit harmful substances to the environment which includes mercury, sulfur dioxide, carbon monoxide, mercury, selenium etc. These harmful substances not only cause acid rain but also are very harmful to humans as well.

IV. POLLUTIONS

There are total seven types of pollutions. The coal mining & coal usage largely contributes in these pollutions i.e. Water, Land, Air, Noise, Thermal, Visual and Light. Main pollutions and the corrective actions to mitigate its effects are mentioned below:

4.1 Air pollution:

Coal and coal waste products (including fly ash, bottom ash and boiler slag) releases approximately 20 toxic-release chemicals, including arsenic, lead, mercury, nickel, vanadium, beryllium, cadmium, barium, chromium, copper, molybdenum, zinc, selenium and radium, which are dangerous if released into the environment. While these substances are trace impurities, enough coal is burned that significant amounts of these substances are released.

The wet cooling towers used in coal-fired power stations, etc. emit drift and fog which are also environmental concern. The drift from the cooling towers is containing Respirable suspended particulate matter. In case of cooling towers with sea water makeup, sodium salts are deposited on nearby lands which would convert the land into alkali soil by reducing the fertility of vegetative lands and also cause corrosion of nearby structures.

Fires sometimes occur in coal beds underground. When coal beds are exposed, the fire risk increases. Weathered coal can also increase ground temperatures if it is left on surface. Almost all fires in solid coal are ignited by surface fires caused by people or lightning. Spontaneous combustion is caused when coal oxidizes and airflow is insufficient to dissipate heat; this more commonly occurs in stockpiles and waste piles, rarely in bedded coal underground. Where coal fires occur, there is attendant air

pollution from emission of smoke and noxious fumes into the atmosphere. Coal seam fires may burn underground for decades, threatening destruction of forests, houses, roadways and other valuable infrastructure.

Sulfur Dioxide (SO2) is released from burning coal which is oxidized to gaseous H2SO2 which scatters solar radiation; hence their increase in the atmosphere exerts a cooling effect on climate that masks some of the warming caused by increased greenhouse gases. Release of SO2 also contributes to the widespread acidification of ecosystems.

In 2008 the World Health Organization (WHO) and other organizations calculated that coal particulates pollution kills approximately one million people annually across the world, which is approximately one third of all premature deaths related to all air pollution sources.

Greenhouse gas emissions: The combustion of coal is the largest contributor to the human-made increase of CO2 in the atmosphere. Electricity generation using coal burning produces twice the greenhouse gasses per kilowatt compared to generation using natural gas.

Coal mining produces methane, a potent greenhouse gas. Methane is the naturally occurring product of the decay of organic matter as coal deposits are formed with increasing depths of burial, rising temperatures, and rising pressure over geological time. A portion of the methane produced is absorbed by the coal and later released from the coal seam (and surrounding disturbed strata) during the mining process. Methane accounts for 10.5 percent of greenhouse-gas emissions created through human activity. According to the Intergovernmental Panel on Climate Change, methane has a global warming potential 21 times greater than that of carbon dioxide over a 100-year timeline. The process of mining can release pockets of methane. These gases may pose a threat to coal miners, as well as a source of air pollution. This is due to the relaxation of pressure and fracturing of the strata during mining activity, which gives rise to safety concerns for the coal miners if not managed properly. The buildup of pressure in the strata can lead to explosions during (or after) the mining process if prevention methods, such as "methane draining", are not taken.

4.2 Water pollution

Opencast mining requires large amounts of water for coal handling plants and dust suppression. To meet this requirement mines acquire surface or groundwater supplies from nearby agricultural or domestic users, which reduces the productivity of these operations or halts them. These water resources (once separated from their original environment) are rarely returned after mining, creating a permanent degradation in agricultural productivity. Underground mining has a similar effect, due to a lower need for dust-suppression water; however, it still requires sufficient water for coal-washing.

Groundwater supplies may be adversely affected by surface mining. These impacts include drainage of usable water from shallow aquifers; lowering of water levels in adjacent areas and changes in flow direction within aquifers; contamination of usable aquifers below mining operations due to infiltration of poor-quality mine water; and increased infiltration of precipitation on spoil piles. Where coal is present, increased infiltration may result in:

- Increased runoff of poor-quality water and erosion from spoil piles
- Recharge of poor-quality water to shallow groundwater aquifers
- Poor-quality water flow to nearby streams

This may contaminate both groundwater and nearby streams for long periods. Deterioration of stream quality results from acid mine drainage, toxic trace elements, high content of dissolved solids in mine drainage water, and increased sediment loads discharged to streams. When coal surfaces are exposed, pyrite comes in contact with water and air and forms sulfuric acid. As water drains from the mine, the acid moves into the waterways; as long as rain falls on the mine tailings the sulfuric-acid production continues, whether the mine is still operating or not. Also waste piles and coal storage piles can yield sediment to

streams. Leached water from these piles can be acid and contain toxic trace elements. Surface waters may be rendered unfit for agriculture, human consumption, bathing, or other household uses. To mitigate these problems, water is to be monitored at coal mines. The five principal technologies used to control water flow at mine sites are:

- Diversion systems
- Containment ponds
- Groundwater pumping systems
- Subsurface drainage systems
- Subsurface barriers

River water pollution: Coal-fired boilers/power plants when using coal or lignite rich in limestone produces ash containing calcium oxide (CaO). CaO readily dissolves in water to form slaked lime/Ca(OH)2 and carried by rain water to rivers/irrigation water from ash dump areas.

5.3 Land Pollution:

Opencast/Strip mining severely alters the landscape, which reduces the value of the natural environment in the surrounding land. Around 4 hacters of land is damaged for every million tons of coal mined by the surface mining. For instance, a capacity of 10 million tons opencast coal mine in 20 years has a potential to destroy around 800 ha of land for a much longer period.

Strip mining eliminates existing vegetation, destroys the genetic soil profile, displaces or destroys wildlife and habitat, alters current land uses, and to some extent permanently changes the general topography of the area mined. Adverse impacts on geological features of human interest may occur in a coal strip mine. Geomorphic and geophysical features and outstanding scenic resources may be sacrificed by indiscriminate mining. Paleontological, cultural, and other historic values may be endangered due to the disruptive activities of blasting, ripping, and excavating coal. The removal of vegetative cover and activities associated with the construction of haul roads, stockpiling of topsoil, displacement of overburden and hauling of soil and coal increase the quantity of dust around mining operations. Dust degrades air quality in the immediate area, has an adverse impact on vegetative life, and constitutes health and safety hazards for mine workers and nearby residents.

Mine collapses (or mine subsidence) have the potential to produce major adverse effects above ground, which are especially devastating in developed areas which requires reclamation plans for future coal mining sites.

5.4 Noise pollution:

The operation of HEMM (Heavy Earth Moving Machineries) deployed in opencast mines make loud noise. Noise pollution is either harmful / annoying to humans and animals. Noise pollution is disruptive to humans' stress levels, may be harmful to unborn babies, and drives animals away, causing nervousness and decreasing their ability to hear prey or predators.

5.5 Thermal Pollution:

Due to deforestation and operation of HEMM and operations of thermal power plants the temperature of surroundings increases. These kinds of environmental pollution can cause aquatic life to suffer or die due to the increased temperature, can cause discomfort to communities dealing with higher temperatures and can even affect plant-life in and around the area.

5.6 Visual pollution

Visual pollution is anything unattractive or visualizing / damaging to the nearby landscape. The formation of overburden heaps by mining and destruction of the natural landscapes/beauty are some examples of visual pollution which blocks the view. Mostly visual kinds of environmental pollution are annoying.

Apart from above, coal mining creates following problems:

Waste: The burning of coal leads to substantial fly ash sludge-storage ponds. In the low-coal-content areas waste forms spoil tip. The waste sites could cause death and significant property damage if an event such as a storm, a terrorist attack or a structural failure caused a spill.

Wildlife: Surface mining of coal causes direct and indirect damage to wildlife. The impact on wildlife stems primarily from disturbing, removing and redistributing the land surface. Some impacts are short-term, and confined to the mine site; others have far-reaching, long-term effects. The most direct effect on wildlife is destruction or displacement of species in areas of excavation and spoils piling. Pit and spoil areas are not capable of providing food and cover for most species of wildlife. Mobile wildlife species like game animals, birds, and predators leave these areas. More sedentary animals like invertebrates, reptiles, burrowing rodents and small mammals may be destroyed. The community of microorganisms and nutrient-cycling processes are upset by movement, storage, and redistribution of soil.

The presence of acid-forming materials exposed as a result of surface mining can affect wildlife by eliminating habitat and by causing direct destruction of some species. Lesser concentrations can suppress productivity, growth rate and reproduction of many aquatic species. Acids dilute concentrations of heavy metals, and high alkalinity can cause severe damage to wildlife in some areas. The duration of acidic-waste pollution can be long; estimates of the time required to leach exposed acidic materials from 800 to 3,000 years.

Economic costs: A major EU funded research study known as Externalities of Energy, undertaken over the period of 1995 to 2005 found that the cost of producing electricity from coal would double over its present value, if external costs such as damage to the environment and to human health, from the airborne particulate matter, nitrogen oxides, chromium VI and arsenic emissions produced by coal, were taken into account. It was estimated in the study that external, downstream, fossil fuel costs amount up to 1–2% of the EU's entire Gross Domestic Product (GDP), with coal the main fossil fuel accountable for this, and this was before the external cost of global warming from these sources was even included. High rates of motherboard failures in China and India appear to be due to "sulfurous air pollution produced by coal that's burned to generate electricity. According to Intel researchers, "it corrodes copper circuitry,".

Dangers to miners: Coal mining has been a very dangerous activity and the list of historical coal mining disasters is a long one. In the US alone, more than 100,000 coal miners were killed in accidents over the past century, with more than 3,200 died in 1907 alone. Opencast mine's hazards are principally mine wall failures and vehicle collisions; underground mining hazards include suffocation, gas poisoning, roof collapse, gas explosions etc. Firedamp explosions can trigger the much more dangerous coal dust explosions, which can engulf an entire pit in underground mines. Most of these risks can be greatly reduced in modern mines, and multiple fatality incidents are now rare in some parts of the developed world. Build-ups of a hazardous gas are known as damps, possibly from the German word "Dampf" which means steam or vapor:

Black damp: a mixture of carbon dioxide and nitrogen in a mine can cause suffocation, and is formed as a result of corrosion in enclosed spaces so removing oxygen from the atmosphere.

After damp: similar to black damp, after damp consists of carbon monoxide, carbon dioxide and nitrogen and forms after a mine explosion.

Fire damp: consists of mostly methane, a highly flammable gas that explodes between 5% and 15% - at 25% it causes asphyxiation.

Stink damp: so named for the rotten egg smell of the hydrogen sulphide gas, stink damp can explode and is also very toxic.

White damp: air containing carbon monoxide which is toxic, even at low concentrations

However, in lesser developed countries and some developing countries, many miners continue to die annually, either through direct accidents in coal mines or through adverse health consequences from working under poor conditions. China, in particular, has the highest number of coal mining related deaths in the world, with official statistics claiming that 6,027 deaths occurred in 2004. To compare, 28 deaths were reported in the US in the same year. Coal production in China is twice that in the US, while the number of coal miners is around 50 times that of the US, making deaths in coal mines in China 4 times as common per worker (108 times as common per unit output) as in the US. Chronic lung diseases, such as pneumoconiosis (black lung) were once common in miners, leading to reduced life expectancy. In some mining countries black lung is still common, with 4,000 new cases of black lung every year in the US (4 percent of workers annually) and 10,000 new cases every year in China (0.2 percent of workers). Rates may be higher than reported in some regions.

In view of above and higher carbon efficiency of natural gas generation, United States has changed to reduce coal production and increase natural gas generation resulting reduction in carbon dioxide emission. Those measured in the first quarter of 2012 were the lowest of any recorded for the first quarter of any year since 1992. In 2013, the head of the UN climate agency advised that most of the world's coal reserves should be left in the ground to avoid catastrophic global warming.

V. Conclusion

We know that adverse impacts from coal mining are occurring today and past practices have ruined some areas beyond any use. There are laws governing mining practices. The land impacts of coal production and use are regulated primarily under the various Acts and Laws. The laws also cover the land impacts of transportation, transmission and waste disposal. The primary purposes laws are to ensure that surface coal mining operations are conducted in a manner that protects the environment and communities where coal is being mined; to ensure that adequate procedures are undertaken to reclaim surface areas as quickly as possible, and to strike a balance between protection of the environment and agricultural productivity and the country's need for coal as an essential energy source.

Considering the growing energy demand the Scientists suggested that no single solution can meet our society's future energy needs. The solution instead will come from a family of diverse energy technologies that share a common thread — they do not deplete our natural resources or destroy our environment.

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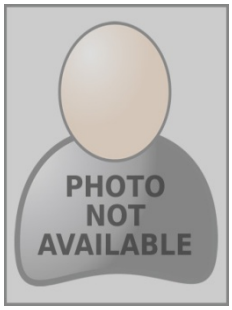
Abbreviations

GHG - Green House Gases. CO_2- Carbon Di-Oxide, SO_2- Sulpher Di-Oxide, NOx-Nitrogen Oxides, WHO- World Health Organization, GDP-Gross Domestic Product, EU-European Union, ha- hector.

AUTHOR(S) PROFILE



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