Dharmateja Bandlamudi, Sahithi Avirneni / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 3, Issue 3, May-Jun 2013, pp.061-065

Power Plant- A Scientific Disaster

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ABSTRACT

The present paper emphasisesthe society's movement towards improvement of power sector as a pavement of luxury and on the benighted dark side of it. This produces the reasons for enchanting power plant as a scientific disaster. This paper gives the detailed list of effects caused by the power plants mainly on coal fired, nuclear and hydroelectric power plants, their adverse effects on environment and in turn human life.

Key words: power plants, coal, nuclear, human habitation

1. INTRODUCTION

Now a days every country is moving towards development and this development is mostly signified by technology development and power generation. So every country around the world is aiming to increase their power generation by establishing new power plants. A power plant is an industrial facility for the generation of electric power.The energy source harnessed to turn the generator varies widely. It depends chiefly on which fuels are easily available, cheap enough and on the types of technology that the power company has access to. Most power stations in the world burn fossil fuels such as coal, oil, and natural gas to generate electricity, and some use nuclear power. There are different types of power plants but major part of power generated is from Coal fired power plant, Hydroelectric and Nuclear power plants. In the name of development every country is ignoring the fact that by generating each Mega Watt they are deploying the environment in the same ratio. As a fact Development implies Deploying Environment. Every power plant has its severe impact on the environment in multiple ways. The major areas being affected by these power plants are water, air and soil.

2. Problems due to Coal as a major source of power

Coal is the only natural resource and fossil fuel available in abundance in India. Consequently, it is used widely as a thermal energy source and also as fuel for thermal power plants producing electricity [1]. Combustion process converts coal into useful Heat energy, but it is also a part of the process that produce greatest environmental and health concerns. Combustion of coal at thermal power plants emits mainly carbon dioxide (CO_2), sulphur oxides (SOx), nitrogen oxides (NOx); CFCs other trace gases and air borne inorganic particulates, such as fly ash and suspended particulate matter (SPM). CO_2, NOx and CFCs are greenhouse gases (GHGs) High ash content in Indian coal and inefficient combustion technologies contribute to India's emission of air particulate matter and other trace gases, including gases that are responsible for the greenhouse effect.

2.1. Fly Ash: The present coal consumption in thermal power station in India results in adding ash estimated 12.21 million tons fly ash in to the environment a year of which nearly a third goes in to air and the rest is dumped on land or Water in spite of various research results a consistent utilization is not evident, and it expected that stocks piles Of fly ash will continue to grow with the increasing number of super thermal power station in India [2]. As reliance upon coal as a fuel source increases, this large quantities of this material will be increasingly brought into contact with the water and soil environment [3]. This may lead to consumption of impure water and food causing health hazard to the human habitation. New methods of utilising fly ash as aningredient for different operations like cement manufacturing, fertilizers, bricks and road construction etc. may help to some extent in minimizing the effect of fly ash. Fly ash comprises maximum part of silica, iron oxide and Aluminium. When these ash particles circulate in atmosphere they create lot of breathing problems to the human kind. So these must be isolated from the atmosphere instead of leaving them into the atmosphere.

Table I
Chemical Composition of Fly Ash

Name	Formula	Percentage
Silica	SiO_2	62
Iron oxide	Fe_2O_3	63
Aluminium	Al_2O_3	26
Titanium oxide	TiO_2	1.8
Potassium oxide	K_2O	1.28
Calcium oxide	CaO	1.13
Phosphorous pent oxide	P_2O_5	0.40
Sulphate	SO_4	0.36
Disodium oxide	Na_2O	0.28

2.2 Problems associated with radionuclide increase in atmosphere coal combustion:Coal, like most materials found in nature, contains radionuclides. The levels of natural radionuclides in a geological formation depend on its composition and geological history. In the production of electric power, coal is burned in a furnace operating at temperatures of up to 1700°C. In the combustion process, volatile radionuclide's such as Pb^{210} and Po^{210} are partly released in the flue gases and escape to the atmosphere. A significant fraction of the radioactivity is also retained in the bottom ash or slag .The greatest part of the radioactivity in coal remains with the ash but some of the fly ash from coal-fired power plants escapes into the atmosphere[4]. Air pollution in the vicinity of a coal fired thermal power station affects soil, water, vegetation, the whole ecosystem and human health[5]."Environmental impact of coal utilization in thermal power plant" notes that "Radon is a colourless, odourless but noble gas, which is radioactive and ubiquitously present. It poses grate health hazards not only to uranium miners but also people living in normal houses and buildings and at work place like coal mines, cement industry, thermal power plants etc. Coal, a naturally occurring fossil fuel is burnt in conventional power plants to meet out about 72% of the electricity needs in our country[6]. It was lesser known hitherto until recently that the fly ash which is a by-product of burnt coal is a potential radioactive air pollutant and it modifies radiation exposure.

2.3 Problems due to Mercury as a by-product in Coal combustion:It is one of the compositions of the Coal Ash. Reports say that Mercury is abundantly available near power plant surroundings in which coal is a source of power. Around 70% of mercury present in rainfall is accounted due to coal combustion [7]. About 42% of mercury available in the atmosphere is near coal based power plants [8]. Mercury is now recognised by the World Health Organisation and the United Nations Environmental Program as a global threat to human health and the environment. When mercury is released into the environment, it evaporates, travels on air currents, and then falls back to earth. People can be poisoned by inhaling mercury vapours, of which approximately 80% is absorbed by the body [9]. This mercury destroys the cell construction and stops haemoglobin functioning, interrupts blood circulation and creates cardiac problems as well. Due to this people near power plants are facing dread full diseases like cancer, heart attacks. It is toxic to the nervous system and to the immune, reproductive and cardiovascular systems.

3. Nuclear Power Plants as a threat to human habitation

In Nuclear power plants the source of power is Fission Reaction. Normally Uranium is combined with a neutron which indeed produces another three neutrons and huge amount of heat. By slowing down the process and controlling this heat water is converted to steam and the same process as in all thermal power plants takes place. The main problems associated with nuclear power plants are while fission process gamma radiations are released, nuclear waste both high level, low level, and solid waste.

3.1 Basic Equation in Nuclear Reactors:
^{238}U + neutron → fission fragments + 2.4 neutrons +192.9 MeV+ gamma radiation [10]

3.2 Fission Fragments: These are basically the waste materials that are available as by-products after fission reaction which have highly harmful radioactive materials which are complex to dissolve or separate from human habitation.

3.3 Solid Waste: The most important waste from nuclear power plants is spent nuclear fuel. It is primarily composed of unconverted uranium as well as significant quantities of transuranic actinides (plutonium and curium mostly) [11]. In addition, about 3% of it is fission products from nuclear reactions. The long term radio activity is due to the actinides and short term radio activity is due to the fission products.

3.3.1 High-Level radioactive waste: every year around 10,000 metric tons of High-Level radioactive waste is being created by the nuclear fleet. The technical issues in accounting this is daunting because of their long life radioactivity. Two main products Technitium-99 and Iodine-129 take around million years to decompose into the earth which means once they are generated their radioactivity lasts for million years [12]. Dumping of these radioactive elements without proper management and precautions would leads to a serious impact on human habitation. The radioactivity of these radioactive elements generated by human forms have much more impact than the natural radioisotopes.

3.3.2 Low-Level radioactive waste: The nuclear industries also producing low level radioactive waste in the form of contaminated materials like clothing, hand tools, water purifier resins, and the materials used to build reactors. Almost every equipment in and around the reactors becomes contaminated with radioactivity because of huge amount of gamma radiations being released during fission reaction [13]. Due to this all the human habitation around the nuclear power plants are

facing inheriting diseases like cancer, heart attacks, and infections.

3.4 Problems in Disposing Nuclear waste: Disposal of nuclear waste is said to be Achilles' heel of industry. Radioactivity demises over time.So proper isolation of these waste from the environment until the hazard is no longer exists. This isolation period depends on the kind of waste. Low-Level waste if isolated for few hours. But when coming to High-Level waste this period would be 10,000 to millions of years. So they must be isolated from the environment by deep burial or transmutation. Waste is mainly stored at individual sites and there are over 430 locations around the world where radioactive materials continue to accumulate [14]. Some experts suggest that centralized underground repositories which are well-managed, guarded, and monitored would be a vast improvement. But till 2009 there were no commercial scale purpose built underground repositories in operation. This is a serious problem for the society.

3.5 Radiation around the nuclear power plant: The principle risk arises with the nuclear power plants from health effects of radiation. On an average a common man under goes to billions of natural radiations normally. But these may not cause such severe health problems because they are not active radiations. One in a billion would of such kind. But radiations released by nuclear power plants are radioactive and if they directly impose on a human body dreadful diseases like cancer may be prevalent. Analysis says that due to these nuclear radiations 0.04% of possibility is there for a person to die on the spot if he undergoes direct contact with these radiations. Around one hour of life span will decrease if a person undergoes partial contact within one kilometre range around a nuclear power plant continuously for ten hours [15]. Mining Uranium to fuel nuclear power plants leaves "mill tailing" the residues from chemical processing the ore, which leads to random exposure to the public. Reports say that eventually a nuclear power plant generating power continuously for one year may result in few hundreds of deaths which occur without any failures in the generation but purely due to radiations.

4. Hydroelectric power plant a threat to soil and water

The name suggests generation of power by using hydropower. The generation of electricity through the gravitational force of falling or flowing water. It is the most widely used form of renewable energy. It is said to be having zero environmental effects, low percent of greenhouse gases than fossil fuel based power plants. But it is the most dangerous part towards on the basis environmental considerations. Hydroelectric power plants are generally located on the canals, rivers where a sudden shift in speeds can be attained.

4.1 Ecosystem Damage and loss of land: Large reservoirs required for the operation of hydroelectric power plants results in submersion of extensive areas upstream of dams, destroying biologically rich and productive lowlands and riverine valley forests, marshland and grasslands. The loss of land is often exacerbated by habitat fragmentation of surrounding areas caused by reservoir [16]. Hydroelectric projects can disrupt aquatic ecosystem both upstream and downstream of the plant site. Generation of power changes the environment of the downstream. Water existing near downstream may contain hardly less suspended substances which result in failure of river bed formations [17]. Uneven flow of river water is observed due to turbine gate operations.

4.1 ***Methane emissions:*** Lower positive impacts are found in the tropical regions, as it has been noted that the reservoirs of power plants in tropical regions produce substantial amounts of methane. This is due to plant material in flooded areas decaying in an anaerobic environment, and forming methane, a greenhouse gas. According to the World Commission on Dams report [18], where the reservoir is large compared to the generating capacity (less than 100 watts per square metre of surface area) and no clearing of the forests in the area was undertaken prior to impoundment of the reservoir, greenhouse gas emissions from the reservoir may be higher than those of a conventional oil-fired thermal generation plant [19].

4.2 Failure Risks: Because large conventional dammed-hydro facilities hold back large volumes of water, a failure due to poor construction, natural disasters or sabotage can be catastrophic to downriver settlements and infrastructure. Dam failures have been some of the largest man-made disasters in history. The Banquo Dam failure in Southern China directly resulted in the deaths of 26,000 people, and another 145,000 from epidemics. Millions were left homeless. Also, the creation of a dam in a geologically inappropriate location may cause disasters such as 1963 disaster at Vermont Dam in Italy, where almost 2000 people died [20]. Smaller dams and micro hydro facilities create less risk, but can form continuing hazards even after being decommissioned. For example, the small Kelly Barns Dam failed in 1967, causing 39 deaths with the Toccoa Flood, ten years after its power plant was decommissioned [21].

5. Water Consumption by these power plants

The amount of water usage is often of great concern for electricity generating systems as

population increase and droughts become a concern. Still conventional energy sources account to 8-10% of the total power generation and these nonconventional sources coal, hydral and nuclear based power plants need water for different purposes.Steam cycle plants (Nuclear, Coal, NG, solar thermal) require a great deal of water for cooling, to remove the heat at the steam condensers. The amount of water needed relative to plant output will be reduced with increasing boiler temperatures. Coal and gas fired boilers can produce high temperatures and so are more efficient and require less cooling water relative to output [22]. But nuclear boilers are limited in steam temperature by material constraints and Solar is limited by concentration of energy source. Water usage in these power plants creating a lot of problems because most of the raw water used here is from rivers, lakes and ponds which is mostly used for irrigation, domestic and drinking purposes. Due to these power plants the available water is decreasing day by day and even the water left for other purposes is also getting contaminated by pollution.

The fly ash from coal based power plants and radioactive materials from nuclear power plants is being dumped in these rivers. Due to this the water is getting polluted and not suitable for domestic usage. On the other hand as the water from condensers for cooling the steam is being circulated directly from the rivers or seas and again into the same which contains huge temperatures. Due to which thermal pollution occurs. Which will adversely affect the marine life. Reports suggests that yearly around 5% of the marine animals near the power plants are vanishing due to this thermal pollution [23]. And they say that thinking about economy will burn marine life and adversely it will effect human mitigation in coming future.

Table II
Water Usage for different Power Sources

Power source	Water usage (gal/Mwah)
Nuclear	400 to 720
coal	300 to 480
hydroelectric	1430
Natural gas	100 to 180
Solar thermal	1080

The water consumption by power plants leading to imbalance in the natural ecological balance. This pollution of water destroying the marine life and human life. The International water resources analysis made it clear that around 25% of water resources available on the earth are just being contaminated only because of these power plant. And 15% of drinking water is being used for the cooling and recirculation of steam in thermal power plants [24].

Conclusion

The present society is running towards development and ignoring the fact that development means deploying environment indeed self-deployment. Electricity is an adventures creation by mankind. But proper ways of generating power must be invented so that they don't have their adverse effects on the environment which is the heart of ecosystem. For power generation natural resources must not be destroyed. Awareness must be created against human civilisation so that electricity consumption is decreased and new ways of power generation are determined and environment is safe guarded. As of sudden these power plants cannot be stopped as the entire world is dependent on these power generations. So long term analysis must be made and new technology must be improved so that there may be change in these environmental conditions. Perfect isolation of these pollutant gases and wastes must be made so the effect can be reduced to some extent.

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