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Desolation Compound of Power Plant Toxic Denouement to the Environment

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Abstract: The development of any country very much depends on the electric power rather in case of developing country in India more than 90% of GDP depends on total power supply out of which more than 61% demands cover-up by thermal power plants most of power generated by combustion of coal the study deals with desolation compound of thermal power plant by coal combustion known as fly ash. Quality of coal in India very low grade produces more than 40% carbon with compare to the imported coal thus the production of Fly Ash is high and need large areas required for its disposal and management but also the Fly Ash becomes major sources of environmental pollution.

Keywords: Coal Combustion, Thermal Power Plant, Fly Ash

Introduction:

Thermal power is the main source of power generation and raw material used for generation of power are coal, gases Fly ash, also known as "pulverised fuel ash" is a coal combustion product that is composed of the particulates that are driven out of coal-fired boilers together with the flue gases. Ash that falls to the bottom of the boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline), aluminium oxide (Al_2O_3)and calcium oxide(CaO), the main mineral compounds in coal-bearing rock strata.

Production of Fly ash Coal is the least efficient of the fossil fuels in terms of the amount of energy gained vs. CO_2 released. Burning it also releases numerous toxic chemicals and particulates, which can exact a cost on a country's population in terms of reduced life expectancy and increased health costs. Coal combustion releases nitrogen oxides, sulphur dioxide, particulate matter (PM), mercury, and dozens of other substances known to be hazardous to human health. Coal-fired power plants that sell electricity to the grid produce more hazardous air pollution in the U.S. than any other industrial pollution sources. Two classes of fly ash are defined by ASTM C618: Class F fly ash and Class C fly ash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the ash. The chemical properties of the fly ash are largely influenced by the chemical content of the coal burned (i.e., anthracite, bituminous, and lignite).

Class F Fly Ash produces by the burning of harder, older anthracite and bituminous coal. This fly ash is pozzolanic in nature, and contains less than 7%lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime—mixed with water to react and produce cementitious compounds. Alternatively, adding a chemical activator such as sodium silicate (water glass) to a Class F ash can form a Geopolymers.

Class C fly ash produced from the burning of younger lignite or sub-bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash hardens and gets stronger over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulphate (SO_4) contents are generally higher in Class C fly ashes.

The constituents of fly ash depend upon the specific coal bed makeup but may include one or more of the following elements or substances found in trace concentrations (up to hundreds ppm): arsenic, beryllium, boron, cadmium, chromium, hexava lent,chromium, cobalt, lead, manganese, mercury, molybdenu m, selenium, strontium, thallium, and vanadium, along with very small concentrations of dioxins and PAH compounds.

In the past, fly ash was generally released into the atmosphere, but air pollution control standards now require that it be captured prior to release by fitting pollution control equipment. In the US, fly ash is generally stored at coal power plants or placed in landfills. About 43% is recycled, often used as a pozzolan to produce hydraulic cement or hydraulic plaster and a replacement or partial replacement for Portland cement in concrete production. Pozzolans ensure the setting of concrete and plaster and provide concrete with more protection from wet conditions and chemical attack.

After a long regulatory process, the EPA published a final ruling in December 2014, which establishes that coal fly ash is regulated on the federal level as "non-hazardous" waste according to the Resource Conservation and Recovery Act (RCRA). Coal Combustion Residuals (CCR's) are listed in the subtitle D (rather than under subtitle C dealing for hazardous waste, which was also considered).

In the case that fly or bottom ash is not produced from coal, for example when solid waste is used to produce electricity in an incinerator (see waste-to-energy facilities), this kind of ash may contain higher levels of contaminants than coal ash. In that case the ash produced is often classified as hazardous waste

Chemical composition and classification

Component	Bituminous	Sub bituminous	Lignite
SiO_2 (%)	20-60	40-60	15-45
Al_2O_3 (%)	5-35	20-30	20-25
Fe_2O_3 (%)	10-40	4-10	4-15
CaO (%)	1-12	5-30	15-40
LOI (%)	0-15	0-3	0-5

Impact of Fly ash on Environment:

According to a report about 195 million tons of fly ash is produced up to the year 2017 coal-fired power plants and slight amount produce by cement industries. The High generation rate of fly ash extremely effects the environment and adverse effects on human beings are follows:

- **Groundwater contamination:** Since coal contains trace levels of trace elements (like e.g. arsenic, barium, beryllium, boron, cadmium, chromium, thallium, selenium, molybdenum and mercury), fly ash obtained after combustion of this coal contains enhanced concentrations of these elements, and therefore the potential of the ash to cause groundwater pollution needs to be evaluated. In 2014, residents living near the Buck Steam Station in Dukeville, North Carolina, were told that "coal ash pits near their homes could be leaching dangerous materials into groundwater.

- **Spills of bulk storage:** Where fly ash stored in bulk it is usually practice to store fly ash in wet condition with respect to dry conditions to minimize fugitive dust the resulting impounds are typical and stable but any breach of their dams typically large and stable for long periods, but any breach of their dams or bunding is rapid and on a massive scale. In December 2008, the collapse of an embankment at an impoundment for wet storage of fly ash at the Tennessee Valley Authority's Kingston Fossil Plant effect a massive area of 5.4 million cubic yards of coal fly ash, damaging lot of properties and flowing into the Emory River and also the Cleanup costs may exceed $1.2 billion
- **Contaminants:** Fly Ash contains trace concentrations of heavy metals and other substances that are known to be detrimental to health in sufficient quantities. Potentially harmful toxic trace elements in coal include arsenic, beryllium, cadmium, copper, lead, mercury effect the environment.
- **Exposure concerns**: Crystalline silica and lime along with toxic chemicals represent exposure risks to human health and the environment. Although industry has claimed that fly ash is "neither toxic nor poisonous," this is disputed. Exposure to fly ash through skin contact, inhalation of fine particulate dust and ingestion through drinking water may well present health risks. Fly ash contains crystalline silica which is known to cause lung disease, in particular silicosis. Crystalline silica is listed by the IARC and US National Toxicology Program as a known human carcinogen.

Physical Impacts of Fly ash

A November 2009 report on the effects of coal by the Physicians for Social Responsibility (PSR) found that coal combustion affects not only the human respiratory system, but also the cardiovascular and nervous system. There are a number of negative health effects of coal that occur through its mining, preparation, combustion, waste storage, and transport. Negative health effects from coal use include:

- **Respiratory Effects:** Premature death: according to a 2004 report by the Clean Air Task Force, fine particulates from power plants result in nearly 24,000 annual deaths, with 14 years lost on average for each death.
- Coal combustion contributes to smog through the release of oxides of nitrogen, which react with volatile organic compounds in the presence of sunlight to produce ground-level ozone, the primary ingredient in smog. Air pollutants such as nitrogen dioxide (NO 2) and fine particulate matter adversely affect lung development. Air pollution triggers attacks of asthma, which now affects more than 9% of all U.S. children, who are particularly susceptible to the development of pollution-related asthma attacks. There are now tens of thousands of hospital visits and asthma attacks each year
- **Nervous System Effects:** According to the PSR report, the nervous system is also a target for coal pollution's health effects, as the same mechanisms thought to mediate the effect of air pollutants on coronary arteries also apply to the arteries that nourish the brain. These include stimulation of the inflammatory response and oxidative stress, which can lead to stroke and other cerebral vascular disease.

- **Cardiovascular Effects:** Air pollution is known to negatively impact cardiovascular health. The mechanisms have not been definitively identified, but studies in both animals and humans suggest they are the same as those for respiratory disease: pulmonary inflammation and oxidative stress. Pollutants produced by coal combustion can lead to cardiovascular disease, such as artery blockages leading to heart attacks, and tissue death and heart damage due to oxygen deprivation

Other effects Reduction in life expectancy (particulates, sulphur dioxide, ozone, heavy metals, benzene, radio nuclides, etc.),Black lung from coal dust, congestive heart failure (particulates and carbon monoxide),Non-fatal cancer, osteroporosia, ataxia, renal dysfunction (benzene, radionuclides, heavy metals, etc.),Chronic bronchitis, asthma attacks, etc. (particulates, ozone),Loss of IQ from air and water pollution and nervous system damage (mercury),Degradation and soiling of buildings that can effect human health (sulphur, acid deposition, particulates),Global warming (carbon dioxide, methane, nitrous oxide),Ecosystem loss and degradation, with negative effects on health and quality of life

Disposal and market sources of utilisation of Fly ash:

In the past, fly ash produced from coal combustion was simply entrained in flue gases and dispersed into the atmosphere. This created environmental and health concerns that prompted laws that have reduced fly ash emissions to less than 1% of ash produced. Worldwide, more than 65% of fly ash produced from coal power stations is disposed of in landfills and ash ponds, although companies such as Duke Energy are starting initiatives to excavate coal ash basins due to the negative environmental impact involved.

The recycling of fly ash has become an increasing concern in recent years due to increasing landfill costs and current interest in sustainable development. As of 2015, Indian coal-fired power plants reported producing 102.54 million tons of fly ash, of which 55.69 million tons were reused in various applications. If the nearly 47million tons of unused fly ash had been recycled, it would have reduced the need for approximately (34,900,000 m^3) of landfill space. Other environmental benefits to recycling fly ash include reducing the demand for virgin materials that would need quarrying and cheap substitution for materials such as Portland cement. Several technologies have been developed have been developed for proper utilization of Fly Ash under the unit of ministry of science and Technology Government of India .Many of the following uses are discussed further below. Coal ash uses include (approximately in order of decreasing importance):

- **Portland cement:** Owing to its pozzolanic properties, fly ash is used as a replacement for Portland cement in concrete. The use of fly ash as a pozzolanic ingredient was recognized as early as 1914, although the earliest noteworthy study of its use was in 1937. Roman structures such as aqueducts or the Pantheon in Rome used volcanic ash or Pozzolans (which possesses similar properties to fly ash) as Pozzolans in their concrete. As pozzolan greatly improves the strength and durability of concrete, the use of ash is a key factor in their preservation.

Use of fly ash as a partial replacement for Portland cement is particularly suitable but not limited to Class C fly ashes. Class "F" fly ashes can have volatile effects on the entrained air content of concrete, causing reduced resistance to freeze/thaw damage. Fly ash often replaces up to 30% by mass of Portland cement, but can be used in higher dosages in certain applications. In some cases, fly ash can add to the concrete's final strength and increase its chemical resistance and durability. Fly ash can significantly improve the workability of concrete. Recently, techniques have been developed to replace partial cement with high-volume fly ash (50% cement replacement). For roller-compacted concrete (RCC) [used in dam construction], replacement values of 70% have been achieved with processed fly ash at the Ghatghar dam project in Maharashtra, India. Due to the spherical shape of fly ash particles, it can increase workability of cement while reducing water demand. Proponents of fly ash claim that replacing Portland cement with fly ash reduces the greenhouse gas "footprint" of concrete, as the production of one ton of Portland cement generates approximately one ton of CO_2, compared to no CO_2 generated with fly ash. New fly ash production, i.e., the burning of coal, produces approximately 20 to 30 tons of CO_2 per ton of fly ash. Since the worldwide production of Portland cement is expected to reach nearly 2 billion tons by 2010, replacement of any large portion of this cement by fly ash could significantly reduce carbon emissions associated with construction, as long as the comparison takes the production of fly ash as a given.

- **Bricks:** There are several techniques for manufacturing construction bricks from fly ash, producing a wide variety of products. One type of fly ash brick is manufactured by mixing fly ash with an equal amount of clay, then firing in a kiln at about 1000 °C. This approach has the principal benefit of reducing the amount of clay required. Another type of fly ash brick is made by mixing soil, plaster of Paris, fly ash and water, and allowing the mixture to dry. Because no heat is required, this technique reduces air pollution. More modern manufacturing processes use a greater proportion of fly ash, and a high pressure manufacturing technique, which produces high strength bricks with environmental benefits. Ash bricks have been used in house construction in Windhoek, Namibia since the 1970s. There is, however, a problem with the bricks in that they tend to fail or produce unsightly pop-outs. This happens when the bricks come into contact with moisture and a chemical reaction occurs causing the bricks to expand.

In India, fly ash bricks are used for construction. Leading manufacturers use an industrial standard known as "Pulverized fuel ash for lime-Pozzolan mixture" using over 75% post-industrial recycled waste, and a compression process. This produces a strong product with good insulation properties and environmental benefits.

- **Embankment:** Fly ash properties are unusual among engineering materials. Unlike soils typically used for embankment construction, fly ash has a large uniformity coefficient and it consists of clay-sized particles. Engineering properties that affect the use of fly ash in embankments include grain size distribution, compaction characteristics, shear strength, compressibility, permeability, and frost susceptibility. Nearly all the types of fly ash used in embankments are Class F.
- **Soil stabilization:** Soil stabilization is the permanent physical and chemical alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load-bearing capacity of a sub-grade to support pavements and foundations. Stabilization can be used to treat a wide range of sub-grade materials from expansive clays to granular materials. Stabilization can be achieved with a variety of chemical additives including lime, fly ash, and Portland cement. Proper design and testing is an important component of any stabilization project. This allows for the establishment of design criteria, and determination of the proper chemical additive and admixture rate that achieves the desired engineering properties. Stabilization process benefits can include: Higher resistance (R) values, Reduction in plasticity, Lower permeability, Reduction of pavement

thickness, Elimination of excavation - material hauling/handling - and base importation, Aids compaction, Provides "all-weather" access onto and within projects sites. Another form of soil treatment closely related to soil stabilization is soil modification, sometimes referred to as "mud drying" or soil conditioning. Although some stabilization inherently occurs in soil modification, the distinction is that soil modification is merely a means to reduce the moisture content of a soil to expedite construction, whereas stabilization can substantially increase the shear strength of a material such that it can be incorporated into the project's structural design. The determining factors associated with soil modification vs. soil stabilization may be the existing moisture content, the end use of the soil structure and ultimately the cost benefit provided. Equipment for the stabilization and modification processes include: chemical additive spreaders, soil mixers (reclaimers), portable pneumatic storage containers, water trucks, deep lift compactors, motor graders.

- **Flow able fill:** Fly ash is also used as a component in the production of flowable fill (also called controlled low strength material, or CLSM), which is used as self-leveling, self-compact backfill material in lieu of compacted earth or granular fill. The strength of flowable fill mixes can range from 50 to 1,200 lbf/in² (0.3 to 8.3 MPa), depending on the design requirements of the project in question. Flowable fill includes mixtures of Portland cement and filler material, and can contain mineral admixtures. Fly ash can replace either the Portland cement or fine aggregate (in most cases, river sand) as a filler material. High fly ash content mixes contain nearly all fly ash, with a small percentage of Portland cement and enough water to make the mix flowable. Low fly ash content mixes contain a high percentage of filler material, and a low percentage of fly ash, Portland cement, and water. Class F fly ash is best suited for high fly ash content mixes, whereas Class C fly ash is almost always used in low fly ash content mixes.
- **Asphalt concrete:** Asphalt concrete is a composite material consisting of an asphalt binder and mineral aggregate. Both Class F and Class C fly ash can typically be used as a mineral filler to fill the voids and provide contact points between larger aggregate particles in asphalt concrete mixes. This application is used in conjunction or as a replacement for, other binders (such as Portland cement or hydrated lime). For use in asphalt pavement, the fly ash must meet mineral filler specifications outlined in ASTM D242.

Other applications include cosmetics, toothpaste, kitchen counter tops, floor and ceiling tiles, bowling balls, flotation devices, stucco, utensils, tool handles, picture frames, auto bodies and boat hulls, cellular concrete, Geopolymers, roofing tiles, roofing granules, decking, fireplace mantles, cinder block, PVC pipe, Structural Insulated Panels, house siding and trim, running tracks, blasting grit, recycled plastic lumber, utility poles and crossarms, railway sleepers, highway sound barriers, marine pilings, doors, window frames, scaffolding, sign posts, crypts, columns, railroad ties, vinyl flooring, paving stones, shower stalls, garage doors, park benches, landscape timbers, planters, pallet blocks, molding, mail boxes, artificial reef, binding agent, paints and undercoating’s, metal castings, and filler in wood and plastic products

The hydrophobic nature of fly ash gives pavements better resistance to stripping. Fly ash has also been shown to increase the stiffness of the asphalt matrix, improving rutting resistance and increasing mix durability.

- **Geopolymers:** More recently, fly ash has been used as a component in Geopolymers, where the reactivity of the fly ash glasses can be used to create a binder similar to a hydrated Portland cement in appearance, but with potentially superior properties, including reduced CO_2 emissions, depending on the formulation...
- **Metal matrix composites:** Hollow fly ash can be infiltrated by molten metal to form solid, alumina encased spheres. Fly ash can also be mixed with molten metal and cast to reduce overall weight and density, due to the low density of fly ash. Research is underway to incorporate fly ash into lead acid batteries in a lead calcium tin fly ash composite in an effort to reduce weight of the battery.
- **Waste treatment and stabilization:** Fly ash, in view of its alkalinity and water absorption capacity, may be used in combination with other alkaline materials to transform sewage sludge into organic fertilizer or bio fuel.
- **Fly Ash as a catalyst:** Fly ash, when treated with sodium hydroxide, appears to function well as a catalyst for converting polyethylene into substance similar to crude oil in a high-temperature process called pyrolysis. In addition, fly ash, mainly class C, may be used in the stabilization/solidification process of hazardous wastes and contaminated soils. For example, the Rhenipal process uses fly ash as an admixture to stabilize sewage sludge and other toxic sludge’s. This process has been used since 1996 to stabilize large amounts of chromium (VI) contaminated leather sludge’s in Alcanena, Portugal.
- **Mountaintop Removal:** In mountaintop removal mining, most common in the Appalachian region of the U.S., mountaintops are literally blown off to reach coal seams, with the waste products deposited into valleys below, causing permanent damage to the landscape and the local ecosystem. According to the Sierra Club, this practice has "damaged or destroyed approximately 1,200 miles of streams, disrupted drinking water supplies, flooded communities, eliminated forests, and destroyed wildlife habitat. Coal companies have created at least 6,800 fills to hold their mining wastes, and the government estimates that if this mining continues unabated in Appalachia it will destroy 1.4 million acres of land by 2020.

Conclusions& Recommendations

Fly Ash is potentially harmful source of pollution have negative effect on natural elements (water& soil) because of its Mineral composition as well as morphology and filtration properties. Utilisation of Fly Ash has already in varieties of construction works But yet more research needed and the change with Fly Ash to reutilise it with 100% following are the few of the many recommdations that can further enhance the utilization level of Fly Ash

1.
odernization of Coal based Thermal Power Plant Stations.
2.
hermal Power Stations have to ensure the utilization of Fly Ash itself.

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3.
he use of Fly Ash in Agriculture and waste land improvement has large potential.

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