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## 43. TACKLING FORMIDABLE INDUSTRIAL POLLUTION BY SOPHISTICATED AND ECO- FRIENDLY TECHNOLOGY

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### ABSTRACT

**T**he contemporary environmental awareness has emerged primarily from the concerns in the late 19th century about protection of the countryside in Europe and the wilderness in the United States and also from the health-issues ensuing the pollution during historic industrial revolution, took place in Britain in the 18th century. Its profound aftermaths such as climate change, urbanization, pollution and over-mining, etc. are challenging even the human existence, although there are certain benefits. It is no exaggeration to say that pollution will be a biggest cause of premature death since the estimations conclude that by 2050 there will be about 3.6 million deaths a year, most of them in China and India (OECD report). Although world leaders' perpetual attention and solidarity on this topic, for instance the Paris agreement on 30 November 2015 on climate change, are more commendable, it has fallen by the wayside.

In this research-initiative my paper would illustrate the use of sophisticated and eco-friendly technology to tackle the formidable challenges of industrial pollution. As the industrial activities are essential for an economy, citizens' well-being and maintenance of employment, its complete elimination is practically beyond the bounds of possibility. Hence, one of the key methods for getting rid of these challenges in the advanced world can be attained through the technological development.

My study focuses on industrial pollution and the use of advanced technologies, introduced as new industrial process or modification of existing one for reducing the impacts of the production on environment, such as accumulation of wastes, air pollution, water pollution and noise pollution, etc.

**KEYWORDS:** premature death, urbanization, sophisticated technology and modification,

### INTRODUCTION

It is virtually a truism that for several centuries, the environment has provided fit habitation for human being and numerous organisms in the face of considerable challenges. But, the last few decades the environment has been perpetually enduring excruciating pain by the insatiable appetites of humans. The major global ecological crises confronting the planet at

present are climate change, deforestation, land contamination and extinction of species of flora and fauna, etc. Many of these are formidable aftermaths of industrial revolution, the rapid development of industry that occurred in Britain in the late 18th and 19th centuries, brought about by the introduction of machinery. Subsequently, profit-making attitude of man excessively exacerbated and aggravated the limited natural resources. No one doubts that the intimidating Environmental challenges are serious threats to even the human existence.

The history of scientific awareness on environmental dates back to 1960s or even before, which was then followed by an intense socio-political awakening. Hence, Environmental degradation and climate change have been an important cornerstone of the global policies since a nation's environment is not its own but is shared with its neighbors and the rest of the world. Recent UN Climate Change Conference in Bonna, Germany on November and former Paris convocation on climate change in 2015 are historic watershed in the 21st century.

Out of these, climate change is a global environmental problem which has been catching intense political attention both at domestic and international levels. The United Nations Framework Convention on Climate Change (UNFCCC) defines 'climate change' as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. As increase in carbon dioxide concentration in the atmosphere is the prime cause of climate change, reduction in emission of this gas and its sequestration from atmosphere are the prime requirements for reducing climate change driven threats.

At present, industrial pollution constitutes major portion of causes of environmental degradation in general and climate change in particular. As industrial activities have played decisive role in advancement of human civilization, there is absolutely no doubt that the feasibility of environmental protection will be hardly ever accomplished without industrial process. Hence, there is no alternative but to fortify ramparts of sustainable development. A set of sustainable goals released by the United Nations in 2015 as

as a successor to the Millennium Developing Goals Officially known as 'Transforming our World: the 2030 Agenda for Sustainable Development', are hearty commendable.

In this advanced world, as everything is more convenient and accessible due to advances in technology across almost all sectors, clean and eco-friendly technologies are better preventive mechanism. Many countries made remarkable progress in recent decades in virtually all industrial sectors in terms of ecological efficiency of production processes by sophisticated technologies.

### **INDUSTRIAL POLLUTION: A BRIEF HISTORY**

While the Industrial Revolution meant that more goods could be produced for human consumption, it also meant that more pollution would be emitted into the sky and more natural resources would have to be exploited in the production process. Although pollution of major proportions has been a problem since the centuries preceding the middle ages, it is worth noting that after World War II, the type of pollution involved changed significantly with introduction of nuclear weapons.

In February 1950, a discussion on problems of nuclear energy was held, where Einstein said that the idea of national security through nuclear weapons was "a dangerous illusion." He also said that "radioactive poisoning of the atmosphere and hence annihilation of any life on earth has been brought within the range of technical possibilities." The only way out of the situation, Einstein said, is "a supra-national judicial and executive body" and "a declaration of nations to collaborate loyally in the realization of such a restricted world government." In 1952, with the break out of 'The Great Smog', which had caused 6,000 deaths within a year due to respiratory diseases, the Clean Air Acts of 1956 and 1968 were formulated. The smog was formed due to burning of coal in production processes. The awareness regarding the situation went on increasing around the 1970's, but the problem by then had taken a dangerous shape. Along with progress in production sectors and industry, the temperature of the earth has also been increasing. But faulty process designs and the greed for more production despite the environmental hazard are still going on. Some countries have formulated laws and regulations regarding the production process in order to ensure clean and safe environment, but when it comes to implementation most of the

countries have failed in fulfilling their duties. The following timeline reflects on the history of Carbon dioxide emissions:

### **INDUSTRIAL POLLUTION AND CLIMATE CHANGE IN INDIA: INSIDIOUS LINKAGE**

In this climate and pollution challenged world, public health is at serious risk from the ominous trends in toxic industrial pollutants and warming gases. industrial pollutants are under scientific scrutiny not only for what they do to our body and health, but also how they enhance climate impacts and associated health risks. Science does not allow us to keep the local public health impacts of industrial pollution and the global warming impacts of green house gases in silos anymore. The emerging science has given us more reasons to be worried about industrial pollution. This demands an integrated framework for mitigation to minimize public health risk.

The speed with which industrial pollution is growing across India is alarming. Close to half of cities are reeling under severe particulate pollution while newer pollutants like nitrogen oxides, ozone and- air toxics are worsening the public health challenge. As many as 95 per cent of Indians across the country breathe air quality that is worse than the WHO's recommended standards. The worrying trend is the proliferation of new hot spots every year. Smaller and more obscure cities are amongst the most polluted in the country. Some mega cities that have initiated some pollution control action in the recent years, have witnessed either stabilization or some lessening of the high levels. But several cities like Delhi, even after the initial stabilization are finding it difficult to sustain their air quality gains and are in the pincer grip of serious multi-pollutant crisis. It is worrying that even after decades of air quality management, particulate air pollution has remained among the top 10 killers globally with disproportionately high health impacts in the developing world. The recent global burden of disease (GBD) estimates shows that in India alone, more than 627,000 people die prematurely and 18 million healthy life years are lost every year due to ill health connected especially with the tiny particles. There are now myriad studies across the world and also in India to prove that outdoor urban air pollution is a serious environmental risk factor that causes or aggravates acute and chronic diseases. Also, given the latency period of toxic risk, Indian cities are likely to see more cancers due to increase in environmental health risk. This makes a strong

case for control of air pollution. Health criteria need to be built into the air pollution control policies more clearly.

Polluted air has also compromised the health of our future generations in cities like Delhi. Considerable evidence has come from the epidemiological study on children in Delhi carried out by CPCB and Chittaranjan National Cancer Institute in Kolkata and published in 2012. This study had covered 11,628 school-going children from 36 schools in different parts of Delhi and in different seasons. Every third child had reduced lung function. There is a marked increase in the number of bio-markers like alveolar macrophages (the first line of cellular defense against inhaled pollutants) in the sputum of children. This shows greater exposure to particulate pollution. Sputum Air Pollution and Climate Impacts: Demystifying Link of children in Delhi contains four times more iron-laden macrophages than those from cleaner environs, indicating pulmonary haemorrhage. The study found the level of these bio markers higher in children from areas with high particulate levels.

Studies are dominated by the focus on respiratory symptoms. But in the recent years, they have begun to include more diverse health end points – cardiac cases, cancer, mutagenic effects, etc. Though this investigation in India is still very nascent, global studies have made more robust linkages with a wide range of health endpoints – diabetes, stroke, hyper tension, effects on brain, effects on foetus etc. Given the fact that endpoint of all toxic risk is cancer, all environmental risk factors should be minimized. This is particularly serious in India that reports overall over 700,000 new cancer cases and National Cancer Control Programme (NCCP) forecast that by 2026, more than 1.4 million people will be falling in the grip of the disease. NCCP has listed greater exposure to environmental carcinogens as one of the most important reasons. The mitigation strategy must reduce environmental risk from all factors – and air pollution is an important factor. Numerous studies in the West assessed the causes such as genetic susceptibility, environment factors and lifestyle. This trend in public health risk is expected to get worse if the pollution trends remain business as usual and the global warming impacts get further enhanced.

#### **TERRIBLE EFFECTS OF INDUSTRIAL POLLUTION**

**Global Warming:** Global warming is among the most serious outcome of industrial pollution, witnessed on the account of the steady rise

of industrial activities. Industries release into the atmosphere a variety of greenhouse gases including carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). These gases absorb thermal radiation from the sun thereby increasing the general temperature of the earth, leading to global warming. It has several severe effects on human health and the environment. Rise in water levels, melting of glaciers, extinction of polar species, tsunamis, flooding, and hurricanes are some of the dire effects of global warming. Furthermore, global warming has threatened human survival and presented health risks such as the increased incidences of diseases like cholera, plague, malaria, Lyme disease and so on.

**Water Pollution:** Pollutants discharged from the industries have widespread implications, and one of the unpleasant effects is on water bodies. Industries demand lots of water for efficient production such as cooling, cleaning, and treatment and as such, the water drawn from the water sources is never the same after use. Inappropriate contamination of used water and the discharge of different waste water into water sources often result in water pollution. In most cases, the water is contaminated with dangerous chemicals, radioactive materials, heavy metals or organic sludge. For this reason, dumping of the wastewater directly into waterways or oceans negatively impacts on marine life, humans, and the environment on various aspects.

**Air Pollution:** Based on the increased counts of factories and manufacturing processes, both large and small scale, gaseous emissions have continued to compound. This makes industrial pollution one of main Causes of air pollution. The emissions from different industries contain gaseous contaminants such as sulfur, carbon dioxide (CO<sub>2</sub>), oxides of nitrogen, methane, and so on. These gases, when too much in the atmosphere, frequently results in several illnesses and environmental hazards. Formation of acid rains, the presence of smog, and heightened incidences of respiratory disorders among humans are some of the implications of air pollution.

**Soil Pollution:** Soil pollution occurs when the soil loses its fertility and structure owing to diverse natural and artificial phenomenon. Disposal of industrial wastes into landfills is among the artificial aspects contributing towards soil pollution. Industrial wastes have in them varied amounts of toxic materials and chemicals such that when deposited in landfills, it accumulates in the top soil thereby depreciating the fertility and biological activity of the soil due to soil poisoning. Such implications eventually

contribute to ecological imbalances thus creating problems in crop productivity. Apart from that, the chemicals and toxic materials in poisoned soils accumulate in plants grown in such areas causing health problems to those who consume such crops.

**Effect on Human Health:** The world Health Organization (WHO) revealed that outdoor air pollution accounts for about 2% of all lung and heart diseases. WHO also underscores, around 5% of all lung cancers and 1% of all chest infections are implications outdoor air pollution. In brief, these statistics indicate just how industrial air pollution depreciates human health. For instance, one of the worst industrial disasters of all times that took place in Bhopal, India, in 1984 claimed the lives of more than 8,000 people and the effects were still being felt more than two decades later. This means, industrial air pollution may not manifest immediately but takes several years.

Industrial toxic and chemical wastes that are disposed into water bodies or landfills are also responsible for cancers and human cell poisoning. For instance, exposure to inorganic arsenic causes tumors to form. Above all, industrial pollutants are responsible for thousands of illnesses and premature deaths across the globe.

**Wildlife Extinction:** The tendency of industrial and manufacturing processes that constantly demands production resources and repeated exploitation of raw materials has cumulatively led to the destruction of forests and the natural habitats that support wildlife. Acts such as mining, deforestation, and utilization of water resources for industrial production have destroyed natural habitats and forced organisms to move further into the wild, exposing them to predators and intolerable living conditions. Consequently, some wildlife species have faced extinction while several others remain highly endangered. Industrial wastes,

Chemicals, emissions, or accidental leaks, fires, oil spills and so on, have also been prime contributors to wildlife extinction. Furthermore, these environmentally damaging materials take several years to clean-up thereby compounding the effects. For example, the BP oil accidental spill in 2012 claimed thousands of marine life, and some of them were among the rarest species on earth. Even after some time had passed, marine animals continued to die.

### **ECO-FRIENDLY TECHNOLOGY AS A PREVENTIVE MECHANISM**

There is absolutely no doubt that injecting the awareness on impacts of environmental

degradation is proper method to protect environment. However, in this advanced world, clean technologies can play decisive role in reducing industrial pollution. Many countries have introduced eco-friendly technologies in industrial process. The following technologies are from different countries:

#### ***Semiconductor industry: innovation moves ahead:***

About 30% of the operations involved in manufacturing semiconductors consist of cleaning silicon wafers by means of large quantities of aggressive chemical solutions such as sulphuric acid. This is harmful to the environment, to which must be added the high costs involved, in particular because of the considerable quantities of de-ionized water (DI) needed. One of the main applications of the process is photoresist stripping. The Interuniversity Microelectronics Center (IMEC), a Flemish association which has become one of the world's leading independent microelectronics research centers, has developed an original alternative to photoresist strip-ping in partnership with a private German company of the Texas Instruments group.

The new technique combines the use of ozone (O<sub>3</sub>) with a DI boundary layer controlled process at the wafer surface. Its superiority over the conventional O<sub>3</sub>/DI technique is due to a stronger concentration of reactive ozone near the surface. The IMEC process avoids the use of sulphuric acid and reduces de-ionized water consumption by 90%. For a medium-sized company, this is tantamount to savings of 2 200 litres of sulphuric acid and 500 000 litres of DI water a week. The possible integration of the requisite hardware in existing equipment, moreover, limits the investment required.

The process has initially been incorporated in IMEC's semi-industrial production line before moving on to full-scale integrated circuit production units of Texas Instruments in Freising (Germany). The many changes made to the conventional system include the installation of an ozone generator. Because of the safety problem of releasing a large quantity of this gas into the air, initial experiments were carried out with an ozone-destroying catalyst conversion system, which has in the meantime been replaced by a thermal system operating at 90% efficiency. Experimenting with such systems under conditions of high steam concentrations in the exhaust circuit has been a "first" in this domain. Moreover, a secured ozone detector ensures protection of workers.

***Ecology and margarine: they are compatible:*** Manufacturing margarine normally generates considerable amounts of polluting waste.

Refining fats by means of sodium hydroxide leads to the formation of sodium soap which has to be eliminated by rinsing and through treatment with chlorohydric acid. This leads to large quantities of highly polluting waste water which has to be purified. The hardening of oil sand fats through hydrogenation involves hydrogen emission into the air. Emulsifiers and other chemical additives complete this brief overview.

Lasem Alimentación<sup>1</sup> used to apply these processes themselves until they decided to switch to sustainable growth and to develop a line of eco-logical products. They received LIFE funding for their project to produce ecological margarine manufactured with raw materials which were likewise ecological, using only clean technology without any chemical treatment and without generating any solid or liquid waste or pollutant emission.

Fats are refined in a physical process under vacuum at high temperature. After mixing, natural coloring and flavoring agents are added and the mixture is emulsified with water. The emulsion is then subjected to crystallization and crystal maturation and stabilization, followed by plasticization (high-pressure cooling). Hydrogenation and a number of other stages are eliminated. The new equipment used wards off risks of contamination and facilitates cleaning.

The raw materials used are coconut fat from coconut palms abundantly growing in the wild in the Philippines. One difficulty is to secure a regular supply of a product from untreated trees, extracted without solvents. Another raw material is sunflower oil which is available in Spain where the plants are cultivated without chemical treatment. In spite of the higher cost of the raw materials, the process consumes less energy and obviates the need for high expenditure on water purification and sludge treatment. It benefits from sound opportunities on a market which is increasingly open to ecological products. Highly innovative, this LIFE project also applies strategic planning which may be of interest to other agrifood producers and other industrial sectors.

Cleaner digital printing in the textile industry: In the Italian province of Como, printing on silk is a centuries-old tradition. However, it has inevitably had an impact on the environment, with large quantities of waste coloring agents and rinsing water, high energy consumption for drying, and noise. The LIFE Tie print project arose from the idea of combining this tradition and modern digital printing techniques to reduce these drawbacks and the costs involved. For this purpose, an SME, Stamperia di Lipomo, formed

a partnership with other local companies and with the Associazione Impresa Politecnico, which is specialized in management of new technology. Digital printing on fabric had been regarded as applicable only to small samples and had not moved beyond the experimental stage. With this LIFE project, the aim was to work out an innovative technique which could ensure regular production in a varied range of fabrics, responding to the growing interest in the textile sector among computer equipment manufacturers and software producers. After taking stock of the activities, costs and resources of the three companies, benchmarking digital ink jet printing techniques and trials with the model chosen (ENCAD/SOPHIS), the next step was to improve performance. For instance, the use of a spectrophotometer makes it possible to determine parameters on the basis of a fabric sample submitted by a customer and then print in the same colors, with savings in time, dye and energy. The results are highly illustrative: dye savings because of a 100% reduction in excess dyestuff, 60% reduction of waste water, 80% savings of thermal energy and 30% savings of electricity, 60% noise reduction and 60% reduction of production space required, and an overall reduction of costs. In addition to these benefits for the environment, there has been a major improvement in working conditions, with positive socio-economic effects. A challenge for the future is to ensure continuity of this activity and success in marketing the products.

Manufacture of diodes: less molybdenum along the Danube: At its ultramodern Vöcklabruck site, one of the major production units in terms of volume and quality, the Vishay Semiconductor Austria Company, which forms part of the Vishay Intertechnology Inc. group, manufactures about 200 million diodes a year. The diodes are used as fast rectifiers in a wide range of applications in the electronics industry, e.g. in switching circuits, fluorescent tubes, computers, monitors and TV sets and as electronic components in cars.

Production of the diodes involves the use of sintered molybdenum (Mo) pins. Before being used in the production process, the oxide film has to be removed from these pins. In the past, they had to be etched with nitric, sulphuric and hydrochloric acid for this purpose and then rinsed with water. The result was a very high concentration of Mo in the waste water discharged into the Vöckla River which eventually flowed into the Danube.

Both because of its desire to protect the environment and on account of new environmental legislation in Austria, Vishay has with LIFE funding developed a project

based on the industrial application of an entirely new technology to remove the oxide film through a mechanical process, barrel polishing, which acts through friction. A new soldering technique to assemble components has been introduced and a new soldering oven with a high precision control system has been installed. The result of the LIFE project has been a drastic reduction of molybdenum in waste water: 0.6 mg/l instead of 18 mg/l at full production capacity. The residual rate is due to the fact that a brief leaching stage is still necessary in producing the pins. In addition to this remarkable result, which also benefits other countries along the Danube, there have been substantial reductions in costs: lower cost of waste water treatment, less acid used and fewer diode rejects. The new process is easily transferable, and a second diode production line has been established at another Vishay production site, in Gyöngyös (Hungary).

Steel goes green - A cleaner steel industry thanks to electrolysis: The AvestaPolarit steel plant of Nyby/ Torshälla is difficult to find surrounded by nature and located some 100 kilometers west of Stockholm, not far from the attractive town of Eskilstuna which is renowned for its old forges. This comes as a surprise in particular to people who believe that steel production is inevitably associated with smoky industrial areas. But this is Sweden, a country with vast spaces where great care is taken to ensure that factories fit in with the landscape and the environment. At Nyby/ Torshälla, high trees surround the site, largely screening off the steel works. The Nyby plant is specialized in cold rolling of flat stainless steel products. The blast furnaces and hot rolling mills are installed at Avesta, 120 km to the north. Steel coils are transported by train or lorry from Avesta to Nyby where they are cold rolled into high-grade stainless steel. Every week the plant produces 3 500 tonnes of stainless steel, 70% of which is exported. It is used for plating high-speed trains, cladding buildings and telephone booths and to manufacture food equipment in accordance with European standards.

## CONCLUSION

The objective of the paper was to present the views on industrial pollution and its prevention by technologies have been widely accepted in the world. On any contentious issue, it is impossible to have 100% acceptance. No doubt, there are differing views on these dual issues. Each differing view has to be evaluated on its own merits.

It appears that polluted environment is global issue and world community would bear

worst results more as they already faced. In this advanced world, it is revealed that as everything is more convenient and accessible due to advances in technology across almost all sectors, clean and eco-friendly technologies are better preventive mechanism. Many countries made remarkable progress in recent decades in virtually all industrial sectors in terms of ecological efficiency of production processes by sophisticated technologies. It offers better environmental world that the dissemination of clean technologies among countries and the launching of new technologies by world wing.

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