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Hazardous Material And Industrial – Nuclear Disasters

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The thing that numbs the heart is this:
That man cannot devise
Some scheme of life to banish fear
That lurks in most men's eyes.

(James Norman Hall, *Fear*)

Hazardous Material: A Cause for Grave Concern

The Industrial Revolution illumined the path to rapid industrial growth carried out to fulfill ever-increasing human requirements. This process disturbed natural elements and created ecological imbalance. Increasing population, emission of carbon dioxide and other toxic gases by factories and vehicle, occurrence of acid rains, nuclear tests and poisonous chemicals have posed a serious threat to the existence and continuance of life on our beloved planet. After much environmental loss, man has now realized the need for protection of life on this solely live planet. World-wide activities are afoot to protect the environment and hence to save life on this beautiful planet. Environmental conservation is now the prime and global concern of mankind.

Hazardous Chemicals

There are many chemicals and other material which do or may cause enormous damage to the environment or life. These are generally termed as 'hazardous chemicals and material'. These include gases like chlorine and phosgene, which choke respiration and cause death. A similar chemical is methyl isocyanate. These were used as chemical weapons first by the Germans and later by the Allies in World War I. Hydrogen cyanide or cyanogen gas is another hazardous chemical. It blocks red blood cells from taking up oxygen. Other examples are sulfur gas and Lewisite, also dispensed as a gas, which burn and blister the skin. There are a host of nerve agents such as Tabun, Sarin, Soman, and VX, which block the transmission of nerve impulses to the muscles, heart, and diaphragm. Botulinum and ricin are also hazardous.Sulphur dioxide (SO_2) is an extremely irritating gas or liquid. It is used in many industrial processes, especially the manufacture of sulphuric acid. When dissolved in water, it forms sulphurous acid (H_2SO_3), which is highly suffocative. Sulphur dioxide emanating from the chimneys of industries, dissolves with water vapours in the air and causes acidic rains which cause harm to animal and plant life. There are many chemicals like Sulphuric Acid (H_2SO_4) which are hazardous owing to their corrosiveness. Nitric Acid (HNO_3) is also a fuming corrosive liquid, which is used in the production of fertilizers, explosives and rocket fuels. Nitric oxide (NO) is a poisonous gas which is produced as an intermediate during the manufacture of nitric acid from ammonia or nitrogen. Nitrobenzene

($C_6H_5NO_2$) is also a poisonous organic compound. Nitrochloroform is a poisonous gas. TNT (Trinitro Toluene) is a powerful explosive. Nitrogen dioxide (NO_2) also called nitrogen peroxide is a mildly poisonous gas, often found in smog and internal-combustion engine exhaust fumes. Nitroglycerine ($CH_2NO_3CHNO_3CH_2NO_3$) also called trinitroglycerin, is explosive on concussion or exposure to sudden heat. It is used in the production of dynamite and blasting gelatine. Mustard gas $(ClCH_2CH_2)_2S$ is used in warfare as a gaseous blistering agent. Dynamite is a powerful explosive composed of nitroglycerin or ammonium nitrate dispersed in an absorbent material such as wood pulp and an antacid such as calcium carbonate.

These chemicals are hazardous and are sometimes used for destructive activities.

Other Hazardous Material

In 1896, Henri Becquerel discovered radioactivity in a Uranium salt. H.G. Wells, the celebrated science fiction writer, wrote *The World Set Free* in 1914, in which he gave an uncomfortably accurate picture of the effects of radioactive contamination after a nuclear war. In 1895, Robert Cromie predicted the atom bomb in his novel *The Crack of Doom*. In 1898 Marie Curie and her husband discovered two other naturally occurring, strongly radioactive elements, Radium and Polonium. The radiation is emitted by unstable atomic nuclei as they attempt to become more stable. The main processes of radioactivity are Alpha Decay, Beta Decay, and Gamma Decay. Radioactive and nuclear emissions may be most hazardous. Nuclear explosions and experiments cause radioactive hazard. Effusion of wastes from nuclear reactors assumes the form of radioactive pollution. Radioactive wastes are Plastic, Lead (Pb), Caesium (Cs)-137, Strontium (Sr)-90, Nickel (Ni)-59, Carbon -14, Uranium (U) and Radionuclei. Besides these Uranium, Radium, Thorium (Th) -232, Potassium (K) and Manganese of Carbon may also cause radioactive pollution. Radioactive pollution has the following adverse effects on human health:

- formation of blisters on the skin and causation of itching;
- erosion of epidermis, bleeding and formation of deep wounds in the long term;
- thinning and falling of hair;
- gases emitted during nuclear fission cause immediate formation of blisters on the skin and on reaching the lungs they cause lung cancer;
- causation of sterility due to inactivation of reproductive glands;
- causation of genetic mutation;
- causation of death of foetus in the womb;
- causation of blindness following damage to lenses;
- causation of cancer and other deadly diseases;
- formation of clots in the blood and development of anaemia.

In addition to causing harm to human health, the radioactive and nuclear emissions have a ghastly injurious effect on animal and plant life as well as environment. Atomic explosion releases Carbon Monoxide which diffuses with clouds and destroys everything. Radioactive emission sticks to plants and causes damage to their elements. Eating of fruit and leaves of such plants causes different diseases of the nervous system, acceleration of the ageing process, leukaemia and bone cancer in humans and other animals. The ionising radiation induces radiation sickness, which ranges in severity from nausea, vomiting, headache, and diarrhoea to loss of hair and teeth, reduction in red and white blood cell count, extensive haemorrhaging, sterility and death. Ultraviolet radiation is that portion of

the electromagnetic spectrum which extends from the violet end of visible light to the X-Ray region. Most UV rays from the Sun are absorbed by the Earth's Ozone layer. It has been reported that this protective ozone layer is being constantly depleted by chemicals like chlorofluorocarbons (CFCs), which are widely used as refrigerant and aerosol propellants.

CFCs released into the atmosphere rise into the stratosphere, where solar radiation breaks them down; the chlorine released reacts with Ozone, depleting the ozone layer. The UV radiation from the Sun has harmful effects like sunburn, suntan, ageing signs, and carcinogenic changes.

Industrial Nuclear Disasters

The human history is replete with tragic industrial-nuclear disasters, chiefly caused by the hazardous material. Some of the horrifying events may be illustrated here.

The Bhopal Gas Tragedy

The Bhopal Gas Tragedy is considered the world's worst industrial disaster. It happened on the night of December 2 and 3, 1984 at the Union Carbide Pesticide Plant in Bhopal. The extremely hazardous Methyl Isocyanate (MIC) gas and other toxic chemicals were used by the plant to manufacture pesticides. During the catastrophe, a backflow of water into a MIC tank caused its leakage, which spread over the nearby shanty towns instantly killing 2259 people. The State Government affidavit (given in 2006) shows that the accident caused 558, 125 injuries including 3900 permanently disabling injuries. Other sources estimate 8000 deaths within two weeks, and another 8000 deaths up to now. Civil and criminal cases were filed against Union Carbide Corporation and Warren Anderson (the then CEO), who died in Florida (USA) on September 29, 2014. In 1989, Union Carbide Corporation paid $470 m to settle the litigation following the disaster.

The Chernobyl Disaster

The Chernobyl disaster was the worst nuclear power plant accident in the human history. It occurred on April 26, 1986 at the Chernobyl Nuclear Power Plant in the town of Pripyat in Ukraine (the erstwhile USSR). It began during a systems test at reactor number four of the plant. There was a sudden and unexpected power surge. An emergency shutdown was attempted which resulted in an exponentially larger spike in power output rupturing a reactor vessel and causing a series of steam explosions. The graphitemoderator of the reactor was exposed to air, causing it to ignite. The resulting fire sent highly radioactive fallout into the atmosphere and over an extensive area extending from western Soviet Union to Europe. A second, more powerful explosion took place about two or three seconds after the first. This explosion dispersed the damaged core and ejected superheated lumps of graphite moderator. The ejected graphite and the demolished channels caught fire on exposure to air, greatly contributing to the spread of radioactive fallout and the contamination of outlying areas. This nuclear excursion released 40 billion joules of energy, the equivalent of about ten tons of TNT. On the International Nuclear Event Scale, the Chernobyl disaster was a level 7 event (the maximum classification). The only other nuclear disaster of the same scale was the Fukushima Daiichi nuclear disaster, which took place in 2011.

Impact of the Disaster

Human Impact

In the aftermath of the accident 5722 casualties were reported among Ukrainian cleanup workers up to the year 1995. In contrast, only 150 casualties of the Belarusian emergency workers were reported by the mid-1990s. 237 people suffered from acute radiation sickness, of which 31 died within the first three months. 28 emergency workers died from acute

radiation syndrome including beta burns and 15 patients died from thyroid cancer in the following years. It is estimated that cancer deaths may reach a total of about 4000 among the persons residing in the contaminated areas. Fred Mettler, a radiation expert at the University of New Mexico puts the worldwide cancer deaths at about 5000, for a total of 9000 Chernobyl – associated fatal cancers. Another study indicates that in Belarus, Russia and Ukraine the accident could have resulted in 10000-200000 additional deaths in the period between 1990 and 2004. Annals of the New York Academy of Sciences (published in 2009) states that the medical records between 1986 (the year of the accident) and 2004 show that 985000 premature deaths have occurred as a result of the radioactivity released.

Impact on Environment

After the accident, the radioactive contamination of aquatic systems became a major problem. In the most affected areas of Ukraine, levels of radioactivity in drinking water caused serious concern during the weeks and months after the accident. A 30 metre deep underground barrier was constructed to prevent groundwater from the destroyed reactor from entering the Pripyat River, which feeds into the Dnieper reservoir system that supplied water to Kiev's 2.4 million residents.

Disastrous impact of the accident was also noticed on flora and fauna. Four square kilometres of pine forest near the power plant turned reddish-brown and died. It was then named the 'Red Forest'. Some animals in the worst-hit areas also died or stopped reproducing. Horses on an island in the Pripyat River (6 Kilometres away from the power plant) died when their thyroid glands were destroyed by radiation. Some cattle on the same island died and those which survived were stunted because of thyroid damage. Bio-accumulation of radioactivity in fish exceeded the concentrations recommended for consumption. The after-effects of the accident are feared to be seen for a further 100 years.

The Petlawad Explosion

A heart-rending chemical disaster took place on September 12, 2015 at Petlawad, district Jhabua, in Madhya Pradesh. Rajendra Kasawa, the accused, had rented space in a warehouse near the local bus stop. Here he stored some gelignite sticks, probably for industrial use. However, it was illegal to store those explosives in a residential area. The initial police report states that a cooking gas cylinder exploded in a nearby crowded restaurant, which triggered the second explosion where stored sticks of gelignite exploded. Further police investigation showed that the initial explosion was in the warehouse.

Impact of the Explosion

Reports say that the explosion killed 105 people and caused more than 150 non-fatal injuries. Eye-witnesses say that the bodies of the deceased were flung in pieces to great distances . The body-parts, limbs and heads, were found hanging on trees and walls. A **Hindustan Times** report (September 13, 2015) said "People were thrown away like pebbles ". The explosion also damaged the building in which the restaurant was located as well as the building where the explosive material was located.

Aftermath

The news of the explosion stirred waves of terrible shock amongst the people. It was reported globally. ***The New York Times***, gave wide coverage to the accident with the article " Explosion in India Town Kills Dozens". ***Hindustan Times*** published the article " Petlawad tragedy grim reminder of MP's thriving explosives bazaar." Madhya Pradesh Police carried out a searching investigation of the incident. A judicial enquiry, headed by the retired high court judge, Shri Aryendra Kumar Saxena, was constituted by the M.P. State Government, which also gave a

compensation of Rs. 200000 to each of the kin of the deceased and of Rs. 50000 to each of the injured.

Peroration : Disasters and the Future of Life on Earth

By their very nature, the manufacture, storage and transport of chemicals as well as handling of nuclear material is hazardous. Chemicals are corrosive, toxic and they may react explosively. At the same time, inadvertent use of nuclear material may be catastrophic. The impacts of chemical and nuclear accidents may be deadly for humans as well as plant and animal life, and also the environment. If life is to be sustained on earth, man will have to design chemical and nuclear power plants with better safety controls that operate at lower temperatures and pressures. He will have to use less toxic and hazardous material. Man has already set foot in this direction by development of 'Green Chemistry'. The celebrated Indian atomic scientist. H.J. Bhabha summarising the course of human history, rightly said in one of his articles:

"In a broad view of human history, it is possible to discern three great epochs. The first is marked by the emergence of the early civilization in the valleys of Euphrates, the Indus and Nile; the second by the industrial revolution leading to civilization in which we live and the third by the discovery of atomic energy and the dawn of the atomic age."

Energy is the prime mover, which makes multitude of our daily activities possible. It makes possible life itself. Bhabha said further : "the discovery of atom has brought about a tremendous change in the energy pattern of society. It involves both a hope and danger. However there is not much reason to doubt that the intelligence of man shall overcome his fear and weakness." It is strongly hoped that the human intelligence will find out the ways and means for sustaining life on this beloved planet. It is not out of place in this regard to quote the words of a Greeck philosopher: "Give me not immortal life, but let me explore the frontiers of possibility".

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