Chapter 8: Studying the Productivity improvements resulting from improvements in EHS Culture and Hygiene Index Levels

Introduction:
Integrated Iron & Steel industries produce a lot of pollutants in the environment – both working and ambient environment. In the manufacturing processes, metals are extracted and produced from ores by various metallurgical processes, are accompanied by evolution of heat, noise, dust fines, fly-ash, oxides of Nitrogen, Sulphur oxides and metals. Particulate matters are generated in large quantities during loading and unloading of raw materials, coke preparation, agglomeration, iron making, steel making and through other various processes. Gaseous matters like gases, vapours, fumes and smoke are produced during melting and pouring operations. The major pollutants like NOx, SOx, Dust etc., are emitted from various work areas in Iron Making Zone like cast house, stock house, and in Steel Making Zone ladle heating, LD Furnace, pouring, heat treatment etc. Pollutants are also emitted in sintering, pelletisation, rolling mills, coke-oven plants, refractories etc. in steel making and by-products recovery.

General Health Hazard Of Integrated Iron & Steel Plant:

Many people are exposed to common air pollutants in their occupations e.g. Smoke, Dust, PM, Carbon Mono-oxide, Sulphur dioxide, Oxides of Nitrogen (Nox), Hydrocarbons, and Heavy Metals like Pb, Cd, Cr, As, Ni etc. Their prolonged exposure causes various health hazards. Heavy metals cause acute and chronic poisoning. Some fugitive gaseous and dust emissions may cause primary occupational health problems to the workers engaged in the different processes, gaseous and dust emissions from the steel making process pose potential health risk to the populations residing in the surrounding areas. Black lung, metal fume fever, silicosis, pneumoconiosis etc. are all occupational maladies which are attributed to inhalation of one or other type of fine dust particles.

Some general health hazards are caused as a result of contact between the pollutants and the body. These hazards are as follows:

- Eye irritation.
- Headache.
- Nose and throat irritation.
- Irritability of respiratory tract.
- Gases like hydrogen sulphide and ammonia cause odour nuisance even at low concentrations.
- High temperature can cause fatigue and dehydration.
• Chronic pulmonary diseases like Bronchitis and asthma, are aggravated by a high concentration of SO\textsubscript{2}, NO\textsubscript{2}, and Particulate Matter.
• Carbon monoxide combines with the hemoglobin in the blood and consequently increases stress on those suffering from cardiovascular and pulmonary diseases.
• Dust particles cause respiratory disease. Diseases like silicosis, asbestosis etc. result from specific dust.
• Carcinogenic agents like PAH’s, Cr(VI), Cd etc. cause cancer.
• Hydrogen fluoride causes diseases of bone (fluorosis) and mottling of teeth.
• Certain heavy metals like lead, cadmium, mercury, chromium, nickel, manganese etc. enter into body by inhalation, skin absorption and through food chain. They cause acute and chronic poisoning.

**Particulates (Dust):**

Air has tiny solid particles or fine liquid droplets suspended within it often called particulates. Usual concentrations are invisible but high concentrations can be seen as a haze, a mist or smoke especially when accompanied by condensing water vapour. The large majority are less than a hundredth of a millimetre across and are known as PM tens (PM\textsubscript{10} = particle ten micrometres = 10\textmu m). The fraction of the PM\textsubscript{10}’s which are thought to be the most poisonous are less than 2.5 micrometres across and are called PM\textsubscript{2.5}’s. The smallest of the particulates are the ultrafine particles which are smaller than 0.1\textmu m across (PM0.1) and often contain less than a million molecules. There are many millions of PM\textsubscript{10}’s suspended in each cubic metre of even clean air.

The chemistry of suspended particulate matter is varied and depends upon the source and can contain carbon, nitrates, sulphates, metals, polycyclic aromatic hydrocarbons etc. When coal or wood is burnt, many of the poisonous emissions start as vapour but quickly condense onto surfaces such as the inside surface of chimney stacks. Particles are the main delivery system for many of the inhalable poisons.

**Health Effects of Dust**

PM\textsubscript{10}’s are readily inhalable and because of their small size are not filtered and penetrate deeply into the cardiovascular system where they cause damage. Those smaller than 2.5 um penetrate deeper than those closer to 10um. Mainly because of their physical properties, they have a strong association with most types of respiratory illness and even mortality. They also have a strong association with circulatory (heart disease and strokes) disease and mortality. Particles allow many chemicals harmful to human health to be carried to many
of our internal organs causing a wide range of illness and mortality including cancer, especially lung cancer, brain damage and damage to the unborn child.

**Noise:**

Noise is one of the physical environmental factors affecting our health in today's world. Noise is generally defined as the unpleasant sounds which disturb the human being physically and physiologically and cause environmental pollution by destroying environmental properties.

**Health effects of noise**

Noise causes a wide range of health effects, including:

- sleep disturbance;
- cardiovascular effects;
- damage to work and school performance;
- hearing impairment including tinnitus.

To assess the health gains of reducing noise levels, experts drew the following conclusions on exposure-response relationships.

Sleep disturbance: Noises disturb rest and sleep. One may feel exhausted after one night's exposure in noises. This condition continuing for a long time may lead to Neurasthenia.

Cardiovascular effects: Among other non-auditory health endpoints, short-term changes in circulation including blood pressure, heart rate, cardiac output and vasoconstriction, as well as stress hormones have been studied in experimental settings for many years. Classical biological risk factors have been shown to be elevated in subjects that were exposed to high levels of noise. In the past several years, epidemiological evidence was accumulated supporting the hypothesis that persistent noise stress increases the risk of cardiovascular disorders including hypertension and ischaemic heart disease.

Loss of Work efficiency: Noise has negative impacts on cognitive performance. For recall and reading, a reduction of the day and night noise level by 5 dB(A) within the range of 65-80 dB(A) was shown to improve performance by almost 10%. For attention and memory, a 5 dB(A) reduction in average noise level results in approximately 2-3% improvement of performance. These adverse impacts of noise on cognitive performance can lead to a reduction in the productivity at work and the learning performance at school.

Hearing impairment: Studies and data are not sufficient to derive relationships between community or social specific noise exposure and hearing impairment in adults and children. Nevertheless, assuming that social noise is not
significantly different from occupational noise and that the equal energy principle is applicable, exposure-response curves can be established on the basis of International Organization for Standardization (ISO) standard 1999 (on determination of occupational noise exposure and estimation of noise-induced hearing impairment), which uses an audiometric threshold shift at 4 kHz.

**Health effects of sulfur dioxide**

**Main Routes of Exposure:** Inhalation.

Inhalation: VERY TOXIC, can cause death. Can cause severe irritation of the nose and throat. At high concentrations: can cause life-threatening accumulation of fluid in the lungs (pulmonary edema). Symptoms may include coughing, shortness of breath, difficult breathing and tightness in the chest. A single exposure to a high concentration can cause a long-lasting condition like asthma. If this occurs, many things like other chemicals or cold temperatures can easily irritate the airways. Symptoms may include shortness of breath, tightness in the chest and wheezing. \{Reactive Airways Dysfunction Syndrome (RADS)\}.

Skin Contact: CORROSIVE. The gas irritates or burns the skin. Permanent scarring can result. Direct contact with the liquefied gas can chill or freeze the skin (frostbite). Symptoms of mild frostbite include numbness, prickling and itching. Symptoms of more severe frostbite include a burning sensation and stiffness. The skin may become waxy white or yellow. Blistering, tissue death and infection may develop in severe cases.

Eye Contact: CORROSIVE. The gas irritates or burns the eyes. Permanent damage including blindness can result. Direct contact with the liquefied gas can freeze the eye. Permanent eye damage or blindness can result.

Effects of Long-Term (Chronic) Exposure: May harm the respiratory system. Can irritate and inflame the airways.

**Health Hazards of NOx:**

Particles - NOx reacts with ammonia, moisture, and other compounds to form nitric acid and related particles. Human health concerns include effects on breathing and the respiratory system, damage to lung tissue, and premature death. Small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease such as emphysema and bronchitis, and aggravate existing heart disease.

Water Quality Deterioration - Increased nitrogen loading in water bodies, particularly coastal estuaries, upsets the chemical balance of nutrients used by
aquatic plants and animals. Additional nitrogen accelerates “eutrophication,” which leads to oxygen depletion and reduces fish and shellfish populations. NOx emissions in the air are one of the largest sources of nitrogen pollution in the Chesapeake Bay.

The works area where employees are working in hazardous area having all types of hazards such as pollutants, noise, toxic gases, heat and any noxious substances, have been improved by implementing and enforcing the flowing safety measures.

- Works Layout
- Ventilation System
- Heat Shield against the radiation heat
- Dust extraction and suppression system
- Noise reduction through use of acoustic materials
- Separation of two equipment to reduce the noise level
- Less exposure of workforce through administrative controls
- Training and education about the hazards
- Use of suitable Personal Protective Equipment to reduce the hazard

The improvement of works environment results better Hygiene Index ranking.

**Improvement of Manpower Productivity**

<table>
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<tr>
<th>Plant</th>
<th>Old Units</th>
<th>New Units</th>
<th>Dust</th>
<th>Noise</th>
<th>Man power productivity</th>
<th>Dust</th>
<th>Noise</th>
<th>Man power productivity</th>
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<tr>
<td>Sinter Plant</td>
<td>62-4836</td>
<td>79.6-108</td>
<td>33572</td>
<td>37-2511</td>
<td>74.8-105</td>
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<td>84.4-110.8</td>
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<td>2077</td>
<td>87.1-103</td>
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<td>Coke Oven</td>
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<td>80.2-109</td>
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<td>162-407</td>
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<td>66.2-107.5</td>
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<td>62.9-103.9</td>
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<td>93-104</td>
<td>16278</td>
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</table>

** Plant is not running full capacity.

**Table-13**

From the above Table, it is observed that the productivity improves in well maintained works environmental conditions.