CHAPTER – I
INTRODUCTION

New technological developments in industry today produce seven times more goods than it did some fifty years ago. It has served as an indispensable engine of growth, in modern societies and is essential to developing countries like India, in meeting the growing need of our people. While industrial development has brought obvious benefits, it has also frequently entailed risk of damage to the human health and environment. The growing priority given by workers and employers organizations to protecting and improving the health of workers and their working environment is a logical extension of their long standing concern for the conditions of work and life of working populations.

One of the technologies, which have been practiced right from the birth of the civilization, is the technology of metal casting. Founding or metal casting is the primary processes of manufacturing metallic products. Foundry technology deals with the technology of metal casting which has been in vogue since the beginning of civilization. Foundry is the mother industry and castings are the backbone of all industrial growth. For example axle heads made of copper used to be cast about 6000 years ago. Life sized portrait head of cast bronze, aged 2250 B.C. have been excavated from Mesopotamia. Grave slabs and cannons shots made of cast iron have been in use for more than 1000 years. The first foundry was set up in China during the Slang Dynasty (1766- 1122 BC) and Abraham Darby established the first cast iron foundry in England in the year 1709.
Earliest Indian castings can be traced to prehistory. The excavations at Mohenjodaro (3300-2000 B.C.) unearthed metal articles many of which must have been produced by castings. The first castings were of copper and copper based images, domestic utensils, art work, from periods of history and all regions of the country are available to show that the art of casting was widely known and practiced in India. The art of casting continued through the centuries as an important metal working craft, attaining great heights of technical and aesthetic perfection. Even today the Indian cast handicrafts in brass, iron and silver constitute as an important item of export from India.

Modern foundry industry has made its beginning in India in the 19th century. The foundry of the Hooghly Docking and Engineering Company was started at Howrah, near Calcutta in 1819. Foundry industry shows tremendous growth, both in volume and variety. In India large number of foundries of all types are present. Totally 5000 foundry units are present in India. More than 95% of foundries are in small sectors; with wide variation in sizes, products, technology standards and work culture. In India of all the foundry units having an installed capacity of approximately 7.5 million tons per annum, amongst which around 95% of them fall under small scale industry category. Foundries in the small and medium industries sector in India occupy a place of special importance in shaping the Indian economy. A peculiarity of the foundry industry in India is its geographical clustering. Each foundry cluster is known for catering some specific end use markets. Five major clusters in India are at Belgaum, Batala or Jalandhar, coimbatore, Kolhapur and Rajkot.
India is 6th largest producer of casting in the world after U.S. China, Japan, Russia and Germany. India ranks 2nd next to China when global rank in terms of operating units.

1. FOUNDRY INDUSTRY IN AND AROUND KOLHAPUR:

Foundry Industry occupies a key role in the economy of the country. It gives direct employment to about 25% of all industrial labor. The foundry industry has an important role to play both in economic stability of the country and in supply of essential quality castings to the various industries. In the present competitive global market, thrust areas of castings are automobile, railways, power plants, cement plants, chemical plants, sugar industry and windmill etc.

Kolhapur over the last decade has emerged as a leading industrial center catering to the automobile, truck, tractor, sugar industry and other industrial segments, through the network of large number of small scale industries.

Kolhapur is considered as the city of foundries, number of renowned industrialist have established foundries in Kolhapur various small scale industries have also started which are related with foundries. Foundry industry mainly produces castings which are required for automobile industry, sugar industry, printing machines, agriculture and farm equipments and various other industries.

In Kolhapur foundry units were located at three different regions, MIDC Gokul Shirgaon, MIDC Shirol, and in Udyam Nagar area which is located in the heart of city. In Kolhapur about 60 foundry units were present in which nearly 10,000 workers are working. This industry play key role in the economy of our state. Thousand of male workers attend the foundry work for 8-10 hours of the day and workforce employed were considered, with planned economic
development of the country; centers of foundry industry have spread in all regions, so that regional distribution is now much more balanced. This has greatly helped by providing more employment opportunities and ensures the effective utilization of regional raw materials. As a result more foundries had come up in the last few years in several states. India totally produces 3.12 million tones of castings of different types. Foundry technology in India has made significant advancement during the last decade.

With rising demands for casting as per international standards melting of metal is gaining more importance in metal casting production units. As molten metal plays an important role in producing quality castings choosing of proper melting route has become an equally important factor.

The art of founding or casting, as it is commonly called, involves the pouring of molten metal in to mould made to the external shape of the article to be cast. The mould may contain a refractory core which determines the dimensions of any internal cavity or hollow. Molten metal is introduced into mould. After cooling, the mould is subjected to a shake out procedure which releases the casting. The casting is then cleared and surplus metal was removed from it. Ferrous foundries produce iron and steel castings. Non-ferrous foundries include castings of copper based alloys (brass and bronze), aluminum, lead, Zinc, magnesium and other alloys.

Kolhapur is located in state of Maharashtra. It is an important foundry cluster of 250 foundry units for automotive castings requirement of the local industries like oil engine manufacturing, sugar mills, and machine tools industries. The geographical spread of the cluster includes Kolhapur, Sangali, Ichalkaranji and Hatkanangale areas.
In Kolhapur foundries are different from one another in many ways. They range in size from small operations to the large production type that turns out thousands of tons of castings each day. The majority of foundries fall in the small to medium size range, many being classed as jobbing foundries. They differ in the size of casting produced, ranging from a few pounds to multi tons. In majority of foundries copula furnace is used for melting metal, while in some foundries electric arc and induction furnaces are used. Experts have observed that Electric Arc Furnace (EAF) and Induction Furnaces (IF) are proper melting routes in terms of quality of molten metal, cost and fuel saving. Foundries are also differed in material melted, such as gray iron, steel, brass etc. Some of them were highly automated, completely manual or somewhere in between.

3. WORK PLACE IN FOUNDRY INDUSTRY

In the iron foundry, thousand of workers were working in various sections like sand plant, fettling section, moulding section, furnace section and core shop. Thousand of to foundry workers attend the foundry units at least of 8 to 10 hours of the day. In the foundry series of processes take place and the work is mechanized. Many times the worker carries out same task all throughout day and on every working day of the year. The worker does only the job that he has been given to do. In exchange, worker receives a wage in cash.

3.1 UNITS IN FOUNDRY

1. Sand Plant:

Sand moulds are commonly used for iron foundries. To produce depression in the sand into which the metal is poured. A pattern of the object to be cast has formed. Hard woods, metals or resins are used by pattern makers. In the sand
plant silica sand is mixed with coal dust and organic binders like bentonite powder or dextrin. Silica sand was brought from coastal areas like Vengurla, Fonda and from coastal regions of Sindhudurg district, as well as coastal areas of Gujarat and Kattach etc. This sand was light brown in color. All these components are mixed well with the help of mixer. The moulding sand from previous pouring is also recycled; water and organic binders were added to the sand before it is reused.

2. Fettling Shop:

The main activities of this section include shot blasting, fettling and grinding. In these processes castings are cleared and dressed to remove any extra metal, rough surfaces, sand other material left from moulding processes.

In shot blasting processes, castings are kept in the shot blasting machine, in the machine small steel shots or balls present which are strike over the castings from all sides, so that castings are cleaned and all adherent sand is removed. In the process of shot blasting large amount of silica and coal dust is generated in the nearby area. During grinding and fettling rough and unwanted surfaces of castings are removed. So castings become smooth and clean. In the grinding and fettling large amount of dust and noise is produced.

3. Moulding Section:

In this section different activities are carried out which includes mould making, casting, pouring of molten metal, knock out, decoring processes and preparation of laddles or buckets, while making mould two half portions of mould boxes were used, one is called as pattern box. In both the boxes mixture of prepared sand is poured with the help of shovel or by using automated moulding
machine, which is operated by molder. Then sand is properly rammed into it cores was placed properly. Both the portion of boxes were used one is called as pattern box, and both are kept accurately one above other, fixed with fastener. Then box is passed ahead for pouring the molten metal.

At the time of pouring, molten metal temperature ranges between $1450^\circ$C to $1500^\circ$C. It is carried in the ladle. Ladle is operated by two workers, with the help of pulley system and whose weight is approximately 500 Kg. Then the worker pours the metal into mould box. After 4 to 5 hours of cooling process, mould boxes are carried forward for knock out. In knock out process mold boxes is kept on the vibrator, which is operated by worker and boxes are vibrated so that mould boxes broken down and inside castings were removed. This process is called as decoring and casting are further cleaned.

4. Furnace Section:

In this section charging, melting slagging and refining processes are carried out. For charging pig iron, C.I. scrap, steel, limestone, coak etc. were used. One charge of furnace consist of about 50 Kg of pig iron + 100 Kg of C.I. scrap + 12 Kg of limestone + 15 Kg of cook + 15 Kg of steel + 500 gm of silicon + 1 Kg of manganese + 500 gms of chromium and 50 gms. of inoculent. The quantity of material depends upon capacity of furnace. Now a days in majority of foundries electric arc furnaces are used for proper melting routes in terms of molten metal, cost and fuel saving. In the foundries melting is started at 9 A.M. for proper heating and obtains the required temperature for electric arc furnace requires 30- 40 minutes. Melting of metal temperature is controlled manually by a worker and $1450^\circ$C to $1500^\circ$C temperature is achieved within 30 minutes from electric arc furnace. After getting proper temperature in the furnace slag is
removed by the workers and at the time of pouring entire furnace is lifted slowly which was controlled by worker and then poured into the ladle. Ladle is then carried towards respective mould boxes for pouring the molten metal. Maintenance of furnace includes cleaning the furnace, removing the attached metal of furnace, checking inner layer and electric cables, coils and sealings.

5. Core Shop:

Cores are made and inserted into the mould in order to determine the internal configuration of a hollow casting. The core must be strong enough to withstand the casting process but at the same time must not be too strong as to resist removal from the casting during the knocking out stage. Core mixture comprises sand and binders, to give necessary strength such as linseed oil, dextrin, which are dried in oven and produce a core.

Cores are made from core sand to which an organic (resin) binding agents are added. The processing of these traditional cores involves oven curing or stoving. For curing various synthetic resins are used. Curing is achieved by chemical reaction and heating the core at temperature 260\(^\circ\)C to 300\(^\circ\)C for about three to five minutes. Then core box was removed from the core furnace or automated core machine, then baked cores was removed and kept for cooling. Inner cavity of cores and outer margins with surplus material are removed and cores are finished.

4. MAN AT WORK IN FOUNDRY ENVIRONMENT:

People work in different professions, occupations, fields such as industries, factories, workshops, agriculture, poultry, and laboratories and so on. Every occupation has its own environment in which people work. All
occupational environments have their own factors that affect the people. It has, therefore, become imperative to study occupational environment and through this study a wakening amongst people about their environment and the effect on them can be brought to their notice and action.

Urbanization, industrialization and ignorance of people about the vital importance of environment have created problems in their day to day life, in their professions, occupations, in almost every field of work and employment. It produces occupational environmental disorders and diseases.

Industrialization, directly and indirectly, have a substantial effect on population. But industrialization is invariably associated with adverse health effects, in the form of various types of health hazards such as silicon dust causing disease (silicosis), cotton dust causing diseases (byssinosis), noise induced hearing loss or even deafness, coal dust causing diseases (pneumoconiosis) to name a few important ones, air and water pollution, various types of accidents causing disability or even deaths due to lack of adequate safety measures etc.

The physical agents in working environment which may be adverse to health of worker are temperature, humidity, air movement, noise, vibrations, light, radiation etc. These factors act in a different way on the health and efficiency of the worker and affects working capacity of workers. In spite of these the amount of working and breathing space, drinking water, washing and recreation facilities, toilets are also important factors in the occupational environment.
The chemical agents in the working environment include fumes of toxic chemicals, dusts, toxic gases, toxins which causes health hazards due to exposure. Some chemical agents and toxic fumes cause respiratory illness some causes injury to skin, eyes etc. and other organs of body.

The biological agents like microbes, fungi and parasitic agents affect on their close contact and also contaminate water, soil and food material. Thus, intermixing of physical, chemical and biological agents severely affects the occupational or working environment, which disturbs the physiological mechanisms in the body of workers.

In the foundry shed, the foundry workers attend the work in various sections for 8 to 10 hours. The work is mechanized. The foundry workers carry same task on all the days and on every working day of year.

In the foundry operations, the workers are exposed to lot of occupational health hazards and stresses, which arises due to moving machinery, excessive noise, vibrations, inadequate light, metal dust, silica dust, coal dust, toxic fumes and higher temperature. Because of illiteracy most of the worker never think or worry about the air they breath, but we must think about them; because they are one of the most important component of total working environment which fulfill the most of the need of automobile, railway, sugar, printing and agricultural industry.

In foundry processes of different sections large quantity of fly dust of silica, metal and coal is produced toxic fumes chemicals which are extremely harmful and primary cause of respiratory illness in the workers. It may also cause irritation and damage to skin. In the foundry shed due to moving
machinery high intensity noise and vibrations are produced which affect not only hearing but also their other organs like nervous and cardiovascular system. The poor illumination affects visual system of workers, leading to decreased productivity. The temperature inside the foundry shed and near the core shop and furnace section is much higher causing heat stress. Profuse sweating due to heavy work load and higher temperature from the furnace make the intermixing effect on workers by disturbing the thermoregulatory mechanisms in the body of workers.

Besides the above stresses, important factor which can be seen in each section of foundry is the working conditions and work environment. The occupational environment or working conditions are most important and significant component of environment in which the worker spends greater part of time all the day and on every working day of year. The provision of adequate nutrition, drinking water, housing and facilities for recreations and culture are the necessary part of social policy, which from significant connection between the working and living status of workers.

5. SURVEY OF LITERATURE:

Foundry industry date back to the sixteenth century in Brazil and at present it has occupied global existence practically all the countries as a strong economic activity.

The industry has always remained in the limelight due to poor occupational environment imposed on its workers. The workers working in the foundry industry are prone to face a number of stresses. The workers are excepted to work tirelessly even as they encounter these stresses. The workers
working in the foundry industry are exposed to severe degree of heat load. Parikh et al., (1977), Saha (1978) have also reported very severe degree of heat stress in the foundry shop at Ahmedabad and Mumbai. Cardiovascular changes during thermal stress are reported by Rai and Ambwany (1980). Physiological responses during work in hot environment have been reported by Sen Gupta et al., (1981). Effect of heat stress on plasma ionic composition was studied by Gill et al., (1984). Effect on glucose electrolyte due to severe heat stress has been reported by Bondopadhyay et al., (1989).

Silica is probable human carcinogen which induces pulmonary dysfunction. Tanaka et al., (1960) reported that in Japanese coal miners tend to suffer from silicosis due to mixed coal and silica dust. Respiratory abnormalities among iron and steel workers have been reported by Johnson et al., (1985). Respiratory diseases in foundry workers were studied by Low et al., (1985). Miller et al., (1985) has reported dust exposure pneumoconiosis and mortality of coal miners. Different factors which affect the lung cancer incidence in foundrymen have been reported by palmer et al., (1986) in relation to core makers and fettlers. Respirable coal dust exposure leads to progressive and massive fibrosis was studied by Hurley (1987). Silica dust is cytotoxic and problem of dust in silica refractors has been reported by Nair et al., (1988). Risk of lung cancer among Japanese coal miners has been reported by Motonobu et al., (2001). Occupational asthma was studied in diamond polisher by Wilk Rivard et al., (2001). Silicosis in sand blasting section under uncontrolled and primitive conditions in foundries in Turkey is reported by Cimrin et al., (2003).

Silicosis is chronic fibrotic disease of the lungs resulting from prolonged and intense exposure to free crystalline silica. Silicosis caused by inhalation of
dust containing free silica or silicon dioxide was first reported in 1947 in India. In
the Kolar gold mines and has since been reported in various other mines and
industries like coal, mica, silver, lead, zinc and manganese mines, pottery and
ceramics, sand blasting, metal grinding, iron and steel industries and several
others.

Elemental composition and source investigation of particulates
suspended in the air of iron foundry has been reported by Zhang et al., (1985). Environ-
mental protection with respect to iron foundry was studied by Kiss et al., (1985). Iden-
tification, assessment and control of fugitive particulate emissions
were reported by Wallace et al., (1985). Studies on occurrence of trace elements
in respirable coal dust have been reported by Sahoo (1991). Environmental dust
hazards and its control in slate pencil industry have been reported by Ghodasara
et al., (1992). Air pollution mitigation strategy in Indian foundries has been
reported by Rao (1996). Environmental dust exposure study in agate grinding
unit has been carried out by Ghodasara et al., (1997).

Singh and choudhary (1992) has been reported work place noise
problems in fabrication industry. Effect of noise on hearing ability of workers bas
been reported by Pal et al., (1992). Occupational health hazards in industries
due to noise pollution have been reported by Madhu and Ravichandran (1999).
Status of noise pollution level in Rourkela industrial complex was described by
Naik and Purohit (2001).

Effective flame retarded fabrics and protective clothing has been
developed by Misuchutin et al., (1986). Similar visual disturbances among
workers exposed to triethylamine in a foundry in Japan have been reported by
Yoshida et al., (2001). Triethylamine is used as catalyst in core making process
of foundry shop. Postural stress test was described, for the clinicophysiological

Pulse rate elevation of arterial pressure and urinary excretion during local
monotonous factory work has been studied by Smirnov et al., (1975). Stress
induced modulation of the immune response was studied by Monjan et al.,

Industrial hand injury among workers has been revealed by Anakhia et
al., (1992). Workers taking addictive substances specially alcohol also reported
higher injury rates.

In (2007) Saha et al., has been revealed a comparison of cardiac strain
among drillers of two different age groups in underground manual coal mines in
India.

Occurrence of silicosis in manufacture of electric cables has been well
recognized in four cases by Fahrettin Talay et al., (2007). Crystalline silica in
respirable dust samples has been determined by infrared spectrophotometer in
presence of interferences by Jun Ojima (2003). Serum angiotensin converting
enzyme activity and serum copper levels in covert silicosis has been revealed by
Tiwari et al., (2005). Pulmonary effects of silica dust in asymptomatic agate
workers have been reported by Rastogi et al., (1988). In 2008 Jinkai et al., has
been revealed computed tomography in diagnostics of small opacities and
complications in silicosis in mine machinery manufacturing workers. Pingle et al.,
(2008) has been reported that neopterin is used as biomarker of cell mediated
immunity and used as biomarker in silicosis and other occupational diseases.
Lung contamination among foundry workers has been studied by Kallomaki et
Tuberculosis and silica exposure in South African gold miners has been reported by Nande (2006). Risk assessment of chronic poisoning among Indian metallic miners has been revealed by Dhatrak et al., (2010). In 2010 Mathur et al., described pattern and prediction of mortality in sandstone quarry workers. Assessment of air pollution and its effects in the health status of the workers in beam rolling mils factory (Iran National Steel Industrial Group) from Ahvaz Iran has been reported by Masoud Rafiei et al., (2010). Maximal expiratory flow volume values evaluation among female quartz grinders has been carried out by Rao et al., (2010). Heat exposure effects among fire fighters have been reported by Patel et al., (2010). Respiratory effects due to occupational exposure to formaldehyde studied by Mathus et al., (2007). Mortality in the U.K. industrial silica sand industry and assessment of exposure to respirable crystalline silica dust has been revealed by Brown et al., (2005). Lack of association between cytokine gene polymorphism and silicosis and pulmonary tuberculosis in Chinese iron miners has been reported by Wu Fen et al., (2008). Acute silica toxicity, attenuation by amiodarone induced pulmonary phospholipidosis has been revealed by Antonini et al., (1994). Silica dust exposure and non malignant respiratory disease mortality among silicotic workers in Hong Kong, exposure response analysis have been reported by Tse et al., (2004). Exposure of silica dust and lung cancer mortality among silicotic workers in Hong Kong, exposure response analysis has been studied by Yu et al., (2004). In 2004 Kakooeil et al., have been reported the effect of coal dust exposure on respiratory systems of coal mine workers in Iran.

Mortality in U.K. industrial silica sand industry, assessment of exposure to respirable crystalline silica has been carried out by Brown et al., (2005).
6. RESEARCH WORK ON FOUNDRY INDUSTRY FROM THIS LABORATORY:

Division of physiology from Dept. of Zoology is extensively engaged in occupational research. The laboratory work related with textile industry, dairy industry, sugar industry and exercise physiology was carried out successfully. Recently work related with occupational hazards and stresses in foundry industry has been undertaken.

As a part of study in foundry industry, survey of foundries, work place study of different sections, physical characteristics and physiological responses of workers were carried out. Hematological study of workers was also carried out from foundry workers. Research work related with foundry industry was also presented in different national and international conferences. In previous study More and Sawant (2001) monitoring of indoor environment was made it has been observed that the workplace environment in foundry was extremely adverse More and Sawant (2001). We have also studied impact of foundry environment on physiological reactions of rat. Alterations in leucocytes in animal model rat exposed to foundry environment have been studied. We have also reported physiological profile of foundry workers in response to workplace environment. It has been observed that noise level in fettling shop ranges from 102-105db. hematological parameters also studied which shows that hemoglobin level of most of workers was above 10% in fettling section significant changes in WBCs were observed More and Sawant (2003). All these observations form part of the present study.
7. Occupational health Hazards:

Urbanisation, industrialization and ignorance of people about vital importance of environment have created problems in their professions, occupations, in almost every field of work and employment. It produces occupational environment disorders and diseases.

The term health is positive and dynamic concept and suggests more than absence of illness. The W.H.O. has defined health as a state of complete physical, mental and social well being and not just absence of disease or infirmity.

As large number of workers spends a great deal of their time in an industrial setting, their working environment is not usually conductive to a healthy life. Moreover Malnutrition, unhygienic and Psychological conditions and the strains and stresses under which they live affect their health. On the one hand efficiency in work is possible only when worker is healthy. On the other hand, the industry in which he is employed exposes him to certain hazards which he would not meet elsewhere and which may affect his health.

Workers in industrial areas are often subject to certain health hazards and occupational diseases. Normal occupational health hazards may be classified in to physical, chemical, biological, environmental and psychological hazards. An individual worker may be exposed to these types of hazards depending upon his occupation.
THE ENVIRONMENTAL FACTORS RESPONSIBLE FOR OCCUPATIONAL HAZARDS AND DISEASES

A) PHYSICAL FACTORS FROM ENVIRONMENT

1. Heat
   a) Heat pyrexia (High fever)
   b) Heat exhaustion (weakness).
   c) Heat syncope (Giddiness)
   d) Heat cramps (contraction pain).
   e) Burns.

2. Cold
   a) Trench foot (Feet with cracks cuts)
   b) Frost bite (cuts due to very cold temp)
   c) Chilblain "(Painful swelling on hands ears and feet)

3. Light.
   a) Occupational cataract. (artificial)
   b) Miner's nystagums (abnormal eye movement)

4. Pressure - In different steam merhains, explosive factories Deep sea diving.
   a) Caisson's disease (Due to reduced pressure disorder in Chest)
   b) Air Embolism
   c) Blasts.
   d) Increased hydrostatic pressure.

5. Noise Machines, Blast Bombs,
   a) Occupational deafness.

6. Radiations
   Exposure to 'X' rays, cosmic ray: and 'UV' rays,
   Infrared
a) Skin cancer.
b) Leukemia (Blood cancer).
c) Aplastic anemia
d) Pancytopenia (formation of abnormal cells)

7. Mechanical Factors

Machineries, Tools, Equipment.

a) Injuries.
b) Accidents.

8. Electricity

Electricity boards, High power thermal projects & electrical establishments.

a) Shocks.
b) Burns.

B) CHEMICAL FACTORS FROM ENVIRONMENT RESPONSIBLE FOR OCCUPATIONAL HAZARDS AND DISEASES:

1. GASES OCCUPATION EFFECT

INDUSTRY

1. So₂ Powerhouse, H₂SO₄ Suffocation, Irritation of throat, Respiratory Diseases.
   Petroleum, Domestic Use of fuel.

2. H₂S Rayon plants, Irritation of Respiratory tract.
   Petroleum, Sewage Treatment plants, Dye Manufacturing,

3. NO₂ Acid Factories, Irritation Bronchitis,
   Automobile exhausts, Oedema of lungs.
Explosive Industries.

4. HF  Fertilizer factories  Flores's molting of Chemical and Aluminium Industry. teeth irritation.

5. CO  Fuel gases, Exhausts, Poisoning, Mines


7. HCN  Production of Cyanamid Respirator difficulties.

8. HCL  Acid industries. Respiratory difficulties.

(2) DUST  Mines, - Asthmatic allergy, (Inorganic)

1. Pneumoconiosis  - This produces lung fibrosis reducing the working capacity of people. Hazardous effects of inorganic dust on lungs depend upon chemical composition, fineness, concentration in air, period of exposure and health status of the people.

2. Silicosis  - Caused due to inhalation of particles of free silica or silicon dioxide. It is very common in mining industry of coal, mica, gold, silver, lead, zinc, Manganese, Pottery industry, Ceramic industry, Metal -grinding, building and construction work, Rock mining, Iron & steel industry.

3. Anthracosis  - Caused due to inhalation of very fine coal dust in coal mining and collieries.
4. **Asbestosis** – Asbestos is a silicate combined with Mg, Fe, Ca, Na, Al. Asbestos particles enter lungs, causing lung fibrosis, Respiratory insufficiency and death. It may produce cancer of gastro intestinal tract and of bronchi.

5. **Siderosis** - Due to fine iron dust, which enters lungs & Intestinal tract, creating injuries in lung alveoli and intestinal mucous membrane. It is seen in the people working in Iron, steel factories, leth machines & iron grinding industry.

**Organic** - It is also known as vegetab1e dust.

- **Cane fiber** - Inhalation of sugar cane dust causes breathlessness, cough, haemoptysis in workers in sugar-cane industries.

- **Cotton dust** - Causing Byssinosis in people working in textile industry, Ginning and pressing factories. Empnvsoma (i.e. closure of some alveoli in lungs) and bronchitis - occurs in workers.

- **Tobacco** - Tobaccossis is seen in workers of Bidi, factories, cigars & cigarette factories. Fine tobacco particles enter lungs & intestinal tract. May get circulated in blood causing heart attack. Workers smoking chewing tobacco get the cancer of mouth, throat, & lungs. Chowing tobacco with panbahr is extremely dangerous. Nicotine present in tobacco causes these disorders. Tobacco smoke contains CO, Nitros amines. Nicotine, Polycyclic aromatic hydrocarbons. In cigarette smoke Benzophyrene is present in addition to above chemicals.

- **Hay or Graindust** - Moist grain dust carries bacteria and fungi especially Hicropolyspora. It causes disorder in the lungs of farmers, and agricultural labors

(C) **Metals and their compounds responsible for occupational hazards**
People working an environment concerning extraction of metals, alloy making industries, ‘plumbing industries, Ayurved medicines wherein Mercury, arsenic are used, electroplating industry.

a. Lead – Present in a environment of storage batteries making industry, glass manufacturers, Printing press, Pottories, rubber industry and the most harmful load environment is produced by the petrol, gasoline used as a fuel in automobiles Toxic effects are abdominal pain, constipation, blue lines of gums, anemia. Organic lead leads to insomnia, headache mental confusion and delirium.

b. Mercury - It produces skin-rashes vomiting.

c. Cadmium - Vomiting, diarrhea, abdominal pain, pulmonary oedema, Dyspnoea, Bone marrow depression.

d. Manganese - Environment in manganese mines produces Psychosis, Parkinsonism, encephalitis' and pneumoconiosis.

e. Chromium - Environment of paint producing industries, Chromate, cement producing Industry, photography and off-set printing material's. Workers in these Industries and in painting work show oedema of fingers, fissures in skin and some vesiculation on skin.

f. Nickel - Environment produced in manufacture of metal article: alloys, electroplating, production of electric wires, hair dressers, tailors and even in cashiers who count nickel containing coins. Skin becomes red, swollen and develops skin eruptions on face and eyelids.
(D) Acids, alkalis and Pesticides responsible for occupational hazards.

Chemical factories where acids, alkalis and pesticides are manufactured create hazardous environment which produces harmful disorders on skin, lungs, intestinal tract, and central nervous system.

E) Solvents

Chemical factories manufacturing solvents like \( \text{CS}_2 \), \( \text{C}_6\text{H}_6 \), trichloroethylene and \( \text{CHCl}_3 \) create a hazardous environment which produces harmful effects on lungs, intestinal tract, central nervous system and cancer leading to death.

Psychosocial Hazards:

The psychosocial hazards arise from the workers failure to adapt to unfamiliar psychosocial environment. Lack of job satisfaction, insecurity, frustration, poor human relationships, emotional tension, are some of psychosocial factors which may damage both the physical and mental health of the workers.

The capacity of mind to adapt to different working environments is influenced by many factors such as educational background, social habits, family life and what the worker expects from employment. The health effects include psychological ill health, including fatigue, headache, pain in shoulders, neck and back hypertension, heart disease and rapid aging.

8. ERGONOMICS AND PROCESS MANAGEMENT IN FOUNDRY INDUSTRY:

Ergonomic process management is foundry industry is a process where by foundry organizations can achieve improvement in workers performance,
quality, efficiency and health with comfort at work place. This can be accomplished by eliminating ergonomic hazards that present the potential for injuries, occupational hazards and other losses. It is an ongoing process. Ergonomic process management in foundry industry is a behavioral engineering approach or human factor engineering approach to solving ergonomic problems. It is based upon the ergonomic objective i.e. the improvement of human health, safety and performance, through the application of sound people and work place principles. The intent of this process is to establish the best way to perform each task through input from individuals involved in the activity. It requires comprehensive examination of every task with safety and comfort.

Occupational environmental stresses arising from environmental health hazards, which leads to produce many disorders. It may be psychological, physiological or environmental. Health hazards in the foundry industries are numerous, just like any other industrial sector and are the result of adverse working conditions, which reflects on the workers health and also on the working efficiency.

In Kolhapur, foundries are established more than 40 years ago. Initially furnace used in the foundry was cupola but now days, to save energy and minimize the pollution; induction furnace and electric arc furnaces are used. But working conditions remain constant and the manual works remain as it is; only some part of work becomes automated. It increases the risk of accidents and makes work more difficult.

The foundry workers work for 10-12 hours per day with very short rest pause. He is paid poorly for the hard work he does every day. Worker is illiterate, poor and undernourished with the responsibility of his family.
The workplace environment is hot, not well ventilated, loaded with high noise and vibrations, some sections are poorly lit with uncomfortable conditions. The air filled with repairable size silica dust, coal dust, metal dust, toxic fumes and musty and metallic odour, hot conditions, lack of cleanliness in the foundry environment. Which causes stress to the workers. Ergonomically speaking, the workplace and machine layout is improper. The workers have to work in a stooping or bending posture, which causes muscular strain and fatigue. The improper workplace layout increases chances of accidents. The unfavorable workplace environment and the aggregated effect of stresses cause physiological, psychological and socio-economic problems besides the general physical strain of overwork on the foundry workers.

9. OCCUPATIONAL HAZARDS IN FOUNDRY ENVIRONMENT:

In each sector of foundry industry, environmental conditions are adverse which affect the health and comfort of workers.

In sand plant, sand reclamation is carried out. Sand is mixed with bentonite powder and coal dust. Old used sand is also recamated. In this activity large amount of coal dust and silica dust was produced.

In core shop cores are made. Sand which is used for core making is coated with liquid resin. During stoving of cores, 300-350° c temp is required. So resinous sand melts and polymerizes to a hardened state. Generally cores with hollow interior are called as shell process. Initially in the core box oil is used which work as catalyst. During stoving from the core box, toxic fumes are generated which are inhaled by the workers, leading to irritation of throat and
also affecting vision of workers. While stoving the cores, sometimes workers have to face physical injuries like burns.

In the moulding section, mould making, casting, pouring knock out and decoring processes are carried out. While making the mould large amount of dust is produced. At the time of ramming in to mould box, high intensity noise is produced and workers have to work in awkward body postures. During pouring hot splashes from the molten metal come out leading to burn injuries. The hot molten metal also irritates eyes of workers due to radiant energy. While pouring the metal into the mould box; toxic fumes come out from the gas vent.

In the furnace section, melting slagging, refining, ladle making processes are carried out. While melting and slagging workers come in contact with intense radiant heat. From the electric arc furnace different gases are also emitted like CO, SO$_2$, H$_2$s, and dust (P.M.), metal dust and fumes are emitted in the foundry environment.

In the fettling shop, shot blasting, fettling, chipping, grinding etc. activities are carried out. In this section due to shot blasting high amount of silica dust and coal dust is produced. During fettling chipping and grinding, high intensity sound and metal dust is produced which lead to eye irritation and hand injuries like cut. Injuries due to manual handling of materials and due to fall may occur. Grinding wheels used for dressing result in hand injuries.

**OCCUPATIONAL STRESSES IN FOUNDRY:**

Stress is a discomfort caused by intrinsic factors called as stressors, which produces changes in normal functions of man, both physical and mental. These effects of stress may be either reversible or irreversible.
Occupational stress can be defined as an additional stress on body and mind, arising due to individuals occupation or employment.

Occupational stress is further divided into many types like physical, chemical, mechanical, socio-economic, psychological, physiological etc. Physical stress originates due to muscular work which may be static or dynamic, various physical factors act as stressors, it includes dust, heat, illumination, vibrations, excessive noise etc. Chemical stress is caused due to chemicals used in various processes from which toxic vapors, fumes and gases are released in foundry environments. Mechanical stress is developed due to mechanical work, repeated cycles of similar work leading to stressful conditions of workers. Workers also show socioeconomic stress. Many workers have very low wages, they have no job guarantee. Some workers also work under psychological stress also called as mental stress. It is due to monotones work, due to responsibilities and worries and as well as family relations of workers and these factors leads to stress on different organ systems of workers. Sometimes workers have to face injuries and burns at work place.

In the foundry operations the workers are exposed to most of occupational health hazards and stress factors. The occupational health hazards in foundry can arise for example due to preparation (mixing) of sand, high concentration of silica dust is produced. In the foundry excessive noise, heat, metal dust, inadequate illumination, vibrations, gases and vapors are present which may result in risk of physical injury to workers.

Dust from foundry shake out and returns to sand handling system is composed of sand particles which are fractured by heat binders such as bentonite, (cereal), clay etc. Dust from casting cleaning equipments. Such as
shot blasting machines, tumblers, vibrators and grinders contains all these particles and large percentage of iron dust particles. Foundry environment also contain other irritants like formaldehyde, isocyanates various amines and phenols. These contaminants are generated primarily by the core making and molding processes and irritates the eyes and respiratory tract.

The working environment in foundry is much noisy and damages not only the workers hearing but also their other organ systems like cardiovascular and nervous system. In the fettling shop, noise level is considerably high, and workers are exposed to noise level over 100 db. Grinding and chipping tools used in dressing operations cause vibrations are other physical factors. These physical factors of working environment are highly important as they are dealt within International Labor Organization Standards as a separate subject. Workers are not always conscious to noise.

In addition to dust, the air in foundries contains other irritants like formaldehyde, isocyanides, various amines and phenol. These contaminants are generated primarily by the core making and moulding processes and irritate the eyes and respiratory tract. Thus possible secondary effect of exposure is an increased risk of accident.

Workers also face serious burn injuries from splashes of molten metal in the melting and pouring areas of foundries. Eye injuries due to fragments of metal occur in fettling shop. Injuries related to the manual handling of materials and due to falls also occur. Grinding wheels used for dressing small castings results in hand injuries.
10. ANIMAL MODEL IN RESEARCH:

The term “Animal Model” is commonly used. A definition may help to clarify the context of the term. The American National Research Council Committee on Animal Models for Research and Aging drafted the following definition. “An animal model for biomedical research is one in which normative biology or behavior can be studied, or in which a spontaneous or induced pathological process can be investigated and in which the phenomenon in one or more respects resembles the same phenomenon in humans or other species of animals.” Animal models used in biomedical research, particularly those used in the study of diseases and other conditions in humans.

An animal model is a living, non-human animal used during the research and investigation of human disease, for the purpose of better understanding the disease without additional risk of causing harm to an actual human being during process. The animal chosen will usually meet a determined taxonomic equivalency to humans, so as to reach to disease or its treatments and cures for human diseases have been developed with the use of animal models.

Medical advancement of the last hundred years has depended on research with animals. Animal studies have provided the scientific knowledge that allows health care providers to improve the quality of life for human and animals by preventing and treating diseases and disorders and by easing pain and suffering.

Laboratory animals and farm animals have been used for studies in toxicology, microbiology nutrition, psychology immunology and surgery for many years. In experimental medicines certain physiological and psychological process in humans can be studied using human models but hypothesis about abnormality and spreading of disease in human body can not be tested directly.
Therefore, various species of animals are required for the studies of pathophysiological processes and evaluation of toxicity. The World Health Organization has also recommended that toxicological and biochemical studies should be carried out in animals prior to the use of drugs and chemicals in human body. From laboratory animals especially among rodents, the rat has been extensively used for toxicological work. The rat is ideal species for toxicological studies in pneumoconiosis as model of environmental pollution. The rats were preferred for studying bronchopneumonia and other related changes in lungs. The other toxic symptoms in rat are very similarly observed in human body.

The study of environmental hazards relates to the determination of physical, chemical and biological agents that affect normal health conditions of human beings. The quality of air, soil, water and food is affected by activities of many forms of life including humans. The increased growth rate of human population, industrialization and development of modern technology have contributed towards the rapid changes in our environment, particularly pollution of natural air and water resources. The nature of pollutant varies from physical agents such as radiation noise, chemicals such as industrial waste products, fertilizers, pesticides and biological agents such as algae, fungi and microbes. Experimental animal model have been used to test the effects of many of these potential health hazards. The effect of certain pollutants in the environment on experimental animal able to illustrate their effects on health problems of human. Therefore, animal model were developed for the study of environmental health hazards.

Animal research has contributed immeasurably to our understanding of tumors and lead to the discoveries of most cancer treatment and therapies. All
cardiovascular advances, including the heart lung machine, the cardiac pacemaker and coronary bypass, could not have been possible without the use of animals. The other discoveries made possible without the use of animal research, including understanding of DNA, X-rays, radiation therapy, hypertension, artificial hips, joints and limbs, monoclonal antibodies, surgical dressings, ultra sound, the artificial heart and the C.T. scan.

Knowledge obtained from animal research has contributed to a dramatically increased human life span; the most significant areas in which animal experimentation contributes to human health in inhalation toxicopathology are the elucidation of pathogenesis and determination of quantitative scaling factors for extrapolating results from animal model to human subjects experimentally and or environmentally exposed to pollutants.

The rat is an ideal species for study in occupational, environmental and toxicological studies because most of the information about its behavior, anatomy, physiology and genetics are well known and hence, results obtained from rats can be correlative or predictive to human. It is known that almost 80% of the total experimental work that almost 20% of the total experimental work that is done is carried out on mice and rats, this is because of its various advantages like they breed easily, profusely and have short gestation period, can be handled easily, occupy small amount of space in the laboratory, they are very economical to breed and maintain in animal houses but, most important of all, practical to use in large number of experiments for obtaining accurate results.

With the advent of industrialization the benefit of progress has brought with it the curse of contaminated air, water, soil, food and altered stressful lifestyle which affects every life on earth in one way or the other, that has
resulted from the changed physical, chemical and biological agents of the environment.

Due to increasing incidents of various dust-related hazards and recommendation by the National Academy of Sciences of the National Research Council, our laboratory has developed an animal model rat. The albino rats (*Rattus novegicus*) selected for the present study showed behavioral and physiological reactions to foundry dust exposure that were similar to that of human on acute exposure study. And hence, the suitability and applicability for the present study was confirmed.

11. Reasons That Lead to the Present Investigation:

The majority studies on foundry industries in our country have been carried out in West Bengal, as major steel plants are located there. The industry employs a large number of industrial workers. It is observed that development in foundry industry in India has not been accompanied by improved health conditions of the workers as observed in several other industries. The working and living conditions of the foundry workers are very poor. The occupational health problems are enormous, which are mainly due to a variety of occupational stress factors such as silica and coal dust, metal dust, noise, vibrations, heat, inadequate illumination, gases and vapors, and excessive workload. Among these, high level of silica dust and coal dust, metal dust excessive heat and high level of noise in foundry environment are very important. Majority of the foundries in our country are using substandard machinery. The workers working in foundry industries are exposed to severe degree of heat load. Parikh *et al.*, (1977) and Saha (1978) have also reported very severe degree of heat stress in the foundry shops at Ahmedabad and Mumbai. The severe degree of heat stress observed in our present study, is also found to be far in excess of the
recommended threshold limit i.e. WBGT 30.0\(^{0}\)C is suggested by OSHA (1974) in case of foundry workers.

Foundry industry in Kolhapur constitute the largest single industry employing over 12 to 14 thousand workers; very less attention has been paid to the health status and safety of foundry workers. Long work shifts improper workplace layout, old machines and poor wage salary that produce the cumulative synergistic effect on the workers. During the process of sand preparation, molding and fettling large quantity of fly dust were produced. This fly dust in the foundry shop, gives rise to various degree of respiratory illness. These respiratory problems occur in workers exposed to silica dust, metal dust and coal dust and persons working in sand plant, moulding and fettling section. The physiological responses and occupational stresses in foundry workers have been paid little attention.

Though much study has been carried out in relation to effect of foundry dust, on human respiratory system. The animal model proposed to develop to study pulmonary reactions. White rat which will mimic the febrile and pulmonary reactions of human. It was also proposed that to identify various etiological agents associated with foundry dust. This study will also be instrumental in growing scientific awareness that acute reactions to foundry dust which has the common basis with regard to etiological agents and mechanism of disease development.

To fully investigate the nature of health hazards and the physiological reactions to foundry dust, its does dependence and the time course, the mechanism governing these reactions and etiological agents associated with foundry dust. It is essential to develop animal models that are predictive to human response. The present study has been carried out to evaluate the
physiological responses/ reactions to foundry dust exposure in white rat- *Rattus norvegicus*.

12. Plan of Proposed Work:

Occupational stresses may be one of the most widespread environmental pollutants in modern industrial societies. Like any other pollutant the damage caused by occupational stress are related to two factors: Exposure level and the duration of exposure. In general the higher the stress, more damaging it is. In addition the longer one is exposed to a damaging level, the more loss one will suffer.

By taking into consideration of all the observed aspects regarding foundry industry and health problems of workers and occupational stresses in foundry industry, the following facts were significantly noticed they are as follows:

1. Foundry industry stood up in the industrial development of country which exports goods and contributes to the national economy.

2. Next to agriculture and textile industry, foundry is one of the largest employers of labor providing work to people in rural and urban areas, throughout the country.

3. The workers working in foundry industry have lot of problems mainly related to lungs, ears, eyes, skin and body joints, vertebral column, due to occupational stress factors such as higher concentration of silica dust, coal dust, metal dust, fumes, excessive noise, heat, inadequate illumination, ventilation, vibrations, as well as excessive work load and unsatisfactory work conditions and ergonomically incorrect work place design.

4. In spite of higher concentration of silica dust, noise is also serious problem affect working environment and induces hearing loss among the workers in fettling section.
5. Higher temperature and inadequate ventilation increases heat inside the foundry and affects physiological thermoregulatory functions in the body of workers. Heat stress is predominant in core shop and in furnace section.

6. Gases and vapors generated in core making and moulding processes also affects eyes and respiratory tract, vapors from various resins can initiate severe allergic reactions. Thus, a possible secondary effect of exposure is an increased risk of accidents and injury to the workers.

This industry has been subject of numerous investigations pertaining to foundry processes but not much work has been done. The working conditions and work environment were extremely adverse and it is difficult to maintain a high level of health status. There are many health and safety problems of these foundry workers, and genuine measures must be taken for the health protection of these workers and this will only be possible if one explores the possible stress factors and occupational health problems by extensive research in this foundry industry of Kolhapur. So it was proposed to carry out detailed investigation on physiological reactions to foundry dust in rat on exposure in the different sections of the foundry at Kolhapur. The plan of proposed work, thus, consists of:

a) Study of workplace environment in foundries.

b) Characterization of an Animal Model:

Albino rats have been selected as an animal model in the present investigation because of ubiquitous use of rats in the scientific research. It is essential to know, how to use rat as an animal model in occupational health status.

c) Identification of etiological agents- Efforts are to be made to identify etiological agents of endotoxins associated with foundry dust which are responsible for occupational health hazards.
d) To study the behavioral responses of an animal model during exposure to foundry environment.

e) To study the nasal lavage bronchoalveolar lavage of an animal after exposure to foundry dust in different sections.

f) To study alterations in histological structure of trachea, lung, liver, kidney and adrenal gland of rat on exposure to different sections of foundry.

g) To study the hematological changes in animal after exposure to foundry dust.

h) To study the liver function tests in rat on exposure to foundry in different sections.

i) To study serum enzyme and serum proteins of rat on exposure to different sections of foundry.

j) Elucidation of mechanism of occupational disease and stresses in foundry environment.

Most of the earlier studies carried out by other investigators have centered around the respiratory system and its responses. In the present study it is proposed to study the extra pulmonary aspects also in relation to causation, symptoms and disease induction.

It is also proposed to study the susceptibility as well as suitability of animal model- rat for occupational diseases by providing basic information regarding the mechanism of disease induction, with careful preparation of the models and conservative interpretation of the data, so as to provide toxicologists with another tool to investigate the occupational diseases.