

## Health and Environmental Impacts of Glass Industry (A Case Study of Firozabad Glass Industry)

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### Abstract:

*In glass city, Firozabad, traditional coal based furnaces and use of chemicals like lead, boron, arsenic, nickel and cobalt along with silica dust in precarious working conditions is distressing not only the health of workers but also the environment. The main objective of this study is to find out the impact of production function and hazardous chemicals on these industrial workers' health and their surroundings and to suggest the initiatives for their betterment. In this study, a survey was done in different types of manufacturing units of glass products and their surrounding population samples, which indicates that, rate of suffering from particular diseases as respiratory tract irritation, bronchial hyperactivity, impaired lung defences, bronchialitis obliterans, and exacerbation of asthma is much higher in industrial locations. All of these diseases are significantly related to exposure of individuals and the influence of possible confounding variables such as occupational conditions, living place environment and socio – economic aspects. Therefore, study emphasized on*

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*technical up gradation with significant modifications in production functions of the glass industries not only to make assure the efficient and optimum use of inputs but also to regularize the use of fuel and other scared resources for sustainable industrial development.*

**Key words:** Chemicals, Glass industries, Environment, Health, Technical reforms.

## **1. Introduction**

Firozabad, a district in Uttar Pradesh, is the glass capital of India and is well known for its beautiful bangles and other glass products. City meets the 70% requirements of the country for different glass items. Its fame is the result of hard work of around 0.4 million people who are directly or indirectly associated with this industry. Each bangle passes at least 60 hands of low paid workers before reaching in the wrist of a consumer. In the glass production units, workers have to work in very harsh conditions including high temperature and high level of pollutants. The production units are based on Liquefied Petroleum Gas (LPG) as well as coal fired furnaces. The hazardous waste from these production units is a major source of environmental pollution. The waste water coming out of the factories contains heavy metals such as Zn, Cd, Ni, As, Cr, Cu and Pb etc in their various hazardous forms. Oxides of these elements raise the temperature and disturb the composition of air in the troposphere. According to the studies of The Energy and Resources Institute (TERI), measurements of Nitrogen Oxide (N<sub>2</sub>O) and Respiratory Suspended Particulate Matter (RSPM) at different locations in the city are drastically higher than permissible limits. The impact of these working conditions and other industrial practices is not only limited to the factory premises but also spread over in city environment. A significant number of workers as well as residents of these areas are suffering from severe health hazards such as asthma, allergies, respiratory disorders, and tuberculosis etc. due to the highly

polluted environment. The situation becomes bitter due to the lack of public health facilities and social security benefits to these workers and to a large share of low income population of the city.

## **2. Problem of the Study**

According to census 2011, the population of Firozabad is 2,498,156 with sex ratio of 875 per 1000 males. A large section of the population resides under poverty and depends on government provided basic amenities for their health, nutrition and other requirements. In the absence of adequate aided health facilities and lack of social security benefits these low paid workers have to pay a big share of their low incomes on their occupational health losses. Plants and animals of the concerned and surrounded areas are also suffering from the negative impacts of these industrial units.

The initial findings show that the share of nitrogen and RSPM is increasing continuously in atmosphere, which is the main cause of bronchitis, asthma, allergy related sicknesses and other respiratory disorders in the population. Moreover, the quality of drinking water is also deteriorated because of hazardous waste such as fluorides, nitrates and Total Dissolved Solids (TDS). These pollutants have tainted the composition of air, water and soil which further affects the agriculture and plant life. Moreover, the influence of possible confounding variables such as occupational conditions, living place environment and socio – economic aspects have made the situation bitter in context of the health and environment. The rate of suffering from particular diseases as respiratory tract irritation, bronchial hyperactivity, impaired lung defences, bronchiolitis obliterans and exacerbation of asthma is significantly higher in this area, which is related to exposure of the individuals to polluted environment. This study concerns with the industrial effect on the health and environment of the

workers and residents of the surroundings. It investigates the reasons behind the health and environmental degradation, and looks in the efforts to control the problem. Finally, it suggests the need of significant technical transformation and policy initiatives, not only to assure efficient and optimum use of inputs, but also to maintain sustainable environment.

### **3. Objectives of the Study**

The main objectives of this study are, to find out the composition of chemicals used in glass industries and their direct or indirect impact on worker's and surrounding population's health, and to point up the impact of production function on environment with the suggestions for preventive measures.

### **4. Methodology**

This study is based on several research findings, reports of governmental and nongovernmental organizations, and the data from environmental institutions. But, for a close experience of the industrial working conditions and its effect on the workers a survey was conducted in different glass manufacturing and processing units of Firozabad. Later on, the supplementary responses from concerned inhabitants enhanced the worth of study. The official data and information about workers and industry related issues is provided by pollution control board and district industrial office. Finally, the collected data and information on concerned issue is processed and synchronized according to the objectives of the study.

### **5. Findings of the Study**

After analyzing various data and information on the topic, these main findings came out from the study:

## **A. Conditions of the Workplace and Production Function**

In the glass industry of Firozabad, majority of the large scale production units prepare unfurnished bangles and other glass products by using gas fired furnaces, but the small industrial or household units are still based on traditional coal fired furnaces for processing of unfurnished bangles and other glass products. The working temperature of furnaces in large scale production units is about 1200°C which consumes a lot of fuel. A number of chemicals are used in glass industry to make glass of desired shape, colour and quality, irrespective to their hazardous nature. Glass Grade & Foundry Grade Silica Sand and Dense Soda Ash are the raw material for the production of glass. These are mixed with certain chemicals at different stages of production according to the requirements of the final product. Table-1 summarizes the list of chemicals which are used at different steps in the production units. Most of chemicals are inferior in quality to reduce the cost of production.

**Table-1: List of Common Chemicals with their use in Glass Industry of Firozabad**

Common Name	Chemical Name	Chemical Formula	Use in Glass industry of Firozabad
<i>Silica</i>	Silicon dioxide	SiO <sub>2</sub>	Is used as raw material
<i>Lime</i>	Calcite Powder	CaCO <sub>3</sub> (93-97%) + MgO (1 -5%) +SiO <sub>2</sub> (1 -2%)	As a raw material as a flux
<i>Soda</i>	Dense Soda Ash (Sodium carbonate)	Na <sub>2</sub> CO <sub>3</sub>	Reduces the melting temperature of silica and reduces the energy required to melt.
<i>Suhaga</i>	Sodium Tetra Borate Pentahydrate	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> .5H <sub>2</sub> O	Is used for lowering the glass melting temperature
<i>Bitumen</i>	Bitumen		Make Glass Water Proof
<i>Kalmi Soda</i>	Potassium Nitrate	KNO <sub>3</sub>	Chemically Strengthen the glass
<i>Oxides of Arsenic</i>	Arsenic Trioxide	As <sub>2</sub> O <sub>3</sub>	Cleaning of Glass
<i>Barium Carbonate</i>	Barium Carbonate	BaCO <sub>3</sub>	Acts as a flux to reduce the melting temperature of glass, provide de refraction and scratch resistivity
<i>Pal</i>	Copper Oxides	Cu <sub>2</sub> O	Glass Pigment
		CuO	Blue Green Colouring agent in glass Polishing Paste of Optical Glass
<i>Zinc Oxide</i>	Zinc Oxide	ZnO <sub>2</sub>	Increases the durability of glass and is used for manufacturing the opaque glass, red and yellow colouring agent
<i>Cadmium Compound</i>	Cadmium Sulfide	CdS	yellow colouring agent
<i>Selenium Compounds</i>	Oxides of Selenium	SeO <sub>2</sub>	Ruby red Colouring Agent
<i>Cobalt Compounds</i>	Cobalt blue		Blue Colouring Agent
<i>Potash</i>	Potassium Permanganate	KMnO <sub>4</sub>	Purple Colouring Agent
<i>Kasis</i>	Sodium dichromate	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	Green colouring agent
<i>Mangnese</i>	Manganese	Mn	Blue Purple Colouring Agent
<i>Gandhak</i>	Sulfur	S	As polishing and acidifying agent
		S + Fe	Red brown coloring agent
		S + Ca	Provide yellow color to glass

Chimneys of the factories are not capable enough to flue these gases from factory premises and surroundings. The factories are filthy and technically flabby. While dealing with hazardous chemicals no safety measurements are used by the owners as well as the workers Figure -1.



**Figure-1: Working conditions factory premises**

The above mentioned factors become more harmful while working in immense heat and sound which is normally higher than permissible levels. The furnaces are kept burning due to limitations of maintaining appropriate temperature for melting and moulding of the glass. Therefore, workers have to work with such deplorable working conditions continuously without proper break time.

The condition of coal fired small industrial units is worse in comparison to the gas fired large scale production units. In these coal fired factories height of chimneys is low which cannot exhaust smoke and other gases out of the factory premises and therefore, these pollutants ensnare local environment.

## **B. Health Impacts of the Industrial Practices**

As stated above, several elements such as lead, boron, arsenic, nickel, copper and cobalt in their various chemical forms along with silica dust are used in precarious working conditions in glass industries. According to a case control study of chronic bronchitis in glass and bangle workers; it was found that, the high prevalence of chronic bronchitis in the glass bangle

industry was the result of long-term exposure to pollutants emitted during the manufacturing process<sup>2</sup>. Moreover, coal fired furnaces and filthy condition of factories have made the health of workers miserable. Due to saving of the cost on fuel, furnaces kept burning without any time off and this practice compels the workers to work without any leisure time. This continuous exposure to immense heat and sound which is far beyond permissible levels adversely affects not only the workers but also the residents of the area.

In spite of the pollutants from the industries, exhaust from automobiles, gas and heaters, cigarette smoke, combustion of organic material, carbonization and other anthropogenic activities are the main sources of these pollutants. **Table -2** typifies the noxious agents with their common sources which can affect the people by several ways.

**Table-2: Pollutants with their Sources and Harmful Effects on Human Beings**

Sl.	Noxious agent	Source	Harmful effects
1.	<i>Oxides of Nitrogen</i>	Automobile exhausts, gas stoves and heaters, wood burning stoves, kerosene space heaters	Respiratory Tract Irritation, Bronchial Hyperactivity, Bronchiolitis Obliterans, Asthma, Permanent Lung Damage with Repeated Exposure, Destroy Ozone in Stratosphere, Mutation in Living Beings
2.	<i>Hydrocarbons</i>	Automobile exhausts, cigarette smoke	Lung Cancer, Bronchial Constriction In Human. Necrosis Of Leaves, Choruses Of Flower Buds, Growth Inhibition In Plants
3.	<i>Ozone (Bad Ozone in Troposphere)</i>	Automobile exhaust, (Manmade sources such as from factories and	Cough, Substernal Discomfort, Bronchoconstriction, Decreased Exercise Performance, Respiratory Tract Irritation Congestion, Emphysema, Asthma

<sup>2</sup> 32<sup>nd</sup> Report of Parliament Standing Committee on 'Welfare of Glass and Bangle Workers of Firozabad – A Case Study', Ministry of Labour and Employment (2011-12). This report had raised various glass industry workers' issues like working conditions, wages and health.

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		power plants)	
4.	<i>Sulfur Dioxide</i>	Power plants, smelters, oil refineries, kerosene space heaters	Exacerbation of Asthma and COPD, Respiratory Tract Irritation, hospitalization may be necessary and death may occur in severe exposure
5.	<i>Lead</i>	Automobile exhausts using leaded gasoline	Impaired Neuropsychological Development in Children, Damage of Central Nervous System, Kidney and Blood Forming Organs and Same in Adults
6.	<i>Polynuclear Aromatic Hydrocarbon (compounds having multiple Benzene Rings ex. Anthracene)</i>	Pyrolytic processes, incomplete combustion of organic material, carbonization.	Epidemiological Disorders, Lung Cancer, May Cause Death, Skin Allergy Eye Burns Damage of Liver and Kidney
7.	<i>Particulate Matter</i>	Industrial waste	Respiratory Disorder, Premature Death Aggravated Asthma and Chronic Bronchitis Tuberculosis, Lung Cancer, Cough and Death of Foetus.

Source: Park. K (2002), Environment and Health, 'Park's Textbook of Preventive and Social Medicine', Bhanot Publishers.

The immediate effect of gasping harmful gases may be cause of acute bronchitis and death by suffocation. These types of industrial accidents are common in glass factories of Firozabad.

The situation becomes bitter due to unawareness of workers about the causes of these accidents. The workers as well as factory administration generalize these accidents as occupational hazards which may occur due to any manual or technical fault. These accidents are the consequence of chemical fumes and contaminated working environment which damage human respiratory and cardio respiratory system in various ways.

It is evident that in nearby areas a significant population is suffering from delayed effects of severe air pollution which reflects as chronic bronchitis, lung cancer,

bronchial asthma, emphysema and respiratory allergies in later ages. Not only this, but the exposure to harmful chemicals and toxicwaste may also cause higher health risks, as lead poisons many systems in the body and severely affects to children in their physical and mental development. Elevated lead levels in children have been associated with neuropsychological disorder and loss of IQ, poor school performance and behavioral difficulties.

The survey data<sup>3</sup> on sickness in population at different localities shows the perilous nature of polluted environment. The findings shows, that 31.94 percent of total males and 23.51 percent of total of females have complained for respiratory problems (Figure-2). In medical diagnosis most of the cases were found as the result of continuous inhalation of polluted air and of direct contact with pollutants. Moreover, the agewise data of sickness shows that a majority of 'sick' persons belongs to later age group in females while in cases of males the sufferings begins in very early ages (Figure-3). The nature of sickness also differs according to occupational practices (Figure-4). The reasons behind the facts are:

1. Male workers do work in large scale production units from their early ages and due to direct contact with hazardous working conditions. They suffer from Aggravated Asthma and Chronic Bronchitis, Tuberculosis, Lung Cancer, Epidemiological Disorders, Skin Allergy, Eye Burns Damage of Lever and Kidney, Cough and lastly Premature Death.

2. Female normally work in small scale production units where they usually don't work with mentioned pollutants, but the atmosphere of the working area is remain same to some limits. In fact, women are the passive victims of these pollutants. So the symptoms of sickness explore in them in comparatively later ages as Cough and Respiratory Tract

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<sup>3</sup> Purposive survey of 165 households with 432 males and 336 females of all age groups, in which 316 and 215 are workers their respective category.

Irritation, Bronchial Hyperactivity, Asthma, Substernal Discomfort, Bronchoconstriction, Decreased Exercise Performance, Emphysema, Death of Foetus etc.

3. In the cases of children, cough, Bronchial Hyperactivity, Asthma, Substernal Discomfort and Decreased Exercise Performance due to different allergies are the common symptoms found in survey.

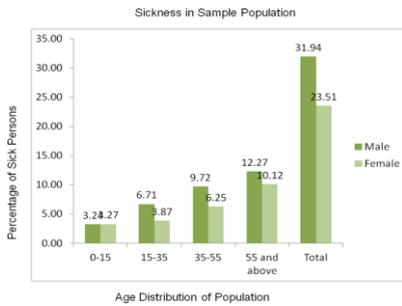


Figure-3: Sickness in surveyed population

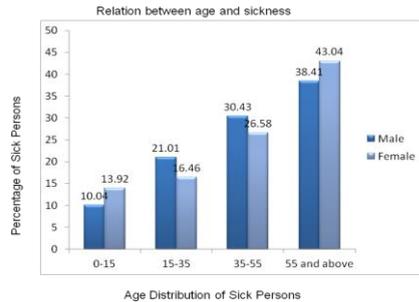


Figure-4: Sickness in different age groups

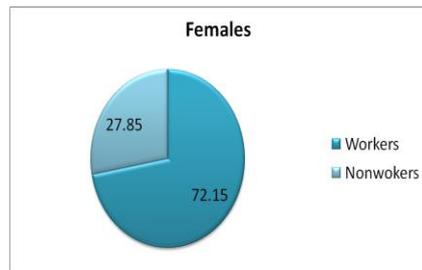
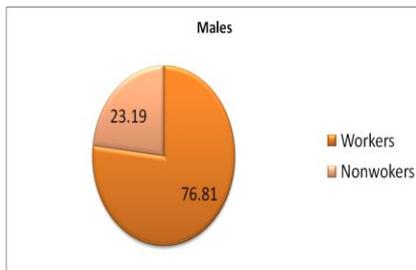


Figure-5: Gender based distribution of occupational sickness

The concentration of these sufferings depends on residential locations and exposure to mentioned pollutants to the population. Unfortunately, the workers belong to the lower income groups, and live in nearby industrial localities which make them detrimental of environmental depletion.

### C. Environmental Impacts of Industrial Practices

Air is the immediate environment of all living beings on which they depend for oxygen, air and other requirements but

pollution of air by dust, smoke, toxic gases and chemical vapours have resulted in adverse effects. Human beings require a continuous and constant supply of pollution free air. Air is the mixture of several gases and its composition by volume is as follows:

Components	Nitrogen	Oxygen	Carbon Dioxide	Other Gases
Percent	78.1	20.93	0.03	Traces

In addition to these gases, air also contains water vapours, traces of ammonia and suspended matter such as dust, bacteria, spores and vegetable debris. In modern era, the rapid growth of industrialization, urbanization and means of transportation has polluted air through various processes especially, combustion of coal, gases, oil etc for generating energy to run industries, powerplants, vehicles; and manufacturing processes of industrial products which give off dust, fumes, vapour and gases are the main causes of impure air. In modern liberalized economy, cut throat market competition is now focused on reducing production cost to get price advantages, and in this process the low grade substitute of raw materials and cheap technology are used for production which further creates health and environmental harms.

In Firozabad, the continuous use of harmful chemicals for production of glasswares, and use of coal in small processing units in furnaces has misbalanced the appropriate ratios of gases in city surroundings. These glass industries emit large amount of carbon dioxide, carbon monoxide, nitrogen oxides, sulphur dioxide, lead, ozone, hydrogen sulphide, hydrocarbons, cadmium, polynuclear aromatic hydrocarbons (PAH), particulate matter and fly ash in atmosphere. Further, incomplete combustion of coal as fuel and lack of proper exhaustion of heat and smoke in makes situation bitter small scale production units which releases Carbon Mono Oxide (CO) in their surroundings. Even in gas fired factories, where chimneys are higher the discharge of waste and green house gases ensnare at lower levels of troposphere Figure-6.

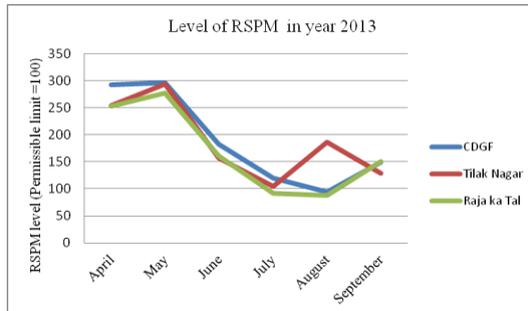


**Figure-6: Pollution from coal-fired furnaces which are located in the dense areas of the city**

The congestion of vehicles has worsened the situation of pollution. The exhaustion of CO<sub>2</sub>, CO, lead, nitrogen oxides and particulate matter from these vehicles directly mix up in atmosphere. Further, in the presence of strong sunlight certain of these hydrocarbons and nitrogen oxide are converted into secondary photochemical pollutants of oxidizing nature, which are the main causes of ozone depletion. Depleted Ozone is not very effective for absorption of harmful Ultra Violet (UV) rays coming from the sun, which is the main cause of mutation in living beings.

It is a fact that nature has a self cleaning mechanism to maintain its composition constant through several practices as-wind dilutes and sweeps away the impurities by its movement, sunlight oxidizes the impurities and kills bacteria, rain cleans the atmosphere by removing the suspended particle and gaseous impurities, green plants remove carbon dioxide by utilizing it in photosynthesis. But the rapid growth of population and industrialization has created a huge demand of land for residential and commercial usages, which has developed concrete jungles and swept away the greenery from landscapes. This amorphous development of city has disturbed the significant self cleansing mechanism of nature which reflects in the findings of pollution control board sources nitrogen oxide is increasing continuously in atmosphere of the

city. The standard quantity of nitrogen oxide in atmosphere is 30 microgram per cubic meter but at different locations it is calculated more than 30 in a month in first six months of the year 2013. The level of SPM is also higher than permissible limits at different location of the city (Figure-7).



**Figure-7: Level of RSPM at different locations of the city in months of year 2013**

It is notable that monthly average of presence of nitrogen oxide in air is much higher than annual permissible limit. The direct effect of increased nitrogen is not so harmful but indirectly it reduces the quantity of oxygen in the atmosphere. Moreover, the industrial fitter in form of Carbon dioxide and heavy metal oxides are progressively contaminating air and decreasing oxygen content due to metabolic processes. Addition to this, rise in temperature, increase in humidity, decrease in air movement and bacterial pollution are the other reasons for changes in concentration of air.

On the basis of mentioned above, it can be stated that, these types of industrial practices have severely polluted the atmosphere and have harmful impacts on health, safety and comfort of living beings. Pushpendra Pathak and K.S. Rana (2011), have studied about the Haematological changes in parrot - *Psittacula krameri manillensis*, after the exposure for 60 days in the polluted air of industrial area of Firozabad. The study proved that blood composition of parrots changed due to long term exposure in the polluted air of Firozabad. The

presence of main constituent of photochemical smog and suspended particulate matter (which exhaust from glass industries), enters in the blood of parrots through lungs and decrease total erythrocyte count. This is one of the examples of several perilous impact of polluted air on birds. It is enough to be aware of seriousness of the environmental degradation. Moreover, the pollution from factories is not only affecting the air but contaminating the soil of the surrounding areas which is the cause of headache, nausea, fatigue, eye irritation, skin rash, congenital disorder and chronic health conditions in concern population. The changed chemical composition of soil also affect plant metabolism of the polluted area. The effect of the glass industry on urban soil metal characterization was assessed by Varun.M.et al (2012) in the different areas of Firozabad. They found that there is an accumulation of heavy metals such as Manganese (Mn), Zink (Zn), Cadmium (Cd), Arsenic (As), Copper (Cu), Cobalt (Co), Lead (Pb) etc in soils as well as in plants. The research findings shows that Mn, Zn, Cu, and As were predominantly partitioned in shoots of the plants while, Co and Cd partitioned in roots. The Pb, Cr and Ni almost equally partitioned between shoots and roots. Most plants exhibited capabilities in mobilizing Co, Pb, Cr, and Ni in the root zone<sup>4</sup>. This accumulation not only affects the agrarian and plantation adversely, but also generates deleterious consequences for ecosystem. In a nutshell, industrial pollution is caused by emission of harmful gases, air-borne particulate materials, fume, smoke and dust in the process of industrial practices. These pollutants affect the insubstantial combination of environmental components. So to minimize environmental degradation all of these factors and variables must be checked in context of their significance and toxicity during the production process.

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<sup>4</sup> To assess the effect of the glass industry on urban soil metal characterization, a comprehensive profile of metal contamination was obtained in five zones, each containing five specific industrial sites of the city.

## **6. Suggestions and Safeguards to Protect Health and Environment**

Glass industry of Firozabad provides not only the employment to a large population, but also generates a significant amount of business. Simultaneously, the pollution attached with production process of glassware and bangles, is an enormous problem for health and environment of the city and its residents. The maintaining of society's health and environment standards with a sustainable growth of the industry is a big challenge for concerned policy makers, innovators and entrepreneurs. Few suggestions and safeguards are discussed here to minimize health and environmental degradation:

### **A. Use of Innovative Technology and Environment Friendly Production Function**

The source of energy plays an important role in any production function and environmental outcome. The traditional coal fired pot and muffle furnaces are one of the main causes of pollution. In 1996, Supreme Court directed all coal based production units to shift to the use of natural gas for their furnaces within a definite time frame. The institutions like TERI successfully designed, developed and demonstrated two such technologies which are environmentally more compatible and economically more efficient than traditional coal fired furnaces. The innovative gas-fired recuperative pot furnace and the gas-fired muffles designed by TERI are similar to traditional coal fired furnaces in terms of structure and functions but reduce energy consumption up to 50% and 30% respectively. Moreover, these gas fired muffles designed by TERI, are made of Silicon Carbide which enhance the life of muffles and their better design help in reducing the suspended particulate matter emissions.

This new system minimizes the wastage of energy, and is more fuel efficient by using the pre – heated air for combustion. Not only this, but also the improved structural

design and use of better quality material for the furnace crown has extended its life upto three years. Especially, better quality refractory materials like Silimanite and Zirmul are used for the floor in place of conventionally used refractories. To check the heat from escaping through the stack, a heat recovery system in the form of a metallic recuperator was installed to pre – heat incoming combustion air to 600°C.<sup>5</sup>

In addition to above, few more alternatives can also save fuel usage for energy by reducing the melting temperature of glass batch, for example,  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 5\text{H}_2\text{O}$  lowers the glass batch melting temperature,  $\text{BaCO}_3$  reduces as a flux to reduce the melting temperature of glass and  $\text{Na}_2\text{CO}_3$  reduce the furnace temperature which is necessary for the melting of silica to reduce the energy requirement.

Waste minimization is another approach to minimize industrial pollution. The raw materials used for the manufacturing of glass products can be recycled easily so that it is used again and again without significant wastage and polluting the environment. So, the large and small scale glass production units should be trained for waste minimization and cleaner technologies with proper arrangements for the disposal of solid, liquid and gaseous waste. All of these technical efforts and changes in production functions can significantly contribute in reducing pollution level of the city environment.

## **B. Providing Economic and Informative Assistance**

The large scale production units have completed fuel based technical changeover, according to supreme directives, but a significant number of small scale units are still using coal as fuel in muffle furnaces. The reasons behind sluggish rate of opting gas based muffle furnaces in small production and

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<sup>5</sup>SDC (Swiss Agency for Development and Cooperation) and TERI in partnership intervened in the Firozabad cluster with their focus on introducing clean, energy-efficient technologies for the pot and muffle furnaces.

processing units are related to several industrial and financial difficulties. Most of these, industries are running by small inverters as household units and not registered properly in respective administrative offices. They are suspicious about the financial or tax related difficulties and formalities, after being a part of systematically regulated supply chain of natural gas as fuel. The another problem is related to the cost of changeover, no doubt, government and other agencies are providing some assistance for concerned technical changeover but still the cost is unaffordable for many small investors, especially for those who are running their units at subsistence levels of profits. So, to apply fuel related technical changeover unanimously, the government should come forward to motivate and assure small investors about their deceptive worries and therefore, provide them appropriate assistance for setting up gas fired furnaces.

### **C. Consciousness about Environmental and Health Perspectives**

There are the Boards and Institutions affiliated to the Government and Nongovernmental Organizations to monitor the level of pollution and to regulate environmental pollution practices. Central Pollution Control Board (CPCB) of India is a statutory organization under the Ministry of Environment and Forests (MoEF) which deals Pollution and Environmental protection issues. In states these responsibilities are fulfilled by State Pollution Control Board and their respective Regional Offices. These Pollution control Boards and Organizations monitor the quality of water and air and other environmental components and provide data for industrial establishments and town planning. They regulate industrialization and protect environment through several legal provisions of prevention and control of pollution. These boards and organizations organize mass awareness programmes, develop pollution control technologies and take legal actions against defaulters.

Firozabad is located in Taj Trapezium Zone (TTZ), which is a defined area of 10,400 sq km around the Taj Mahal to protect the monument from pollution. The use of coal/ coke in industries located in the TTZ is banned by a ruling of Supreme Court in December, 1996 and the Mission Management Board of Taj protection programme keep an eye on environmental parameters of the concern area. The Board has already recommended for Automatic Air Monitoring Stations, Display Boards and Networking at Agra-Mathura and Firozabad, which will support the awareness efforts about the significance of environmental issues.

Simultaneously, the awareness about pollution from coal fired furnaces and its harmful impacts on health and environment should be accentuated to concerned workers and residents of the area. Whenever, these workers and local residents will be conscious about their health and environment they can coerce effectively for adoption of fuel related technical changeover in small production units in their respective localities.

Moreover, the policies for sustainable enterprise development and fundamental investments in basic education, health and physical infrastructure can provide effective inclusive outcomes for the efforts of environmental protection.

#### **D. Other Suggestions**

Industries are the major source of pollution of air, water and soil. It is necessary to protect at least the residential areas from such environmental hazards, and therefore, few more solutions are suggested to control environmental degradation:

- a) The strict policy restrictions should be imposed on non-eco-friendly industries for releasing toxic waste in the environment. Even in case of inevitable industrial production functions, a limited consent of releasing treated toxic waste can be given after ensuring proper treatment of industrial waste according to

pollution control directives. The several techniques for recycling of industrial waste are invented and are used to sustain supply of raw material and to protect ecosystem. For example, the biological processing with the appropriate microbes can be used to reduce toxicity of very reactive heavy metal ions as Mercury, Cadmium and Manganese (Hg, Cd, Mn) and, the waste solution should be made slightly alkaline to precipitate as much metal hydroxides as possible before releasing into the environment.

- b) Therefore, with the growth of industrialization, a consequent research and management mechanism is required to develop more efficient eco-friendly inputs and techniques.
- c) The taxes and levies should be imposed on the use of hazardous chemicals according to their ecotoxicity. The Carbon Tax (CT) is an important component of the pollution control mechanism.<sup>6</sup> This will motivate producers for gradual transformation of toxic inputs of production, with comparatively less dangerous chemicals. But for a significant effect the use of toxic compounds will need to be substituted with eco friendly inputs in any production function.
- d) Any of the industrial establishments should not be allowed in the surrounding areas of inhabitants. Moreover, the industries, which are already located in the dense areas of the city, should be shifted to the other locations, and for this a proper coordination in urban and industrial planning is necessary.
- e) The regular health check-up camps and awareness programs should be organized in industrial areas of the city, so the low paid workers and poor can also get benefits of medical facilities. Unfortunately, in glass

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<sup>6</sup> CT is a specific excise tax on the carbon content of the fossil fuels to offset the atmospheric warming effect of CO<sub>2</sub> they produce. (Bannock et al., 1992).

industry of Firozabad, the most of the workers are working as unorganized and unregistered status and, so they can't avail government incentives in their hard times. The Social Security Board under Unorganized Workers Social Security Act, 2008 should be implemented effectively to eliminate this unjustified discrimination and the social security policies should be launched for unorganized workers also.

- f) Finally, it is a responsibly of factory owners, and the government, to provide safe and healthy working environment to the workers and society. The directives of 'National Policy on Safety, Health & Environment at Work Place' by Ministry of Labour and Employment, are very clear about the adoption of latest and eco-friendly techniques and technology to reduce unhealthy and polluting impacts of industrial practices. But, the implementation of such measures is still a big challenge, so concerned agencies should come forward to motivate factory owners and labour organizations for effective technical transformation to protect the health and environment of their surroundings.

## **7. Conclusion**

In a nutshell, if industrial development is a necessity of modern lifestyle and economy, even then, sustainable environment is an essentiality for existence of life. So, it is a responsibility of the concerned government and the society to prevent their ecosystem by controlling and abating various types of pollutions. Overall, the study recommends for inclusive efforts to improve environmental quality of the industrial areas with the use of, technical innovations and transformations, health and environmental awareness and economic and logical assistance to entrepreneurs and workers, etc. to maintain the hale and hearty eco system.

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