

A PRELIMINARY STUDY OF HEALTH HAZARDS  
IN THE  
SMALL SCALE DYESTUFF INDUSTRY OF AHMEDABAD

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INTRODUCTION

The Small Scale industry in India provides employment to a workforce of approximately more than thirty lakhs. (1) Many of these units are not covered by the Factory's Act or the E.S.I. Act. Being outside the purview of any legislative supervision implies that those employed in such units are at a higher risk to Occupational illnesses as a result of working in an unhygienic work environment. Since this population is not covered by any Industrial Health Service it becomes extremely important to identify occupational illnesses and their environmental agents in such units and to suggest preventive measures to the management.

The discovery by Perkins in 1856 of the first synthetic dyestuff initiated the development of the modern dyestuff industry. The annual production of dyestuffs in India has increased over a period of five years from 10,000 to 14,000 tonnes. In the large and medium small scale sector a workforce of 10,000 find employment in the manufacturing of paints, colours and varnishes. In the small scale sector an equal number are involved in the manufacture of dyestuffs and intermediates. The city of Ahmedabad abounds in Textile Mills. Closely associated with these textile mills are the dye-manufacturing industries comprised of 100 small scale units. These units provide employment to a workforce of approximately 5000 men and women. Being in the small scale sector these concerns are installed with open manufacturing systems and are entirely operated manually. Ample opportunities during dyestuff manufacture exist for human contact with these compounds, and there is no reason not to suspect significant absorption of these chemicals through the respiratory or cutaneous route. In 1963 the Dye Panel of the Government of India (2) met to lay down a code of work practices in connection with the small scale dye industry. The report was based on a hygiene survey which revealed that workers were exposed to substantial amounts of chemicals at the workplace.

DYESTUFFS AND DYEINTERMEDIATES:

Definition

The term dyestuff refers to products used to impart colour to other materials and includes both dyes and pigments. Dyes are soluble and the colour tends to attach itself to textile fibres or other materials immersed in the solution. Pigments on the other hand are insoluble and they impart colour to an object by being dispersed through out in finely subdivided particles. (3)

The term dye-intermediate refers to the innumerable raw materials used in the manufacture of dyestuffs. They are usually primary, secondary and tertiary derivatives of aromatic amines.

#### CLASSIFICATION AND TYPES:

1. Natural dyes of animal, insect, and mineral origin e.g. Sepia and Tyrian purple, Indigo, Archil and Woad - Blue dyes, Safflower and Kermes-Red dye.
2. Synthetic dyes e.g. Aniline dyes, Azo dyes, Phenylendiamine dyes. More than 3000 synthetic dyes are listed in the Colour Index and they fall into the following categories: Acid Dyes, Basic dyes, Disperse dyes, Solvent dyes, and food dyes.
3. The aromatic amines are a class of chemicals derived from aromatic hydrocarbons, e-g- benzene, toluene, naphthalene, and anthracene by the substitution of at least one hydrogen atom by an amino group. A compound with a free amino group is described as a primary amine. When one of the hydrogen atoms of the - NH<sub>2</sub> group is substituted by an alkyl or aryl group, the resultant compound is a secondary amine, when both hydrogen atoms are replaced a tertiary amine results.

#### MANUFACTURE:

The essential reaction in the manufacture of dyestuffs specifically Azodyestuffs is the reaction between the Diazo compound and the Coupling component. In the small scale sector with open manufacturing systems the first step is the weighing out of raw materials to be fed into the various reaction plants. The process of Diazotisation takes place in the first reaction plant with aromatic amines, Nitrite, and acid or alkali under certain environmental conditions. The formed diazo compound is then transferred to the second reaction plant together with the coupling component to yield the finished azo dye product. The liquid dyestuff is subjected to the filter press where in with resulting loss of water, cakes of dyestuff are formed. These are placed in the hot air oven to further dehydrate them. The solid cakes of dyestuff is then powdered in the pulverisor to yield a fine powder. This is then mixed and packed manually.

#### HAZARDS:

The hazards of dyestuff manufacture arise largely from the primary and intermediate compounds, and from the reagents and solvents used in the synthesis (3).

#### SYNTHETIC DYES:

Dermatitis, both contact and irritant has been the most commonly reported problem in the dye manufacturing industry. Irritative effects in the eye and respiratory system due to accidental splashing and inhalation of dye dust respectively have also been documented. Sensitization of the respiratory system leading to Bronchial Asthma has also occasionally been observed. Recent evidence from NIOSH indicates that many of the synthetic dyes derived from certain aromatic amines are carcinogenic

when absorbed into the body and metabolised by tissue enzymes to release the parent aromatic amino compound which then accumulates in the urine and exerts a carcinogenic effect. (4) A strong association relating human exposure to benzidine based dyes with the subsequent development of bladder tumors was presented after a case-control mortality study of 200 bladder cancer patients in Japan (5).

#### AROMATIC AMINES:

The most frequent acute effect due to absorption of aromatic amino compounds is cyanosis due to the formation of Methemoglobin. At low concentrations this results in Headache, dizziness and easy fatigability. At higher concentrations i.e. above 10% - 15% the ensuing anoxia is dangerous and may lead on to collapse and death. The toluidines both ortho and para may produce transient haematuria after heavy exposure due to irritative effects on the urinary epithelium. Many aromatic amines produce Heinz bodies in the red blood cells. Certain others are skin sensitizers. The compound p-phenylenediamine is a respiratory sensitiser and may cause Asthma in sensitised individuals. Certain diamines have potent hepato toxic effects.

The most serious effect due to chronic exposure to aromatic amines is that of Cancer of the Upper and Lower Urinary system. It is established that Benzidine, 2-Napthylamine, and Zenylamine are potent carcinogens in humans, while there is sufficient evidence to state that 1-Napthylamine, o-tolidino, o-dianisidine, and o-dichlorobenzidine are also suspect carcinogens. An undue incidence of bladder cancer among Workers employed in the dyestuff industry has been documented in a number of studies in Europe and U.S.A. since the year 1895 (6-7). Experimental evidence in support of the association between bladder cancer and exposure to Benzidine and 2-Napthylamine has been demonstrated by Hueper et al (8) in 1938. 15% of all neoplasms due to occupational exposure arise in the Urinary Tract being second in number only to Occupational cancers of the skin (9). Case R.A.M. et al (10) in 1954 reported in a follow up of 25 exposed workers 13 developed bladder cancer deriving a gross incidence rate of 52%. Maltoni et al (11) in his review on this subject also reported an association between upper urinary tract cancer and occupational exposure to dyestuffs and their intermediates. The latency period in most studies ranged from 10-20 years while the least exposure time associated with the development of cancer was 1 year (9).

#### OBJECTIVES:

A preliminary study of the health hazards in the Small-Scale dyestuff industry was planned and executed with the following objectives:

- 1) To assess the health impairment of workers employment in Small-Scale dyestuff industry.
- 2) To identify the priority areas of research on which a definitive study could be planned.

- 3) To identify the most hazardous stage in the manufacture of dyestuffs in small scale units.
- 4) To suggest low cost preventive measures to the management.

METHODOLOGY:

One hundred and forty six workers and forty unexposed workers (controls) comprised the study group in this survey. They were drawn from four small scale units located near to the Institute. All the workers were interviewed and clinically examined. The following investigations were conducted.

- Methemoglobin content in blood sampled during the middle of the shift.
- Urine microscopic examination.
- Pulmonary Function Tests to determine F.E.V. 1 and V.C.

RESULTS & DISCUSSION:

1. Respiratory Ailments.

30% of the workers had Respiratory Problems on the day of examination. The corresponding figure in the control group was 4.3%. Affected workers reported experiencing cough, chest pain, breathlessness while at work.

MEDICAL PROBLEMS OF DYESTUFF WORKERS

Illness	% Of Workers	% of Comparison Group
Respiratory	30.0	4.3
Skin	20.9	1.8
Urinary	8.3	Nil
Loss of Appetite/Nausea/Vomiting	7.6	1.6
Accidents	4.1	Nil
Others	10.8	6.3
None	18.3	76

METHEMOGLOBINEMIA IN DYESTUFF WORKERS

Group	Normal 0 to 2%	Elevated but Acceptable 2%to5%	Significantly Elevated 5%
Workers (%)	31.5	47.3	21.2
Comparison (%)	100	Nil	Nil

RESPIRATORY FUNCTION TESTS RESULTS OF  
DYESTUFF WORKERS

Parameter	% of Workers with Functional Abnormality
F.E.V.1%	35
V.C	Nil

URINE EXAMINATION RESULTS OF DYESTUFF WORKERS

Group	R.B.C. Only	Pus Cells Only	R.B.C. + Pus Cells	Normal
Workers (%)	13.4	7.5	22.4	56.7
Comparison (%)	Nil	Nil	2.6	97.4

These symptoms came on as a result of inhalation of irritant gasses released during the chemical reaction at the diazotisation plant. Smoking habits did not aggravate the symptoms. Pulmonary function tests revealed that 35% of the workers had impaired lung function evident in a mild impairment of F.E.V.1. Many workers in the mixing and packing division also complained severely of respiratory symptoms due to the inhalation of dye dust released during operation of the pulverisor and while manually mixing and packing the dye powder. None of the workers either at the Diazotisation Reaction plant or at the Mixing and Packing division were observed to be wearing any kind of Respiratory Protective device.

2. Skin Diseases.

Skin diseases were detected in 20.9% of exposed workers and 1.8% of unexposed controls. The nature of the leison indicated both an allergic and irritative actiology. Leisons were observed in the exposed parts of the body which came in contact with Chemicals. Workers in the Filter press division unduly complained of skin problems and this could be attributed to frequent splashing and spillage of chemicals in this process. Although all the workers were provided with work clothes these were changed infrequently and were all observed to be dirty and stained.

3. Methemoglobinemia.

21.2% of exposed workers had significantly elevated methemoglobinemia in the blood. 47.3% of them had an elevated but acceptable level. Raised methemoglobin in the blood is a reversible condition and is indicative of the effects of absorption of aromatic amino and nitro compounds. Easy fatiguability and mild head ache were reported by some exposed workers. Those employed in the mixing and packing divisions had the highest levels.

#### 4. Urinary Complaints.

8.3% of exposed workers reported urinary complaints. These were hematuria, and pain and burning during micturation which could be attributed to the irritative effects of absorbed aromatic aminoderivatives. Microscopic urinary examination corroborates this finding and 13.4% of exposed workers had detectable microscopic hematuria.

#### 5. Accidents.

4.1% of exposed workers reported having experienced accidents at work. Most of these were falls due to slipping on a slippery floor. Many of these accidents occurred around the filter press which often was very wet due to spillage of chemicals. There was one instance of accidental poisoning due to ingestion of Sodium Nitrite at meal time.

#### Conclusions.

The results of this survey reveal that the small scale dyestuff industry as it is operating these days does pose certain hazards detrimental to the health of the workers. Respiratory, skin and urinary complaints were reported by exposed workers. Most of them had an elevated Methemoglobin level in the blood and a significant proportion of them had microscopic hematuria in the urine. The most hazardous stage is the mixing and packing department, workers in this stage had the highest methemoglobin levels indicating maximum exposure to aromatic amino and nitro compounds. It is not possible to attribute any of these effects to exposure to any particular compound due to several reasons. Workers are simultaneously exposed to numerous compounds in any single factory and have also had past exposures to unknown compounds in their previous places of employment. This makes it almost impossible in the small scale industry to identify the hazards due to any specific compounds.

#### RECOMMENDATIONS:

The most serious problem in the dyestuff industry is that of Bladder Cancer which has been extensively studied and documented. The above survey since it was a limited exploratory one did not reveal this problem. A more definitive study has been planned to study the Urinary tract cancer risks in relation to the dyestuff industry. A Case-Control study is to be conducted at the local Cancer hospital to examine the association between occupational and Upper and lower urinary tract cancer. Also planned is a large scale longitudinal 5 year urine cytology survey of these workers.