CHAPTER VI
SUMMARY, CONCLUSION AND RECOMMENDATIONS
The present study embodied the work done on the "Evaluation of work environment and its impact on health in ceramic industry". A total of 41 ceramic factories were surveyed to assess their hygienic conditions, like dustiness, cleanliness, sanitary facilities, safety measures used etc. Out of these factories, eight units - 4 from urban and 4 from rural - were selected for assessing the work environment. The study was carried out to evaluate: (i) Dust exposure (ii) Lead exposure and (iii) Thermal stress. Highlights of the findings of the study and the conclusions drawn on the basis of the results, as well as recommendations suggested, are discussed as follows.

SUMMARY

I. ENVIRONMENTAL ASSESSMENT

1. General and hygienic surveys of the ceramic factories situated in urban as well as rural areas revealed that the general hygienic conditions of these factories were found to be poor.

1.1. It was observed that plant design was poor, having no exhaust system, inadequate sanitary facilities and, moreover, the maintenance and cleanliness was very poor.

1.2. In most of the factories, the general working
environment was found dusty and in the kiln department thermal condition was severe hot. Illumination and noise levels were apparently not a major problem.

2. Dust was a major problem as airborne dust concentrations at various work places were found higher than the recommended TLV in both urban and rural factories.

2.1. In comparison of rural factories, the total airborne dust concentrations and respirable dust concentrations in the urban ceramic factories were higher.

2.2. Apparently very high dust concentration was found in the grinding and glaze spray departments. In grinding department the average total airborne and respirable dust concentrations were 253.8 mg/m$^3$ and 43.8 mg/m$^3$, and in the glaze spray department the total airborne and respirable dust concentrations were 88.5 mg/m$^3$ and 9.5 mg/m$^3$ respectively.

2.3. Airborne dust contains considerable amount (about 25%) of free-silica, which indicates that exposure risk is very high.

2.4. There was observed a good correlation between respirable dust and total airborne dust concentrations in various departments.

2.5. Among the airborne particles, about 80% of the particles were of respirable size.
3. At glaze spray operation sites the workers are exposed to very high dust concentrations, which was found much higher than the ACGIH TLV, but the ambient lead concentration was found very much low, i.e. 2.84 µg/m$^3$ which is far below the recommended TLV.

3.1. The glaze used in these factories contains lead, but the levels of lead were found very low, i.e. the average lead content was 31.3 µg/gram.

4. Glaze workers showed the absorption of lead in comparison to control subjects.

4.1. The levels of blood lead and urine-lead in the exposed subjects were found well within the normal range, i.e. the average Pb-B and Pb-U were found 20.1 µg/100 ml and 100.7 µg/litre respectively.

4.2. Lead burden among the glaze workers was increased with the duration of exposure. However, it remained within the acceptable normal range.

5. Ambient thermal conditions inside the kiln was found to be very hot.

5.1. In comparison with rural factories, thermal stress in the urban ceramic factories was observed higher.

5.2. In monsoon and summer seasons, almost all the WBGT observations exceeded 32°C, the recommended permissible levels by OSHA (1974).
5.3. In urban and rural factories, WBGT levels were observed up to 54.4°C and 48.8°C respectively.

6. The workers exposed to severe heat showed low physiological strain.

6.1. Pulse rate observations indicate that only 15.5% of pulse rate observations exceeded 120 bpm.

6.2. Shift average pulse rate of the heat exposed subjects did not exceed the level of 110 bpm, the standard recommended by WHO (1969).

6.3. Recovery pulse rate observations confirm the absence of any significant cardiovascular strain in the kiln workers.

6.4. Study on serum enzyme changes, such as GOT, GPT, LDH and Aldolase, revealed that the activities of these enzymes were elevated significantly among the heat exposed workers.

II. HEALTH ASSESSMENT

1. The results showed that the prevalence of silicosis among the ceramic workers was found about 15.1%.

1.1. There was a close association between the duration of work in ceramic factories and prevalence of silicosis.

1.2. The prevalence of silicosis was closely related to the respirable dust, the respirable dust concentration, and its free-silica content.
1.3. Pulmonary function tests indicated both obstructive and restrictive types of lung disorders in the ceramic workers who are exposed to silica dust for more than 20 years.

1.4. Severity of silicosis, as determined by pulmonary function tests, was related to profusion of the small opacities of the chest radiograph.

1.5. Pulmonary function test values were more impaired in the cases of silicosis complicated by tuberculosis.

CONCLUSIONS

1. The existing hygienic conditions and house-keeping of the ceramic industry were found poor and hazard prone.

2. Overall working environment of the factories was found dusty, and total airborne dust and respirable dust concentrations at the various work places were found higher than the permissible levels. Under these circumstances, the workers carry a high risk of development of silicosis during their working life-span.

3. Ceramic glaze contains lead, but the lead content of glaze dust was well below the TLV. In ceramic glaze workers the lead absorption was observed, but it was well within the normal range, which indicates that lead intoxication is not a serious problem in our ceramic industry.

4. In the kiln department, the workers are exposed to severe heat stress, well above the permissible levels.
(32°C WBGT) suggested by OSHA (1974). However, it is striking to note that the physiological strain observed of these workers, i.e. rise in pulse rate and body temperature, was comparatively much less. It indicates that the heat tolerance capacity of our workers is relatively high which may be due to acclimatisation and tropical climate of the country.

5. Activity of some of the serum enzymes, such GOT, GPT, Aldolase and LDH, was elevated among the ceramic workers due to heat stress, which may adversely affect the metabolism of these workers.

6. Prevalence of silicosis and silicotuberculosis, diagnosed by radiological and pulmonary function tests among the ceramic workers, was observed to the levels of 15.1% and, therefore, it may be concluded that this reflects the high concentration of respirable dust having excessive free-silica content, because the prevalence of silicosis is closely associated with the respirable dust concentration and its free-silica content.

Conclusively it was revealed that the problems of health hazards in the small-scale ceramic factories of urban and rural areas are mainly due to excessive exposure to dust and, in the kiln department due to heat stress. It needs prompt attention and introduction of practicable measures to minimise the dust exposure among the ceramic workers. For the improvement of working environment and to minimise
the overall health hazards, the following measures are re­
commended.

RECOMMENDATIONS

1. The working area should be properly ventilated to have
free air movements. This can be achieved by proper design
of the factory building.

2. Shifting of raw materials and dry grinding should be
carried out under effective exhaust draft. Machines, eleva-
tors, conveyors, etc. should be effectively enclosed and
necessary exhaust draught should be applied.

3. The places marked for glaze spray, dry grinding, dry
finishing of wares should also be provided with effective
exhaust draught, so that the spreading of the dust in the
general environment can be eliminated and the contaminants
suppressed at the source.

4. To prevent dissemination of dust from one department
to the other, dusty processes, and processes with higher
dustiness, should be isolated from non-dust processes and
processes with less dust concentration.

5. Clay grinding process, which is the main source of
dust, should be isolated from general shed, and it should
also be enclosed properly.

6. Cleaning of dry wares by blowing the air should be
avoided.
7. Manual cleaning of the floors, benches, equipments etc. should not be carried out during the work session; it should be finished either before the work shift or after the shift.

8. Substitution of raw material without or with less free silica, e.g. instead of ball clay, china clay can be used, which contains less silica.

9. In glaze preparation, instead of lead compound, less toxic compounds such as compounds of zinc or zirconium which are comparatively less toxic can be substituted.

10. Inside the kiln, at the time of unloading, a draft of cool air should be passed to avoid heat stress.

11. Periodical monitoring of environmental dust and thermal conditions should be carried out regularly, and a record of this should be maintained properly.

12. The workers should be made aware about the potential hazards due to dust, glaze and heat etc. Simultaneously, safety education and vocational training programmes should be arranged regularly for them.

13. The workers working in processes such as grinding, slipcasting, jolly-jigger, spraying, and glaze dipping should be provided suitable safety overalls, such as gloves, gum-boots, clothes, respirators etc. Workers working under severe hot conditions should be provided heat protective clothes, and they should be advised to take ample water to
avoid electrolyte imbalance and dehydration.

14. Employment of women and children in certain dangerous processes such as grinding, cleaning, weighing out, glaze spraying etc. should be prohibited.

15. Pre-employment and periodical medical examination, including chest X-ray, of the workers employed in ceramic and potteries units should be made compulsory and medical records should be maintained properly.

16. The Management and workers jointly should take all possible effective measures to improve the environmental conditions and to minimise the health hazards.