AN INVESTIGATION INTO THE HEALTH HAZARDS OF "Aluminium Welders"

BY

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Welding, although not considered as an industry as such - is infact a ubiguitous process, as the application of welding is quite widespread that there is hardly any industry, metal or chemical, where welding is not used in one form or other towards either fabrication of metals or maintenance & repair of worn metal parts etc.

It is a common sight in metal industries to observe a hooded welder, perched upon a large steel vessel or crouched uncomfortably inside a shell, directing a stream of arc at a connection of steel joints, melting the metal pieces and fusing the same into a single piece. When the metal cools, the casting is as strong as the base metal or even better.

During the process of arc welding, oxides of various metals like iron, calcium, lead, aluminium, manganese, silicon, cadmium, copper, magnesium, titanium etc. are produced, in association with nitrous fumes and ozone. These metal oxide fumes are evolved either from the base metals, electrode coatings or from various types of flux used in welding. The nitrous fumes and ozone are produced from the atmospheric oxygen and nitrogen as a result of high arc temperature. The inhalation of these submicroscopic particles (0.05-0.5U) of various metal oxide fumes, results in various occupational respiratory illnesses, owing to deposition of oxides in alveolus.

A welder in particular, is more prone to excessive exposure to potentially toxic materials, as he is often required to weld in close, confined, ill ventilated spaces.

The aim of this study is to investigate into various health hazards in welders, engaged in 'Aluminium welding'.

Aluminium welding has been introduced recently at our metal fabrication plant. This welding consists of 'double welding operator technique' method, wherein, two welders direct their stream of arc at the same welding site on opposite sides on aluminium plates under argon gas shield, using bare wire aluminium electrodes as a filler metal. The arc current amperage used, is between 200-380 Amp, depending upon the thickness of the welded metal. This result in high intensity welding arc, and more ultraviolet and infra-red radiation is produced than when stainless steel is welded; besides a bright sheet of aluminium reflects almost 90% of the U-V energy with a wave length of 300mu, whereas stainless steel reflects only about 30%. It has been noted by Frant[1] that more ozone is produced during Aluminium welding than during the welding of steel and also more ozone was formed, when argon was used for shielding than when CO2 was used.

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MATERIALS & METHODS & OBSERVATIONS:

A total 12 welders engaged in Aluminium welding were examined physically. Routine blood counts and chest X-rays were taken. A detailed H/o present symptoms and past evidence of respiratory and eye complaints as recorded in the 'medical case records' were taken.

Various air samples for estimation of ozone & nitrous oxide from the welders' breathing, zone were collected during Aluminium welding. However, no samples of Aluminium oxide were taken.

Pattern of symptoms among all the Aluminium welders were frequent dry cough, throat irritation, chest pain, anorexia and epigastric discomfort. Ophthalmic symptoms revealed conjuctival irritation, lachrymation, photophobia.

Erythema face & other exposed parts of upper extremities were also complained by all welders.

Incidence of 'arc eyes' among these welders were also recorded during last one year in comparison to welders engaged in stainless steel welding.

TABLE I

Incidence Of Arc Eyes Among Welders

ALUMINIUM WELDERS		S.S.WELDERS
Initial three months	: 10 episodes in a month on an average	3 episodes in a month
Subsequent three months per	: 8 episodes in a month	4 episodes in a month

It is apparent from above table that the welders engaged in Aluminium welding are more prone to the effect of high intensity of U-V rays, emanating from Aluminium welding.

TABLE II

Results of Air Samples

Operation	Contaminant	Average Air Borne conc.	TLV
1. Al.Welging	Nitrous Oxide	5 ppm	5ppm
2. " "	Ozone	0.15 ppm	0.1ppm

It is seen from the above table that the air borne concentration of ozone has exceeded the TLV limit of 0.1 ppm, in contrast the concentration of nitrous oxide, which is within TLV limits.

The chest X-ray pictures in 4 out of 12 welders showed reticular pattern, particularly over the midzones.

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There was no evidence of nodular formation. All the welders were non-smokers.

DISCUSSION AND REVIEW OF THE LITERATURE:

The higher incidence of 'arc eye' in al. welders has been due to exposure to high-intensity ultra-violet rays and increased reflectivity of such rays from the aluminium surface. This clinical picture of 'conjunctivitis' is characterized by a latent period, which may vary from half an hour to 24 hours, but it usually is 6-12 hours. Welder often complains of F.B. sensation in eyes, irritations, lachrymation and blepharospasm, accompained by erythema of the facial skin surrounding the eye lids. These acute symptoms usually last for 6-24 hours and the individual is visually in capacitated for varying periods of time. It is rather difficult to define a safe exposure to U-V rays in a welding process, and according to pattee etal[2], this depends on: (i) The distance of the worker from the arc, (ii) the angle at which the rays of energy strike the welders' eye, (iii) radiation intensity and (iv) the type of eye protection used by the worker. Bates[3] has estimated that a safe exposure would be 20 seconds at 7 feet and 17 minutes at 50 feet.

Besides the effect on the eyes, ultra violet radiation can produce a skin burn very similar to sun burn[4] and such burns occur over the exposed parts of the body during welding. The skin irritation can occur in seconds when exposed to high intensity U-V rays, unlike eye changes. It is important to note that the ocular tissue, unlike the skin, does not develop tolerance to repeated exposure to U-V rayg. Kinsey etal[5] studied the production of eye damage from arc-produced ultra-violet radiation and Rieke[6] considered it to account for 40% of all injuries in engineering shops. In our fabrication plant, however the welders' arc eyes comprised of 0.4% - 1.4% of all industrial accidents. Powell etal[7] studied hazards from both laboratory and industrial plasma torches and observed that the output of these sufficient to cause eye and skin irriation on long exposure. The chronic effects of repeated U-V exposure over unprotected skin result in basophilic degeneration of the connective tissue, fragmentation of the elastic tissue and Carcinogenesis[8] Considerable details regarding histological and cytologic changes induced by U-V radiation may be found in NIOSH criteria document for occupational exposure to U-V radiation.[9] This document describes a variety of environmental sources producing U-V energy throughout the U-V spectrum.

The International Commission on Illumination[10] has classified the ultraviolet spectrum into three different wave length bands, 315-400 nm, 280-315 nm and 200-280 nm. These ranges are also referred to as near, midranges and far ultraviolet wave lengths respectively (Table III). Wave lengths below 200 nm are of little biological significance, since U-V radiation in this region is absorbed in very short path lengths in air, with associated production of Ozone(II).

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TABLE III

Ultraviolet Spectrum

AIR						WINDOW GLASS	
ABSORPTION						TRANSMITS	
- OZONE		- Germicidal Erythenal -					
150	200	250	280	300	315	350	400
	Far			Mid-range			

WAVE LENGTH IN MU OR NANOMETERS

"Aluminosis": As mentioned earlier Aluminium fumes were not examined for their concentration in the welding environment. The chest X-ray pictures in four welders strongly revealed fine lace-like reticular pattern in upper and mild zones of lung fields, indicating early pulmonary fibrosis. While direct relationship between possible high Aluminium fumes in the environment and presence of lung changes cannot be made, it is highly suggestive of such a correlation.

'Aluminosis' is a variety of pnemoconiosis, due to an inhalation of aluminium or aluminium oxide (TLV : Al. Fumes: 10mg/Cm^3 Al. oxide : 30 ml. particles/cu. ft. of air)-.

Aluminosis is mainly associated with the manufacture of coriundum, an extremely hard abrasive. The process consists of fusion at a high temp. (2000°c) of bauxide to which are added small quantities of coke and iron and steel scarp. The fusion is effected in electric arc furnaces and is attended by the evolution of dense white fumes, that contain Al. Oxide, Silicon (29-44%, 41-62%). It is likely that the lung disease produced by the inhalation of these fumes is a mixed-dust pneumoconiosis.

Gorale-wski[12], (1950) has described a clinical study of 'Aluminium Lung' in a monograph, giving an account of his own extensive observation on workers employed in the aluminium powder industry. Aluminium powder was made by rolling the metal and reducing it to particles of which finest grade measured 0.6 u.

In the examination of 628 workers, 28 gave h/o standing TB; in more than a third, there were h/o acute inflammatory processes in the lungs & pleura, and of influenza and bronchitis; annually recurring attacks of bronchitis were not infrequent.

Subjective symptoms did not usually correspond with objective signs, sometimes with wellmarked x-raysigns, no symptoms were complained of, and with slight or negetive x-ray findings, dyspnoea and cough was present. The important symptoms are dyspnoea, cough and sputum.

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In the clinical examination the outstanding characteristic was the discrepancy between the scanty findings on clinical examination on one hand and the radiological and spirometric results on the other hand.

The first reaction to the inhalation of dust was irritation of the respiratory passages, with cough & sputum; this apparently harmless reaction should not be disregarded in the aluminium powder industry. The experience showed that a serious pathognomic phase might develop with radiographic changes from these early symptoms.

In some workers, the signs of irritation ceased although the disease progressed to infiltration of the lungs; spontaneous pneumothorox was not infrequent. At this advanced stage, the aluminium lung resembled silicosis, except that in the former the development from the early to the late stage was much more rapid.

Morphologically there is general parenchymal fibrosis with induration of lung, and presenting a diffuse fine network of fibrosis tissue and broad radiating bands. Nodular fibrosis is not seen. Emphy-sematous bullae may be prominent, pleural thickening is often present - hilar & tracheo-bronchial glands are not enlarged & free from nodulation.

Histopathologically there is diffuse interstitial fibrosis with celluar infiltration of the thickened alveolar walls, which later become fibrotic with collagenous deposites- discrete or matted together with wide bands of scar tissue - Emphysematous blebs present in the midst of the overwhelming fibrous tissue. The quantities of silica in the lungs has varied between 21% & 31% and alumina between 25% to 41%.

Chest X-ray in the early stages reveal fine lace-like reticular pattern that gradually become coarser as the disease progresses, and is more pronounced in the upper lung fields. Hyperlucent areas and linear shadow marking the borders of bullae or cysts are quiet characteristic. In some cases, the mediastinum was widened and the hilar shadows were partially obscured.

The excessive diffuse fibrosis favours a 'Chemical dust as the cause'. The high silica content of the fumes, and of the lungs, suggests silica as the specific cause, which appears unlikely because the silica was amorphous and the fibrotic changes in lungs was not nodular. If this is a form of silicosis, the problem still remains to explain why the anatomic form of the reaction is diffuse and not nodular.

It is therefore suggested that the amorphous dust causes a rapid sclerosing process in the septa, which interferes with phagocytic transmission of the dust, thus giving rise to a diffuse fibrosis without nodulation. It is also possible that the amorphous alumina dust in intense concentration is the dominant aetiologic agent.

A theory by JAMIN & JOTTEN, suggested the possibility of Al. lung depending on an allergic reaction. 628 Al. workers-blood was examined in 95; in about a 1/3rd lymphocytosis of 40-70%. In 1/5th, an eosinophilia of 4-7% was present. In our series-there was moderate lymphocytosis in all cases, though no statistical significance could be given, as the no. of cases examined were rather small.

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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 occured 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 factofy 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.

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