FILE NAME: Colonial Sugar Refinery (CSR)

DATE: 1958 Mar

DOC#: CSR033

DOCUMENT DESCRIPTION: Trade Journal Article - Toxic Agents in the Factory

Doc · 147 1 15 55 415 555 Doc 147

Toxic agents *in the* factory

INDUSTRIAL diseases occupy a unique position in the field of medicine, because all industrial diseases can be prevented.

When an industrial medical officer takes up an appointment in an industry, his initial step is to study all the different types of operations, by a procedure called job analysis.

At this time the industrial medical officer—usually in company with the safety officer, the employment officer and the foreman of a section—analyses and records the physical and environmental factors in a particular job. Such conditions as light, heat, humidity, air-pressure, noise, dusts, gases, toxic chemicals and radioactivity are noted.

He then applies the general procedure of ensuring through an industrial hygienist (usually an officer of the very well-informed, well-equipped and extremely helpful Industrial Hygiene Division of his State Public Health Department) whether any toxic agents are above their maximum allowable concentration, called the M.A.C.

Should this prove to be the case, recommendations are made for the elimination of the agents, or substitution by a less-toxic agent, or a controlled process to ensure that the operator does not expose himself to concentrations above their maximum allowable limit.

For example, suppose a de-greasing area were being studied and trichlorethylene was the de-greasing agent used. The industrial medical officer knows that this chemical is an anaesthetic, is an efficient de-greaser and may cause burns. Also, when drawn over a very high temperature source, it may turn to the highly toxic gas phosgene.

He would know if he could smell its familiar odor that probably there was more in the air than the maximum allowable concentration of 200 parts per million. He would then recommend steps to be taken, possibly for the properly controlled ventilation at the de-greasing area.

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When all the jobs have been analysed and completed, the information might well be collated by the formation of a chemicals committee which would set up standards for use on these various chemicals and make recommendations for their effective control or substitution.

Dr T. A. Lloyd Davies has classified industrial diseases into groups based on their manner of origin. The principles to be adopted for their prevention and a brief sketch of each is presented below.

Physical

Temperature: Heat cramp occurs with temperatures above 100 deg. F. They are seasonal, occurring mostly in foundries, forges and mines. Cramps are experienced in the areas of the hands, legs and feet and in the back and lumbar region.

They are due to loss of fluids and particularly loss of sodium and potassium, by sweating. Saline drinks will prevent cramps, the drink being composed of 72 grains of sodium chloride and 48 grains of potassium chloride added to a half gallon of water.

Heat exhaustion may call for redesign of work areas, particularly with aluminium screens and aluminised clothing. Air-conditioned rest rooms are very effective.

Cold: Exposure to cold may precipitate and aggravate existing colds, bronchitis and kidney inflammations.

Light: Ultra-violet light, as produced for example by a welder, cooks the protein in the cells of the transparent part of the eye, causing the well-known welder's flash. This may be entirely prevented by correct preventive eye-wear.

Infra-red over a period of many years, from such sources as molten glass and the heat and glare of annealing furnaces, causes the lens of the eye to become opaque and thus produces a cataract. The industrial hazard may be abolished by improvement in manufacturing methods.

Pressure: Compressed air illness is caused by greater volumes than normal of oxygen and nitrogen being absorbed in the blood. With the rapid releases of nitrogen on decompression, severe damage may be caused in the nerves, bones, ligaments and tendons.

In America, mixtures of oxygen and helium are used as a substitute for oxygen and nitrogen, to prevent these so-called "bends" and also as an effective agent in abolishing symptoms similar to acute alcoholism caused by the poisoning effect of nitrogen.

Vibration: Pneumatic tools average about 700 to 3,000 blows per minute, although some vibratory tools may go to 6,000 blows per minute. They may, by a nervous reflex, produce "dead hand" or white fingers in one hand.

Usually, the left hand is first affected in a right-handed person. The vibrations may also affect the joints and bones. Prevention embraces rest periods for workers, tool balancing, silencers and exhaust design.

Noise: Prolonged exposure to overall noise levels above 94dbs., especially in the frequency range from 500-2,000 c.p.s., may cause a permanent nerve defect. A preventive technique here is to have an audiometric exam-

(Continued on Page 38)

v. 12 March 1958

THE DISEASES THAT CHEMICALS CAUSE

(Continued from Page 36)

ination of new workers and periodic checks of employees.

Partial deafness, when present, indicates the necessity of removing the worker from the noisy field and evaluation of recovery of the nerve over a maximum period of six months.

Electricity: Electric shock results depend on where the electric current routes itself through the body. Changes in the nervous system only result if the current passes through the brain, spinal cord or nerves. Serious results may come from paralysis of the portion of the brain controlling respiration; also, irregular beating of the heart.

It is of extreme importance to commence artificial resuscitation, a stated figure being that if respiration is commenced within one minute from the accident, 90 per cent should survive and if respiration is commenced as long as six minutes after the accident, 90 per cent fail to recover.

All potentially dangerous apparatus may be shock-proofed. Electrical burns require the same care as thermal burns.

Radio-activity causes ionization of proteins, with possible damage of germinal tissue, damage to the blood-forming system and inflammation of the membranes lining the digestive tract. Additional effects may include damage to blood vessels, damage to bones, tumour formation, cataract, skin inflammation and death, and occasional cancer formation of the skin.

Preventive measures require screen booths, efficient ventilation and monthly examinations of workers. Protective clothing and gloves must be considered. Common hazards are X-rays used for examining castings and the inhalation of radio-active dusts and gases.

Disease Due To Chemical Causes

Chemicals may be absorbed into the body through the digestive tract, through the skin and by the lungs. The lungs are the most important portal of entry in industry.

Trinitrotoluene manifests its poisoning effects with a dermatitis, turning the skin a dark orange color. On an insensitive person it gives an acute redness of the skin exposed.

The blood may be altered, giving a blueness of the lips, pain in the chest and shortness of breath. Gastritis is frequently complained of, as is toxic jaundice, and sometimes anaemia of an incurable type.

The prevention of trinitrotoluene poisoning involves mechanical handling, adequate ventilation, good nutrition and periodic medical examination of workers, with adequate washing facilities and barrier creams.

Dusts: Pneumoconiosis is an inflammation of the lungs produced by dusts, particularly silica, predisposing as it does to tuberculosis. The maximum allowable concentration of silica is 3,000 particles per c.c. Silicosis sometimes may not be produced until 10 or 20 years after exposure.

Asbestos is another destroyer of lung tissue and the maximum permissible concentration is two and a half million particles per cu. ft; that is, 87 particles per c.c.

The prevention of silicosis and asbestosis revolves itself around the suppression of dust and exhausting it, plus personal protection of workers by respirators. Pre-placement and periodic medical examinations are essential, with radiological reviews.

Cotton protein inhaled is felt by many to give the combination of chronic asthma and bronchitis called Byssinosis. Talc causes a similar condition in the lungs as asbestos.

Fibres left after the sugar has been extracted from cane sugar produce the allergic lung disease known as Bagassosis. Vanadium will produce lung inflammation, and is usually found as a contamination in oils, especially those used for firing furnaces. It is essential that workers cleaning the furnaces use completely protective clothing and have an air-feed into their respirators.

Manganese, as well as beryllium fume, causes a chemical inflammation of the lungs.

The inhalation of particles of iron oxide will cause siderosis (which can be detected in X-ray films of workers) and fine mottling of the lu
Metal fume fever may result from welding of metal producing meta oxides, particularly those of zi Chromium may give lung cancer a nickel may produce cancer the nose.

The inhalation of lead in the fo of a dust, where there is more th 1.5 mgm per 10 cu. ft. of air, w produce lead poisoning, with its we known effects on the muscular syste and the blood and nervous system

It is deposited in the bones ar can be prevented by periodic medic examination of exposed workers, t gether with personal protection an adequate ventilation. It is treated now adays with E.D.T.A., a chelatin agent which effects the removal o heavy metal from the body.

Mercury: Poisoning from mercury is most often absorbed through the lungs in the form of vapor, with classical symptoms of loss of teeth, salivation and generalised progressive weakness. Industrially, the symptoms are those of tremor and extreme apprehension on the part of the sufferer.

Arsenic may cause poisoning through the inhalation of the gas arsene. Arsenic compounds giving rise to dusts may produce nose-bleeding, as well as various skin diseases.

Zinc and cadmium, by their oxides, produce severe irritation of the lungs.

Antimony salts, taken by the mouth, give abdominal pain, nausea, nervousness and giddiness.

Gases: Arsene has a delayed reaction and causes the red blood cells to dissolve. Phosphene gases rapidly lead to coma and death from nerve-centre paralysis.

Cyanide is well known and all industrial medical establishments carry preparations for use in the acute emergency that arises from the inhalation and swallowing of cyanide.

Carbon dioxide, by replacing the oxygen in blood, may cause unconsciousness.

The prevention of gassing is directed around five lines:-

1. Escape of poisonous gases.
2. Adequate exhaust ventilation.
3. Respirators.
4. Reliable trained persons for rescue and resuscitation.

(Continued on Page 57)

Control of toxic agents in plants

(Continued from Page 38)

5. Periodic medical examinations.

Carbon tetrachloride may be acute or delayed in its poisoning effects, and its maximum allowable concentration is somewhere in the region of 100 parts per million.

Other chemicals requiring control if they are used are chlorinated naphthalenes, ethyl alcohol, methyl alcohol, methyl sulphate, methyl bromide, methyl chloride, carbon disulphide, ethylene oxide and diethylene.

The following table is a good general reference one for limits of toxic chemical concentrations. It has been promulgated by I.C.I., Industrial Process and Health Research Committee.

Gas	Concentrations in the general atmosphere of the plant greater than those given below indicate unsatisfactory conditions.
Acetaldehyde	200
Acetic acid	20
Acetone	400
Acetyl chloride	1
Acrolein	5
Ammonia	85
Iso Amyl acetate	100
Aniline	10
Arsine	0.5
Benzine (petroleum spirit)	250
Benzol (benzene)	50
Benzyl chloride	5
Bromine	0.5
Carbon dioxide	5,000
Carbon disulphide	10
Carbon monoxide	50
Carbon tetrachloride	p p m v/v 50
Chlorcinitro benzene	1
Chlorine	1
Chloroform	50
Dichlorbenzene	25
Ethanol	500
Ether	500
Ethyl chloride	2,000
Ethylene chlorhydrin	2
Ethylene dichloride	10
Ethylene oxide	10
[illegible]aldehyde	10
[illegible]ogen chloride	10
Hydrogen cyanide	10
Hydrogen fluoride	2
Hydrogen sulphide	20
Methanol	200
Methyl bromide	20
Methyl chloride	100
Nitrogen oxides (as nitrous fumes)	10
Nitrobenzene	1
Perchlorethylene	200
Phosgene	0.5
Styrene	100
Sulphur chloride	5
Sulphur dioxide	10
Tetrachlorethane	10
Toluol (toluene)	100
Trichlorethylene	400
Xylol (xylene)	100
Dusts, fumes and metals	**mg/cu metre (20 deg C.)**
Chlorinated naphthalene	1
Chromium compounds	0.1
Dinitrophenol and salts	1
Lead	0.15
Mercury	0.1
T.N.T.	2.0