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the mayor, which must be renewed every week. The Californian law enjoins that no child under at least 16 years of age can be employed in a studio unless duly authorised and after medical examination carried out by a medical man in the Child Welfare Service. These examinations are made every three months. Children taking part in film production must not be employed more than eight hours a day, including lessons lasting four hours given by a qualified teacher, paid, but not selected, by the studios. Employment of children before 8 a.m. and after 5 p.m. is prohibited.

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For other sources, see *Bibliography of Industrial Hygiene*, published quarterly by the International Labour Office.

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Asbestos

French: *Amiante, Asbeste, Pierre à coton.* — German: *Asbest, Amianth, Bergflachs.* — Italian and Spanish: *Amianto.*

Chemical Properties

Asbestos is a brilliant filamentous mineral, oily to the touch, white, silvery grey, greenish or blnish. Its density is 2.3-2.9. Its chemical composition consists, according to its origin, of calcium silicate and magnesia or of a magnesia silicate accompanied by quantities of iron, more or less extensive. Analysis of different varieties of asbestos reveals a silica content of 40-50 per cent. — 41.2 in Canadian asbestos, 41.8 in Siberian asbestos, and 51.1 in the African variety — while oxide of magnesia varies between 2.3 (African) and 41.7 (Canadian), oxide of iron between 2.32 (Canadian) and 35.8 (African). In Siberian asbestos there is besides 16.39 per cent. of alumina. When cut up it presents a silky cotton-like form which lends itself easily to weaving. It is incombustible, prevents heat loss, is a thermic and electric insulator and is not attacked by most acids.

Of the three different mineral varieties known by the name of asbestos, it is serpentine asbestos or chrysolite and hornblende asbestos which are the most commonly used; the first of these is the most sought after variety. Industrial asbestos is chiefly derived from Canada, Russia, Italy, and the Transvaal.

Technology

Extraction involves two distinct operations: (1) quarrying of the asbestos-bearing rock, generally mined in open quarries or, in countries having a severe winter climate, in galleries; (2) separation of the asbestos from the surrounding rock. The rock is cut in terraces, sometimes reaching a depth of some 150-200 ft. Quarrying is more economical and effective than underground work even despite exposure to weather. Drilling and blasting are engaged in as in ordinary stone quarrying. The mineral got from the quarry is rough sorted, different grades being chosen for length of fibre and sent to "cobbing sheds" where dressing is carried out. This consists of separating the asbestos fibres from the surrounding rock and may be done (*a*) by hand — the stone being broken by a small sledge hammer and the fibre thrown thereafter into one box and the waste into another — or (*b*) by machine ("mills").

Hand separation ("picking and sorting") is not difficult since the fibres lie in layers more or less loosely attached to the rock and can frequently be picked off with the fingers; but hand dressing is not thorough and the waste material from the cobbing tables contains much fibre, the further utilisation of which represents large profits to the mine, and these fine pickings have to be dressed mechanically. They are passed after drying to crushers where they are broken by successively finer-set rollers and further reduced by cylindrical fibrisers and the cyclone machine, which reduces them to fine powder. The cotton-like fibres come to the surface and are mechanically withdrawn by suction. The pulverised rock and ground asbestos are then separated by passing them through a shaking screen. In some mills the particles of iron present are taken up by strong electric magnets. The crude fibre on separation from the waste rock resembles mineralised wool. The asbestos is graded according to the length of fibre on a series of cylindrical screens. It is then carded and packed in sacks and placed on the market in bulk.

Industrial Uses

The uses to which asbestos is put are very varied. The long fibres are used in the textile industry for the manufacture of cloth, braid, rope, theatre curtains, decoration, upholstery, hangings, and for finishing pistons for steam engines. The shorter fibres together with an agglomerating agent are used in the manufacture of felt, paper, cardboard, varnishes, covering agents (especially for strong

rooms), cements, rubber tyres for automobiles and bicycles. Asbestos is also used as an electrical insulator for covering electric wiring for high and low pressure currents, in the manufacture of tiles, planks, panelling and exterior coverings for buildings, mattresses, heat insulating gloves, firemen's clothes, laboratory equipment, porcelain, balls for gas fires (made of fireclay and asbestos), etc.

Dangers and Hygiene

The worker engaged on the extraction and manufacture of asbestos is constantly exposed to danger from dust, more especially, however, in the operations of spinning and weaving.

The baneful influence of the dust in relation to the production of tuberculosis is brought out in the *Annual Report of the Chief Inspector of Factories for England and Wales for 1910*, which records 5 deaths from tuberculosis amongst 40 workers engaged in an asbestos weaving factory, where the most dangerous process was revealed to be the weaving of asbestos mattresses composed of bags of woven asbestos filled with short asbestos fibre. They were placed on a table and beaten out flat by a man with a wooden flail, which process occasioned the production of much dust. Women sewed the mattresses into sections using asbestos threads and as they worked beside the beaters they also of necessity inhaled much dust.

Towards the beginning of 1924 a fatal case of poisoning by asbestos dust was reported at Rochdale (England). The victim was a woman who had been employed in an asbestos factory. A post-mortem examination revealed death as due chiefly to a fibrosis of the lungs due to the inhalation of mineral particles and in part to tuberculosis. A microscopic examination of the lungs and of dust samples taken from three different workshops of the factory revealed the same black particles present in each, alike in form and dimensions.

Another fatal case was studied in 1927 by Cooke and Hill (Great Britain).

A striking example of the noxious property of asbestos dust is instanced by the following case: in an asbestos spinning and weaving factory (Calvados) there were 40 deaths in the five years 1890-1895. The mortality rate decreased considerably with the installation of a good system of local ventilation over the carding machines. (See also article "Tuberculosis".) In an asbestos weaving factory in Saxony the workers complained of headaches and loss of appetite. These affections were caused by fumes given off by a rubber solution with which the asbestos cloth had been coated to eliminate dust.

An investigation carried out in Canada in 1911 revealed that hygienic conditions were greatly improved as a result of the adoption of an effective system of ventilation. Nevertheless, a local doctor with long experience stated that respiratory troubles, and in particular tuberculosis, were of very frequent occurrence amongst asbestos workers.

Rambousek drew attention to the risk of lead poisoning during the weaving of asbestos when a thread of lead is added to the weft, as is sometimes the case.

Marked frequency of chronic conjunctivitis with hypertrophy of the rims of the pupils has also been noted amongst the asbestos workers of the Island of Cyprus. The workers in question were chiefly engaged in grinding, screening, and packing the asbestos in sacks.

The weaving of asbestos has only developed importance during the last twenty years. Now that it is widely practised the application of local exhaust systems during such processes as that above described is called for. All processes from extraction onwards unquestionably involve a considerable hazard, and American and Canadian life insurance companies generally refuse asbestos workers on account of the assumed deleterious conditions in the industry.

The lack of more accurate and detailed data in medical literature regarding this industry in its various branches, including the utilisation of by-products, is to be deplored in view of the self-evident importance of asbestos dust as a predisposing cause of pulmonary tuberculosis, more especially since the rapidly increasing development of industries utilising asbestos adds greatly to the urgency of studying the conditions with a view to their amelioration.

All provisions already described for withdrawal of dust should be enforced in this industry.

Legislation

In *Italy* boys under 15 and girls under 21 years of age are excluded from workshops where dyeing and weaving of asbestos are engaged in, unless effective

means are taken to prevent the diffusion of dust throughout the atmosphere.

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Ashes, Cinders

French: *Cendres.* — German: *Aschen.* — Italian: *Ceneri.* — Spanish: *Cenizas.*

Ashes present problems from the point of view of industrial hygiene, not only when cinders from hearths are in question (dangers from hot dust, presence of certain products, etc.), but especially when they are employed for special purposes. Thus, for instance, treatment of goldsmiths' ash by lead may cause injury by reason of the metallic dust which it liberates.

Hygienic measures assure covering of any openings giving on to the public streets, thorough ventilation of the workshop, the installation of hoods for the furnaces and cupels connected to the chimney by a strong exhaust. If the treatment is effected by means of mineral acids, application of measures of protection against toxic fumes is required, viz. condensation of lead fumes. Noisy machinery should be isolated, and measures applied for evacuation of residues and the protection of workers from the heat and glare of the furnaces.

Pearl ash from combustion of organic material, such as shoots of vine, wine lees, vinasse from beetroot, etc., is composed of impure potassium carbonate and its treatment liberates sharp, piquant, thick, and disagreeable fumes and injures vegetation in the neighbourhood. Factories should be erected at a long distance from dwelling houses and calcination should be effected in closed ovens. Gases and fumes should be led to special hearths or requisite measures taken for their destruction. The chimney must be a very high one. It would be advisable to collect the incandescent mass of carbonate of potassium in a special apparatus so constructed that the gases can be led to the hearth or into apparatus where they can be burnt. Hoods should be installed above the evaporation boilers. The water should be led to a sewer: the residues require fairly frequently to be removed and can be utilised as manure.

By the expression "dust shot with a lead content" is meant the impure oxides which form on the surface of each bath containing lead or lead alloys. This scum or black dross is removed as it forms and is often put aside on the floor, where it becomes mixed with other substances. In appearance it resembles ashes, hence the French expression "*cendres de plomb*".

Kelp ash is lixiviated for the extraction of the salts of potassium. The ash is got by burning different kinds of sea-weed known as kelp or wrack and thrown up on the seashore. Dried in the sun, they are thereafter reduced to ashes in furnaces lined with refractory bricks. The product of combustion "kelp ash" is in the form of a solid compact block, from which the salts of potassium are extracted. The blocks are then ground and put into special apparatus for gradual dilution with water. The solution is concentrated in iron boilers and poured into vats where, after cooling, the potassium chloride is deposited in crystals, which are then subjected to purification.

Hygienic precautions to be recommended are impermeable flooring, cement walls to the height of one metre, hoods provided above the boilers to draw off the fumes to the chimney, all openings to the public highways to be kept closed, and neutralisation of the water used before it enters the sewers.

The Recommendation adopted at the International Labour Conference at Washington (1919) regarding the protection of women and children against lead poisoning demands the exclusion of women and young persons under eighteen years of age from work involving manipulation, treatment, and reduction of ashes containing lead.

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Asphalt

(Mineral Pitch, Hard Bitumen)

French: *Asphalte, Poix minérale, Bitume.* — German: *Asphalt, Erdpech, Erdharz.* — Italian and Spanish: *Asfalto.*

Earth and rocks impregnated with bitumen are called asphalt. In mineralogy, however, the name asphalt is also given to bitumen in a free state. It is highly important to distinguish between these two products. Asphalt is generally in the form of fine grained rock, black or dark brown in colour according as it is more or less