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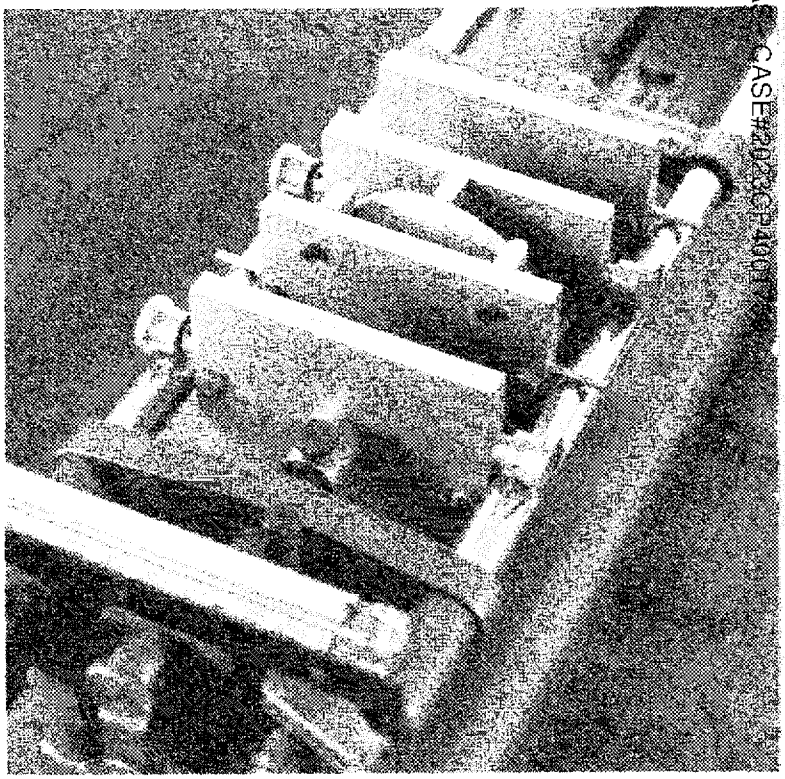
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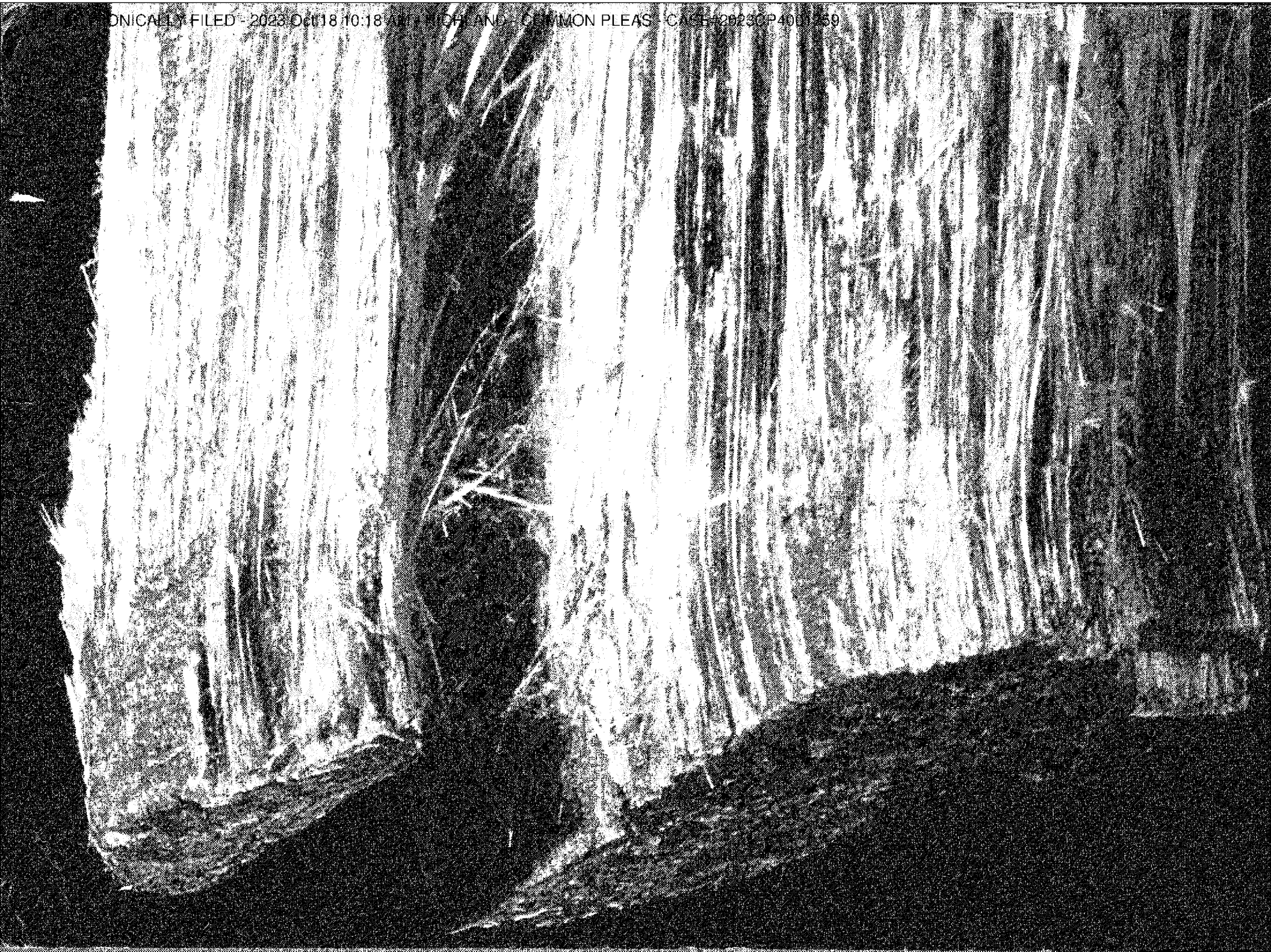
Amphibole Asbestos







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Amphibole Asbestos

Asbestos is a unique material – the only naturally occurring mineral fibre. It is found in two major forms, the first of these being Chrysotile (White Asbestos) and the second being the Amphibole group which includes the two important types known as Amosite and Crocidolite (Blue Asbestos). Whilst by no means as abundant in occurrence as Chrysotile, the Amphiboles are of considerable specialised importance. In some applications, they are indispensable in their own right, in others, they enhance and complement the properties of Chrysotile.

Prepared by the Cape Asbestos Group – the world's largest producer of Amosite and Crocidolite – this publication is a compact and useful reference on many aspects of Amphibole asbestos from mining to ultimate application.

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Front cover

Upper and lower: Sections from photomicrographs of Amosite asbestos cut as seen through the polarising microscope

Centre left:
Bauer-McNett Classifier
The Bauer Bros Company
Springfield Ohio USA

Centre right:
Roomfield Tensometer
Messrs Tensometer
31 Midland Road
Croydon CR0 6HG

Back cover

Upper and lower: Sections from photomicrographs of Amosite asbestos cut as seen through the polarising microscope

Centre left:
Continuous Fibre Classifier
Ultrasonoscope Company (London) Ltd.
Sudbourne Road
London SW2

Centre right:
Burdett Air Permeability Apparatus
Griffin and Georbe Limited
Ealing Road
Alperton
Wembley, Middlesex

Inside front cover

Burnt specimen of Amosite rock

Inside back cover

Enlarged section of Crocidolite rock

Asbestos History and Development

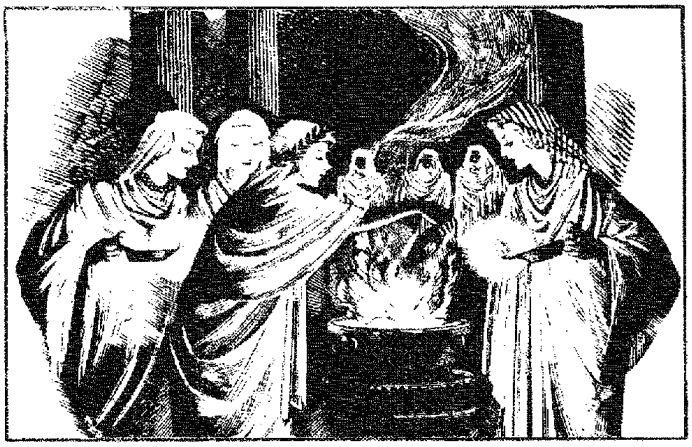
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'The stone which is combed and woven'

Asbestos has been known and used for its unique properties for many centuries. Early Greek and Roman writings make many references to the material and mention specific sources, including mines which at that time had already been worked out.

The essential characteristic of asbestos is that it will not burn, but its name is a contradiction. A Greek word, it means inextinguishable or, once burning, cannot be quenched.

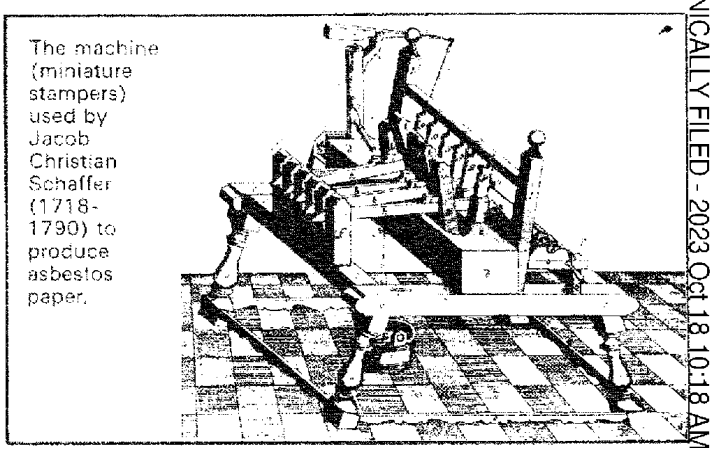
The paradox is perhaps explained by the use of asbestos in lamp wicks, the most famous example being in the woven material used in the perpetual lamps of the Vestal Virgins. Throughout industry, however, the fame of asbestos has been largely based on its incombustibility. Plutarch, who lived in the first century A.D., refers to rock yielding "soft, petrous filaments like yarn" which are made into "towels, nets and women's head coverings which cannot be burned by fire; but if any become soiled by use their owners throw them into a blazing fire and take them out bright and clean".



In the Middle Ages, the Emperor Charlemagne is said to have impressed an enemy and prevented a war by exhibiting strange powers—he threw his tablecloth into the fire and recovered it cleaned and unharmed. Undoubtedly, it was woven asbestos. In 1250, the Venetian explorer, Marco Polo, records that he was shown unburnable cloth in Siberia, and he learned of the existence of asbestos mines in the area.

References are also found in history to exploitation of other asbestos properties. Archaeological finds dating back over 2,500 years show very early uses of fine asbestos fibre for reinforcing lightly fired pottery. And a Greek doctor about 28 B.C. noted that "if a tree is surrounded with linen made of asbestos the noise of the blows given by the axe will be deadened thereby, and the tree may be cut down without making a noise". Recognition even then of the acoustic insulation properties of asbestos!

So through the centuries asbestos has been widely known and used. But it remained an object more of curiosity and superstition than of practical value right up until the 19th century.



The machine (miniature stampers) used by Jacob Christian Schaffer (1718-1790) to produce asbestos paper.

New asbestos discoveries

Although some of the earlier accounts may have referred to the use of other varieties of asbestos, it was clearly Chrysotile or White asbestos which figured largely in the early history. But some time between 1803 and 1806, a German geologist called Lichtenstein, travelling near the village of Prieska in the Orange River Valley in South Africa, came upon a mass of asbestos which was lavender blue in colour. Apart from its colour, it had a different texture from Chrysotile and belonged to the Amphibole group of minerals. It was named Crocidolite, recorded, and then forgotten. Almost ninety years were to pass before the material was mined commercially.

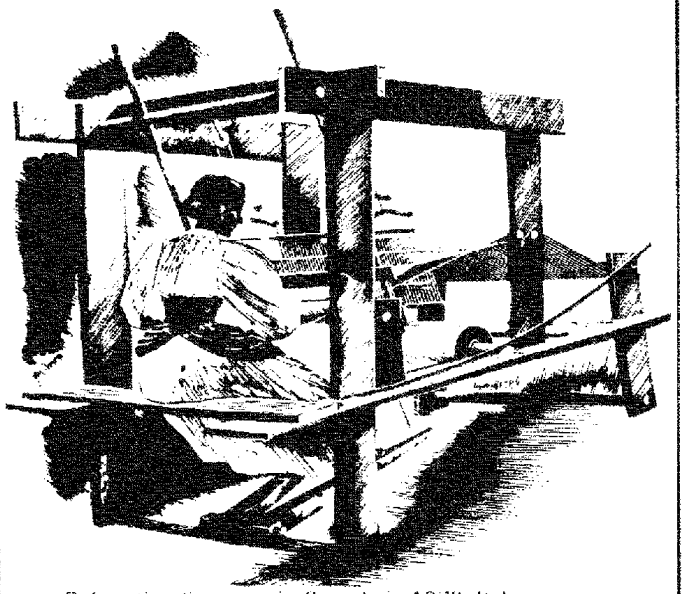
Long before this, in 1847, immense deposits of Chrysotile asbestos had been discovered in Quebec by Sir William Logan, the first Director of Geological Survey in Canada. Once again, it was a discovery too early for commercial exploitation. Even as late as the 1870's asbestos was still a material for tricks and spectacles. At that time, asbestos was produced in Italy but its cost made any possible large-scale use uneconomic.

Mining of the rich Quebec deposits finally started at the beginning of the 1880's, and since then there has been continual expansion. Canada and Russia are today the largest producers of Chrysotile asbestos fibre.

The Cape Asbestos Company

Meanwhile, the end of the 19th century saw development of that other major type of asbestos, Amphibole. Francis Oats, a director of De Beers Consolidated Mines Ltd., the company controlling the diamond mines of South Africa, formed in 1891 the Cape Mineral Syndicate to exploit Crocidolite which had recently been re-discovered in the Orange River Valley. On December 28, 1893, The Cape Asbestos Company Limited was incorporated in London, its objective being to take over the Cape Mineral Syndicate's mining operations, to manufacture in London, and to acquire an Italian asbestos insulation factory as an outlet for Blue asbestos.

The early days of the Cape Asbestos Company Limited were not rosy, and for the years up to 1905 losses were reported far more often than profits. During this period there was a two-year shutdown on mining because production far exceeded demand, and the Boer War, which lasted from 1899 to 1902, led to yet another shutdown. In the meantime, the Italian factory carried on manufacture using white asbestos from other sources, but fierce competition in white asbestos goods made profitable operation impossible.
Further setbacks followed, some commercial, some due to a severe three-year drought in South Africa that paralysed production and communications. But the Company's confidence and persistence were rewarded. By 1911, the directors were able to declare confidently that the value of the Company's land in South Africa was increasing, and from then on profits were regularly being shown.
After the first world war, fears were expressed that the Company's Blue asbestos mines might give out entirely in a few years. These fears have, of course, proved to be groundless but following investigations into alternative sources of supply, the Company acquired in 1925 a number of mines in the Transvaal producing a fawn-coloured amphibole asbestos. This had been discovered in 1907 at a site called Amosa—from the initial letters of 'Asbestos Mines of South Africa'. The mineral became known as Amosite. It had long, stiff, rigid fibres and whilst unsuitable for easy spinning, proved itself ideal for the manufacture of insulating materials.
The world's supply of Amosite asbestos still comes largely from the South African mines of the Cape Group.



Before the discovery in Canada in 1878, Italy was regarded as the pioneer and main producer of asbestos, and many textile factories wove asbestos as a sideline.

Growth of asbestos cement industry

Just before the turn of the century there took place one of the most significant events in asbestos history, a development that more than any other created a vast world market for the new raw material. Ludwig Hatschek, the owner of a paper and board making plant at Vöcklabruck, near Vienna, began experimenting with cement added to an asbestos millboard. At about 80% cement and 20% fibre he discovered he had made a new product.
The original asbestos cement was a flat sheet about 40 cm x 40 cm, forerunner of the many sizes and types of asbestos cement products now made and used all over the world.
Manufacture began first in Austria, then in 1903 in Switzerland, followed by Belgium in 1905. Also prominent in the history of asbestos cement is an Italian engineer named Mazza. He met Hatschek and contributed greatly to the development of suitable production equipment for asbestos cement. He also developed a process for the production of high pressure asbestos cement pipes. Asbestos cement pressure pipe manufacturers still use his basic method. Another process for pipes was developed by Alessardo Magnani. This uses a revolving metal mandrel on to which is fed a thick slurry, a method still widely used today for asbestos cement pipes. Magnani is also known as the designer of the first machine for the continuous production of corrugated asbestos cement sheets.
Apart from asbestos cement, there was also rapid development in this period in other asbestos-based products. Asbestos textiles were used in packings for steam engines, boiler insulation mattresses, conveyor belting, steam pipe jointing materials, and protective clothing. In the first decade of the 20th century woven asbestos cloth was used as a basis for brake linings and clutch facings on motor cars, commercial vehicles and mechanised military transport.

Cape Group expansion

As these and other new asbestos products appeared, demand for raw materials increased. In the Cape Group, there was steady expansion in output from the mines, and at the same time the Group extended its original policy of being both a raw material supplier and a specialist manufacturer.
Today, the Group is an international organisation engaged not only in mining and supplying asbestos fibres, but in manufacturing asbestos-based and other products for use in building, shipbuilding, vehicle manufacture and servicing, and insulation applications throughout industry.

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Mining and Milling

Occurrence

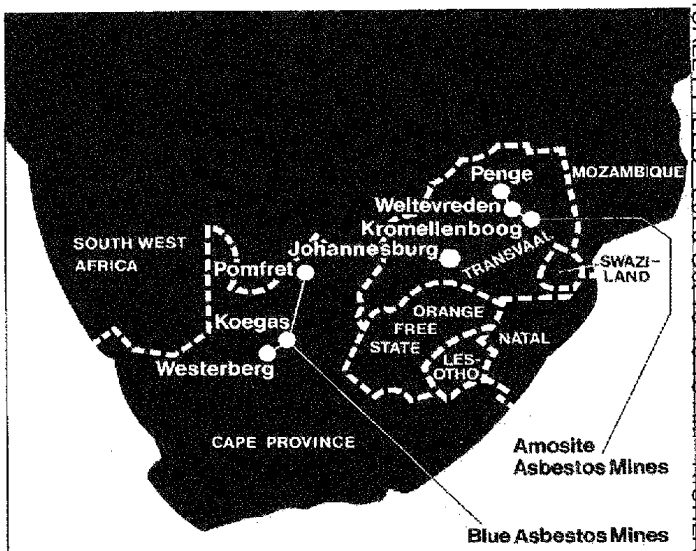
Most of the world's supply of Amosite and Crocidolite asbestos comes from Southern Africa. The deposits occur in the banded ironstone beds of the Transvaal system of rocks which are exposed in a long arc stretching northwards from the Orange River in Cape Province to Botswana and thence eastwards to the Olifants River area of Eastern Transvaal.

The most important Crocidolite mines are situated along a 300 mile line of hills in the Cape Province extending from Koegas in the south to Pomfret in the north. Crocidolite from these mines is known as 'Cape Blue' to distinguish it from 'Transvaal Blue' taken from the much smaller deposits in the Malips River area of Eastern Transvaal. Transvaal Blue is not a pure Crocidolite and has intergrowths of both Amosite and silica. Amosite occurs in Eastern Transvaal, the mines being located at Penge, Kromellenboog and Weltevreden.

Other fibrous Amphiboles (Tremolite, Actinolite and Anthophyllite) are found in relatively limited quantities in many parts of the world. Their low tensile strength limits their commercial importance in the asbestos industry.

Mining

The mining methods employed for Amosite and Blue are entirely different from those employed for Chrysotile. Chrysotile occurs in soft serpentine rocks as fibre seams close to the surface, and massive in nature. Such deposits can be mined by open cast or block caving methods. The narrow rich seams of amphibole fibre run deep into the ground often at inclines varying from the horizontal to almost vertical. The angle of dip determines the mining method but some mines are currently operating at 300 metres below surface.



Location of Cape's Amosite and Blue Asbestos Mines

Milling

The mined rock containing Amosite or Crocidolite is hoisted to the surface and separated into fractions initially for various drying, crushing and sorting operations, according to size. Because the ironstone rock is so hard and abrasive it is essential to remove as much as possible before attempting to extract the fibre.

The product is then fed into fiberisers for release of the asbestos which is then separated from dust, rock particles and stones. After further processing, the separated fibre is cleaned in special de-gritting and de-dusting equipment. There is then a final grading and air washing after which the fibre is pressure packed into bags ready for sale.

Classification Chart of the Asbestos Minerals

Asbestos

- **Chrysotile** (White Asbestos) $3MgO, 2SiO_2, 2H_2O$
- **Fibrous Amphiboles**
  - **Amosite** $5.5FeO, 1.5MgO, 8SiO_2, H_2O$
  - **Anthophyllite** $7MgO, 8SiO_2, H_2O$
  - **Crocidolite** (Blue Asbestos) $Na_2O, Fe_2O_3, 3FeO, 8SiO_2, H_2O$
  - **Tremolite** $2CaO, 5MgO, 8SiO_2, H_2O$
  - **Actinolite** $2CaO, 4MgO, FeO, 8SiO_2, H_2O$

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Physical and Chemical Properties

Structure

The basic structural unit of Amphibole asbestos is a double silica chain, each chain having four silica tetrahedra in its cross sectional view (Fig. 1). The two parallel chains are separated by a band of cations, which in the various forms of Amphibole asbestos include magnesium, calcium, iron and sodium together with other elements in minor quantities. In Amosite and Crocidolite these cations are mainly composed of ferrous and ferric iron. The cross section of a microscopic fibre of Amphibole asbestos comprises a uniform stacked arrangement of these structural units (Fig. 1). The strong cross linking in this structure leads to considerable rigidity in the fibre, and as a result small fibres of Amosite and Crocidolite are always straight while larger fibres possess marked resilience in the axial direction. This is the main reason why these types of fibres provide much more bulk volume in both the dry state and in aqueous suspensions than Chrysotile. The route of the preferred cleavage lines through the amphibole structure (A—A in Fig. 1) leaves most the resulting fibre surface is formed substantially by silica tetrahedra. It is the presence of this surface which is responsible for the relatively high chemical stability of Amosite and Crocidolite and for the specific surface properties of Amphibole fibres generally.

Fig. 2 shows a schematic structure of Chrysotile asbestos. This is entirely different from the Amphibole structure and accounts for the differences in nature of these fibres. Note that the external surface of Chrysotile fibre consists of an alkaline magnesium hydroxide layer.

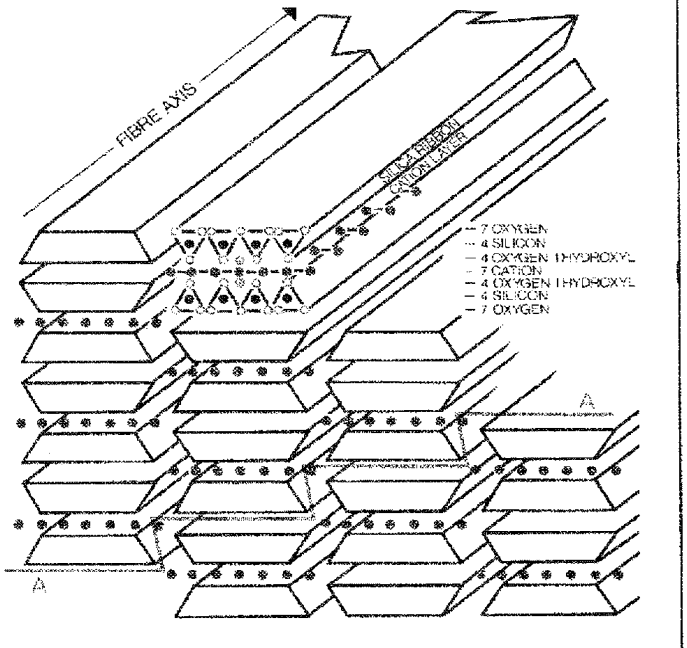


Fig. 1. Schematic diagram of the crystal structure of an Amphibole fibre, indicating the unit cell based on $X_7 Si_8 O_{22} (OH)_2$. The line A-A represents the edge of the preferred cleavage plane along which the fibres will split to form even smaller fibres.

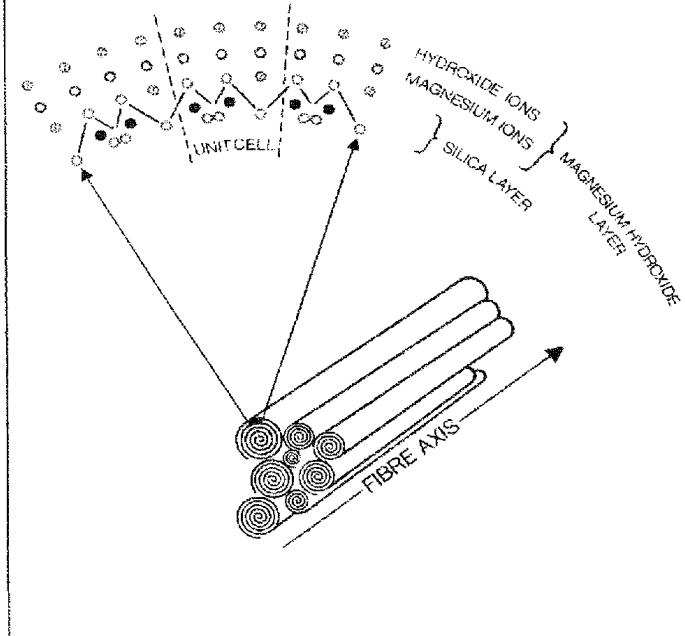
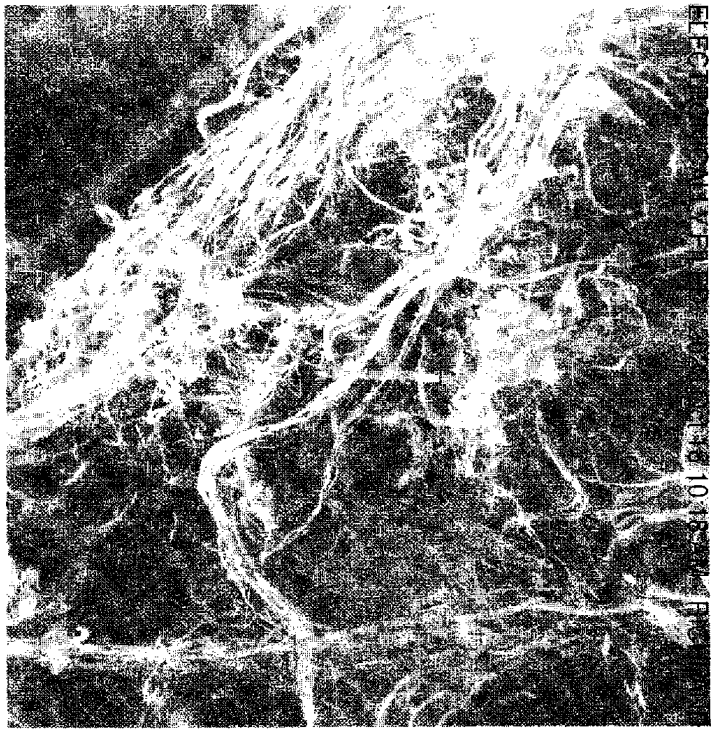


Fig. 2 Schematic diagram of the structure of a Chrysotile fibre formed of several scrolls of individual crystallites. Each scroll is formed from a closely connected double layer having magnesium hydroxide units on its external face and silica units on its inner face. The details of a small section of the scroll show the structure of the double layer and of the unit cell based on $Mg_3 (Si_2O_5) (OH)_4$.

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...scan photograph of Amosite Fibre (magnification ×4400).



Stereoscan photograph of Chrysotile Fibre (magnification ×4500).

...ical Properties

...hain silicate structure of Amphibole asbestos has ...igh intrinsic strength attributable to the bond ...etween adjacent silica tetrahedra. Crocidolite from certain deposits has the highest known tensile strength, at 35,000 kg/cm², of any mineral fibre. Amosite has a lower tensile strength of 25,000 kg/cm². Table 2 summarises the most important of the physical and physico-chemical properties of the main varieties of asbestos. In comparing the Amphibole fibres with Chrysotile fibre it will be seen that certain large differences exist, notably in density, fusion temperature, surface charge and optical properties. Some of these properties are important in the identification of different types of asbestos while surface charge characteristics are of considerable importance in asbestos technology.

Table 2

Physical and Physico-Chemical Properties of the Asbestos Minerals

Property	Amosite	Crocidolite	Chrysotile
Colour	Ash Grey	Blue	White
Natural Fibre Length	3 to 70 mm.	3 to 70 mm.	1 to 40 mm.
Fibre Diameter (micron)	0.1 to 1	0.1 to 1	0.01 to 1
Crystal System	Monoclinic	Monoclinic	Monoclinic and Orthorhombic
Occurrance	Banded ironstones	Banded ironstones	Serpentines
Optical Properties	Biaxial positive extinction parallel	Biaxial positive or negative. extinction parallel	Biaxial positive extinction parallel
Refractive Index	1.657–1.698 non-pleochroic	1.685–1.698 pleochroic	1.50–1.55 non-pleochroic
Specific Gravity	3.2–3.45	3.37	2.55
Hardness (Mohs' scale)	5.5–6.0	4.0	2.5–4.0
Specific Heat k-cal/gm/°C	0.193	0.201	0.266
Tensile Strength kg/cm²	25,000	35,000	31,000
Youngs Modulus kg/cm²	1.65×10^6	1.9×10^6	1.65×10^6
Heat resistance:			
% residual strength at 200°C	100	100	100
400°C	37	38	100
600°C	7	18	16
Fusion point °C	1,100	1,000	1,500
Surface Charge	negative	negative	positive

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Table 3 **Chemical Compositions of the Asbestos Minerals**

(Typical data)

	Amosite	Crocidolite	Chrysotile
SiO_2, silica	49.7	50.9	38.9
FeO, ferrous oxide	39.7	20.5	2.0
Fe_2O_3, ferric oxide	trace	17.45	1.6
Al_2O_3, alumina	0.4	—	3.1
CaO, calcium oxide	1.0	1.5	0.9
MgO, magnesium oxide	6.4	1.0	40.0
MnO, manganese oxide	0.2	0.05	0.1
Na_2O, sodium oxide	0.1	6.2	0.1
K_2O, potassium oxide	0.6	0.2	0.2
H_2O, water	1.8	2.0	12.6
CO_2, carbon dioxide	0.1	0.2	0.5
	100.0	100.0	100.0

Physico-Chemical Properties

The behaviour of asbestos in water is determined by the surface charge. The charge on Amosite and Crocidolite is slightly negative while that on Chrysotile is more strongly positive. Because of their low surface charge, Amphibole type fibres interlock together in water to give an open lattice work of fibres having high bulk volume and acting as filter aids. These properties are quite different from those of more strongly charged fibres which by mutual repulsion slide over each other to form a compact mass of small volume. Amosite and Crocidolite are thus complementary to Chrysotile and have particular importance in extending fibrous bulk and improving drainage rates in wet systems containing Chrysotile.

Chemical Properties

The chemical compositions of Amosite and Crocidolite given in Table 3 show that these forms of asbestos contain up to 40 per cent of combined ferrous and ferric iron as oxides and up to 50 per cent of combined silica. Since they contain oxidisable iron, both Amosite and Crocidolite turn reddish brown when they are heated. Certain types of Amosite and Crocidolite from surface deposits have similarly suffered oxidation by natural weathering during many millions of years and such fibres contain by-products of weathering which diminish the properties of the asbestos. It is only the Amosite and Crocidolite fibres mined in deep sub-surface deposits which possess all the properties described in these pages.

Asbestos fibres, no matter what types of asbestos, cannot be regarded as being completely thermally resistant. All varieties of asbestos break down progressively through a series of internal reactions which may begin as low as 200°C, reaching finality at about 800°C. They lead to a conversion of the composition and structure to simpler silicates and oxides and are accompanied by a loss in strength (see Table 2). Although Amosite and Crocidolite break down in this way when heated it does not mean that their properties as heat insulators are diminished. When compounded partially or wholly into heat insulating materials Amosite and Crocidolite fibres retain their form though they are internally changed at high temperatures. They possess ablative properties in that the products of decomposition at a hot surface form a poorly conductive layer which provides protection for the succeeding layers of insulation.

Since the surfaces of amphibole asbestos are substantially formed of silica units, they are relatively inert and possess considerable resistance to decomposition by chemical reagents. Crocidolite in particular has high resistance to acids (see Fig. 3) and combines the advantages of high chemical resistance with high reinforcing characteristics. This type of asbestos is particularly useful in applications requiring both reinforcement and corrosion resistance.

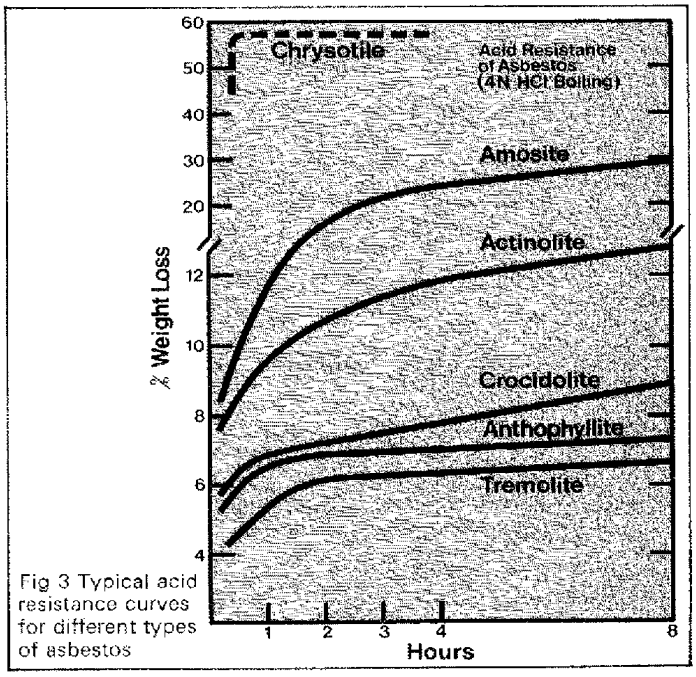


Fig 3 Typical acid resistance curves for different types of asbestos

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The Technology of Amosite and Crocidolite

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Fibre Length

While complete segregation into precise length gradings is not possible for any type of asbestos, the fibres of Amosite and Crocidolite are separated into different grades by length classifiers during the milling process.

The fibre length characteristics of Amosite and Crocidolite contribute in a major way to the insulating properties of these fibres. Fibre length produces the fibrous bulk which is essential to good thermal insulating materials.

Tests have shown that even the shortest fibres in any grade will play a part in providing valuable reinforcement in cement based and plastic materials, and in developing the cellular structure that is important in thermal insulation.

Fibre Diameter

Fibre diameter is also important in determining the efficient application of asbestos fibres. Fibre diameter is an expression of degree of fiberisation, that is, the degree to which the asbestos is split down to fine fibres, ideally approaching 1 micron in diameter. The thermal insulating properties of Amosite are as much dependent on fibre diameter as on fibre length. Amosite can be milled to produce fine fibres with minimal reduction of length thus producing a fibrous mass of very high bulk. The reinforcing properties of Amosite and Crocidolite are also dependent on fibre diameter, maximum reinforcement being obtained from the finest undamaged fibres. It is for this reason that the importance of good techniques for fiberisation is stressed in a later section. (Page 13).

Tensile Strength

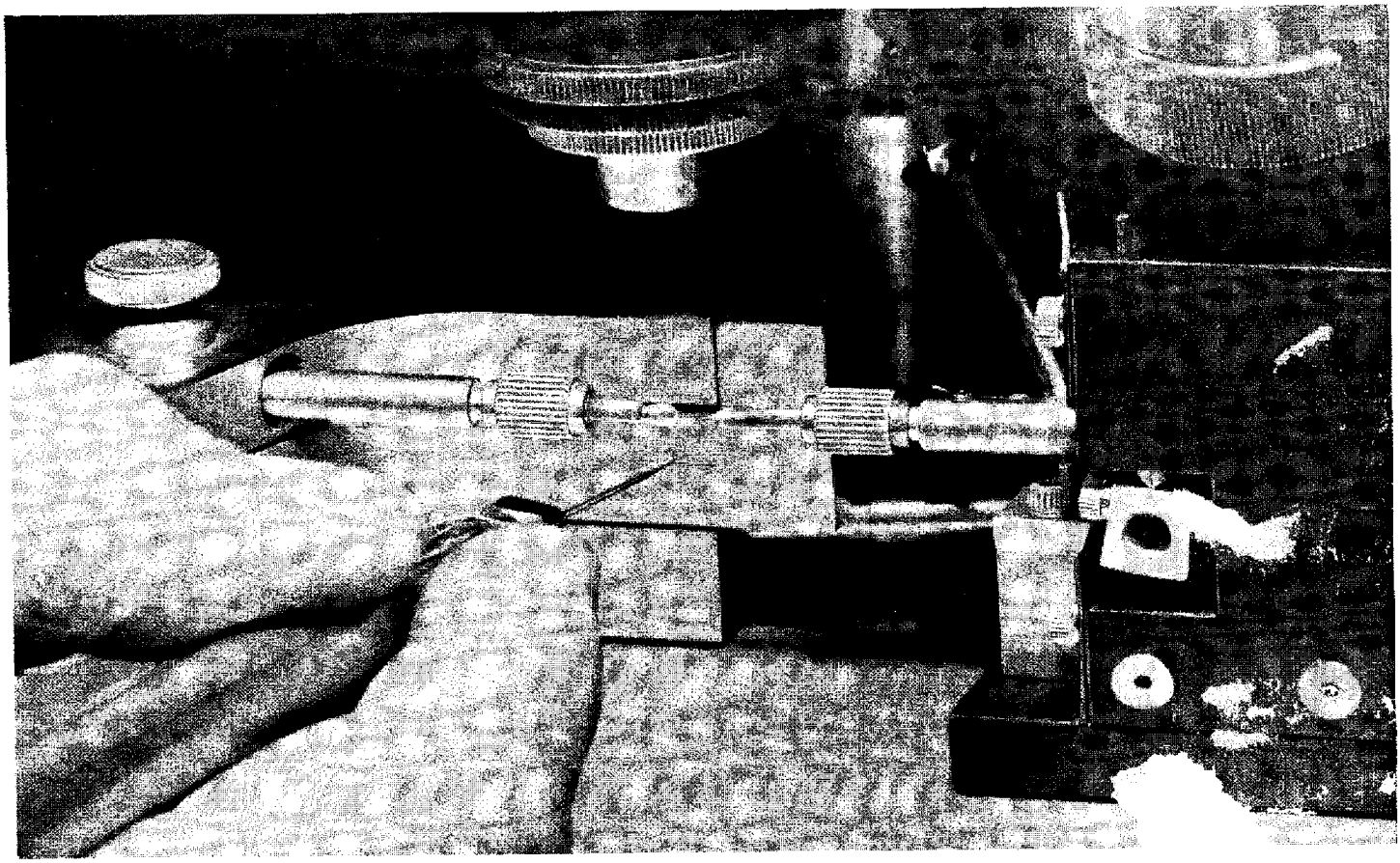
Crocidolite asbestos has the highest tensile strength of any known mineral fibre, and it follows that in composite materials such as asbestos cement and reinforced plastics, Crocidolite imparts the highest reinforcement among all forms of asbestos. The mean tensile strength of Amosite is about 70 per cent that of Crocidolite and its reinforcing strength is proportionally lower.

Surface Properties and Drainage

In any manufacturing process employing a wet system in which asbestos fibres are used, the surface properties of the fibres have a vital effect. In the asbestos cement system, Chrysotile fibres tend to coagulate together, while Amosite and Crocidolite fibres form a uniform dispersion. Aqueous suspensions of cement and Chrysotile drain with difficulty, while similar suspensions of cement with Amosite or Crocidolite drain as much as three or more times as rapidly as those with Chrysotile. Both these extremes are undesirable and therefore blends of Chrysotile with the amphibole fibres provide a means of obtaining an optimum balance. Up to 20 per cent of Amosite is required in a blend with Chrysotile to assist drainage without interfering with the essential plasticity of the furnish in asbestos cement sheet manufacture. In the

Stereoscan electron micrograph of Amosite reinforcement in asbestos cement. (Magnification x 2100).





Measurement of the tensile strength of asbestos

production of asbestos cement pressure pipes up to 40 per cent of Crocidolite—or Crocidolite with Amosite—in the blend with Chrysotile is required not only to assist drainage in the manufacture of thick walled pipes but to provide the reinforcement needed in medium and large diameter pipes.

Amosite and Crocidolite are thus complementary to Chrysotile in the asbestos cement process. Their surface properties are such that the fibres perform as filtration aids, and also assist in dispersing the Chyrsotile fibres more effectively.

The drainage properties of Amosite are also important in other systems, particularly those concerned with the manufacture of insulation products. In the manufacture of thermal insulation and insulating boards based on calcium silicate, the drainage rate of raw materials suspension either on Hatschek machines or in press forming methods is maximised by the use of high proportions of Amosite in the furnish.

The surface properties of Amosite and Crocidolite are also important in the field of reinforced plastics. Since the surface of Amphibole types of asbestos is nearly non-polar it follows that these will have a greater affinity for the less polar resin systems. Amosite and Crocidolite are thus more compatible with polyhydrocarbon systems such as polythene and polypropylene than with polyester and phenolic systems. This does not in any way preclude their use with the latter materials, where their known reinforcing effect is very high.

Thermal Insulation

Amosite asbestos, by virtue of its fibre length, its fine fibre diameter, its harshness or stiffness, and its surface properties will, when suitably processed, give a fibrous mass of high bulk volume, both as a dry product and as a suspension in water. When the dry fibrous mass is compressed it encloses air distributed in tiny pockets throughout its entire bulk. Suspensions of Amosite in water, with such other materials as are essential for the manufacture of calcium silicate thermal insulation or fire resisting boards, will similarly after complete processing and drying contain these well distributed tiny voids of air. Modern high temperature thermal insulations are made in a density range from 0.2 to 0.3 g/cm^3 to provide a porous structure and maximum thermal efficiency.

Heat transfer by convection can only occur where air movement through the insulation is possible. Any such movement is controlled by the fine fibrous nature of Amosite which simply restricts convection by virtue of the high flow resistance of the fibrous mass.

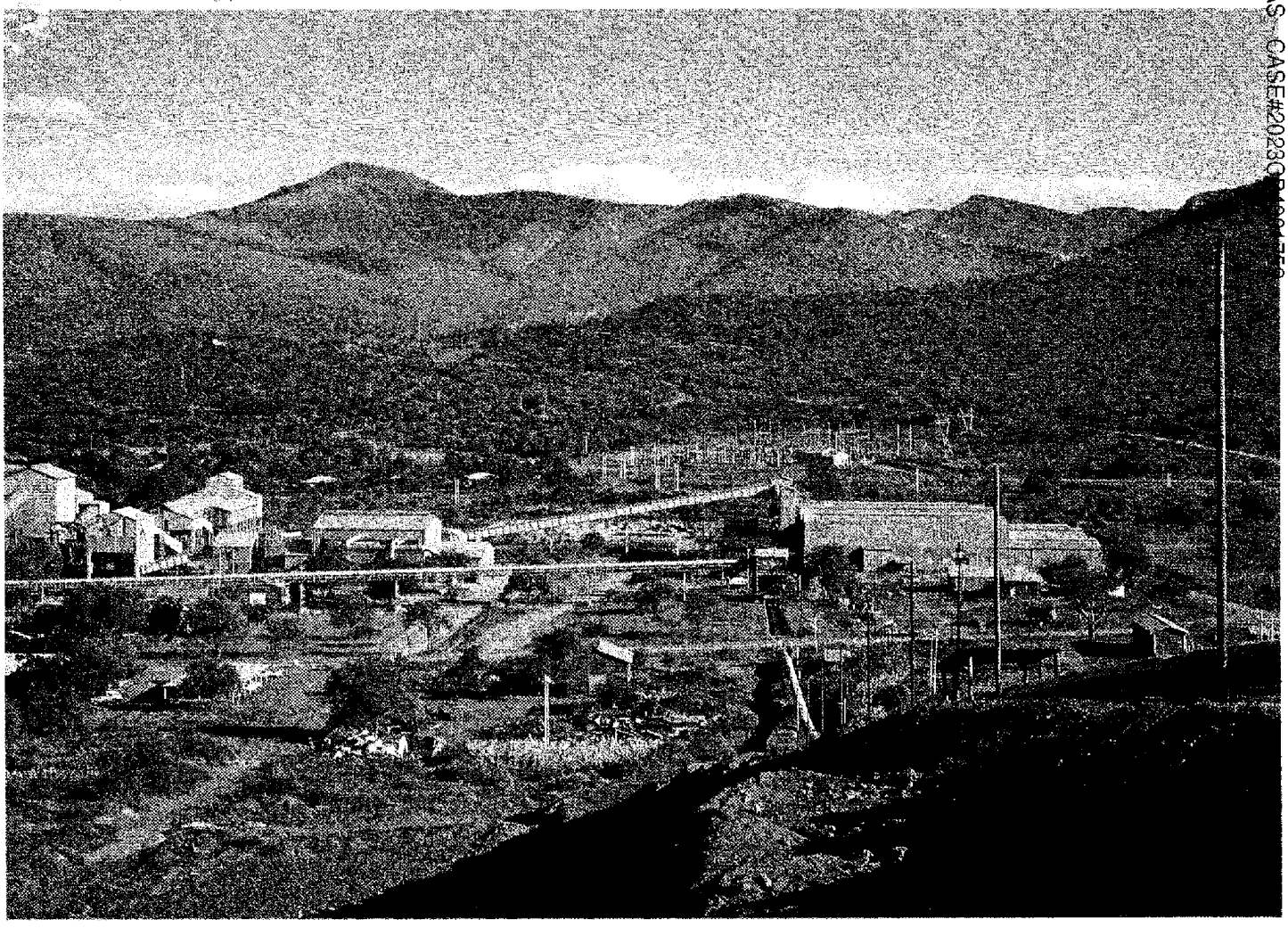
Radiation losses in a thermal insulation are controlled by the opacity to infra-red wavelengths of the solid phase of the insulation. The fine fibres of Amosite asbestos provide such opaque barriers, and so assist in keeping radiation losses to a minimum.

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Perge Asbestos Mine. Amosite Asbestos seams in a face.

View of Perge including part of Mt.



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Quality Testing

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Quality control of Amosite and Crocidolite at all stages from the mine refineries to Central Quality Control Laboratory, Research Laboratory and ultimately to Works and Plant Control Laboratories is governed by the recommended techniques given in the manual of "Test Methods for Blue and Amosite Asbestos", published by Cape Asbestos Fibres Ltd. The most important tests for Amphibole asbestos are summarised in the following paragraphs:

Fibre Length

This is determined by a length classification test such as Quebec Standard Asbestos Test, the Rotap Test and the Bauer McNett Classification test. The first two of these are dry screening tests in which a standard weight of fibre is shaken on a stack of screens of diminishing mesh size.

The Bauer McNett Test is one of the most useful classification tests for any form of asbestos. This is a wet classification test by which a sample of fibre is washed through a series of screens of diminishing mesh size. The fractions of fibre collected by each screen are dried and weighed and expressed as percentages of the test sample. The largest screen in the Bauer McNett is size 4 mesh. The fraction collected on this screen can ultimately be assessed by hand sorting to give an account of the upper length range of the sample tested.

Fibre Diameter

This is determined indirectly by measuring the apparent surface area of the asbestos sample, the results being expressed in terms of cm^2/g. The surface area of fibrous materials is approximately proportional to the inverse ratio of fibre diameter; in other words the greater the surface area, the smaller will be the fibre diameter.

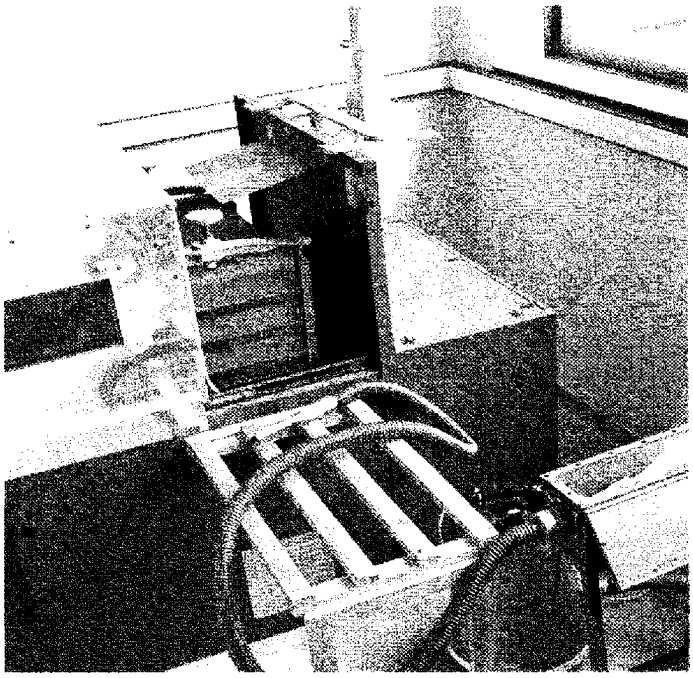
The surface area of Amphibole asbestos is most easily measured by an air permeability method. A plug of asbestos of standardised weight, volume and porosity is compressed in a cylindrical steel cell, perforated at both ends. A standard volume of air is then drawn through the cell and the time taken to do this is measured. The Rigden Air Permeability Apparatus is normally used for this test.

Taken together the Surface Area Test and the Bauer McNett Classification Test are the two most important means of assessing the properties of Amosite and Crocidolite fibres.



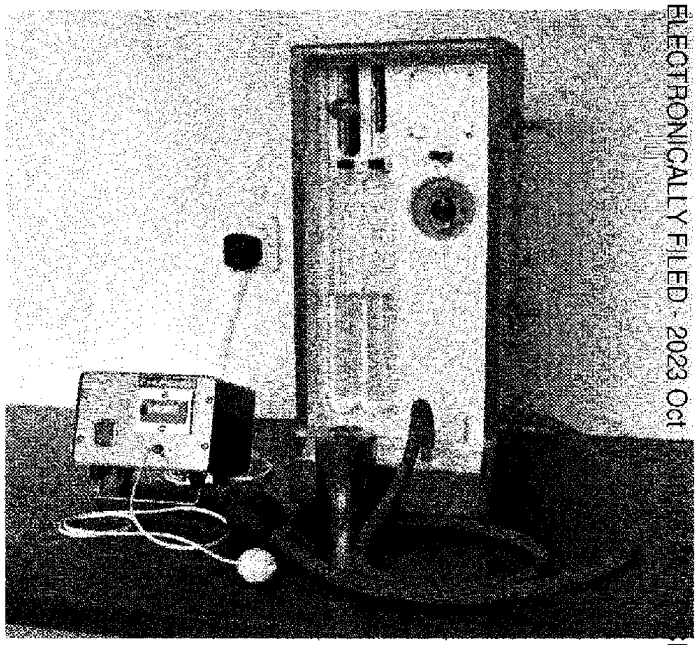
Bauer-McNett Machine

Quebec Standard Asbestos Test Machine, fully enclosed and dust exhausted

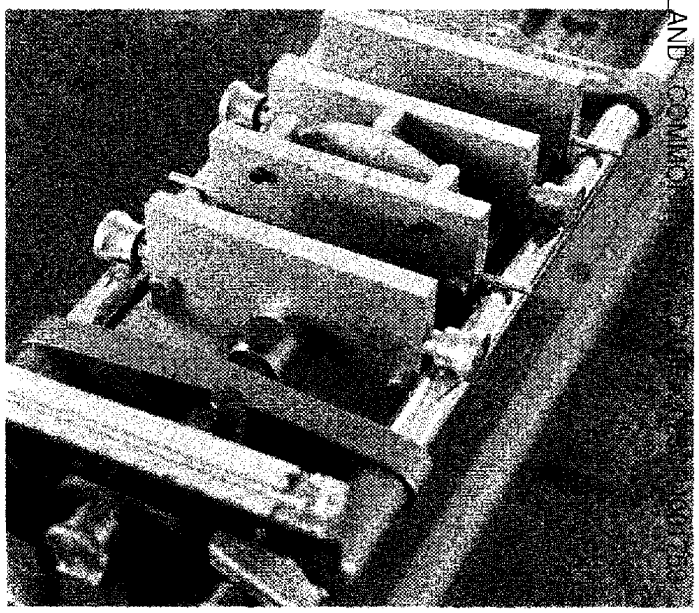


Reinforcement Tests

On a laboratory scale the reinforcing strength of asbestos fibre in asbestos-cement composites is determined in the following way. An asbestos-cement cake is made by filtration of the solid materials from a thoroughly mixed suspension of 1 part of asbestos fibre to 9 parts of cement in water. The suspension is filtered on a suitable filter box to form a disc or rectangular pad, the component weights being chosen so that a finished thickness of about 6 mm is achieved. The cake is then compressed in a mould so designed that the finished density of the cake will be about 1.6 g/cm^3. The cake is then cured and tested for flexural strength by three point loading in a standard test machine. The modulus of rupture is then determined from the loading and the dimensions of the test jig and is corrected by proportionation to an exact density of 1.6 g/cm^3. The reinforcing strengths of all types of asbestos can then be compared in terms of a standard weight of asbestos in the mixture, and at a standard density of product.



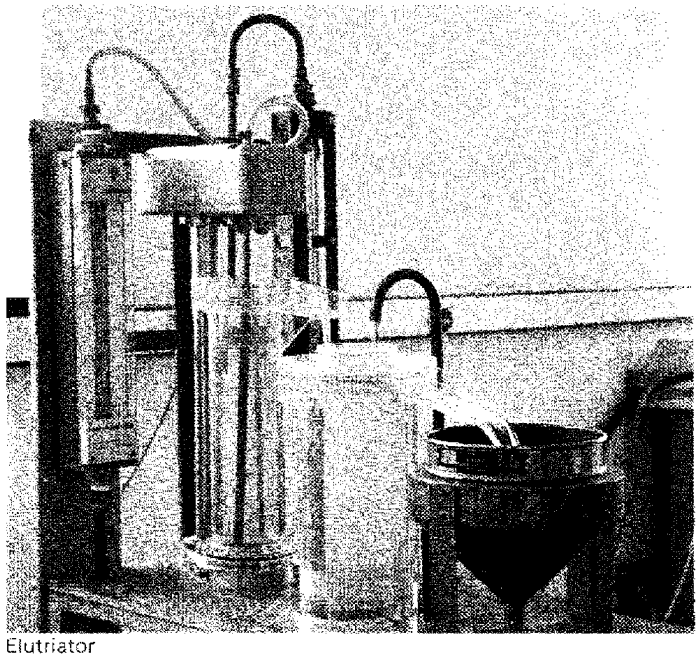
Rigden air permeability apparatus



Hounsfield Tensometer

Elutriation Test

In another type of wet classification test the asbestos fibre is elutriated in rising columns of water. The elutriation technique separates fibres on the basis of fibre diameter. This technique enables the crude spicules to be separated from the open fibre in any sample, and therefore gives a measure of the conversion of crude fibre to useful open fibre after processing.



Elutriator

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Wet Volume and Filtration Tests

The object of these tests is to provide data on the properties of asbestos fibres in an asbestos cement system under conditions which as far as possible are intended to resemble those in the mixing vessels and vats and on the felts of the asbestos cement machine. Wet volume, or buoyancy tests, when correlated with machine running conditions provide a guide to:

- the stability and homogeneity of asbestos cement slurries
- settling rates of solids in such slurries, and consequently their response to the efficiency of available wet mixing vessels
- the bulk volume of pick up at sieve cylinders and consequently the density of the film transferred to the felt

Similarly, filtration tests provide a guide to:

- drainage rates at sieve cylinders
- filtration rates of films on machine felts

The standard method of test for both wet volume and filtration requires an asbestos cement slurry to be made with a solids content not greater than 5%, the solids having an asbestos cement ratio of 1:9.

The wet bulk volume or buoyancy of asbestos cement mixes is measured by suspending a fixed weight of the standardised mix in a fixed volume of water in a measuring cylinder. The suspension is thoroughly mixed and then allowed to stand for thirty minutes, when the volume of settled solids is measured.

The filtration time is measured on a similar suspension of asbestos and cement in water, by filtering it under standard conditions through a suitable filter base. The time taken for the filtration of a fixed volume of the suspension is a measure of the filtration characteristics of the fibre.

Ancillary Quality Tests

The laboratory of Cape Asbestos Fibres Ltd. uses additional tests to assess the quality of Amosite and Crocidolite asbestos and these include

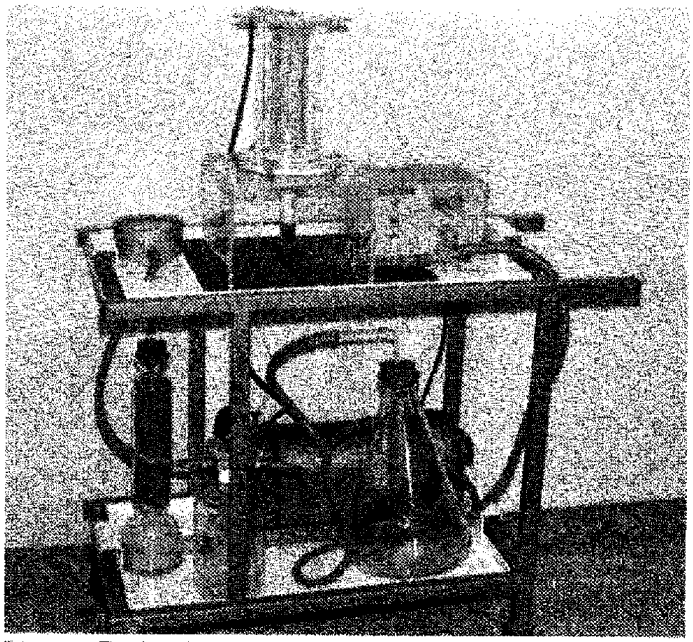
Thermal Analysis (DTA and TGA) to determine the effect of heat on asbestos fibres;

Infra Red Analysis for rapid identification,;

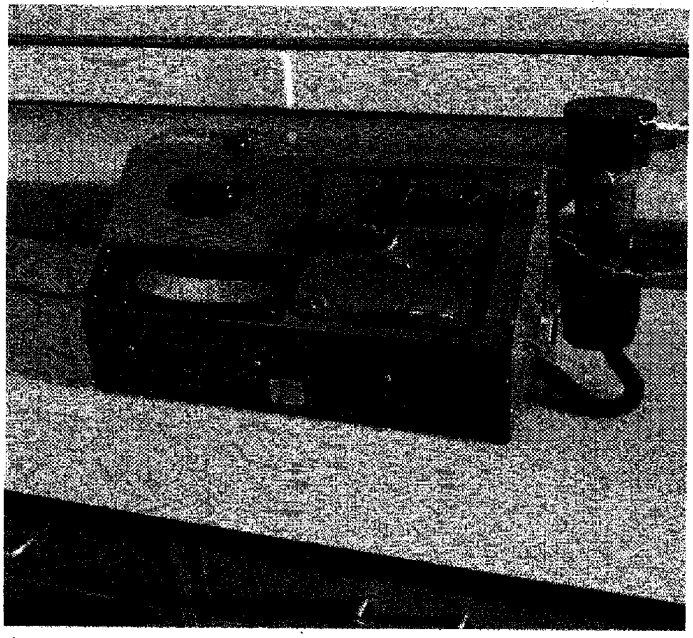
Chemical Analysis in the evaluation of asbestos ores;

Colour Testing in the rapid assessment of purity;

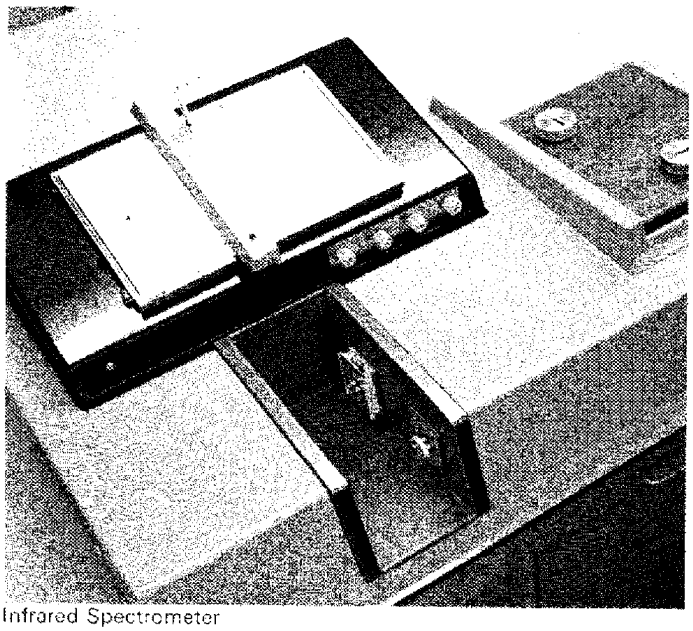
Tensile Tests for the determination of absolute tensile strength of asbestos fibres.



Filtration Testing Apparatus



Colourmeter



Infrared Spectrometer

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Fiberising

All forms of asbestos differ in texture. To describe this fundamental property of asbestos, which cannot be stated in quantitative terms, the designations harsh, semi-harsh and soft are universally adopted. Amosite is a harsh asbestos with resilient and spiky fibres. Crocidolite also has resilient fibres but being softer than Amosite is described as semi-harsh. Chrysotile fibres from their many different deposits vary from semi-harsh to soft types.

These differences in texture have an important bearing on the choice of processing machinery which will be used to fiberise asbestos to the degree required in its many applications. The mine refineries supply Amosite and Crocidolite in the semi-crude and semi-processed form in press packed bags to reduce freight costs to a minimum. Before the asbestos can be applied to a manufacturing process it therefore has to be fiberised to the degree appropriate to the process and by the best means available to manufacturers.

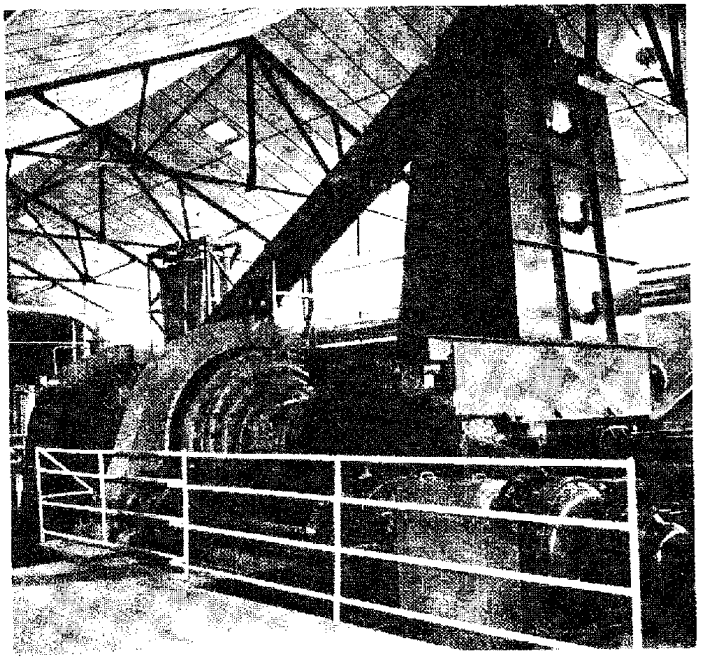
The following summary outlines the effectiveness of the various types of processing machinery currently available for fiberisation of Amosite and Crocidolite.

Wet Fiberisation

Rod Mills

Amosite and Crocidolite in blends with Chrysotile are processed in the rod mill with the addition of water, using the same loading of rods as for Chrysotile alone. If Amosite alone is to be processed in the rod mill then a much lighter loading of rods will be required. Whereas processing by rod mill increases the intrinsic reinforcing value of Chrysotile above that obtained by dry fiberising methods, the reinforcing value of Amosite and Crocidolite is found to be the same at the same degree of fiberisation whether the processing be by rod mill or by dry fiberising mill. At the same time rod mills do not have any abnormal effect on the drainage properties of Amosite and Crocidolite.

Rod mill used in continuous fiberising of asbestos fibre.



Kollargangs

Semi-fiberised Amosite and Crocidolite grades are recommended wherever fibre processing by Kollargang is operated. Amosite and Crocidolite should be fed to the Kollargang with Chrysotile at the beginning of the crushing cycle and will require the addition of water up to 50 per cent of the total weight of fibre feed.

Turbo Mixers and Hydro-disintegrators

These machines which operate on a water borne suspension of asbestos will fiberise both Amosite and Crocidolite. The time cycle of wet disintegrators of these types is usually not more than 15 minutes and the degree of opening which can be achieved with Amosite and Crocidolite in this time is limited. Semi-fiberised grades of these fibres are therefore recommended where turbo mixers and hydro-disintegrators are the main means of fibre processing.

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Hydropulpers

These are effective wet disintegrators and have the advantage that fiberisation of asbestos and the mixing with other raw materials may be done in one vessel. Semi-fiberised Amosite and Crocidolite should be fed to the hydropulper with the total water charge, and processed in the hydropulper for not more than five minutes before addition of other raw materials. Mixing is usually complete after a further five minutes.

Dry Fiberisation

Dry fiberisation machines have the advantage of providing a wide range of degrees of fiberisation and a product which, being dry, can be tested for fiberising effect by measurement of its surface area and by classification tests. This is not so with wet fiberisers where it is difficult or even impossible to retrieve the product in a suitable form for testing. In general a much greater degree of product control can be exercised when fiberising asbestos by dry methods than by wet methods.

Hammer Mills with Screens

In this type of mill the asbestos is fed through the centre of the mill casing and is disintegrated by impact with high speed rotating hammers. The exit port is tangential and is covered by a screen or grating. The asbestos fibre cannot leave the mill until its length is reduced to a size compatible with the apertures at the exit. Amosite and Crocidolite may be fiberised in these mills, but satisfactory degrees of fiberisation are attained only at the expense of important fibre lengths. This type of mill is recommended therefore for short grades of Amosite and Crocidolite.

Hammer Mills without Screens

These mills normally have a disc type impeller with radiating beater arms. Fiberisation takes place by impact of the asbestos against a circumferential liner in the mill casing. The exit port of the mill has a variable orifice by which the dwell time of the material in the mill is controlled. Decrease of the orifice increases the dwell time and increases the degree of fiberisation. This type of mill is especially efficient with Amosite and Crocidolite asbestos, since is offers a wide range of degrees of fiberisation with minimum loss of length, for all medium and short grades. *See photo of Varyiser mill.*

Willow Mills

These are fan type disintegrators with both self-induced and separately induced air flow. They are recommended for the processing of long Crocidolite for textile applications, where an initial degree of opening is required. Other grades of Amosite and Crocidolite can effectively be fiberised in a willow mill with minimum loss of length, but may require more than one pass through the mill to achieve the required degree of fiberisation.

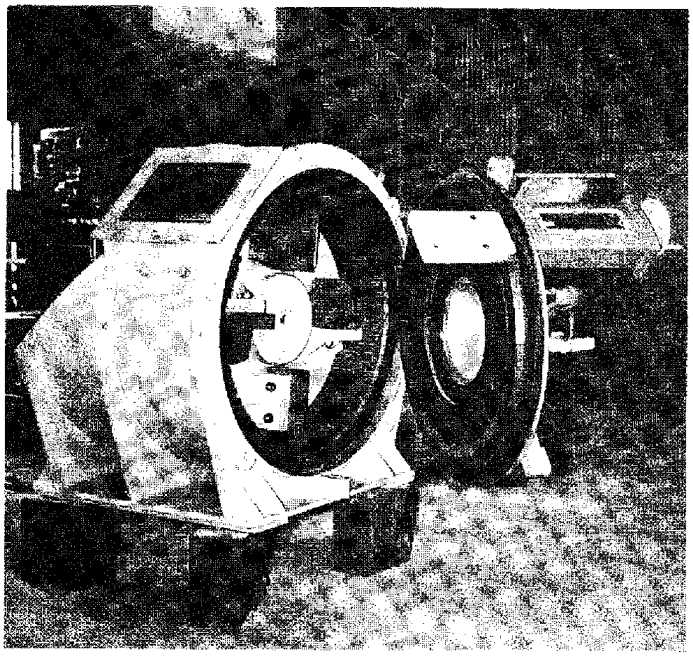
Attrition Mills

This type of mill has a disc impeller carrying a number of pins or anvils on its plane surface which intermesh with similar pins or anvils on the plane surface of the mill casing. This type of mill is suitable for the fiberisation of softer types of asbestos. It is recommended for the processing of short grades of Amosite and Crocidolite, but may induce considerable shortening in length of the medium and long grades of these forms of asbestos.

Recommended degrees of fiberisation of Amosite and Crocidolite in various applica

	Degree of fiberisation as Surface Area, $m^2/gm.$
Range in crude and semi-crude grades	1,500 to 6,000
Range in semi-processed grades	8,000 to 10,000
Amosite in thermal insulation	12,000
Amosite in insulation boards	8,000
Amosite in spray insulation	10,000
Amosite in asbestos cement	9,000
Crocidolite in asbestos cement	11,000
Amosite and Crocidolite in bitumen compounds	8, 10,000
Amosite in catalyst supports	12 00
Amosite in packings	8,000 to 9,000
Amosite and Crocidolite in plastics	10,000 to 13,000
Crocidolite in textiles (pre-cards)	4,000

A Varyiser mill showing rotor in position.



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Table 4

Amosite Grades

General Classification	Grade			McNett Test		Surface Area cm²/g	Main Use
	Penge Mine	Weltevreden Mine	Kromellenboog Mine	+14 M %	−100 M %		
Extra Long	D.11			70	20	3000	Moulded Insulation
Long	M	W3	K3	64	26	3500	Moulded Insulation
	S11			62	26	3500	General Insulation and Board Products Asbestos Cement Pressure Pipes
Medium	S22	SW	SK	59	26	4000	Insulating and
	S22/65			40	35	8500	Fire Resisting Boards Refractory Tiles
Short	S33	GW	GK	46	35	5500	Insulating and Fire Resisting Boards
	S33/65			33	40	8500	Refractory Tiles and Asbestos Cement
	S44			18	50	8500	Asbestos Cement Sheets and
			RK	21	47	6000	Moulded Products
			6605	10	55	7000	Plastic Reinforcement

above table are typical test results and are not to be used as specifications.

Table 5

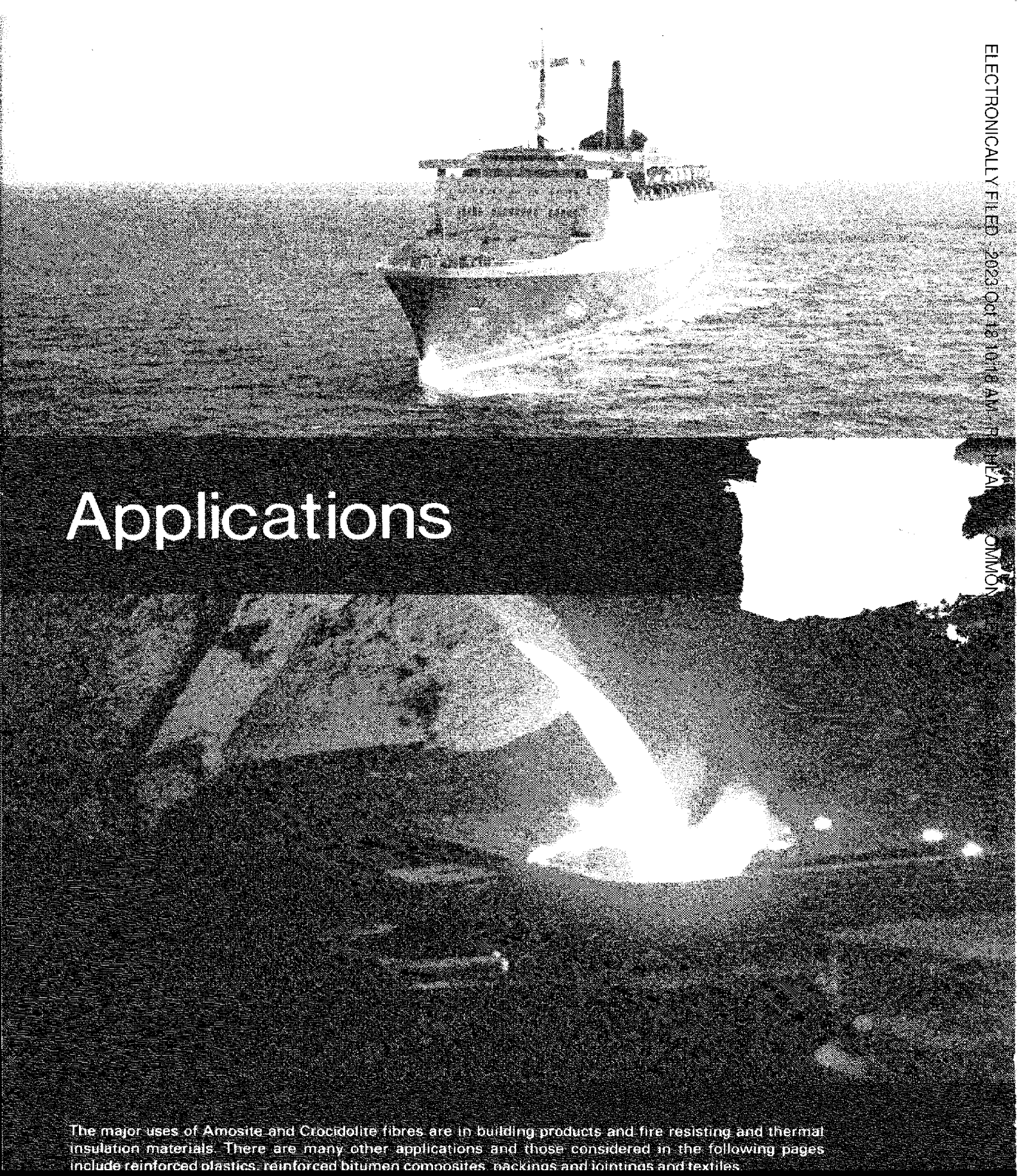
Crocidolite Grades

General Classification	Grade	McNett Test		Surface Area cm²/g	Main Use
		+14M%	−100M%		
Long	C	94	4	1000	Asbestos textiles
	A	90	7	2000	Felts for reinforced plastics
Medium	S	67	26	6500	
	S80	62	30	10,000	Asbestos cement pressure pipes
	2S	58	30	7000	
	H	50	33	8000	
	H80	36	43	10,000	Asbestos cement sheets
Short	C10	30	49	14,000	Asbestos paper
	WDS	33	43	9000	Asbestos cement sheets

The values shown in the above table are typical test results and are not to be used as specifications.

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Applications

The major uses of Amosite and Crocidolite fibres are in building products and fire resisting and thermal insulation materials. There are many other applications and those considered in the following pages include reinforced plastics, reinforced bitumen composites, packings and jointings and textiles.

Amosite Insulation

This type of insulation is made from 60 to 85 per cent Amosite together with inert fillers such as diatomaceous earth, bonded with an inert adhesive, sodium silicate. The process of manufacture is semi-dry and relies completely on the high dry bulk volume of ·iberised Amosite to achieve a low density product. The ·site requires fiberising to a surface area of 12,000 ·n for this process. The end product has a density ·e of 0.2 to 0.3 g/cm³ its thermal conductivity ·imately 0.2×10^{-3} cal/cm²/sec/(°C/cm) at ·s heat resistance as an insulation is good ·es in the range 650 to 800°C, depending

·ed grades of Amosite: D11, M, S11.

Silicate Insulation

·terials based on autoclaved calcium ·n 10 to 15 per cent Amosite which in this ·s mainly as a reinforcing fibre, having at ·nsulating and temperature resistant products are made by moulding the ·ing both vacuum and pressure, from a · materials containing lime, silica, and ·e conditions the rapid drainage proper- · essential for the achievement of ·rates from the moulding equipment. ·e products is in the range 0.2 to 0.3 al conductivity (K) at 550°C hot · s approximately 0.2×10^{-3} cal/cm²/(°C/cm). Their heat resistance can be extended to 1,000°C at a product density of 0.3 g/cm³.

Amosite is important in this type of insulation as a reinforcement for the otherwise fragile calcium silicate, preserving the integrity and reducing the shrinkage of the insulation at high temperatures.

Recommended grades of Amosite: M, S11, W3, K3.

Asbestos-Cement Products

Asbestos-cement products are essentially incombustible weather proof materials for external use on buildings. Typically asbestos-cement sheets and the products made from them have an intrinsic modulus of rupture between 160 and 200 kg/cm² at densities between 1.55 and 1.65 g/cm³. The basic material in flat sheet form is manufactured predominantly on Hatschek board machines.

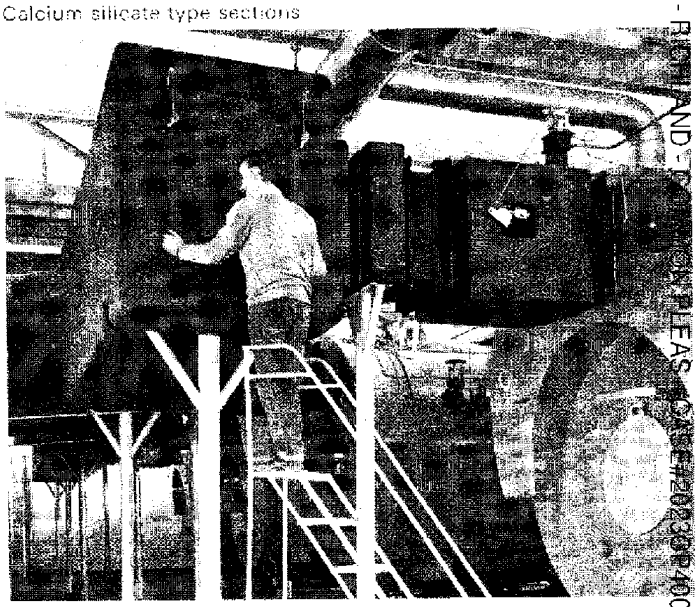
These products contain about 12.5 per cent asbestos, mainly Chrysotile.

Amosite is widely used in the asbestos-cement process in proportions between 10 and 30 per cent of the total asbestos content, and provides a number of advantages. Primarily it is a filter aid and increases the drainage rate of the asbestos-cement mix at the machine by up to 10 per cent of that attributable to Chrysotile blends alone. It also improves the wet strength of the sheet leaving the machine. In terms of reinforcing strength, short Amosite fibre may be regarded as equivalent to all grade 5 Chrysotiles, and medium length Amosite as equivalent to some grade 4 Chrysotiles. Where lower grades of Chrysotile predominate in the manufacture of asbestos-cement, Amosite is advantageous in the control of product density which otherwise may be considerably higher than the optimum, thus giving rise to high raw material consumption.

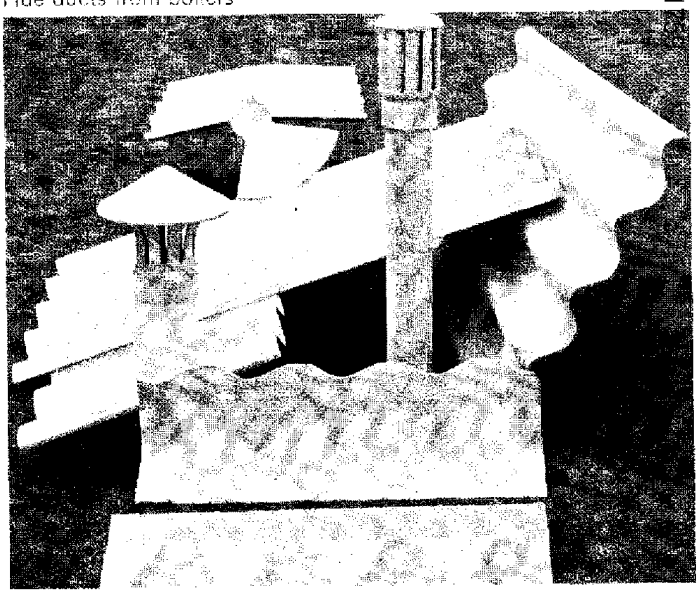
Recommended grades of Amosite: S22, S22/65, S33, S33/65, GW, GK, S44.



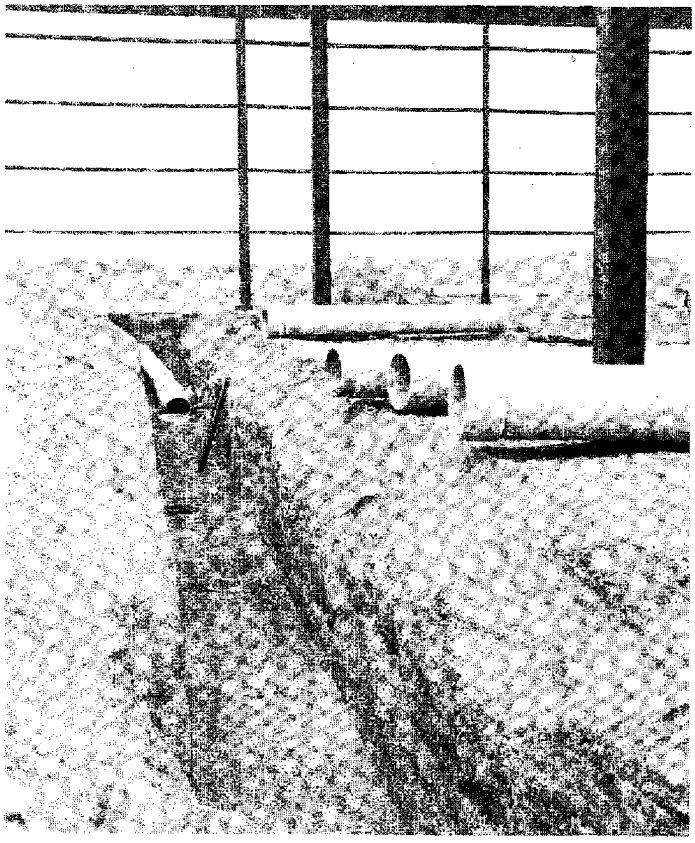
Calcium silicate type sections



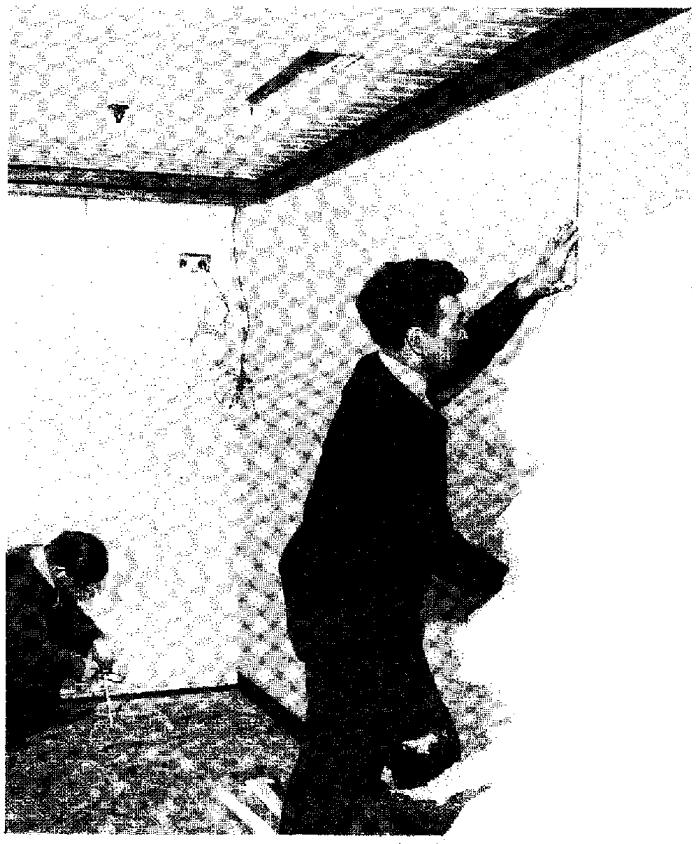
Flue ducts from boilers



Asbestos cement roofing components



Asbestos cement pressure pipes during installation



Bulkheads and linings of Marinite fire r
veneered with laminate plastic, being
"Queen Elizabeth 2"

Asbestos-Cement Pressure Pipes

Asbestos-cement pressure pipes are manufactured to withstand hydraulic test pressures up to 47 atm. and working pressures up to half this value. They normally contain 15 to 20 per cent of asbestos fibre. The high hydraulic standards of pressure pipes demand high hoop tensile strengths in the barrel of the pipes and a high degree of orientation of reinforcing fibres in the circumferential direction.

Crocidolite fibre provides both the reinforcing strength and length to satisfy these standards. Typical fibre blends for asbestos-cement pressure pipes contain 20 to 40 per cent Crocidolite and 80 to 60 per cent medium length Chrysotile.

Good drainage of the wet asbestos-cement mix is essential at all stages in the manufacture of pressure pipe, from the sieve cylinder, to the felt, and finally at the making mandrel itself. At the latter stage drainage is inhibited by the density of the pipe wall (up to 2.0 g/cm^3 in the finished product) and also by the thickness of the wall, which may be up to 50 mm. Drainage performance in this process is controlled by the Crocidolite fibre, also by the incorporation of medium length Amosite in the fibre blend. A recommended blend of long standing and frequent use includes 30 per cent Crocidolite, 10 per cent Amosite and 60 per cent Chrysotile.

Recommended grades of Crocidolite: S, S80, 2S.

Recommended grades of Amosite: S11, S22, SW, S22/65.

Insulating and Fire Resisting Boards

Insulation boards possess properties mid-way between thermal insulation products and asbestos-cement sheets. They are fireproof, incombustible, both thermal insulating and sound insulating, and are manufactured for use as internal linings in buildings and ships. Their typical properties are: density 0.7 g/cm^3, thermal conductivity (K) at ambient temperatures 0.3×10^{-3} cal/ $cm^2/sec/$ (°C/cm); mean modulus of rupture 125 kg/cm^2.

This type of board contains up to 40 per cent of Amosite in a calcium silicate matrix, the latter being formed from lime and silica by direct synthesis. The raw materials mix is formed into the boards by filter moulding under pressure or on a Hatschek or Magnani type board machine.

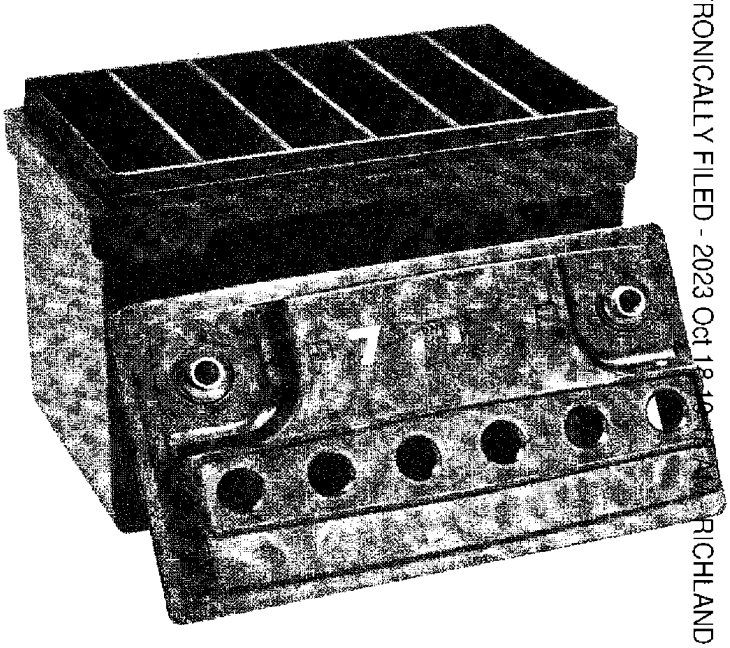
Insulation boards rely on Amosite to provide adequately low densities; to allow for rapid drainage in the manufacturing stage of what is normally a high production rate board; to give high reinforcing strength for a relatively low density; and to give the board integrity and low shrinkage in specified fire rating tests. These boards are unaffected by wet conditions and will not support mould growth. The world is becoming very much more conscious of loss caused by fire and more and more Amosite asbestos is being used in the manufacture of fire resisting boards.

Recommended grades of Amosite: S11, S22, SW, SK, S22/65, S33, S33/65, GW, GK.

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Fire protection of steelwork using sprayed asbestos



Battery box made from Bitumen/Asbestos composition

Sprayed Insulation

Sprayed insulation is a means of placing an insulating layer on non-uniform and otherwise inaccessible surfaces, though it is frequently and equally well used to cover flat surfaces. It has both thermal and acoustic insulating properties, and normally has an asbestos content exceeding 60 per cent. Spray insulation consists of a wet asbestos-cement mixture, prepared on site and applied to the working surface through a pressurized spray gun. The adhesion and stability of the wet spray is governed by its water content and plasticity, and the insulation properties of the finished surface are determined by the bulk volume of the asbestos used.

Amosite grades of various lengths, depending on the type of gunning machinery, are used in spray compounding. Blends of Amosite and Chrysotile provide respectively the essential insulation bulk and plasticity, Amosite in addition giving a means of control of the water content of the compound by virtue of its low water absorption properties.

Recommended grades of Amosite: M, S11, W3, K3, S33, S33/65.

Short grades of Amosite are recommended where a heavier density compound is needed for fire protection. Recommended grades S44 and 6605.

Bitumen Compounds

This heading covers a number of applications, including motor vehicle battery boxes, water cisterns and pitch fibre pipes. The manufacturing process invariably requires a hot molten bitumen either as moulding mixture with asbestos in the manufacture of battery boxes and cisterns, or for impregnation purposes in the pitch fibre pipe process.

Since bitumen contains phenolic and cresylic acids, only the acid-resisting types of asbestos, Crocidolite and Amosite, can be used in these applications. In the finished product Crocidolite and Amosite fibre provide reinforcement, but even more important is that these types of asbestos give stability to the product inhibiting creep and deformation at ambient temperatures up to 40°C.

Amosite is used in proportions of up to 15 per cent as the reinforcing and stabilising fibre in water cisterns and pitch fibre pipes. Crocidolite is the preferred asbestos fibre used in the manufacture of battery boxes, since apart from its reinforcing value, it has high resistance to attack by sulphuric acid, and a low manganese content which is essential to avoid poisoning of the lead-acid cell. Amosite is sometimes used.

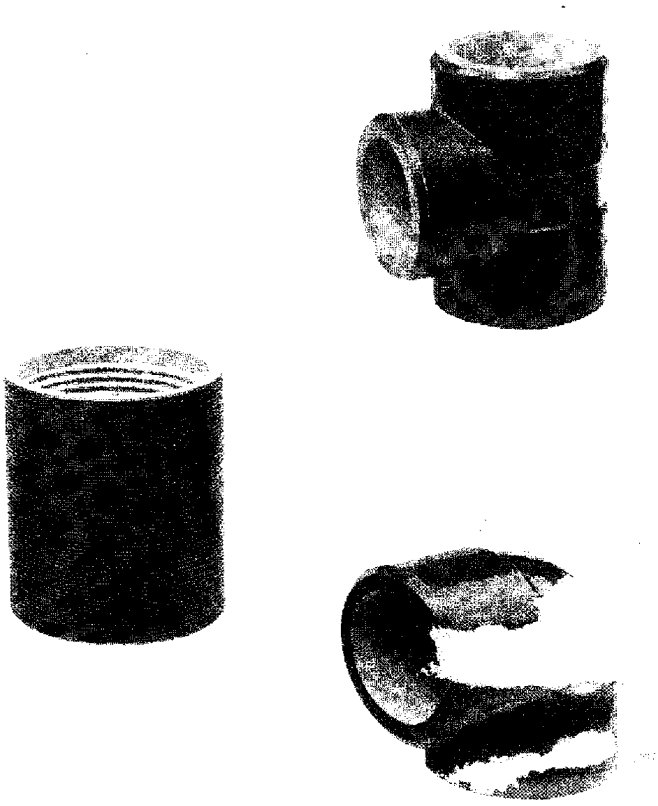
Recommended grades of Amosite: for pitch fibre pipes; M, S11, W3, K3, S22, S22/65; for water cisterns; S33, S33/65, GK, GW.

Recommended Grade of Crocidolite: for battery boxes; H80.

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Uphill teeming of alloy steel ingots from 135 ton ladle, using moulds lined with refractory tiles



Asbestos reinforced plastic pipe fittings

Refractory Tiles

In the process of casting high quality de-oxidised alloy steels in ingot moulds, the shrink-cooling of the ingot causes a cavity to develop in the upper parts of the solidifying metal. This cavitated portion of the ingot is removed in the subsequent ingot rolling process, and as such constitutes wastage which is returned for remelting. To minimise this wastage, ingot moulds are surmounted by a steel hot top lined with refractory tiles, the purpose of which is to reduce the rate of heat loss at the top of the ingot and in turn to reduce cavity development.

The major refractory and insulating component of these tiles is silica sand, to which is added an organic resin binder together with Amosite fibre as the reinforcing agent. These tiles are made from the wet raw material mix by vacuum forming, and Amosite is essential in the preservation of a uniform mixture and in minimising the drainage time on vacuum forming. Amosite gives strength to the finished product and ensures its handlability. Finally, in the user stage at exposed temperatures near 1,500°C, Amosite fibre helps to preserve the integrity of the burnt-out tile by acting as a high temperature binder.

Recommended Grades of Amosite: S22/65, S33/65, S33.

Reinforced Plastics

The incorporation of Amosite and Crocidolite produces properties in reinforced plastics which are not found with glass fibre or Chrysotile. Amosite and Crocidolite are not necessarily replacements for either of the latter materials but may be used in conjuction with them or in their own right. Amosite and Crocidolite are known to be compatible with all the well known resin systems, such as polyester, epoxide, phenolic, and polyhydrocarbon, and form a fibre resin bond which can give advantages in strength and stiffness over comparable glass fibre resin bonds.

The major application for Crocidolite in such materials is in equipment manufactured for the chemical industry, including corrosion resistant linings in pipe lines and storage vessels, and corrosion resistant parts for pumps and mixers. Shatter proof mouldings for application in the automotive industry include Amosite and Crocidolite in their composition, and the ablative properties of Crocidolite reinforced phenolic resins have been utilised in rocket heat shields.

Recommended grades of Crocidolite: A, S, H80, C10.
Recommended grades of Amosite: S22/65, S33/65, RK, S44.

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Catalyst Supports

Low temperature catalytic reactions involving gaseous hydrocarbons require high surface area catalyst for maximum conversion efficiences. Fully processed long fibred Amosite is recommended as a support for valuable catalysts in these applications. In this form Amosite has a high absolute surface area, approaching 4 m^2/g, a high bulk volume of self supporting fibres, an open texture with high porosity and penetration, and is technically viable in any non-oxidising application up to temperatures of 300°C.

Recommended Grades of Amosite: D11, M, S11.

(These grades require to be reprocessed for use as catalyst supports.)

Packings and Jointings

Packings, joir ings, and sealing compounds based on asbestos fibres possess three features in common. ey must have a degree of resilience to permit ation of a perfect seal under high pressure. ey must be resistant to heat and chemical permit a wide range of usage. Thirdly, they igh tensile strength to prevent material

e high degree of resilience found in Amosite idolite makes these fibres generally unsuitable for use in compressed rubber type sheeting for gaskets, they the essential properties to satisfy the other requirements. Their natural bulk volume and resilience impart the right degree of compressibility to the product. They are heat resistant and have high intrinsic tensile strength, thus imparting high reinforcement in flange gaskets and gland seals. Crocidolite in particular is chemical resistant and is specially recommended for jointing materials in pipe-lines carrying hot acids and alkalis.

Recommended grades of Amosite: S22/65, S33/65.

Recommended grades of Crocidolite: C (for plaited or woven packings), S80, H80.

Asbestos Textiles

Long fibred Crocidolite has for many years been used in the manufacture of yarn and woven cloths. When suitably processed it has an acceptable texture for carding, spinning and weaving.

Such textile products combine all the outstanding features of Crocidolite. Crocidolite yarn and cloth have high tensile strength, high resistance to corrosive chemicals and vapours, are heat resistant and incombustible. They have applications in the chemical industry as screen cloths, gas filters, and insulation cloths. In the manufacture of reinforced plastics both the yarn and the cloth when suitably impregnated will produce materials having tensile strengths up to 4,000 kg/cm^2 in finished products.

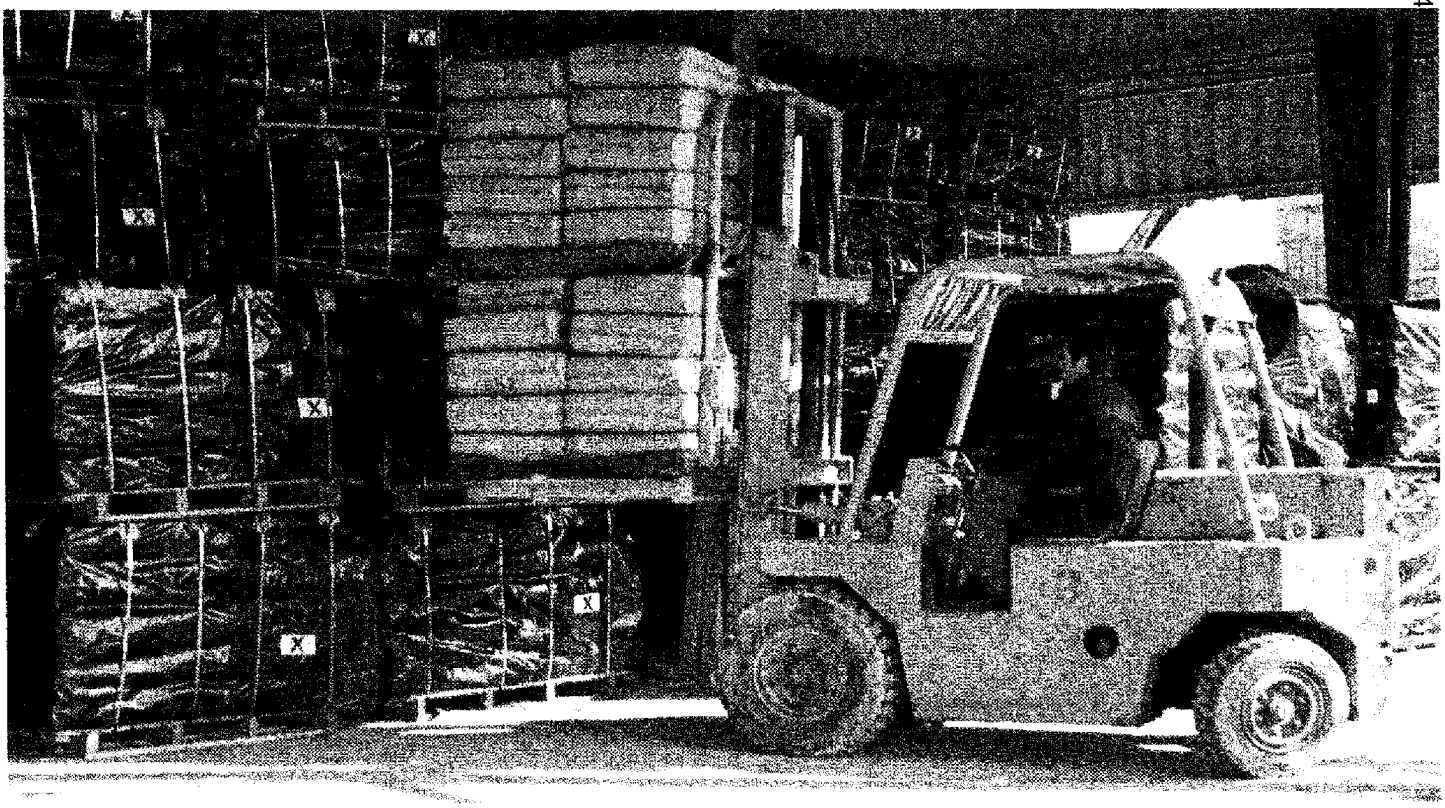
Recommended grade of Crocidolite: C.

Other Applications

A few examples of other applications of Amphibole fibres are as follows:

1. Amosite millboard—for example, in the surfacing of calender rolls used in plate glass manufacture.
2. Amosite compounds as plug and crack fillers.
3. Blue asbestos for diaphragms of electrolytic cells.
4. Chemically resistant filters.

Pressure packed fibre ready for shipment



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Cape Asbestos Group

Technical Advisory Service

A comprehensive technical service is offered to users of Cape Amphibole fibres world wide. Technical representatives in the field advise manufacturers on fibre selection and processing and they are backed by the work of the Fibre Research Laboratory at Uxbridge. This ultra-modern laboratory block contains the latest equipment for the study of asbestos fibres, and helps customers to obtain maximum economic use from them. Licensees of Cape processes also benefit from the extensive manufacturing experience of companies in the Cape Group, which covers Asbestolux and other lightweight fire resisting boards, asbestos-cement flat and corrugated sheets, insulation materials, brake linings and other products.

Safety in handling

Most countries have established regulations to ensure the safety of workpeople employed in the asbestos industry. In the United Kingdom the Asbestos Industry Regulations of 1931 have now been replaced by the Asbestos Regulations 1969, which extend these precautions to all persons employed and are more specific in their control measures.
The precautions are based in the main on the standards recommended by the British Occupational Hygiene Society, and the new Regulations provide for exemption from their provisions where acceptable levels are not exceeded.
Where higher levels are unavoidable, control by enclosure, exhaust ventilation or other means [illegible] to users of many industrial materials are required. Advice and information concerning safety and [illegible] in the use of asbestos is readily available from the Asbestos Fibres Laboratory, or from the Environmental Control Committee of the Asbestosis Research Council which has produced a number of advisory leaflets for the guidance of asbestos users.

Commercial Information

Tarriff Classifications

1. Brussels classification for asbestos and asbestos containing products is as follows:
   Chapter 25.24 Asbestos not worked beyond beating, cleaning and sorting.
   Chapter 68.12 Asbestos cement articles.
   Chapter 68.13 Asbestos reinforced with wire mesh.
   Fabricated Asbestos and articles thereof worked, carded, dyed or spun.
   Mixtures based on Asbestos alone or with magnesium carbonate.
   Chapter 68.14 Friction materials for brakes.
2. The standard International Trade classification for asbestos fibre is: 276.4.

Asbestos fibre can be imported into most countries free of duty but may be liable to internal taxes such as Turnover Tax and Added Value Taxes, which vary from country to country and should always be checked by the Buyer before orders are placed.

Shipping Information

Orders should be released before the 8th of the month if shipment is required the following month. Advance notice of shipment is required because of the distance of the mines from the ports and the long transit times involved. The transit time from the Amosite mines to the ports is between 4 and 7 days depending upon the port used. Transit times from the Crocidolite mines are between 6 and 14 days depending upon the port used. Transit times to main markets throughout the world fall between 30 and 60 days according to the destination. Speed of delivery also depends upon the number of sailings available. Detailed information on this subject can be provided by Cape Asbestos Fibres.

Packaging

Amosite and Crocidolite is supplied press-packed in standard 50 kg impermeable bags.

Cape Fibres News

News of developments in packaging, and other improvements in service to customers, together with up-to-date technical information, appears in the quarterly Cape Fibres News, available free on request.

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Middlesex
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Telex: 23471/UXB

North American Asbestos Corporation
150 North Wacker Drive
Chicago, Illinois 60606
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Telephone: (312) 726-8515 Telegrams: Noramco Fax

Research Centre

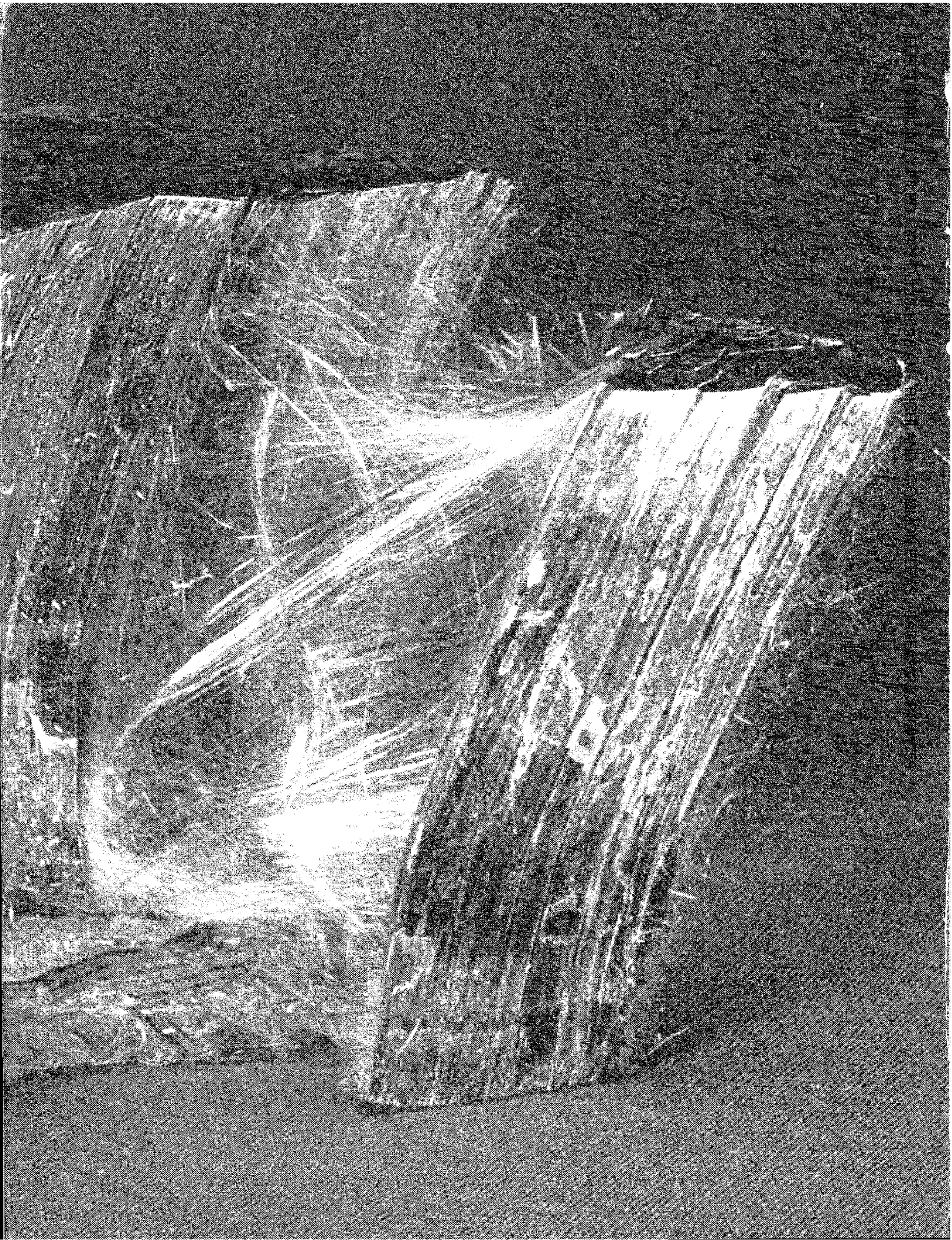
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