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Asbestos cement pipes — a manufacturing review

ONE OF THE LARGEST asbestos-cement pipe manufacturing plants in operation is at Eternit-TAC's facility at Kapelle-op-den-Bos in Belgium. The plant currently has a turnover of BFr800-900million, and forms a division of the larger Eternit company, whose turnover is over BFr5billion annually.

The organization is based on the use of asbestos in building products of all types, pipe manufacture being one of several divisions. The pipe division, since absorption of the UK based TAC company in 1986, now produces about 60,000 tonnes per year of AC pipe in Belgium in 4m and 5m lengths as standard, for a wide range of industrial uses. Although water supply and sewage disposal are obvious applications, other current uses of AC pipe include slurry transportation for the UK's CEBG and waste oil transportation for French Railways.

Eternit-TAC's plant is undoubtedly impressive to the visitor, more so when it is revealed that the complex process of manufacture (described below) is almost fully computer controlled. To the uninitiated, the process seems difficult to understand, but, as Geoff Vintin describes in his detailed article on the manufacturing process, 10-

tonne pipes are produced by a remarkably-clever process involving rotating mats, different surface tension, and even an application of DC current at the right time.

As is described elsewhere in this issue of Pipes & Pipelines International (see below), asbestos cement has an important role to play in the manufacture of pipes for many applications. Eternit-TAC is certainly well aware of the uses of the material, and is (equally-importantly) aware of the possible problems with asbestos as a constituent. The visitor to Kapelle-op-den-Bos cannot fail to note the precautions with which asbestos is dealt, from the carefully-controlled unpacking of the raw materials to the continuous monitoring of production and waste management.

We are pleased to publish below a detailed account by Eternit TAC's UK General Manager of pipe production at the company. As Dr Commins states (see page 11), the material has probably been more carefully examined from the safety point of view of the end user than any other pipe material, but it is also true to say that asbestos cement has been equally carefully examined from the point of view of its manufacture.

The manufacturing process of AC pipe

by Geoff Vintin

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THE STRENGTH AND flexibility of asbestos fibres confer the toughness and tensile strength on the mixture known as asbestos cement. The asbestos fibres are analogous in their action to the

steel reinforcement used in ferro-concrete mixtures, but with the very important advantage that the fine asbestos fibres are intimately mixed with the cement and have an affinity for the cement

particles, providing a homogeneous mass of uniform strength throughout the body of the material.

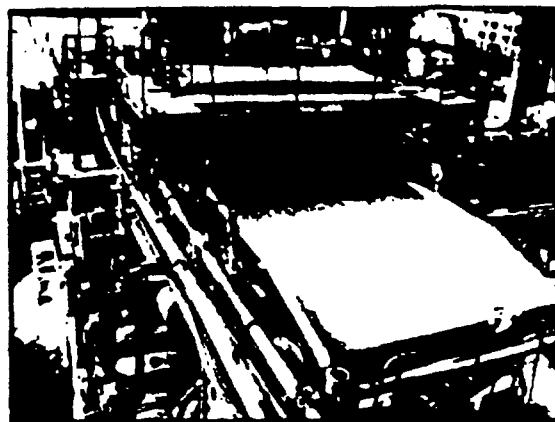
Asbestos is a naturally-occurring mineral, which is found as densely-compacted crystalline fibres aligned axially in voids in volcanic rock. The asbestos is separated from the general rock matrix at the mine head, but before the intrinsic qualities of the asbestos can be utilized, the densely-compacted fibres must be separated or 'opened.' The process of 'opening' takes place partially at the mine head, after which the now cotton wool-like material is pressure-packed and wrapped for shipment.

The process of 'opening' is continued at the Eternit factory - a blend of grades of fibre appropriate to the products in manufacture is fed via bag openers to one of five roller mills, together with approximately 10-15% water. The aim of the opening process is to separate the fibres without reducing their length. This is achieved by "crushing" the fibres under two axially-opposed, horizontally-running steel or granite rollers. The axle connecting the two rollers does not incorporate a differential gearbox and since the outside edges of the rollers have a greater horizontal circumference to travel than the inner edges, a constant 'skid' is induced, which has the effect of mechanically tearing the fibres apart. The water introduced to the mill with the asbestos performs two functions: it helps to keep down dust within the mill and it assists in the 'opening' process. Water is absorbed into the asbestos mass by capillary action between the unopened individual fibres, and as the weight of the rollers comes to bear, being incompressible, the water effectively explodes the fibres apart.

Opened fibre is mixed with an excess of water and specially coarse ground Ordinary Portland cement or sulphate-resisting cement in the approximate ratio of 12 asbestos:88 cement. This slurry at roughly 65% solids is pumped to a holding vessel, which is used to convert the batch milling and mixing process to a continuous supply to the pipe making machines. From fibre bag opening to the holding vessel, all processes, plant and raw material input are constantly monitored by a computerized control system specially developed for the purpose.

Slurry from the holding vessel is further diluted with water to approximately 4% solids and transferred to one of the two pipe-making machines, which between them can manufacture pipes ranging in internal diameter from 75mm to 2500mm. The large excess of water is used as a transportation medium and as a factor in the control of the subsequent pipe-making process.

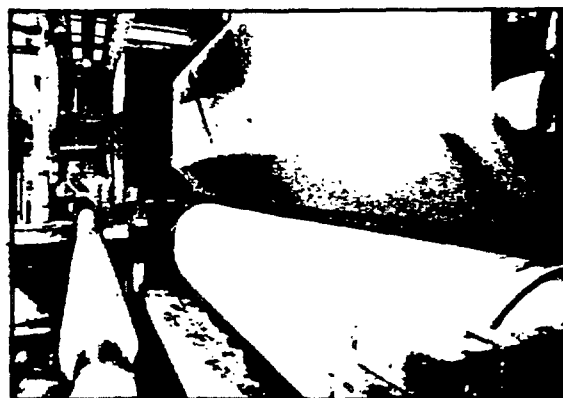
Pipe making is carried out using the Mazza process developed by Comm. Mazza in Italy in



General view of an a-c pipe manufacturing plant, showing the felt band with the layer of a-c slurry.

1913-16, which was itself a development of the Hatchek process used in the manufacture of asbestos-cement sheeting products. The process is essentially one of controlled filtration, dewatering and consolidation. The slurry, which by now has the appearance of dirty water, is fed simultaneously to two adjacent vats, in each of which is a cylindrical horizontally rotating sieve, approx. 1m in diameter and 5m plus in length. The sieve cylinders sit in end seals, so that slurry fed into the vat on the outside of the cylinder is filtered through the sieve wire, depositing a layer of asbestos fibres and cement on the sieve surface. Filtrate water passes from the inside of the cylinder to return to the dilution system in a closed circuit. The Belgian factory has its own water treatment plant, which ensures that only the correct water quality is fed to the process and that no process water is allowed to go to waste. The thickness of the lamina built up on the outside of the sieve is a function of the speed of rotation of the sieve, the solids' content of the slurry fed to the vat, the hydrostatic head between the inside and outside of the sieve cylinder, slurry temperature, fineness of the cement and drainage characteristics of the blend of asbestos fibres being used. At this stage of the process the asbestos fibres

Close-up of the felt band depositing a layer of a-c onto the steel mandrel. A smaller-sized mandrel can be seen on the left supporting a newly-made pipe.



act as an additional filtration aid, continuously collecting the fine cement particles from suspension and preventing them passing through the comparatively-open sieve wire.

Passing over the top of the vats is an endless, 5m plus wide polyester filtration blanket (felt) in contact with the tops of the two cylindrical sieves. The felt itself is the driven element which rotates the sieve cylinders in the vats by frictional forces alone. The lamina of asbestos fibres and cement deposited onto the sieve wire is constantly carried up to the point where the sieve and felt come into contact, at which point changes in surface tension cause the lamina to transfer from the sieve wire to the polyester felt and to be continuously carried away by it. The lamina produced in the second vat moves in an identical way, but is deposited on top of the lamina from the first vat. The combined laminae thickness on the felt is approximately 0.4-0.5mm. The felt carries the laminae over a series of suction boxes which progressively dewater the layer as it is moved towards the compression section of the Mazza machine.

Pipe formation

The compression section or head is that part of the machine where actual pipe formation takes place. The felt passes over a driven 'anvil' roller; positioned over the roller on the felt is a steel mould or mandrel, which has vertical, downward pressure applied to it by a series of rubber-covered pressure rollers. The mandrel is a steel cylinder in excess of 5m in length, and is positioned across the width of the machine. It can be seen therefore that in asbestos cement pipe production, it is the width of the machine which fixes the length of the pipe which can be produced.

The felt transports the layer to the point of contact with the steel mandrel where, again, differences in surface tension cause the layer to transfer from the felt to the surface of the rotating mandrel. The layer is then continuously wound around the mandrel until the total thickness of AC appropriate for the particular class of pipe under manufacture is achieved. Throughout the rolling-up period a carefully controlled pressure profile is applied through the pressure rollers, which completes the dewatering process and consolidates the laminae. At this stage, the physical characteristics of the white asbestos fibre begin to make a bond between successive laminae as they come into contact.

At the end of the rolling-up process a DC current is briefly applied across the AC/steel mandrel interface, which electrolyses the water present at the interface into minute gas bubbles. Due to the continued rotation of the mandrel and AC pipe, these gas bubbles separate the AC from the steel

sufficiently to allow the mandrel to be withdrawn at a later stage. The mandrels are manufactured to dimensions which take account of the separation gap and ensure the internal dimensions of the finished pipes are to specification.

The pipe and mandrel are then lifted from the head and the next mandrel, which may be for a completely different size of pipe, moved into position and the process repeats itself. Different sizes and classes of pipe require their own machine parameters, such as pressure profile at the compression head, etc. The individual parameters for all pipes are stored in a process control computer, which, when told the order of manufacturing, continuously monitors and controls all the appropriate parameters through the pipe-making process from dilution of slurry from the holding vessel onwards.

The AC pipe, still on the mandrel, is traceability marked and then moves into a curing stove through which it passes for approximately eight hours under carefully-controlled conditions of temperature and humidity. Throughout this period slow rotation continues in order to prevent ovality developing due to the weight of AC on the mandrel and the separation gap. At the end of this time the mandrel is withdrawn from the AC pipe, which by now has sufficient green strength due to the presence of the asbestos fibres to be self-supporting and remain cylindrical.

The process of dewatering and consolidation produces an AC pipe which has insufficient final moisture content to fully hydrate the cement. The green pipes are therefore submerged in water maturing tanks for a period of 5-7 days. It is possible to steam-cure AC pipes but, although water maturing takes 10 times longer, the product is less susceptible to cracking, has a greater density and has a smoother bore.

After maturing the pipes are machined on the ends to the correct spigot dimensions and accurate length, and hydrostatically tested to twice working pressure. If the materials are being supplied grey, uncoated, they are bundled and moved to stock. Alternatively they can have a range of coatings applied to them, depending upon the specific requirements of the application.

Eternit Tac is able to supply pipes and fittings with a variety of surface finishes to suit a wide range of environmental conditions. In ascending order of protection, the finishes are as follows:

- natural grey OPC;
- natural grey sulphate-resisting cement;
- bitumen coating, internal, external or overall;
- epoxy-tar coating (bitumen/epoxy resin mixture);
- pure epoxy, 300-micron coating (food-quality available);

- pure epoxy, 500-micron coating (food-quality available).

The *Widnex* and *Comete* AC push-fit, drop-tight joints are manufactured in the same way and from the same material as the AC pipes which they suit, and have the same pressure rating. The mandrels used are specifically sized for the purpose and the 'joint pipe' is rolled to a greater thickness to allow for subsequent machining. When removed from the water maturing tanks, instead of going for end turning, a 'joint pipe' is sawn into slices which are then machined internally to the appropriate ring groove profile and tolerances for the particular joint.

There is also a variety of other facilities for the production of specialist products. These include:

- the fitting of end caps if pipes are to be used as storage tanks;
- drilling of pipes for 'French'-drain type applications;
- conversion into single-piece manholes, incorporating all the customer-specified connections in the correct positions, baffles and hydraulic profiling (benching);
- sawing of pipes into oblique slices and subsequent rebonding to form fabricated bends;
- bonding of one pipe section into another to form angled junctions;
- fitting of brackets and shelving into large-diameter pipes for use as service galleries;
- extraction of the mandrel prior the curing stove for moulding of 5-m pipes into slow bends.

Process control and operator responsibility, in conjunction with a high degree of automation and mechanical handling are the basis of a strict quality assurance regime. Overseeing the factory disciplines, a company-wide quality-control department responsible to the Managing Director monitors all raw materials, production and finished product for compliance with both internal and external standards. The pipe factory already has compliance with several European Quality Assurance Standards, and has made application for compliance with BS 5750.

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Pipe Machine Information