CORROSION PREVENTION

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Natural rubber, modern synthetic rubbers, and plastic materials, are all within the orbit of Dunlop and Semtex anti-corrosive materials for protecting chemical plant against corrosion and liquids from contamination. For over fifty years Dunlop have been specialists in this field and have pioneered almost every fresh development. With the continual progress that spans the world and, as the Chemical and Allied Industries have become more exacting in their requirements, Dunlop and Semtex specialists have found methods and materials to combat each new situation.

CORROSION AWARENESS

Today more than ever before there is a great awareness of the toll of corrosion, which extends from the home to the fabrics of many great architectural wonders. In the chemical and allied industries corrosive materials are essential and frequently formed as by-products during the production of many commonplace and occasionally rare consumer goods. Manufacturing equipment in contact with these corrosive materials is often made with corrosive-resistant materials throughout, such as glass or ebonite. Where this is not practicable because of cost, strength, or other structural features, equipment can be covered with a selected corrosive-resistant material and bonded together with perfect adhesion. The rubber and plastics industry has large interests in producing solid anti-corrosive equipment, but its greatest contribution is in providing protective surfaces for chemical plant. It is by the combination of steel, non-ferrous metals, concrete and wood, with surfaces of anti-corrosive rubber, selected plastics, glass, brick or cements, that it is possible to meet all known conditions of strength, load-carrying, wear-and-tear and corrosion.

The choice of method and material is made after considering the nature of the corrosive agent, the structural limits of the plant and conditions during use, such as wear-and-tear and fluctuations in temperature. The corrosive agent might not, in the true sense, be considered a corrosive material; water for instance, by seepage into microscopically fine cracks could completely disintegrate a surface during frosty conditions. Oxygen from the air we breathe, in humid conditions will produce one of the most common forms of corrosion, rust. Linings are not always applied solely to resist corrosion but often to prevent contamination. For example, in many processes it is vitally important to prevent water being contaminated in the slightest degree by salts that could be dissolved from the surface of containers. In every circumstance, Dunlop and Semtex combined, are prepared to provide the answer from the smallest acid-resisting bucket to lining large reservoirs involving thousands of square feet of protective material, or giant-sized vats containing boiling and highly corrosive acids.

METHODS OF PROTECTION

There are four different ways to resist corrosion, or contamination:-

SOLID ANTI - CORROSIVE SECTIONS

In this way corrosives can be handled without any undue deterioration to the plant. Vital plant sections are made entirely from corrosive-resistant materials, such as glass or ebonite. Many solid ebonite sections, for equipment such as marine pumps and battery boxes, are produced at the Gaythorn Works of the Dunlop General Rubber Goods Division.

ANTI - CORROSIVE LININGS

Chemical plant constructions with conventional materials like steel, concrete and wood, have suitable non-corrosive lining materials 'tailored' and bonded on to them. These linings protect the equipment from corrosive attack and add durability to strength.

Fitting the lining is usually followed by a heat treatment, either to vulcanise the rubber, if rubber is used, or to cure the bonding agent that attaches the lining to the equipment. For this purpose, large autoclaves up to 15 ft. diameter and 22 ft. long, and 6 ft. diameter and 40 ft. long are installed at the Gaythorn Works.

A brewery bottling hall, with a Semtex anti-corrosion floor. The cleanliness of the floor is shown by the roof lights reflected from it.

For a number of applications it is not practicable to give any heat treatment. A rubber-lined reservoir is obviously too large and under these circumstances specially compounded and vulcanised rubber, rubber that will vulcanise at room temperature, or synthetic rubbers or plastics that need no vulcanisation at all, are used together with low temperature bonding agents.

ANTI - CORROSIVE PAINTS

Painting is a familiar means of protection and a number of paints are specially prepared for the various requirements of the chemical and allied industries. Some paints are blended just prior to application and are self-hardening, others are hardened by heating.

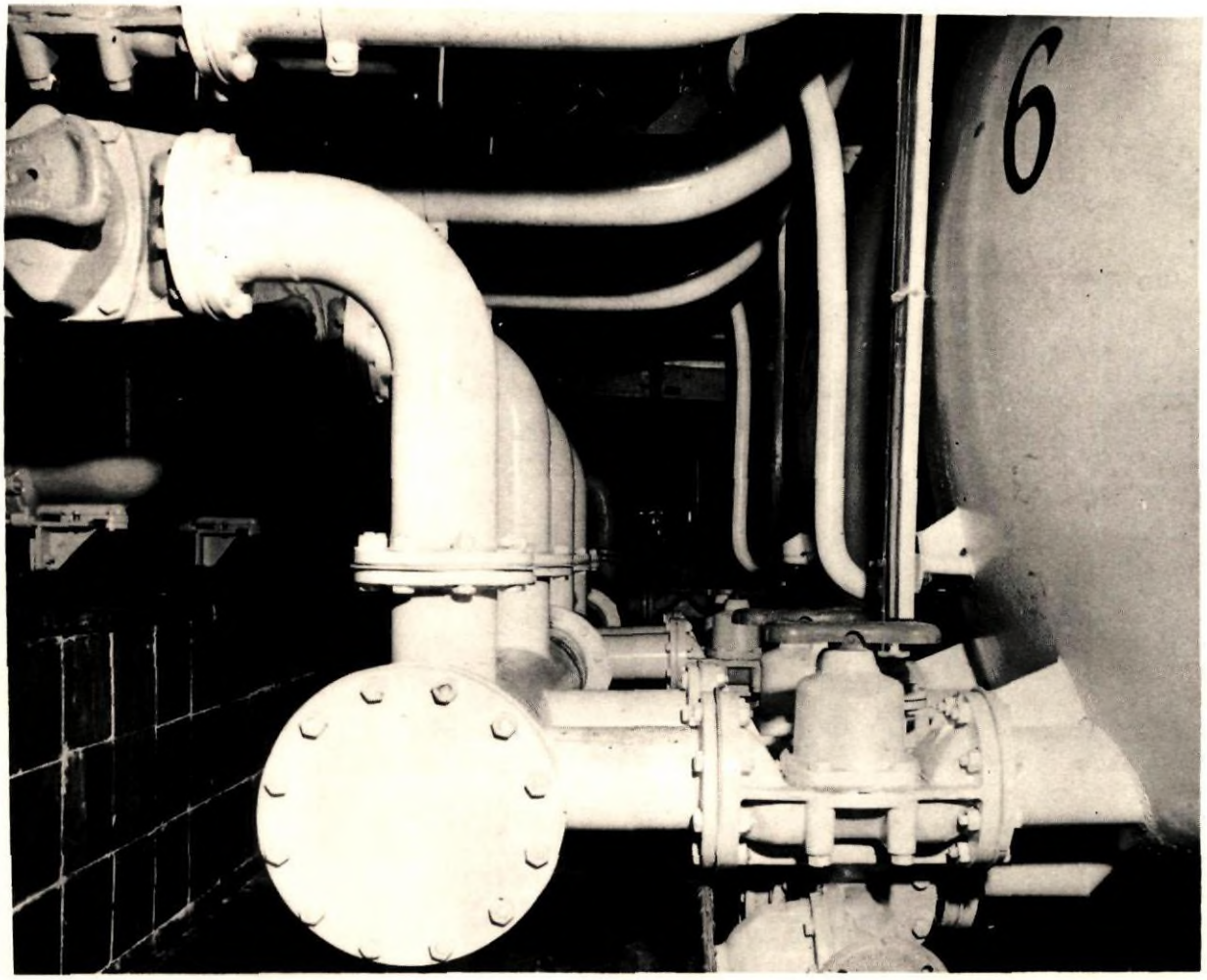
BRICK, TILE AND CEMENT (OR MORTAR)

Selected (clay) bricks are very corrosive resistant and frequently used for lining anti-corrosive tanks. For this type of construction, corrosive - resistant cements are absolutely essential.

Brickwork is usually installed as a first line of defence with a corrosive-resistant and impermeable membrane underneath. Pickling baths for the iron and steel industry are typical examples of this, where tank surfaces become scored by material such as rolled strip, that is both heavy and hot.

Anti - corrosive floors and other flat surfaces are frequently covered with tiles. Again, as with bricks, the cement is vitally important and a corrosion-resistant membrane is often necessary.

In both cases it is preferable not to assemble the joints in lines; half bond or



A complex pipe structure, which has been rubber-lined against corrosion.

herringbone pattern of laying is preferred and the cement, or mortar, made flush with the main surfaces.

MANUFACTURING FACILITIES

The size of projects varies enormously. There are small bore tubes that require special techniques to feed anti-corrosive linings into them. At the other end of the scale, many of the gigantic pieces of equipment escorted through Manchester streets are destined for Gaythorn Works, to be shot-blasted, made scrupulously clean, lined with rubber, synthetic rubber, or plastic, and then vulcanised in one of the world's largest autoclaves. Gaythorn Works are equipped to handle almost anything that can be transported by road, but larger projects, such as lining reservoirs with acres of rubber sheeting, are carried out in situ by specialised field technicians from the Dunlop General Rubber Goods Division. At times it is convenient to use the tank itself as its own autoclave for vulcanising the liner. The lined tank is filled with water which is then heated to boiling, or, when possible, it is filled with steam under pressure.

Some of the units received at Gaythorn Works for linings are very complex. For example, medium-sized tubes with knuckles and valves are patiently tailored internally, even when there is little room to manipulate a hand freely inside the equipment.

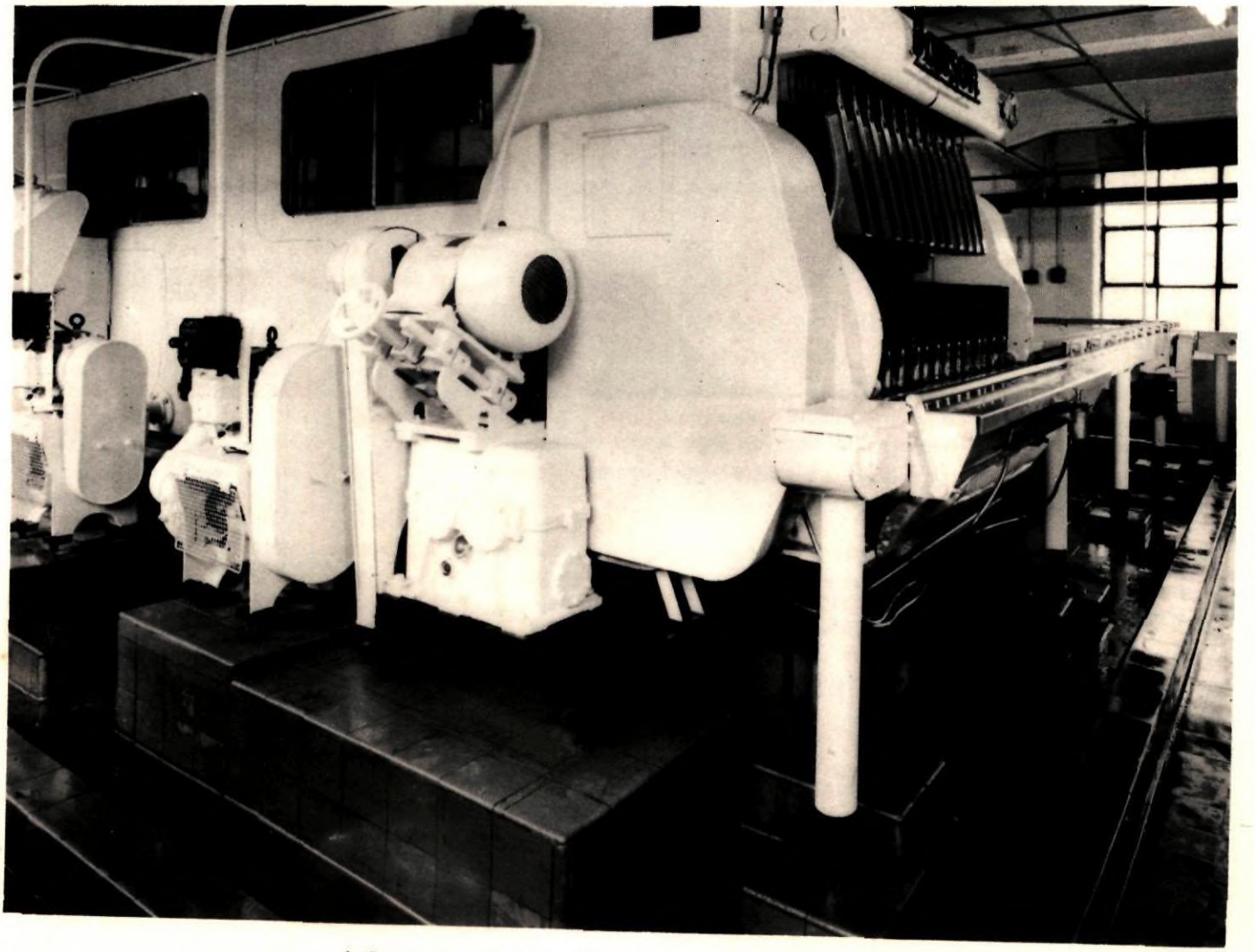
Many of the really large projects are in brick or tile. This obviously applies in the case of flooring in places such as large chemical plants and breweries. Again, this type of work is carried out in situ by an expert staff from the Semtex branch of the Dunlop organisation.

TESTING

It is most important that linings are flawless. An electrical apparatus producing 25,000 volts is used to detect any faults. This apparatus has a probe which, when hovering over a weak place in the linings, produces a train of sparks $1\frac{1}{2}$" long that can be seen to pass through any thin spots.

THE FUTURE

No one material is applicable to every requirement of the chemical and allied industries; the future rests in the selection of suitable materials for each particular operation. Between the products of the Dunlop General Rubber Goods Division and the Semtex Company there is a completely comprehensive range of anti-corrosive materials. Experts are available to advise and deal with any situation large or small, in the factory or in the field.



A flooring contract in Threlfall's Brewery, Liverpool, carried out with corrosion resistant tiles, bedded and jointed with Semtex latex cement.

MATERIALS

NATURAL RUBBERS

The resistance of natural rubber to a variety of corrosive materials has been recognised for many years; rubber or ebonite stoppers in glass bottles containing corrosives are quite common. Natural rubber has another very important property; it is relatively impermeable to gases and liquids and is frequently used as a membrane behind anti-corrosive materials that are not so impermeable, but form a good heat insulator or protective layer against mechanical damage.

There are many types of natural rubber, hard and soft, electro-conductive and non-conductive, resilient and non-resilient, to mention only a few. Their properties depend upon various chemicals compounded with the basic natural rubber before the process of vulcanisation.

Rolling down natural rubber panels in the interior of a large tank, at the Gaythorn factory.

Ebonite (hard natural rubber)

In combination with a high ratio of sulphur, a hard rubber, ebonite, is produced which is very popular for solid sections and for plant linings. At room temperature it is resistant to concentrated hydrochloric acid and phosphoric acid, 65% sulphuric acid and 8% nitric acid. It is very resistant to alkalies and is used to store formic acid, dyestuffs, and in chlorine plants. For anti-corrosion coupled with electro-conductivity, for example in electro-precipitators, another type of ebonite is produced by adding conducting carbon black or graphite to the compound. Buckets for carrying sulphuric acid are made from NERFLEX, a fabric-reinforced ebonite.

Ebonite tends to soften at temperatures above 70°C. At sustained high temperatures it becomes brittle and for this type of application a more flexible material has been developed and marketed under the trade name DUROLINE, which is resistant to as many chemicals as ebonite itself. DUROLINE is not particularly resistant to the halogen type of acid.

Soft natural rubber

Soft natural rubber has, in addition to a wide range of corrosive resistant properties, a remarkable resistance to abrasion and mechanical abuse. It can be bonded to all structural materials and consequently has many applications for rugged work. It is resistant to most inorganic chemicals, acids and alkalies up to a temperature of 80°C, and to many organic chemicals. It is not resistant to higher oxidising acids such as chromic and nitric. Its stretchability makes it particularly suitable where heat expansion is involved; for this reason it is sometimes used as an interlayer for rigid anti-corrosive linings, to prevent contrary expansions fracturing the protective lining.

Rubber latex

Another form of natural rubber is rubber latex, a milk-like liquid from rubber trees, which is used to make corrosive resistant mortars for brickwork and tiles. This will be referred to again under 'cements'.

SYNTHETIC RUBBERS

One of the great advances of recent years has been the large-scale production of a number of new rubber-like substances known as synthetic rubbers. Apart from their most valuable contributions to all products of the rubber industry as a whole, they increase the range of corrosion-resistant materials. One of them, SBR, has resistance properties similar to natural rubber and provides an alternative to it, whereas others differ quite appreciably. There are five synthetic rubbers of particular interest to chemical plant engineers -

Neoprene
Butyl
Nitrile
Hypalon
Polyisobutylene

Lining a pickling vat in situ.

A comprehensive table of their chemical and physical properties has been prepared by Dunlop General Rubber Goods Division and the Semtex organisation and a few of their outstanding features are mentioned below:-

All synthetic rubbers except polyisobutylene possess greater resistance to heat and oxidising conditions than natural rubber.

Nitrile — Nitrile rubber has an excellent resistance to oils and, like natural rubber, it can be compounded to the ebonite or hard rubber stage.

Neoprene — Neoprene has a marked resistance to most oils and has the property of inhibiting the growth of marine and certain other organisms.

Butyl Polyisobutylene — Butyl rubber and polyisobutylene have exceptionally low water and gas permeability values but because it is not possible to vulcanise polyisobutylene, it has more limited applications.

Hypalon — Hypalon withstands 95% sulphuric acid and is used for reaction vessels where temperature and concentrations of acid fluctuate to a wide degree. Hypalon, mixed with suitable resins is the basis of a superior coating (SEMPREN H.P.) which can be applied by brushing or spraying.

PLASTICS

Plastics have further increased the range of corrosion resistance, so much so, that with natural and synthetic rubbers, the range is almost complete.

PTFE — PTFE (polytetrafluorethylene) for instance, is more resistant to chemical attack than glass itself and is resistant to hydrofluoric acid, one of the most penetrating corrosives. It also has a very smooth surface and can withstand high temperatures but is very expensive and, although solid sections can be made from it, they can only be used for special applications, because PTFE does not withstand mechanical abuse. Dunlop General Rubber Goods Division manufacture a limited number of PTFE products, in particular for the baking industry.

Polypropylene

Polypropylene is a clean smooth material, resistant to many chemicals and solvents, suitable at temperatures up to 115°C. It is semi-rigid and has a different heat expansion value to that of steel. To overcome the heat expansion difficulties when used as a lining, a laminated material (DUPLENE) has been developed. DUPLENE consists of a laminated layer of polypropylene, bonded to a layer of rubber which is bonded to the metal structure. In this way the deformable rubber layer takes care of varying expansions. Joints are welded by using a hot air torch and polypropylene welding rod. Polypropylene can also be used as a constructional material for rigid fabrications.

Penton

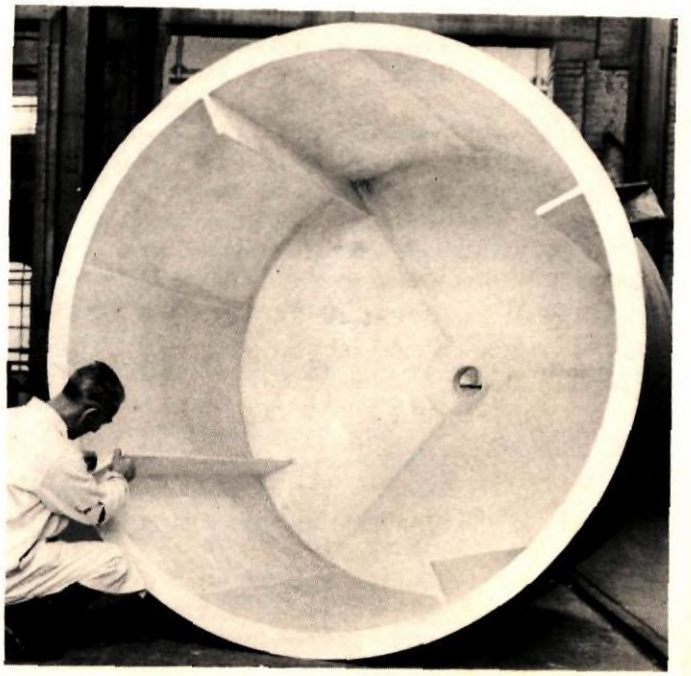
PENTON (a chlorinated polyether) is very corrosive-resistant and has a higher temperature range than polypropylene. Again, as with polypropylene, a laminated material (DUPENT) has been developed with nitrile rubber as the interlayer and will be available shortly.

PVC

Rigid PVC is a good corrosive-resistant material. It is also non-flammable and fungus-resisting. Rigid structures can be made in this material or it can be plasticised to produce a material suitable to bond onto metal, wood, or concrete. PVC will not resist temperatures above 70°C and the plasticised material is not suitable for organic solvents and concentrated acids or alkalies - the plasticisers tend to leach out.

BRICKS, TILES, CEMENTS AND MORTARS

Clay bricks and tiles afford considerable protection against corrosion, but when constructing large surfaces with these units, it is most important to bind them together with non-corrosive cements (or mortars). Continual research and development has produced



A container is lined with DUPLENE at the Gaythorn factory of General Rubber Goods Division.

a range of these materials, but as with 'Natural Rubber', 'Synthetic Rubber' and 'Plastics', their main features only will be described.

Latex cement

Latex mixed with cement forms only a partially acid-resistant mortar, but in contact with mild acid, a surface action takes place which forms a seal and prevents penetration. Latex cement has a particularly distinguishing feature, it can resist conditions of alternating acid and alkali attack, whereas some acid-proof cements are easily dissolved by mild alkali. Latex cement is used in brickwork for sulphuric acid tanks and for many other applications.

Silicate cement

Silicate cement consists of an inert aggregate bonded together with a solution of sodium or potassium silicate. It is brittle and tends to develop hair-line cracks. Brickwork with this cement is always backed with a rubber or some other suitable membrane, such as lead. It is resistant to acids, particularly

strong acids, but not alkalies, and is adversely affected by water.

Sulphur cement

Sulphur cement is a mixture of sulphur, inert fillers and a small percentage of synthetic rubber, which helps the material to pour and also eliminates some of its brittleness. It is resistant to strong acids and weak alkalies. It is very laborious to apply, necessitating hot pouring into specially arranged cavities formed behind and between the brickwork or tiles. It is always used in conjunction with an impermeable membrane.

Plastic cement

Semtex Plastic Cement contains phenolic type resins and is resistant to a fair range of chemical attack. It has a useful degree of flexibility, but is relatively difficult to handle and is one of the most expensive cements.

Resin cements

Furane resin cement is the most versatile and widely used anti-corrosive cement, but it does not stand up to oxidising agents, for example 2% nitric acid. It is prepared by blending inert fillers into the syrup-like liquid produced by the action of an acid on furfuryl alcohol.

Semtex G.P. cement is another resin-based cement but it does not have the characteristic poor resistance to oxidising agents associated with many resins. It is a furfuraldehyde type of compound mixed with inert fillers. It will withstand nitric and chromic acids up to 30% and hydrogen peroxide up to 30 volumes.

GLASS LININGS

Surface deterioration can be brought about by abrasion and rubber is well-known to have excellent abrasion resistance. Another surprisingly interesting material for this purpose is glass. This material adheres readily to concrete or steel by applying Semtex latex cement, and it is widely used for lining coal storage bunkers and chutes. Glass also has excellent resistance to chemical corrosion and its coefficient of friction is low enough to be appreciated by chute designers.

Part of the 25 - million - gallon reservoir at Easington, with a General Rubber Goods Division expert at work on the lining.