

**Linings for
Phosphoric Acid Plants**

**Soft Rubber and Ebonite produced
by HAW LININGS
Applications in the field of
production of Phosphoric Acid**

Experience

References

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1 Introduction

Since 1974 has rubber lined various evaporators, crystallizers, digesters, storage tanks and other equipment with VULCOFERRAN rubber materials used for the production of phosphoric acid up to temperatures of 100°C.

Some of our major projects are:

- Maroc Phosphore I, Safi/Morocco
- Maroc Phosphore II, Safi/Morocco
- Jordan Phosphate Mines Co. Ltd., Aqaba/Jordan
as well as the rehabilitation
- Philippine Phosphate Fertilizer, Leyte/Philippines
- BAGFAS, Bandirma/Turkey - Revamping and upgrading of the existing plant

All our VULCOFERRAN rubber materials and their adhesive systems have been developed in the HAW-laboratories and are exclusively produced in the HAW-rubber production workshop under the strict quality control acc. to DIN EN ISO 9001.
The corresponding certificate has the registration No. 08/100/9020/3.

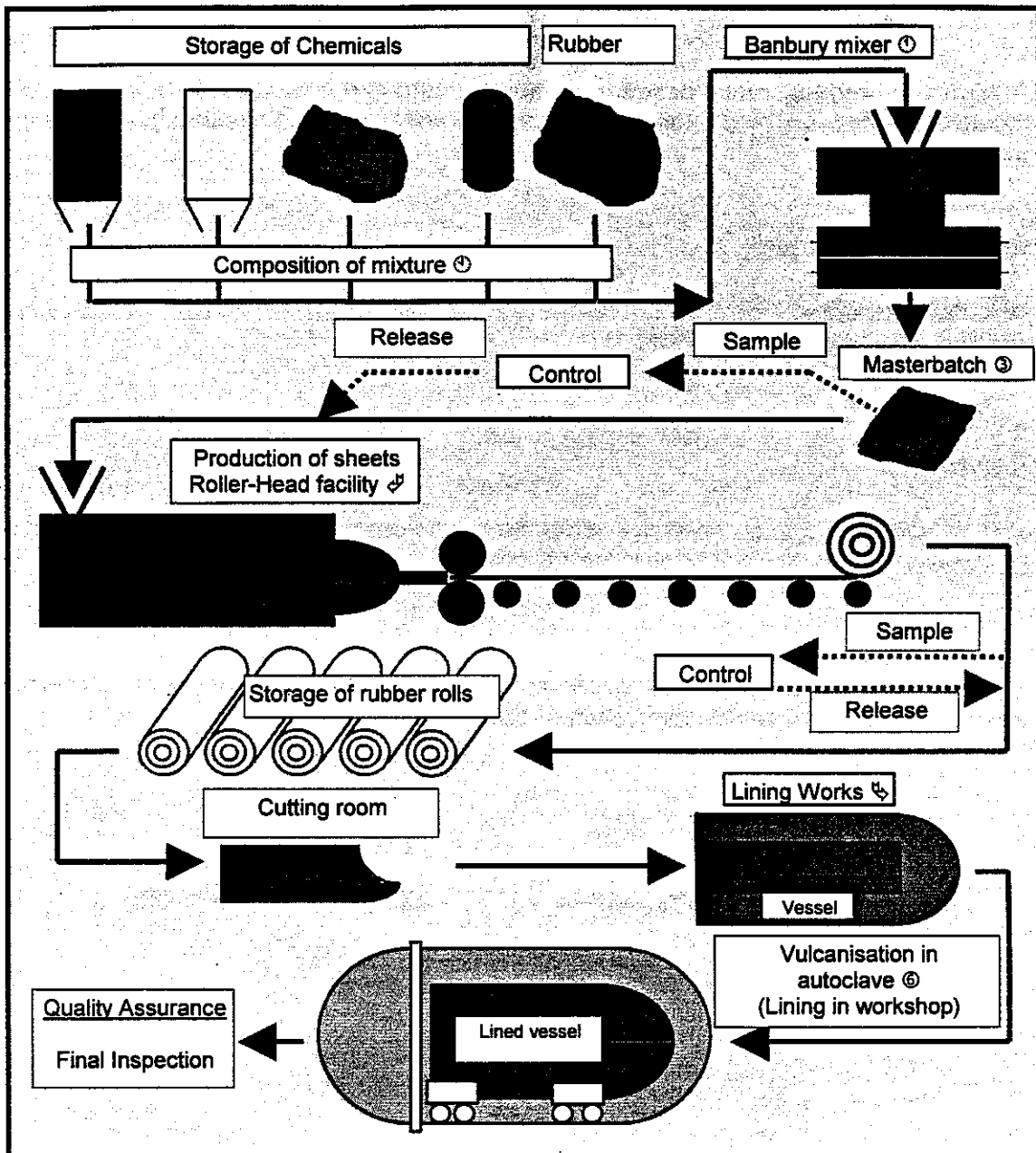
The VULCOFERRAN rubber materials are produced in extruded sheets and are unvulcanised during application. The adhesive system is based on the same polymer as the corresponding VULCOFERRAN rubber material. Both, the rubber materials and the adhesive systems, do not contain any chloroprene. The vulcanisation after application leads to an excellent bonding between the rubber sheets and the steel substrate. The bonding is temperature stable up to 100°C.

This temperature stability of the bonding system minimises the risk of permeation which in combination with the excellent physical properties of the proposed VULCOFERRAN rubber materials will result in a long life expectancy of the HAW-rubber lining. Our references confirm this.

2 Lining Materials produced by HAW LININGS

Hard rubber linings / Soft rubber linings -in the workshops -
The Know-How - the basis for our success

The fabrication of rubber is a process of various steps. A mixture ☉ is composed by several raw materials and special synthetic rubber acc. to an individual recipe. This mixture is put into the Banbury mixer ☉ to receive a masterbatch ☉. The rubber sheets will be produced by an extruder in the Roller-Head facility ☌. Hard rubber linings / Soft rubber linings ☍ are manual works carried out by qualified personnel. If linings are carried out in the workshops the vulcanisation of the lining will be made in the autoclave ☎ at temperatures up to 150°C and pressures up to 6 bar. If the linings are carried out on site we use selfvulcanizing rubber materials which can be vulcanised on site.



The quality and lifetime of the HAW rubber lining has been achieved by a profound study of the rubber behaviour during

- tests in our laboratories
- production in our workshops
- application in our workshops and on site and - of course
- during operation

These are the reasons for this success in Morocco and other installations in the world.

Rubber is an organic material based on polymeric/macro molecules that form a three dimensional network by an interlacing process known as vulcanisation. The two categories of rubber are:

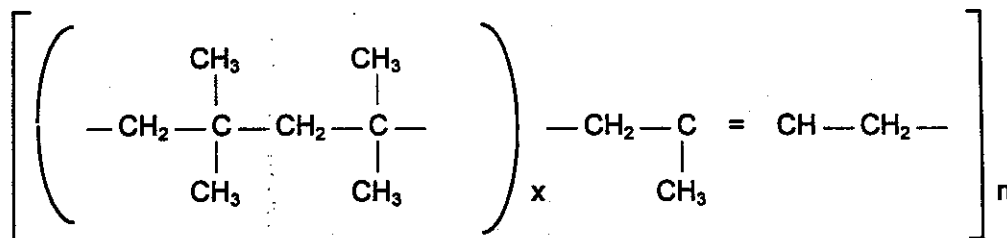
Hard rubber / Ebonite

hard material with a high elastic modulus (high cross linking of the polymer) and very good diffusion/permeation resistance.

Soft Rubber

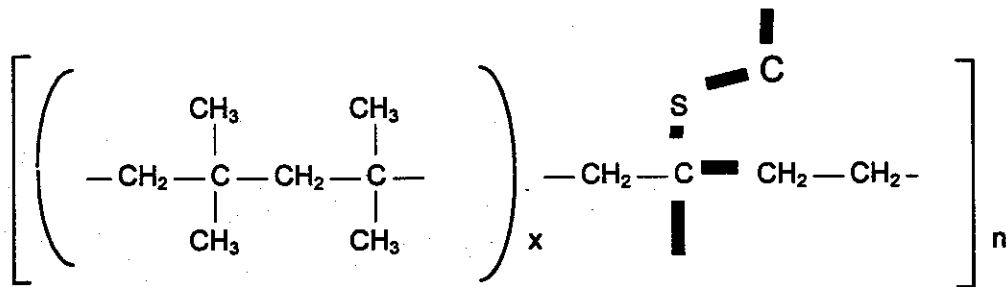
soft material that can be reversibly deformed up to some 100% of it's length without being destroyed. Outstanding corrosion resistance.

The raw material for rubber production are long polymer chains, that are unvulcanised and have a chemically weak double carbon-bond.

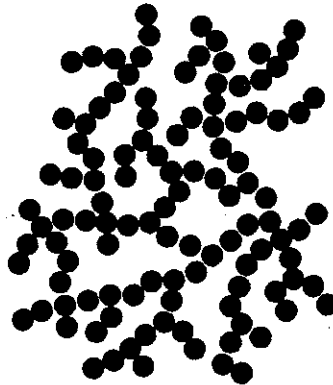


The production Know-How of HAW is to treat the raw material in a way, that (mainly) two things happen:

- the double bond is saturated with sulphur to attain chemical resistance
- the polymeric chains vulcanise among themselves.

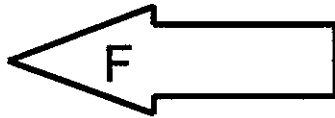


If this is done properly during production and vulcanisation, the result is a three dimensional interlaced (vulcanised) rubber material which results in a chemically resistant material suitable for a long lasting corrosion production.

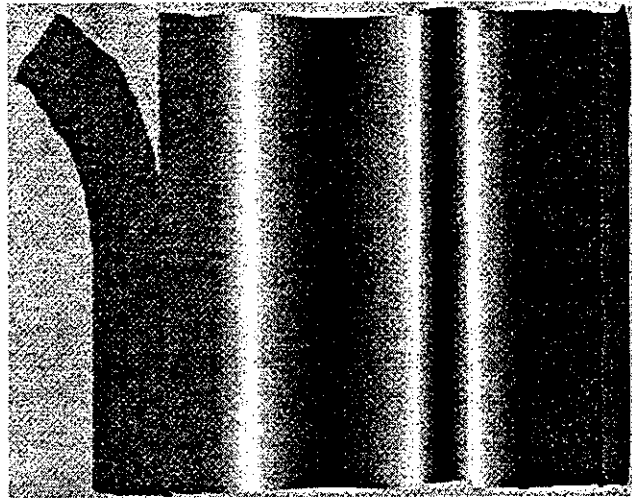


Bonding Behaviour at Elevated Temperature and Permeation

The bromobutyl - bonding system 2206/L1



(during bonding test -
peeling method)



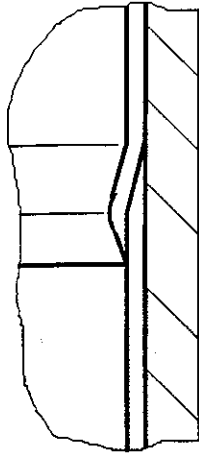
- **Bonding by interlacing**
- **Break (during bonding test) in the rubber sheet, not in the bonding system**
- **Very low water adsorption**
- **Temperature range up to 100°C**

Bonding force > 2N/mm after 80000 hours operation due to the interlacing bonding system.

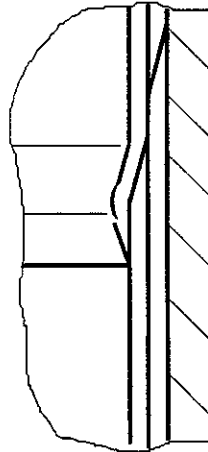
Standard technology

Execution of Rubber Seams

Single layer of rubber



Double layer of rubber

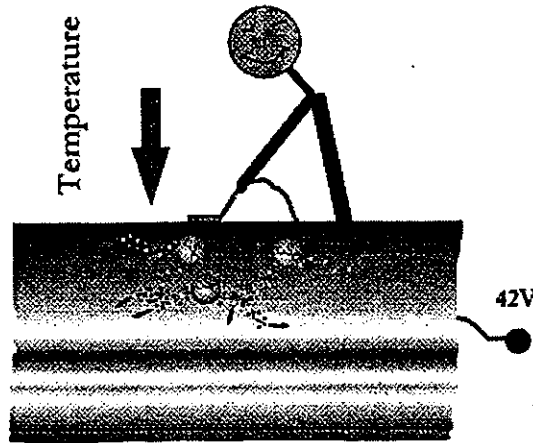


4 Loading into a Refrigerated Truck

The application of unvulcanised rubber sheets is easier than the application of prevulcanised rubber sheets

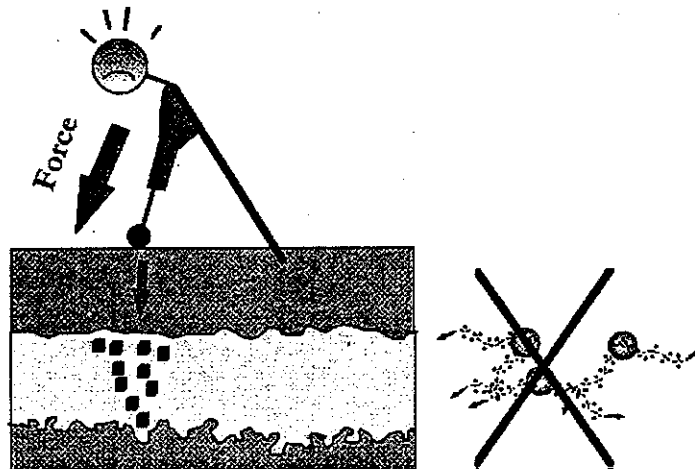
Unvulcanised rubber sheet with bonding system:

Rubber and bonding system react chemically. Hardly any force is necessary for this bonding - but a proper contact and no remaining air between rubber and steel. This is achieved by a smooth application with a heated flat iron tool.



Prevulcanised rubber sheet with chloroprene glue:

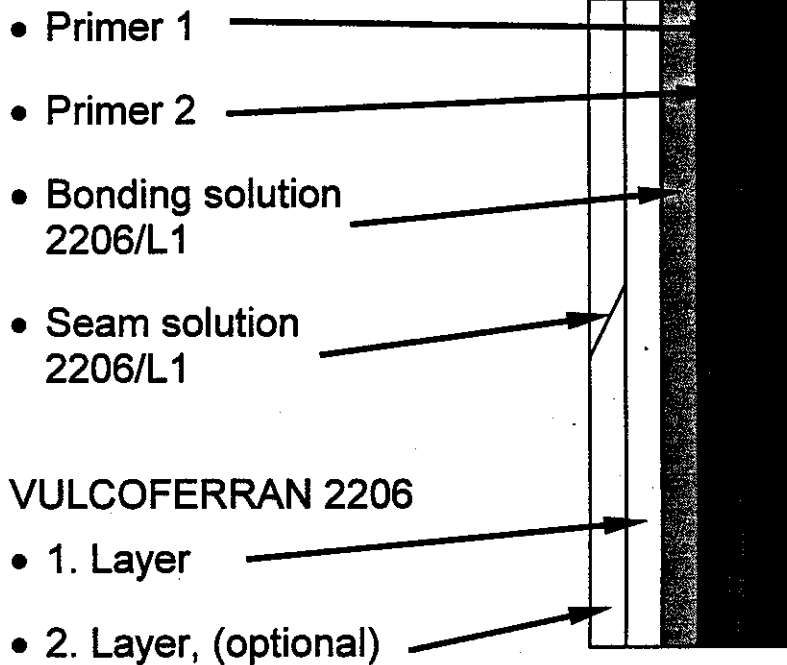
There is no bonding of the glue and the rubber material as the rubber is already prevulcanised. The sticking is reached by the formation of crystals and a mechanical connection to the steel. The crystals only form under pressure during application.



8 Composition of a HAW Rubberlining

VULCOFERRAN 2206 - bonding system

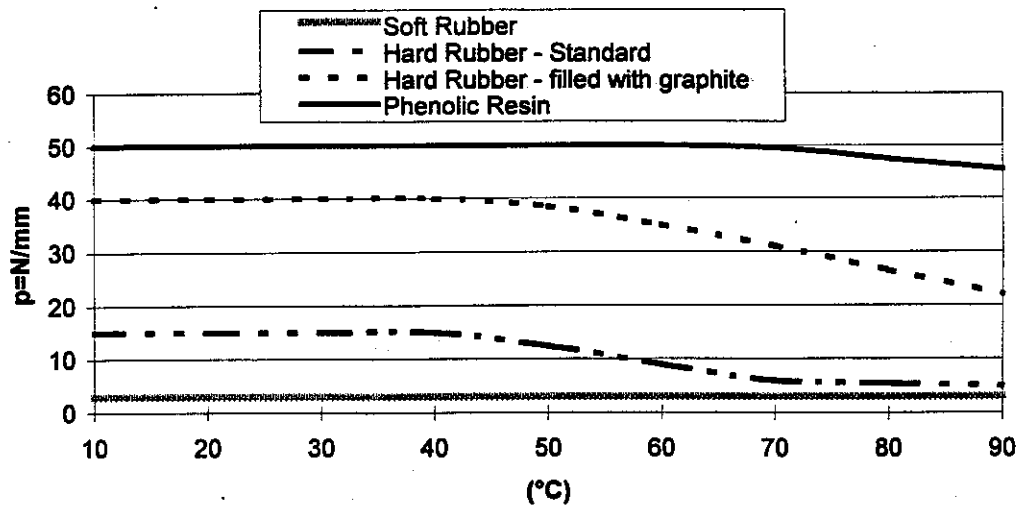
Bonding system



Protection of the steel due to:

- Bonding of the rubber to the steel and between the rubber sheets
- Resistance of the rubber and the bonding system against
 - Corrosion, chemical attack
 - Temperature
- Tightness against permeation / diffusion

10 Maximum Surface Pressure for Linings



This diagram shows the maximum permissible surface pressure for some lining materials.

The indicated values are only for general information only to show the differences between the lining materials.

The indicated values depend on the lining material of each manufacturer.

If there are higher temperatures, either hard rubber materials with high temperature stability will be chosen or gaskets with steel rim.

Normally following surface pressures are used:

up to **10 N/mm² = 10 MPa** for ebonite
and up to **2 N/mm² = 2 MPa** for prevulcanised rubber

at temperatures up to 70°C.

It is not recommended to use unvulcanised lining materials on the sealing faces of flanges!

12 Criteria for the Choice of Rubberlining Materials

The most important criteria for the appropriate lining material are:

- the liquid with indication of fluorine and chlorine content
- service temperature
- service pressure
- influence of ultraviolet sunrays
- defoamer
- required pureness of phosphoric acid
- references

The reasons for these criteria are:

- if the content of hydrofluoric acid is more than 5% at temperatures above 70°C it is **not** recommended to use
 - any rubber materials or glues on chloroprene basis due to the chemical attack
 - any materials on butyl basis with mineral silicate fillers as these fillers are dissolved out by the fluorine
- at service temperatures above 70°C it is recommended to use
 - lining materials whose adhesion is even at these temperatures > 2 N/mm for soft rubber and > 4 N/mm² for ebonite
 - lining materials which are diffusion/permeation tight in order to avoid the formation of bubbles, especially in the area above the liquid level
 - no prevulcanised lining materials because for the sticking of these materials a glue on chloroprene basis is needed. Its adhesion tapers extremely off at temperatures above 70°C

Remark

If lining materials with good or very good bonding are used, a bricklining which forms a protection against temperatures is not necessary.

- in the case of vacuum - e.g. in the evaporators - a lining material is recommended that shows an excellent adhesion

- if the lining is exposed to ultraviolet sunlight, e.g. in vessels without cover or ducts the lining material must be resistant to ultraviolet sunlight

- defoamers often contain oily hydrocarbons to which soft rubber lining materials are not or not sufficiently resistant

- during the production of phosphoric acid for the food industry (food grade) it is necessary that the lining material does not contain any lead-base additive which are e.g. contained in chloroprene based lining materials or adhesives/glues

- a very important criteria for the choice of lining materials are the experiences with our lining materials gained by our clients and ourselves.
The evaporators of Maroc Phosphore II - lined with VULCOFERRAN 2194, 4 mm thick - have a life time of 18 (eighteen) years

Recommendation

Let the choice of the lining material to the rubberlining company who knows its materials at the best and grants a warranty.

13 Criteria for the Choice of Lining Thickness

These criteria are:

- the content of solids of the fluid
- mechanic influences
- resistance to diffusion / permeation
- processibility
- bricklining

The reasons for these criteria are:

- depending on the solid content and the form of the crystals a bricklining might become necessary for the bottom and the lower cyl. part. Also a double layer of the areas of the baffles in flow direction might become necessary
- the damaging of the ebonite lining of the evaporator due to falling solids can be avoided by an additional soft rubber lining in the endangered areas. In this case a bricklining is not necessary
- the minimum lining thickness is 3 mm in order to ensure a good protection against permeation / diffusion
- The optimum lining thickness depends on the service conditions and on each lining material. These thicknesses differ because each rubberlining company has its own recipes.
- in order to ensure a good processibility of the lining material, the lining thickness should not exceed 5 mm. In the case of prevulcanised materials this thickness can already be too much, if e.g. internals with complicated forms must be lined.
- The rubberlining thickness protected by bricklining against abrasion / erosion should in any case not exceed 4 mm .
- The optimum lining thickness for rubberlinings with VULCOFERRAN is 4 mm in one single layer.

Recommendation

Let the choice of the lining material thickness to the rubberlining company who knows its materials at the best and grants a warranty.