

## EFFECT OF CHLORINATED WATER ON BUTYL AND EPDM LINERS

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### **Background**

Butyl and EPDM liners have been used in water storage tanks since the mid 60's, and have a proven record of long service life.

However, to ensure maximum service life, special attention must be given to the use of chlorines for sterilization of the water.

### **Chlorine - Basic Information**

Chlorine is very poisonous and will cause death even when at low concentrations.

Chlorine is a very reactive oxidising agent, which will react instantly with almost anything organic and most inorganic materials. Of the elements within the periodic system only Fluorine is more reactive. It is because of this powerful oxidising property that chlorine is such an effective sterilising agent. It is important to understand, however, that chlorine will react not only with the chemicals in water, but also with any organic material in the tank. Butyl and EPDM liners are such organic materials.

Chemically, chlorine is a halogen, and always wants to add an electron to its outer electron shell. This electron must be taken from another material, with which the chlorine reacts.

The chlorine dosed in water will always, when correctly dosed, first react with materials in the water, then with the materials in contact with the water (like a liner), and the surplus volume of chlorine will evaporate from the water into the air as a poisonous gas.

At an ideal chlorine dosing level, the chlorine is completely consumed or neutralised by sterilizing the bacteria and micro-organisms in the water. If the chlorine is not fully consumed by the water, the remaining chlorine will continue to react with the liners, reducing their life, until it is fully consumed or evaporated into the air.

### **Factors Which Influence Liner Degradation**

As stated above, chlorine is extremely reactive and will react with all materials. However, four factors significantly influence the degree of attack on the liner material:

- 1. Concentration of chlorine**
  - Linear relation
- 2. Time exposure to chlorine**
  - Linear relation
- 3. Temperature.**
  - As a rule of thumb, a 10°C increase in temperature will double the effect of chlorine.
- 4. Liner installation quality.**
  - Folds and tensions in the installed liner will reduce life time, as folds will be the point of chlorine attack.

**Liner Resistance to Chlorine**

All flexible liners will be attacked by chlorine but those produced from Fluorocarbon rubbers, Fluor silicones and PTFE will have a “fair” resistance. However, these types of products are not commercially available and are significantly more expensive than Butyl or EPDM.

Butyl and EPDM are considered “non-resistant” and Butyl is rated as better than EPDM as Butyl remains more flexible under chlorine attack and has extremely low gas permeability (chlorine is a gas)

**Methods of Dosing Chlorine**

Dosing of chlorine is generally carried out in one of the following forms:

- Hypochlorite in solution
  - The most common form of chlorine.
- Chlorine dioxide as a powder together with an acid
  - Becoming more common.
- Chlorine in gas form.
  - Very unusual method, with high risks and extreme process control.

It is very important to realise that the way dosing is carried out can have an effect on the liner and it is recommended that the following procedures should be observed:

- **Dosing should be made outside of the tank,**
  - Reduces the attack on the liner.
- **Adequate and constant measuring of chlorine content.**
  - Normally a small part of the chlorine in the water will remain active, to prevent the growth of any bacteria or micro-organisms. Both the total amount of chlorine and active chlorine should be measured and controlled to recommended levels.
- **A high turnover of chlorinated water in the tank**
  - This will increase the effect so chlorinated water turnover should be kept low.

**Mechanism of Chlorine Attack on Butyl and EPDM Liners**

The chlorine attacks on the polymer by cutting the polymer chain and making the material depolymerise. This oxidation takes place on the liner surface and the sheet surface of Butyl becomes tacky and softer.

With EPDM the surface becomes much harder and more brittle.

It is believed, that the speed of de-polymerisation will decrease with time but this is not proven but it is believed that the de-polymerised layer will act as a protective barrier on the surface of the liner.

**Liner Thickness and Degradation**

As the process has the character of a surface attack it follows that thicker membranes will give longer life.

At a constant concentration of 0.2 mg/l of chlorine, approximately 0.1mm of membrane thickness will depolymerise over 5 year period.

**Normal Chlorine Concentrations in Water**

Typical dosing levels are:

Tap water	0.1-0.4mg/l (ppm)
Swimming pools	0.5-5.0 mg/l (ppm)
Disinfection, max	500 mg/l (ppm)

### **Chlorine Concentrations for Butyl and EPDM Liners**

The recommended maximum concentration at ambient temperatures for Butyl and EPDM liners is as follows:-

- **Constant chlorine of max. 0.2 mg/l (ppm)**
  - Will not have a significant effect on the service life of the liner.
- **Chlorine concentrations constantly higher than 0.2 mg/l**
  - Will have an effect on the life time of liners.
  - The expected life time of the Butyl and EPDM liners is 20-25 years but will obviously be reduced with higher chlorine concentrations and the user must balance take this into account when calculating the expected practical life of the liner.
- **Temporary increases in concentrations**
  - up to 5.0mg/l for a maximum of 24 hours and not more than 20 times over a year can be accepted without major effects on the liner
  - Temporary increases of concentration up to 50 mg/l for a maximum of 24 hours and not more then once a year, procedure according to BS 6700, can be accepted without major effects on the liner.
  - Or a concentration up to 500 mg/l for a maximum of 1 hour, followed by an immediate clean water wash, can be accepted for disinfection.

### **Liability**

Butyl and EPDM liners are by nature not resistant to chlorine, although decades of practical experience in the use of tank liners proves that they have a prolonged life when used for the storage of chlorinated water.

As the site and operating conditions and installation of each application are beyond the control of the CSTVulcan, we are unable to assume any liability for the effect of chlorine on the liners.

In respect of de-polymerisation of Butyl and EPDM liners due to chlorine attack, there is no guarantee for the service life, express or implied, and CSTVulcan shall under no circumstances be liable for any incidental or consequential damages, direct or indirect, including but not limited to damages to equipment, building, loss of production or profit of any other losses.