

# PermaTreat® PC-191

Membrane Antiscalant



Product Bulletin

## PRODUCT BENEFITS

- Highly effective antiscalant across a broad spectrum of waters
- Minimises scaling and reduces the frequency of membrane cleaning
- Will usually replace the need for acid addition
- Low dose rate gives a highly cost-effective solution to scale control
- Compatible with all membrane types
- Effective iron and manganese sequestrant
- More stable and effective than sodium hexametaphosphate and most polymers
- Enables systems to work at enhanced rates of recovery
- Classified for use in producing potable water including ANSI/NSF Standard 60, Kiwa-ATA and DWI certification

The PermaCare logo, which consists of three horizontal lines to the left of the word "PermaCare" in a bold, italicized, sans-serif font, with a registered trademark symbol (®) to the right.

## PRINCIPAL USES

**PermaTreat PC-191** was first used in a membrane system in 1980. Since then it has become the preferred method of scale control in thousands of installations throughout the world, including some of the largest potable water plants ever built. It is recommended by most of the world's leading membrane manufacturers who consider it a highly cost-effective scale inhibitor and product of choice.

Scale inhibition processes have been studied in detail. From this work, it has been determined that 'Threshold' is the key mechanism in the prevention of scale formation in membrane systems.

**PermaTreat PC-191** reduces the risk of scaling and eliminates the use of hazardous acids, resulting in efficient plant operation with the highest possible conversion rate. It is, therefore, a more cost-effective alternative for membrane protection than pH control or ion exchange softening.

**PermaTreat PC-191** is a super-threshold agent able to stabilise a wide range of supersaturated salt solutions, thereby preventing precipitation on the membrane surface. This property allows engineers to design RO systems to successfully operate at higher recoveries than systems that do not utilise this technology. Equipment manufacturers that design systems to operate at higher recoveries have a significant advantage over their competitors because they can offer the end user benefits such as:

- Improved cost effectiveness
- Less feedwater required
- Less concentrate for disposal
- Less chemicals to be used
- Better environmental acceptance of concentrate discharge

## GENERAL DESCRIPTION

For typical chemical and physical properties, refer to the **PermaTreat PC-191** Material Safety Data Sheet.

## PERFORMANCE

### Scale Control

As water passes through the membrane, the increase in the concentration of the remaining ions causes the precipitation of inorganic salts, including those of calcium carbonate, calcium sulphate, calcium fluoride and barium sulphate. If precipitation is not controlled, membrane performance will quickly decline.

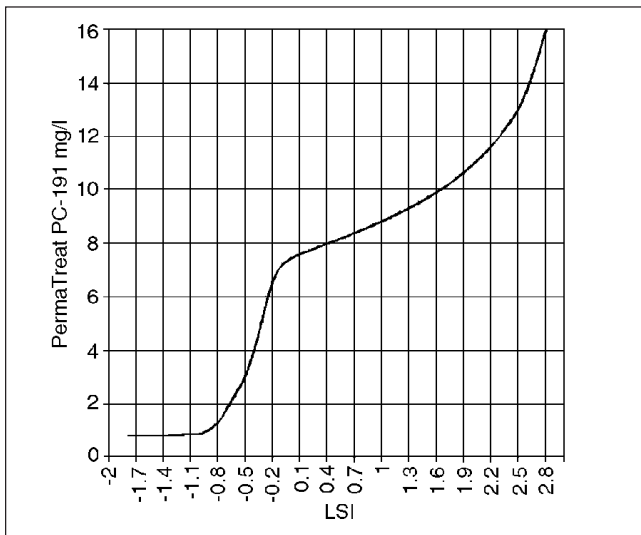


Figure 1 — PermaTreat PC-191 brine dosage vs. Langelier Saturation Index (LSI) of the brine.

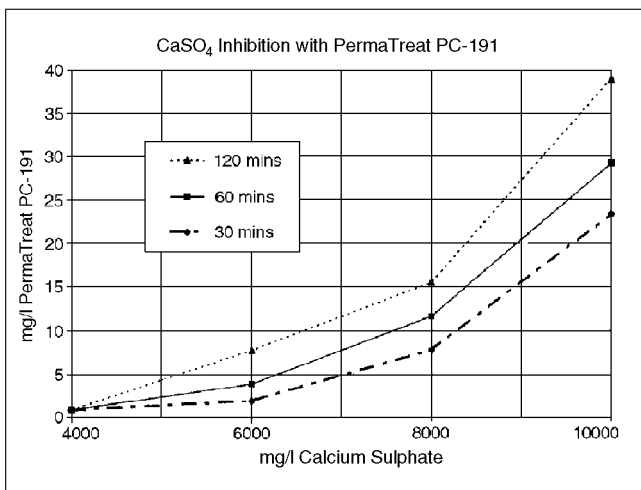


Figure 2 — PermaTreat PC-191 vs.  $\text{CaSO}_4$

PermaTreat PC-191 is an excellent inhibitor for a wide range of scaling species. Figures 1 and 2 show the dosage of PermaTreat PC-191 to control the most common scale of calcium carbonate and calcium sulphate. Table 1 shows the suggested brine saturation limits and typical feedwater dosages for controlling various scales and foulants with PermaTreat PC-191.

Table 1 — PermaTreat PC-191 Brine Saturation Limits

Foulant	Index	PermaTreat PC-191 limits	Typical dose rate in feed
calcium carbonate <sup>(a)</sup>	LSI	<2.6	1.0 to 3.5 mg/l
calcium sulphate	$\text{IP}_b : \text{K}_{\text{sp}}$	<3.0	1.5 to 2.5 mg/l
barium sulphate	$\text{IP}_b : \text{K}_{\text{sp}}$	<50	0.5 to 2.5 mg/l
strontium sulphate	$\text{IP}_b : \text{K}_{\text{sp}}$	<12	N/A
calcium fluoride	$\text{IP}_b : \text{K}_{\text{sp}}$	<120	N/A
silica	SCR <sup>(b)</sup>	<1.32	0 to 4.0 mg/l
iron	IFI <sup>(c)</sup>	<1.2	0 to 6.0 mg/l

<sup>(a)</sup> Where the Stiff and Davis Saturation Index is calculated and PermaTreat PC-191 is used, the maximum S&DSI limit has not been reached

<sup>(b)</sup> Saturation Concentration Ratio (SCR) at 25°C, pH 7.5 with 165 mg/l  $\text{SiO}_2$  in the concentrate

<sup>(c)</sup> Iron Fouling Index (IFI) developed by PermaCare International restricts the total iron level in the concentrate stream to 1.2 mg/l

### Silica Fouling

There are many recorded instances where PermaTreat PC-191 has allowed systems to operate effectively with supersaturated silica levels. Generally, PermaTreat PC-191 is used with silica levels in the concentrate less than 180 mg/l. For higher silica concentrations, PermaTreat<sup>®</sup> PC-510 is the preferred treatment programme to control scaling and fouling of reverse osmosis systems.

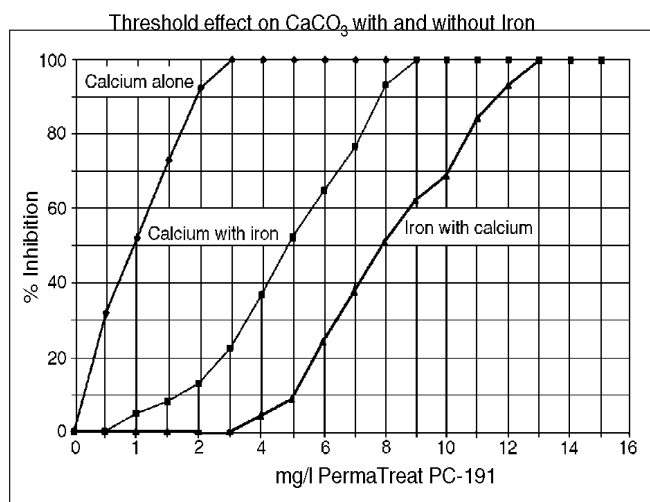
## Iron, manganese and aluminium fouling

Laboratory experiments determined the **PermaTreat PC-191** threshold performance against calcium carbonate and ferric salts under the test conditions shown in Table 2.

**Table 2** — Laboratory test conditions

pH	8.0	Duration	2 hours
calcium (mg/l as ion)	640	Agitation	200 rpm
bicarbonate (mg/l as ion)	1,952	Temperature	25°C
chloride (mg/l as NH <sub>4</sub> Cl)	5,000	LSI	+2.43

The results show the effect that 0.5 mg/l of iron has on inhibitor performance. In the blank case (without iron), complete calcium stabilisation is achieved with 4.0 mg/l of **PermaTreat PC-191**. In the presence of 0.5 mg/l of iron, **PermaTreat PC-191** must be present at 9 mg/l to fully stabilise the calcium. As complete calcium inhibition occurs at lower **PermaTreat PC-191** levels than complete iron inhibition, higher inhibitor levels are necessary to prevent the precipitation of both species. In this case, 13 mg/l of **PermaTreat PC-191** is needed to prevent both calcium and iron precipitation. See Figure 3.



**Figure 3** — *PermaTreat PC-191* effect on CaCO<sub>3</sub> with and without 0.5 mg/l of Fe<sup>3+</sup>

With 1.0 mg/l of iron, only 10 mg/l of **PermaTreat PC-191** is needed to inhibit calcium precipitation, but 26 mg/l is needed to inhibit both calcium and iron. With iron at 1.5 mg/l, 40 mg/l of **PermaTreat PC-191** is needed to fully inhibit both calcium and iron.

Manganese salts have a higher solubility than the comparable ferric salts, although their precipitation properties are similar. Laboratory experimentation has confirmed the ability of **PermaTreat PC-191** to adequately prevent both manganese and iron fouling. In practice, iron fouling is far more of a problem than manganese fouling.

As aluminium is invariably present in the colloidal form, **PermaTreat PC-191** performance is not adversely affected by its presence.

## Advantages of PermaTreat PC-191 over acid dosing

**Handling** — **PermaTreat PC-191** is safer to handle than sulphuric or hydrochloric acids.

**Technical** — Sulphuric acid is only effective against carbonate scale and increases the calcium sulphate scaling potential, whereas **PermaTreat PC-191** is an effective calcium carbonate and sulphate inhibitor. When using **PermaTreat PC-191**, the permeate produced has a higher pH and is of better quality due to enhanced bicarbonate rejection.

**Cost advantage** — The dose rate of **PermaTreat PC-191** is much lower than the acid dose rate and offers a lower total cost solution to carbonate scale control.

**Corrosivity** — At natural pH, the operating environment is less corrosive.

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## Advantages of PermaTreat PC-191 over sodium hexametaphosphate (SHMP) dosing

**Handling** — SHMP has a short shelf life and solutions must be made up daily.

**Technical** — **PermaTreat PC-191** is a far more effective antiscalant than SHMP, maintaining salts in solution at high LSI and  $IP_b/K_{sp}$  values, which means systems can operate at higher recovery rates with **PermaTreat PC-191**.

**Cost Advantage** — The dose rate of **PermaTreat PC-191** is significantly lower than that of SHMP. Use of **PermaTreat PC-191** offers a lower total cost solution to control scale and iron deposition.

**Cleaning** — **PermaTreat PC-191** is far more stable than SHMP, which frequently contributes to calcium- and iron-based phosphate deposition. For this reason, the interval between cleaning when using **PermaTreat PC-191** is significantly longer.

## DOSAGE AND FEEDING

**PermaTreat PC-191** has been used for more than 20 years as an antiscalant and antifoulant in RO and NF membrane systems fed by a selection of brackish, high salinity, process and effluent feedwaters.

**PermaTreat PC-191** is dosed continuously into the feedwater prior to the membrane systems at typical dose rates of 2-4 mg/L depending on water chemistry and system operating conditions. Dose rates are easily calculated using the RO12 computer programme.

## SAFETY AND HANDLING INFORMATION

A **PermaTreat PC-191** Material Safety Data Sheet is available upon request.

**Potential Hazards:** **PermaTreat PC-191** is not considered hazardous but as with all industrial chemicals, care should be taken in its handling and use.

## TOXICOLOGICAL AND ENVIRONMENTAL ASPECTS

The large portfolio of data on **PermaTreat PC-191** includes aquatic, avian and mammalian toxicity. Bioaccumulation, Biodegradation, Abiotic Degradation, Activated Sludge Adsorption and River die-away tests with  $^{14}C$  labelled material are part of the many studies undertaken. The results show the acceptability of **PermaTreat PC-191** for potable applications and its environmental acceptance in concentrate streams.

## TEST METHODS

There are several **PermaTreat PC-191** test methods available. They mainly rely on phosphonate hydrolysis and the measurement of the resultant orthophosphate.

## REMARKS

For assistance and information, such as product availability and packaging, contact your nearest Nalco representative or office:

Naperville, Illinois: 630-305-1000  
Leiden, The Netherlands: 31-71-524-1100  
São Paulo, Brazil: 55-11-5644-6500  
Singapore: 65-6861-4011

For more news about Nalco and PermaCare® programmes, visit our website at [www.nalco.com](http://www.nalco.com).

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SUBSIDIARIES AND AFFILIATES IN PRINCIPAL LOCATIONS AROUND THE WORLD

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