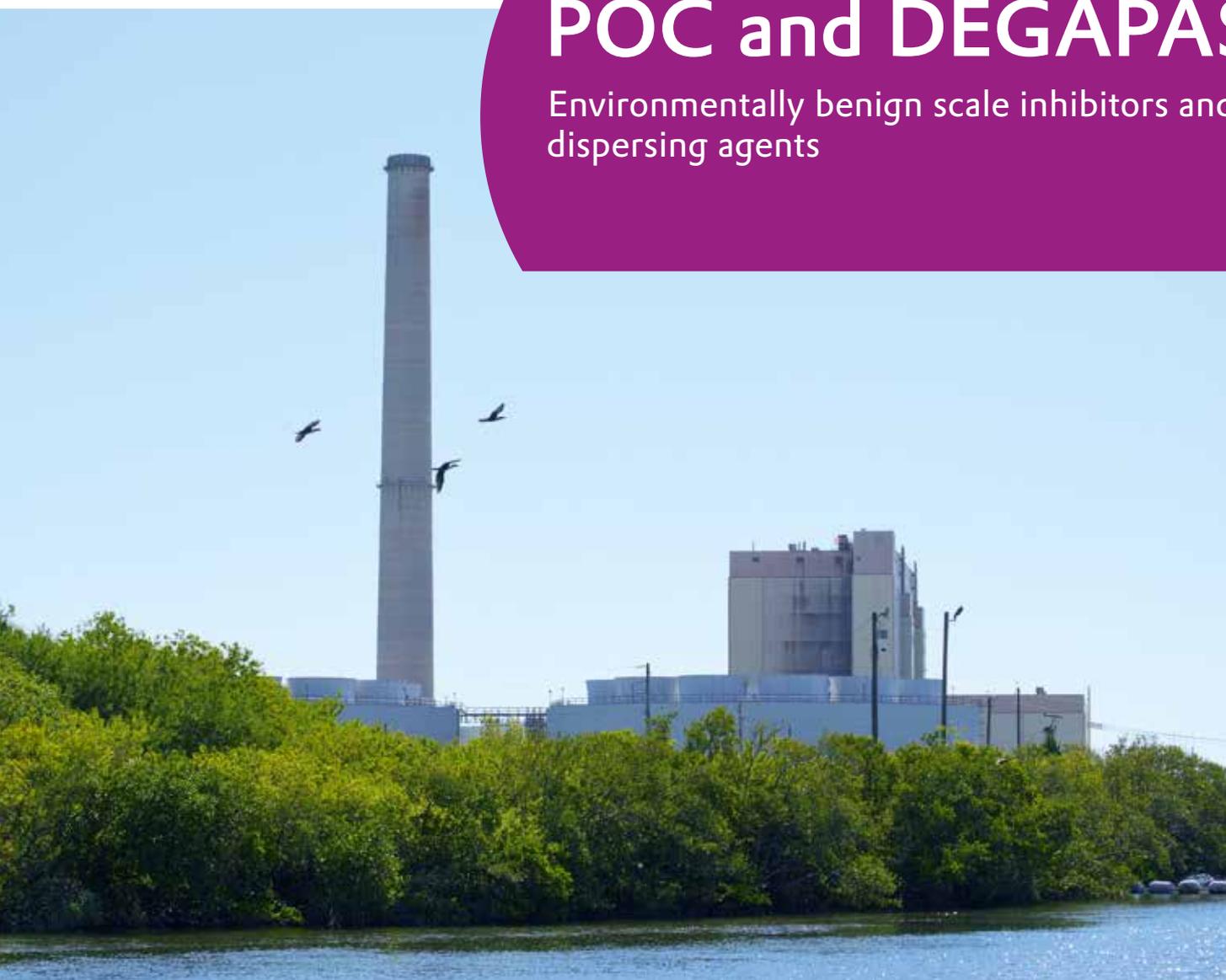


POC and DEGAPAS[®]

Environmentally benign scale inhibitors and dispersing agents





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Introduction

Polyoxycarboxylates (POC) and DEGAPAS® are aqueous polymersolutions with excellent dispersing properties. Both product groups are free of nitrogen and phosphorous. Due to their anionic nature and polymer structure they are capable of interrupting inorganic crystal growth and thus are perfect antiscalants/ dispersants. They are optimized to prevent formations of scalants based on calcium-, magnesium-, iron- and/or manganese salts. Scale formation and deposits can be detrimental to water bearing systems, heat exchanger or boiler systems resulting of poor heat transmission and subsequently bad economics. Very small amounts of POC or DEGAPAS® can prevent scaling and improve the economics significantly. POC and DEGAPAS® are ideally suited to substitute phosphorus containing products when required by legal regulations.

Both product series have been used by customers over decades with complete satisfaction.

This brochure is designed to offer information on the properties and various applications of the POC and DEGAPAS® range and to foster the development of new uses for these products.



Scale inhibitor in water loops

Scalings in boilers and deposits of sludge on surfaces of heat exchangers, in tubes, on walls etc. reduce the effectivity of plants. The results are:

- increase of heating costs
- reduction of flow rate
- overstress of pumps
- pressure losses in pipes
- increased corrosion
- plugging

In general POC products are already very effective inhibitors in concentrations far below stoichiometric demand for crystallisation of calcium carbonate, calcium sulphate and other salts of the earth alkali elements. Brown deposits of iron-salts, occurring in many fresh waters, can be prevented as well. CaCO_3 resp. CaSO_4 remain soluble in presence of few mg/l POC and form a oversaturated, transparent solution, even when above the thermodynamic "solubility product".

The mode of action is explained in that way, that the growth centres of tiny CaCO_3 or CaSO_4 particles are blocked by adsorption of POC. Subsequently further growth is suppressed and agglomeration to larger structures is not possible anymore.

The inhibition of crystallisation starts at a concentration of a few mg POC per liter and depends on the kind and type of the substances present in the water. The sudden loss of effectivity by going under this

"level" of concentration led to the definition of the "threshold effect". In most cases the POC products are more efficient concerning antiscalant properties than the DEGAPAS® products. One exception are Magnesium salts were DEGAPAS® 3104 S and DEGAPAS® 4104 S are slightly more efficient.

POC AS 2020 is especially very efficient for steam power stations as scale inhibitor.

In cooling towers POC HS 2020 and POC HS 5060 are the most recommended products in case of antiscaling and dispersing properties.



Dispersing agents

POC and DEGAPAS® are recognized as chemically stable dispersing agents—i.e. they do not undergo hydrolysis. They liquefy high-solids aqueous pigment dispersions at concentrations as low as 0.1 to 0.3%. Kaolin slurries and Titan dioxide suspensions between 50 and 60 weight percent with a significant viscosity reduction are examples for a good efficiency of POC and DEGAPAS®.

Main user is the paint and coating industry.



Additive in washing and cleaning processes

POC and DEGAPAS® fulfil the requirements of modern detergents or cleaners for effective and environmentally benign builders:

- Good lime binding capacity
- Dispersing action, in particular with fatty soil, for increasing the dirt carrying capacity of the liquor
→ less greying of textiles
- Synergistic activation of the active detergent substances beyond the straightforward electrolyte effect
- Stability in the presence of oxidizing agents like active oxygen compounds
- Good water solubility
- Ability to mix with liquid tensides and electrolytes
- The neutralized products, POC AS and DEGAPAS® N Products, are suitable for spray drying and spray mist blending processes
- phosphorous free

Furthermore DEGAPAS® 4104 N can be used in chlorine containing cleaner formulations and does not destroy the chlorine.

Scale inhibitor in other industrial segments

In the production of potable water by evaporation of sea water (**Sea Water Desalination Plants**) in multistage flash evaporation units (MSF) formation of scalings can be a problem. Salts being present in sea water will be concentrated, precipitate and form deposits, which will disturb the process. Depending on the water quality and working temperature these deposits contain CaCO_3 , CaSO_4 , $\text{Mg}(\text{OH})_2$ and other salts, which are only removable by treatment with mineral acids. POC HS 2020 (50%) has been approved for the production of potable water in MSF-plants from the United States Environmental Protection Agency and from the Department of the Environment,

Great Britain up to a concentration of 10 mg/l POC HS 2020. KIWA, Netherlands approves that POC HS 2020 can be used as scale inhibitor in desalination plants producing drinking water.

Membrane reverse osmosis processes nowadays are state of the art processes in water treatment and widely used in drinking water production. Many membrane processes require pre-cleaning steps. To keep a constant effectiveness of the membranes building of scalants has to be avoided by using POC.



Antiscalants can also be used in all industrial segments when scaling can occur. The oil and gas field industry as well as the waste water treatment industry are further examples POC and DEGAPAS® can be used.

Production process

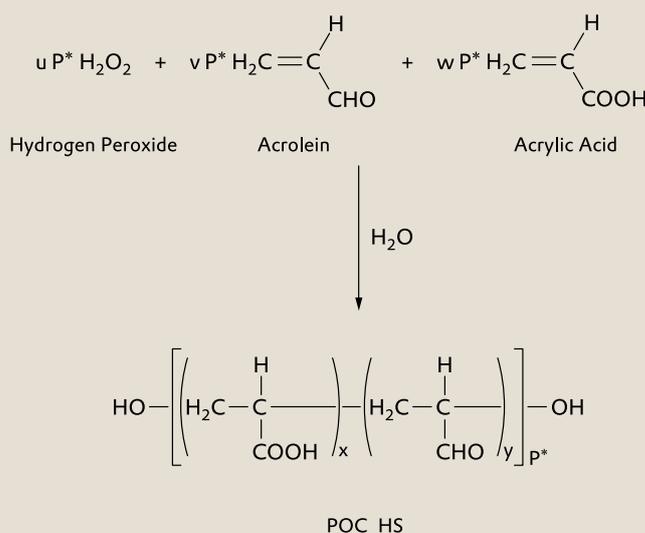
1. POC

The group of polycarboxylic acid products is classified under the abbreviated heading "POC" and identified by the suffixes "HS" for the free acid grades and "AS" for the sodium salt grades. Each of these groups consists of a number of qualities with different chain lengths.

POC is manufactured by a process specially developed by Evonik Industries AG, the "oxidative polymerisation" of acrolein. Acrolein, either alone or mixed with

acrylic acid, is treated in aqueous solution with hydrogen peroxide. The H_2O_2 acts as a polymerizing initiator and a molecular weight regulator. At the same time, the hydrogen peroxide oxidizes some of the aldehyde groups in the acrolein to carboxyl groups. The resulting polymers which possess side aldehyde and carboxyl groups are the poly (aldehyde-carboxylic acids), which we refer to as POC HS.

Oxidative copolymerisation of acrolein with acrylic acid to produce POC HS



$$v + w = x + y = 1; x \gg w; y \ll v$$

P^* = average degree of polymerisation

2. DEGAPAS®

The group of water soluble polyacrylic acid products is classified under the abbreviated heading "DEGAPAS®" and identified by the suffixes "S" for the free acid grades and "N" for the sodium salt grades. Each of these groups consists of a number of qualities with different chain lengths.

DEGAPAS® is manufactured by a process specially developed by Evonik Industries AG using acrylic acid as single monomer. The polymerisation is carried out in water resulting aqueous solutions of polyacrylic acids. For N-grades the carboxyl groups of these polymers are neutralized with sodium hydroxide.

Products and physico-chemical properties

POC	content [%]	pH-value	density [g/ml]	molecular-weight [g/ml]
HS 2020	50	< 2	1.2	9,400
HS 5060	40	< 2	1.1	31,000
AS 0010	50	6 - 8	1.3	4,500
AS 2020	50	6 - 8	1.3	9,100
AS 5060	40	6 - 8	1.2	26,000

DEGAPAS®	active matter [%]	pH-value	density [g/ml]	molecular-weight [g/ml]
3104 S	40	< 2	1.1	41,000
4104 S	40	< 2	1.1	70,000
3104 N	40	6 - 8	1.3	40,000
4104 N	40	6 - 8	1.2	65,000

POC AS 5060 is also available as a powder: POC AS 5060 Powder

Packaging and storage

Common forms of Packaging for POC and DEGAPAS® are:

Plastic canisters: 60 kg content

Plastic drums: 220 kg content

IBC (Intermediate Bulk Container):

- 1100 kg, POC HS- and DEGAPAS® S-products
- 1200 kg, POC AS- and DEGAPAS® N-products

POC HS- and DEGAPAS® S- products can cause irritation to the skin and mucous membranes, so that all contact with the skin or eyes must be avoided. If contact does occur, rinse with copious amounts of water. POC AS and DEGAPAS® N, on the other hand, call for no special safety precautions.

Due to the acidic pH value POC HS- and DEGAPAS® S- products belongs to dangerous products.

All products should be stored at normal room temperatures.

For storage tanks, metering equipment etc., stainless steel, polyethylene, polypropylene, PVC or glassfiber-reinforced plastics may be used.

If the correct storage conditions are maintained, the shelf life of POC is guaranteed for 24 month after production. After several months, POC and DEGAPAS® solutions may acquire a more pronounced color, but this does not reduce the product's effectiveness.

It should be noted that during cold weather POC solutions should be homogenized by stirring before usage.

All liquid POC-qualities are stable in concentrated or diluted solutions at least to temperatures up to 300°C and do not undergo hydrolysis. The powder of POC AS 5060 is stable up to appr. 250°C and soluble in water or ethylenglycol.



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Reference to trade names used by other companies is neither a recommendation, nor does it imply that similar products could not be used.



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