Your partnership for perfect anti-corrosion and protection

Application technologies and system
SAEKAPHEN guarantees high profitability in refineries, in petrochemical and chemical process plants year after year billions are lost in highly industrialised countries due to corrosion and fouling.

More than 500.000 heat exchangers, condensers and air coolers have been coated on the tube- and on the shell-side.
One issue of the trade journal HYDROCARBON PROCESSING concerning the problems caused by fouling in refineries, reported that, in 1995 alone, worldwide costs on the order of $4.5 billion were incurred in crude preheat trains.
SAEKAPHEN’s research and development in materials intends to assist in overcoming these problems.

Where corrosion protection is concerned, SAEKAPHEN sets new standards.

For more than 50 years coating materials and application technologies have been developed, which provide a reliable corrosion protection and prevent fouling and have consequently become world famous under the name SAEKAPHEN.
SAEKAPHEN know-how

if perfect corrosion protection is required

from practical experience
This is SAEKAPHEN

The SAEKAPHEN coating is produced from complex mixtures of liquid thermosetting coatings and is applied to the equipments using flooding and spraying technologies.

It offers two coating technologies:

• Heat Cured Coating
• Cold Cured Coating
# SAEKAPHEN product mix

**Heat cured material**

<table>
<thead>
<tr>
<th>SAEKAPHEN</th>
<th>Material type</th>
<th>colour</th>
<th>surface</th>
<th>dry film thickness µ</th>
<th>density g/m³</th>
<th>solid volume ltr./100 kg</th>
<th>hardness (König) Imp./sec.</th>
<th>resistance</th>
<th>field of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAEKAPHEN</td>
<td>Si 14 E</td>
<td>dark-green</td>
<td>hydrophob, smooth</td>
<td>200</td>
<td>1,39</td>
<td>27,41</td>
<td>190</td>
<td>high acid to slightly alkaline, salt solutions, cooling water, gases, organic liquids</td>
<td>heat exchangers, air coolers, condensers, evaporators, tanks</td>
</tr>
<tr>
<td>SAEKAPHEN</td>
<td>Si 14 EG</td>
<td>red-brown</td>
<td>hydrophob, smooth</td>
<td>250</td>
<td>1,30</td>
<td>29,32</td>
<td>134</td>
<td>water vapour diffusion, slightly acid a. alkaline liquids and vapour</td>
<td>heat exchangers, condensers, condensate containers, thermal degasers</td>
</tr>
<tr>
<td>SAEKAPHEN</td>
<td>Si 17 E</td>
<td>red-brown</td>
<td>hydrophob, smooth</td>
<td>200</td>
<td>1,44</td>
<td>30,13</td>
<td>143</td>
<td>liquid or gaseous KW, salt solutions, oils, acid to slightly alkaline mediums to PH8</td>
<td>inside coating of tanks for storage of flammable liquids, class of isk Al/All and B, alphatic hydrocarbon</td>
</tr>
<tr>
<td>SAEKAPHEN</td>
<td>Si 57 E</td>
<td>red-brown</td>
<td>hydrophob, smooth</td>
<td>200</td>
<td>1,16</td>
<td>30,10</td>
<td>200</td>
<td>high alkaline to acid, all cooling waters incl. brackish- a. sea-water</td>
<td>heat exchangers, condensers, evaporators, vessels, Water treatment plants</td>
</tr>
<tr>
<td>SAEKAPHEN</td>
<td>Si 57 E-HC</td>
<td>black</td>
<td>Satin-finished</td>
<td>200</td>
<td>1,20</td>
<td>30,10</td>
<td>200</td>
<td>high alkaline to acid, all cooling waters incl. brackish- a. sea-water</td>
<td>heat exchangers, condensers, evaporators where a higher heat conductivity is required</td>
</tr>
<tr>
<td>SAEKAPHEN</td>
<td>Si 57 EG</td>
<td>grey-olive</td>
<td>matte</td>
<td>250</td>
<td>1,24</td>
<td>29,52</td>
<td>120</td>
<td>water vapour diffusion in, alkaline to low acid liquids</td>
<td>condensers, condensate, containers, degasers a. boilers</td>
</tr>
</tbody>
</table>
Chemical Resistance of SAEKAPHEN Coatings vs. conventional Coatings

The chemical resistance was tested in a laboratory test by dipping the coated panel in a SAEKAPHEN-specific unique solvent mixture containing i.e. chloro-acetic acid and methylen chloride.
Two heat exchangers with welded tubes

without SAEKAPHEN           with SAEKAPHEN

Practical example 2 parallel operating heat exchangers, operating time 2 years without cleaning.
## Basic Resistance Chart

### Oxides

<table>
<thead>
<tr>
<th>Oxide</th>
<th>SAEKAPHEN Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrogen peroxide</td>
<td>oxidizing Si 14E</td>
</tr>
<tr>
<td>carbon monoxide</td>
<td>Si 14E/EG</td>
</tr>
<tr>
<td>carbon dioxide, carbonic acid</td>
<td>Si 14E/EG</td>
</tr>
<tr>
<td>sulphur dioxide, sulphurous oxide</td>
<td>Si 14E</td>
</tr>
<tr>
<td>sulphur trioxide</td>
<td>Si 14E</td>
</tr>
<tr>
<td>silicon dioxide</td>
<td>Si 14E</td>
</tr>
<tr>
<td>Superoxide</td>
<td>Si 14E</td>
</tr>
</tbody>
</table>

### Acids

<table>
<thead>
<tr>
<th>Acid</th>
<th>SAEKAPHEN Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrochloric acid, chloric acid gas</td>
<td>Si 14E</td>
</tr>
<tr>
<td>nitric acid</td>
<td>oxidizing Si 14E</td>
</tr>
<tr>
<td>hydrogen sulphide, hyrosulphide</td>
<td>Si 14E</td>
</tr>
<tr>
<td>sulphuric acid</td>
<td>Si 14E</td>
</tr>
<tr>
<td>ethanoic acid, acetic acid</td>
<td>Si 14E</td>
</tr>
</tbody>
</table>
### Alkaline Solutions
- calcium hydrate, hydroxide
- kalihydrat, caustic potash solution
- sodium hydroxide, caustic soda hydrated
- ammonia

### Sulphates
- calcium sulphate, calc.sul. Hemihydrated
- copper sulphate
- sodium sulphate, Glauber’s salt

### Carbonates
- calcium carbonate, calcareous
- potassium carbonate
- sodium carbonate
**Nitrates**
- potassium nitrate
- sodium nitrate, Chile salpeter

**Chlorides**
- sodium chloride, common salt
- ammonium chloride, salmiac

**Solvents**
- acetone
- ethyl acetate, acetic ether
- formaldehyde, formalin
- octane
- ethyl alcohol, benzine, alcohol

**Cooling Water**
- seawater, brackish water, river water
# SAEKAPHEN product mix

## cold cured material

<table>
<thead>
<tr>
<th>Material type</th>
<th>colour</th>
<th>surface</th>
<th>dry film thickness µ</th>
<th>density g/m³</th>
<th>solid volume ltr./100 kg</th>
<th>hardness (acc. König* Shore°**)</th>
<th>resistance</th>
<th>field of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAEKAPHEN HR 60 extra G</td>
<td>green, red, grey</td>
<td>smooth, glossy</td>
<td>400-500</td>
<td>1,50</td>
<td>60,3</td>
<td>120*</td>
<td>high alkaline to acid mediums, brackish, sea a. deionized water as well as inorganic salt solutions</td>
<td>tanks, silos, filters, vessels</td>
</tr>
<tr>
<td>SAEKAPHEN HR 60 extra TG</td>
<td>red, grey red-brown</td>
<td>matte</td>
<td>300-350</td>
<td>1,40</td>
<td>33,1</td>
<td>100*</td>
<td>slightly acid to alkaline aqueous mediums water to 100°C a. water vapour diffusion</td>
<td>desalization plants, condensation tanks, process water tanks, metal pipelines</td>
</tr>
<tr>
<td>SAEKAPHEN K 80 LS</td>
<td>red-brown</td>
<td>satin-finished</td>
<td>400- max. 800</td>
<td>1,40</td>
<td>66,4</td>
<td></td>
<td>acids to high alkaline aqueous, mediums water to 100°C a. water vapour diffusion</td>
<td>water tanks in power stations, turbine condensers, heat exchangers, coolers evaporating a. cooling water pipelines</td>
</tr>
<tr>
<td>SAEKALINE</td>
<td>red-brown, white</td>
<td>smooth, glossy</td>
<td>mind. 700</td>
<td>1,55</td>
<td>64</td>
<td></td>
<td>water to 100°C a. temperature drop to the surface, temperature difference up to 80°C</td>
<td>boilers a. other water heaters for drinking nondrinking water, KTW recommendation a. all ranges of cold a. heat water</td>
</tr>
<tr>
<td>SAEKA-Flake 900</td>
<td>beige</td>
<td>smooth</td>
<td>1000</td>
<td>1,28</td>
<td>87**</td>
<td></td>
<td>aggressive media of chemical industry, high acid ranges a high temperatures</td>
<td>flue gas desulfurizing plants, tanks, pipelines, tanks, vessels, pipes</td>
</tr>
<tr>
<td>SAEKA-Flake 900 Black</td>
<td>black-grey</td>
<td>smooth</td>
<td>1000</td>
<td>1,32</td>
<td>87**</td>
<td></td>
<td>slightly alkaline to high acid mediums, sea-water, inorganic salt solutions, flue gas, electrostatic derivation ability</td>
<td>storage tanks, containers, flue gas channels,desulfurizing plants,process tanks, washing towers, gas purifying plants</td>
</tr>
<tr>
<td>SAEKATAR D extra</td>
<td>black, red-brown</td>
<td>matte</td>
<td>mind. 500</td>
<td>1,5</td>
<td>79,5</td>
<td>74*</td>
<td>good chemical resistance, high temperature toad, higher water vapour diffusion</td>
<td>power stations, nuclear power stations, cooling water pipelines, tanks</td>
</tr>
</tbody>
</table>
SAEKAPHEN-coated equipment has been widely used for many years by industries such as refineries, fertilizer, petrochemical and chemical plants, particularly refrigeration, crude oil distillation and water treatment.
This is what SAEKAPHEN can do

prevents corrosion

prevents fouling, allowing a considerably lower fouling factor when designing new heat exchangers

is resistant to water vapour and to extreme temperature fluctuations

has a long life at temperatures ranging from -20°C to +220°C

is non-conductive
SAEKAPHEN
the perfect alternative for protection against corrosion
Coating Technology
Heat Exchanger to be SAEKAPHEN Treated Require Specific Constructional and Surface Conditions

In accordance with

DIN EN 14879-1

Some typical constructions of heat exchanger.
U-Tube bundle
Floating-Heat Exchanger
Tubular-Heat Exchanger
Air cooler
Constructional conditions for SAEKAPHEN coating on the tube side of tube bundles in accordance with DIN EN 14879-1

different alternatives of the tubes ends welded / expanded on the tube sheets from optimized best solution (1) to poorest solution (5)
Best solution: Welded tubes with rounded tube edges on the tube sheets in accordance with DIN EN 14879-1 (main part of coated heat exchanger in Europe)
Alternative solution: Just put tube ends, seal expanded tubes, rounded tube edges and seal welding for protection from capillary faults in accordance with DIN EN 14879-1
Insignificant solution: Jut out tube ends rounded tube edges seal expanded without seal welding. Capillary faults between tube sheets and the shell side of the tube within the boring without recommendation
Poor solution
Seal expanded tubes, jut out tube ends not rounded, without seal welding. Faulty quality of coating
Worst solution has to be treated ahead

Seal expanded tubes, long jut out tube ends not rounded tube, edges (sharp edges), and no seal welding. Faulty quality of coating.
Surface preparation by sand blasting

Before starting the surface preparation by sandblasting the construction has to be inspected in accordance with the DIN guidelines, especially the DIN EN 14879-1.

The internal surface of the tubes shall be sandblasted tube by tube either by hand or with an automatic sandblasting machine. The grade shall be Sa 3 with a roughness of 40 - 60 micrometer guaranteeing high adhesion of the SAEKAPHEN coating.
sand blasting, manual and mechanical
Coating flooding technology
The Know how of SAEKAPHEN
• SAEKAPHEN - MOVIE
Baking process

The units to be protected have to be baked after each layer of the heat cured coating.

Prebaking temperature: 120 - 150 °C, final baking: 200 - 220 °C.
testing equipment
Film-Thikness Measurement
testing equipment
Pinhole or Sparkling Test
Dependence of heat transfer on operating time

Operating period in days
Water-cooled condensers, parallel operation
Entry temperature of condensate: 98 – 103 °C
Cooling water speed: 0.3 m/sec.

K value
W / (m² x K)

with SÄKAPHEN coating
without SÄKAPHEN coating
A practical example

The heat transfer of a new uncoated heat exchanger amounted to 800 W/mK. After an operating of approx. 2 months, the heat transfer was reduced to 600 W/mK as a result of increasing fouling and incrustation.

After approx. 19 months of operation and interim high-pressure cleaning, the heat transfer was reduced to approx. 350 W/mK.

The heat exchanger was then decommissioned.
SAEKAPHEN - the Alternative

A heat exchanger coated with SAEKAPHEN, operated at the same location and under the same conditions, has been operating for approx. 3 years without any cleaning and with a constant heat transfer of approx. 625 W/mK.

This heat transfer corresponds to the heat transfer of an uncoated tube after approx. 2 months of operation.
SAEKAPHEN
- the optimum solution against corrosion

**Application**

Capital costs are reduced due to the usage of simple carbon steel

Operational costs are reduced as fouling/scaling on the tube surfaces of the heat exchanger are prevented.

It will prolong the life of the units coated to average durability of 10 to 15 years.

**Economic Benefits**
Total Cost for Heat Exchanger
(Example: 25x1.5x6000mm 150 tubes)

Investment and Maintenance Costs Heat Exchanger over 8 Years

<table>
<thead>
<tr>
<th>Material</th>
<th>Costs €</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Steel</td>
<td>0</td>
</tr>
<tr>
<td>Carbon Steel + SAEKAPHEN</td>
<td>5000</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>3000</td>
</tr>
<tr>
<td>Cu-Ni</td>
<td>15000</td>
</tr>
<tr>
<td>Titanium</td>
<td>20000</td>
</tr>
</tbody>
</table>

- **Maintenance Costs 5th to 8th year**
- **Maintenance Costs 1st to 4th year**
- **SAEKAPHEN-Coating**
- **Investment Costs Heat Exchanger**
# SAEKAPHEN Coating Pricing Range

<table>
<thead>
<tr>
<th>Total Surface Area</th>
<th>Price Range per sqm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 10 sqm</td>
<td>€ 500 to € 218</td>
</tr>
<tr>
<td>10 sqm to 30 sqm</td>
<td>€ 218 to € 131</td>
</tr>
<tr>
<td>Above 30 sqm</td>
<td>€ 131 to € 60</td>
</tr>
<tr>
<td>Tag No.</td>
<td>E 2352</td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>Location</td>
<td>OXO C4</td>
</tr>
<tr>
<td><strong>Construction Of One Shell</strong></td>
<td></td>
</tr>
<tr>
<td>Ref.</td>
<td>Shell</td>
</tr>
<tr>
<td>1</td>
<td>Design Pressure, internal</td>
</tr>
<tr>
<td>2</td>
<td>Design pressure, external</td>
</tr>
<tr>
<td>3</td>
<td>Max. Design Temperature</td>
</tr>
<tr>
<td>4</td>
<td>Min. Design Temperature</td>
</tr>
<tr>
<td>5</td>
<td>Test Pressure (Hydrostatic)</td>
</tr>
<tr>
<td>6</td>
<td>Stress factor, design</td>
</tr>
<tr>
<td>7</td>
<td>Stress factor, test</td>
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<tr>
<td>8</td>
<td>No. Plates per shell</td>
</tr>
<tr>
<td>9</td>
<td>Compression allowance</td>
</tr>
<tr>
<td>10</td>
<td>Corrosion allowance in fluid</td>
</tr>
<tr>
<td>11</td>
<td>Joint efficiency</td>
</tr>
<tr>
<td>12</td>
<td>Radiographic examination</td>
</tr>
<tr>
<td>13</td>
<td>Other Loads</td>
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<tr>
<td>14</td>
<td>Pressure design to</td>
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<tr>
<td>15</td>
<td>Material to</td>
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<tr>
<td>16</td>
<td>Heat treatment</td>
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<tr>
<td>17</td>
<td>Non-destructive testing</td>
</tr>
<tr>
<td>18</td>
<td>Shot-blasting / Painting</td>
</tr>
<tr>
<td>19</td>
<td>Surface Treatment</td>
</tr>
<tr>
<td>20</td>
<td>Cladding/Lining</td>
</tr>
<tr>
<td>21</td>
<td>Construction tolerances</td>
</tr>
<tr>
<td>22</td>
<td>Type of welded joints</td>
</tr>
<tr>
<td>23</td>
<td>Rating of welded joints</td>
</tr>
<tr>
<td>24</td>
<td>Support type</td>
</tr>
<tr>
<td>25</td>
<td>Shell diameter</td>
</tr>
<tr>
<td>26</td>
<td>Shell nominal diameter</td>
</tr>
<tr>
<td>27</td>
<td>Shell wall thickness</td>
</tr>
<tr>
<td>28</td>
<td>Type of shell cover</td>
</tr>
<tr>
<td>29</td>
<td></td>
</tr>
</tbody>
</table>

**BASF Petronas Chemicals specify SAEKAPHEN**
BASF Germany
specify SAEKAPHEN
circulation water condenser, ordered by Fertilizer Plant, Kuwait
some tube bundles (shell- and tube-side coated)
turbine condenser (tube-side coated), ordered by BP Deutschland, Germany
condenser for power plant (ordered by Siemens AG; before coated)
condenser after tube-side coating
condenser ready for shipment
air cooler (tube-side coated), ordered by Caltex, Germany
shell-side coated tubes (tube by tube)
assembling of shell-side coated tubes and tube sheets
shell-side coating of U-tube bundle
The SAEKAPHEN heat cured coating technology

The special know how with long experience - of SAEKAPHEN does not only apply to the coating of heat exchanger, tube bundle, condenser and air cooler but also to tanks, vessels and road- or railway containers.

Size of Heat exchanger to be coated with SAEKAPHEN heat-cured material up to:
4,0 m in diameter, 16,0 m in length

Heatcured coating of longer units requires a special movable polymerisation oven, available only at the workshop of the belgian licencee.
another road container coated
heat cured coating Si 14E of railway container
heat cured coating Si 14E of a storage tank
storage tank internal coated with SI14E
high pressure coated with SI14E
internal heat cured coating Si 14E of a channel
internal heat cured coating Si 14E of drinking water tanks
SAEKAPHEN - leading manufacturer of special coating
Material and applicator of special coating technologies

Heat cured coatings

Cold cured coatings
SAEKAPHEN - leading manufacturer of special coating materials and applicator of special coating technologies

*Customer profile*
National/international engineering companies
End customers: refineries, fertilizer plants, chemical and petrochemical industry, power plants, pharmaceutical industry, sugar industry, breweries, wine producers, and the food and beverage industry.
Equipment manufacturers: producers of heat exchangers, chemical equipment, tanks and silos, pipelines, vessels, road and rail-road containers

*Range of coatings:*
Heat cured coating of heat exchanger with expanded or welded tubes, U-tube bundles, condensers, tube sheets, air coolers, preheaters, storage tanks, vessels, road and railroad containers, hot-water boilers, turbine motors and pipelines.
Cold cured coatings of storage tanks, transportation vessels, containers, silos, boilers, filters, pipelines, chimney components used for flue gas desulphurisation
SAEKAPHEN - Offering competence and experience in anti-corrosion protection. Optimum product quality and service. Setting the standard for process and operational reliability.
coating Workshop in Damman, K.S.A
of our Licensee Al-Qhatani
coating Workshop in TELUK KALONG, Malaysia
of our Licensee UMW SAEKAPHEN COATING SDN BHD
coating Workshop in Gwangyang-City, Korea of our Licensee Saekaphen Korea Co., Ltd.
SAEKAPHEN LICENSEES
World-wide licensees

- SOUTH-KOREA, Gwangyang
- DENMARK, Hvidovre
- SPAIN, Cantabria
- FRANCE, St. André
- U.K, West Yorkshire
- ITALY, Milano
- USA, Wisconsin
- USA, Texas
- AUSTRIA, Kleinneusiedl
- BELGIUM, Trazegnis
- KINGDOM OF SAUDI ARABIA, Dammam
- POLAND, Gliwice
- PORTUGAL, Lisboa
- MALAYSIA, Kuala Lumpur
New Licensee for Oman

- AITS
- Arabian Industries Technical Support L.L.C.
- P. O. Box 51,
- P. C. 124, Al-Rusayl
- Muscat/ Sultanate of Oman
- Mr. Anindya Chatterjee, Business Unit Head
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Thank you