heat cured coating

cold cured coating

Sandblasting
Priming
Coating
Testing
Inspection
Repairing
Maintenance
Service

Your partnership for perfect

Application technologies and system

anti-corrosion protection

SAEKAPHEN guarantees

in petrochemical and chemical process plants

high profitability

Year after year billions are lost in highly industrialised countries due to corrosion. Increasing operating and repair costs affect the profitability of production plants. Repairs and maintenance are facts which increasingly burden industry.

More than 300.000 heat exchangers, condensers and air coolers have been coated on the tube-side and the shell-side

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

Definition

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

It offers two coating categories:

- Heat Cured Coating
- Cold Cured Coating

SAEKAPHEN-coated equipment has been widely used for many years by industries such as petrochemical and chemical industries, refrigeration, water treatment and crude oil distillation.

This is what SAEKAPHEN can do

Application

prevents corrosion

is resistant to water vapour and to extreme

temperature fluctuations

has a long life at temperatures ranging from

-100°C to +200°C

is non-conductive

prevents incrustation, allowing a considerably

lower fouling factor when designing new heat exchangers

Two heat exchangers with welded tubes

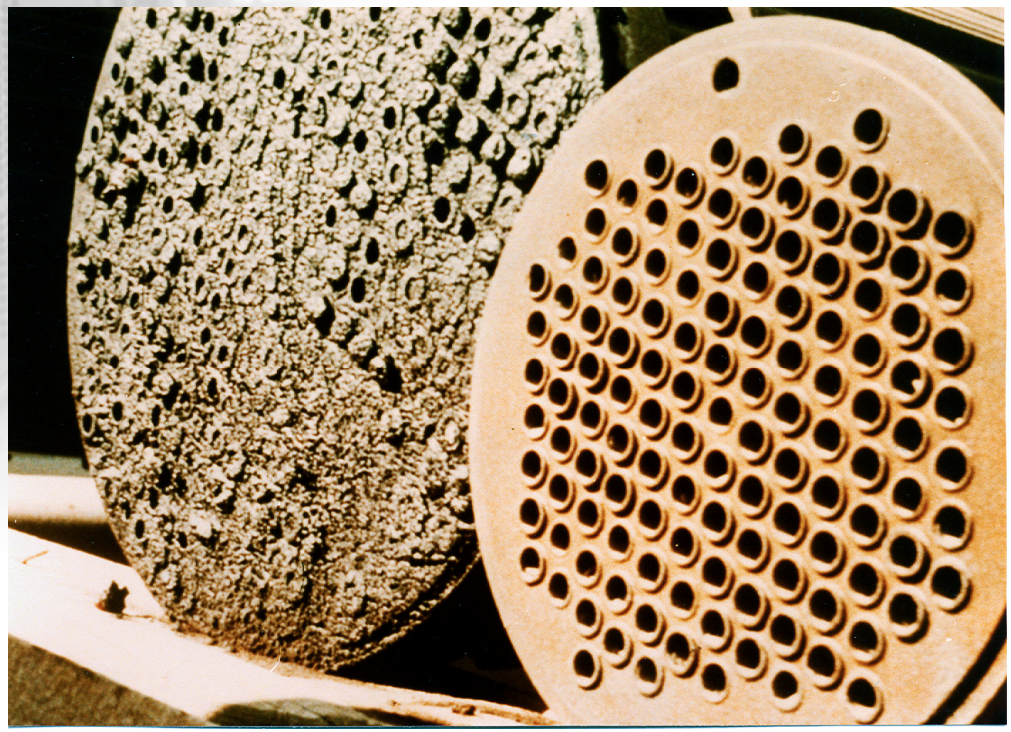
without SAEKAPHEN

with SAEKAPHEN

Practical example 2 parallel operating heat exchangers,

operating time 2 years without cleaning.

Two Heat exchangers with expanded tubes



without **SAEKAPHEN** with **SAEKAPHEN**

SAEKAPHEN

the perfect alternative for protection against corrosion

Coating Technology

Constructional and Surface Conditions of Heat Exchanger to be SAEKAPHEN Treated

1. Constructional Recommendations

The manufacturer of the heat exchanger must be given precise technical data on the heat exchanger (technical specification). In addition, drawings (including details) of the heat exchanger to be **SAEKAPHEN** treated should be given to the protective coating applicator at the tendering stage.

2. Specific Requirements in the Construction of Heat Exchanger

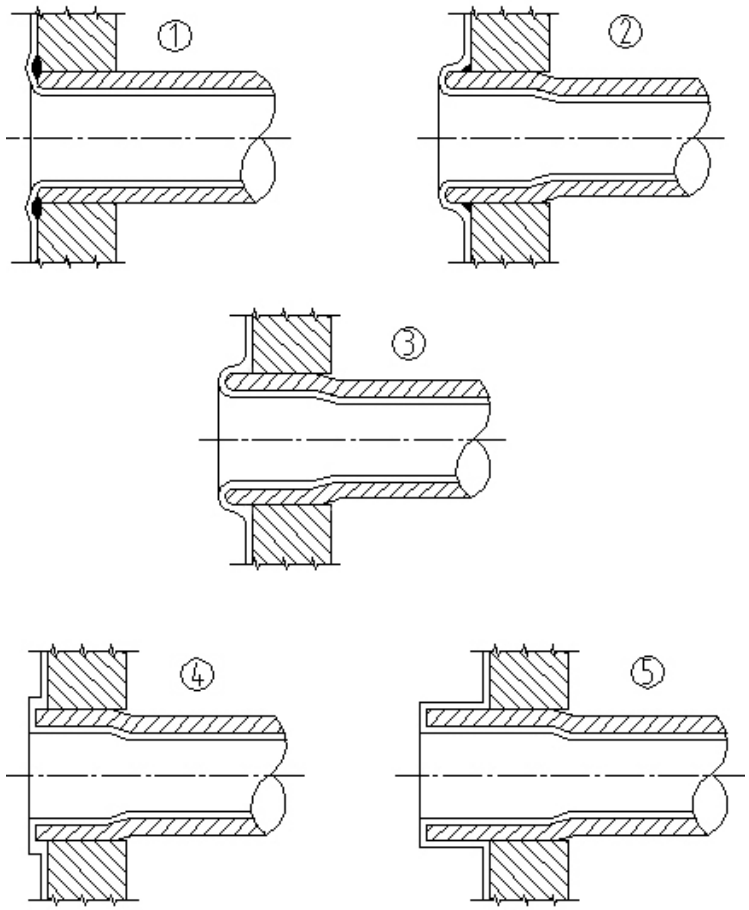
Apart from these recommendations, the following should be referred to in designing heat exchanger components which are to be **SAEKAPHEN** treated:

DIN 28051 Choice of the type of **SAEKAPHEN** and methods
DIN 28053 Testing and construction of the metal structures to be protected and the coating materials

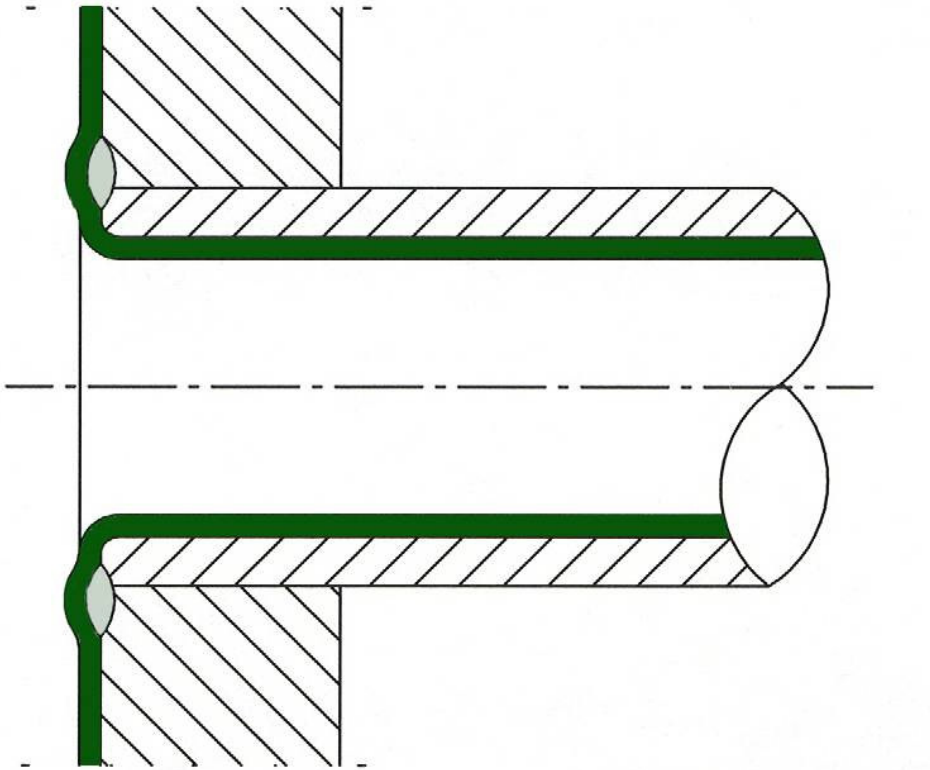
Constructional recommendations for the design and welding of heat exchanger and pipework to be treated issued by **SAEKAPHEN** GmbH. A pre-requisite for satisfactory **SAEKAPHEN** treatment is the design and welding of heat exchanger components in accordance with VDI recommendation 2532 and the details given below, where a distinction should be made between the coating of the tubes and the coating of the shell.

Constructional conditions for SAEKAPHEN coating on the tube side of tube bundles in accorlance with DIN 28051 and 28053

different altenatives of the tubes ends welded / expanded on the tube sheets from optimezed best solution (1) to poorest solution (2)



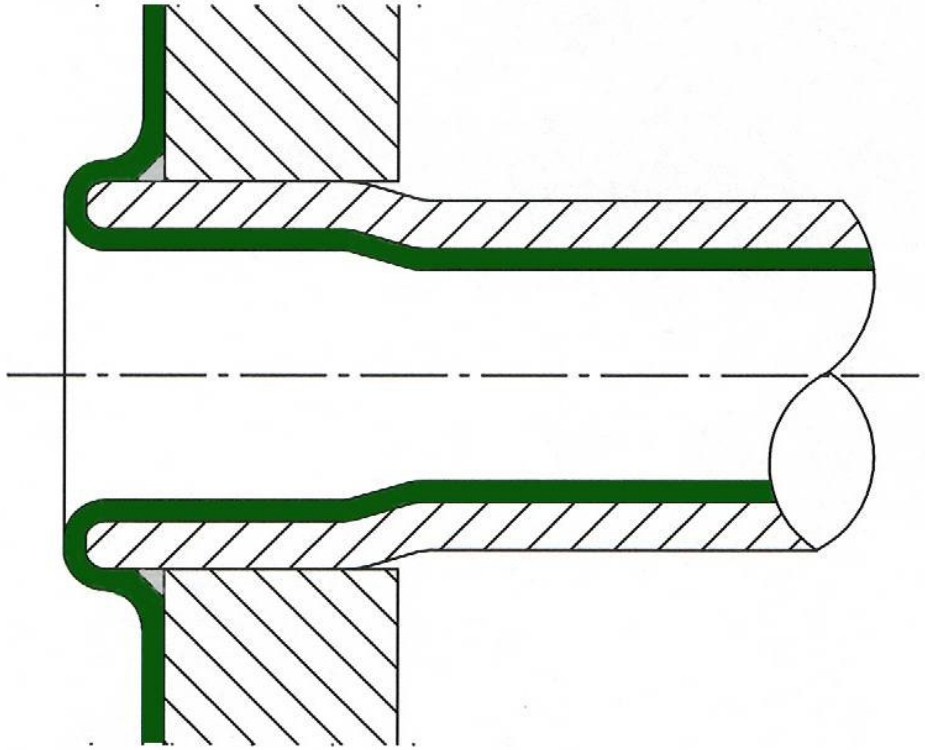
Optimal best solution:
Welded tubes with rounded tube edges on the tube sheets
in accordance with DIN 28051 and 28053
(main part of coated heat exchanger in Europe)



1

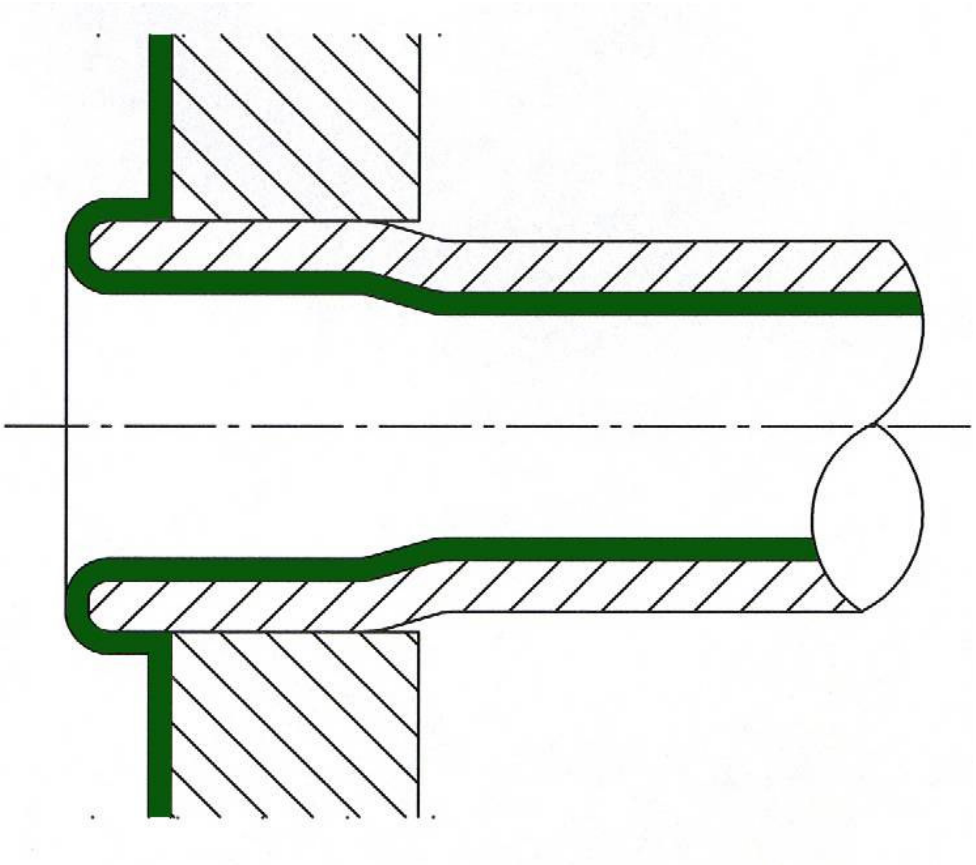
Two tube bundles with welded tubes on the tube sheets

Best solution:
Jut put tube ends, seal expanded tubes, rounded tube edges and seal welding for protection from capillary faults in accordance with DIN 28051 and 28053



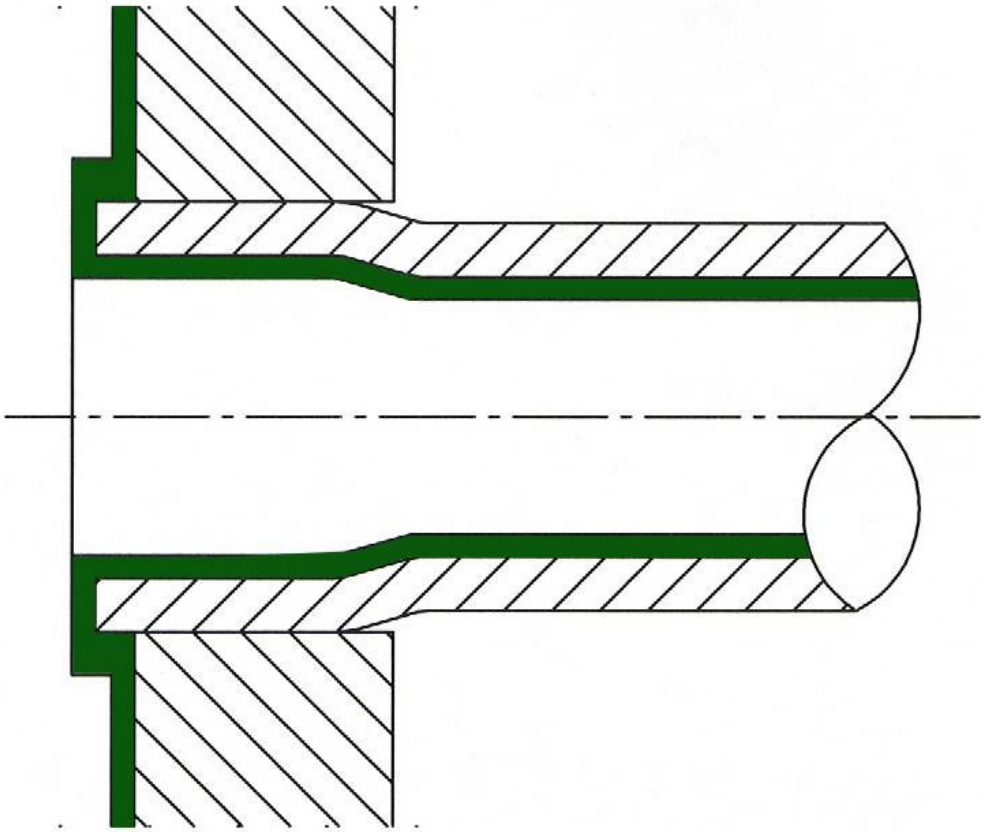
2

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



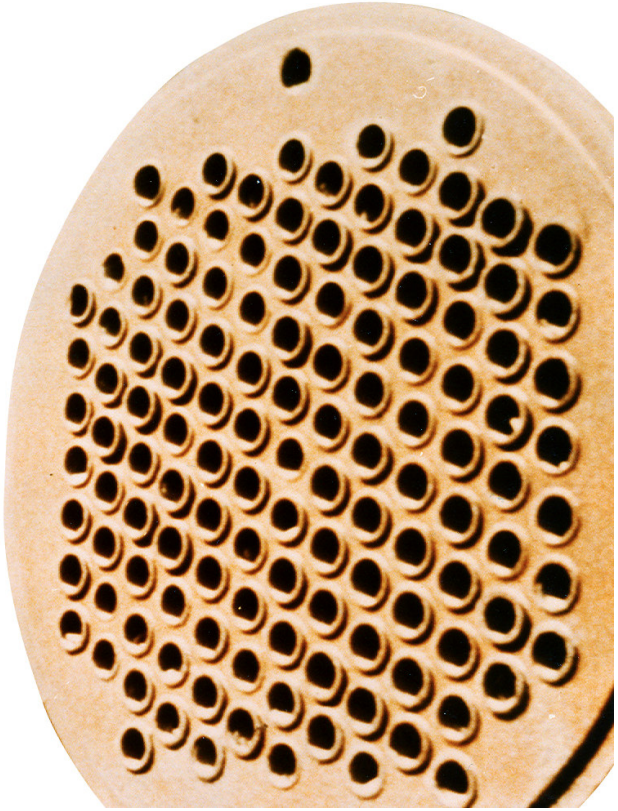
3

Poor solution
Seal expanded tubes, jut out tube ends not rounded, without seal welding. Faulty quality of coating



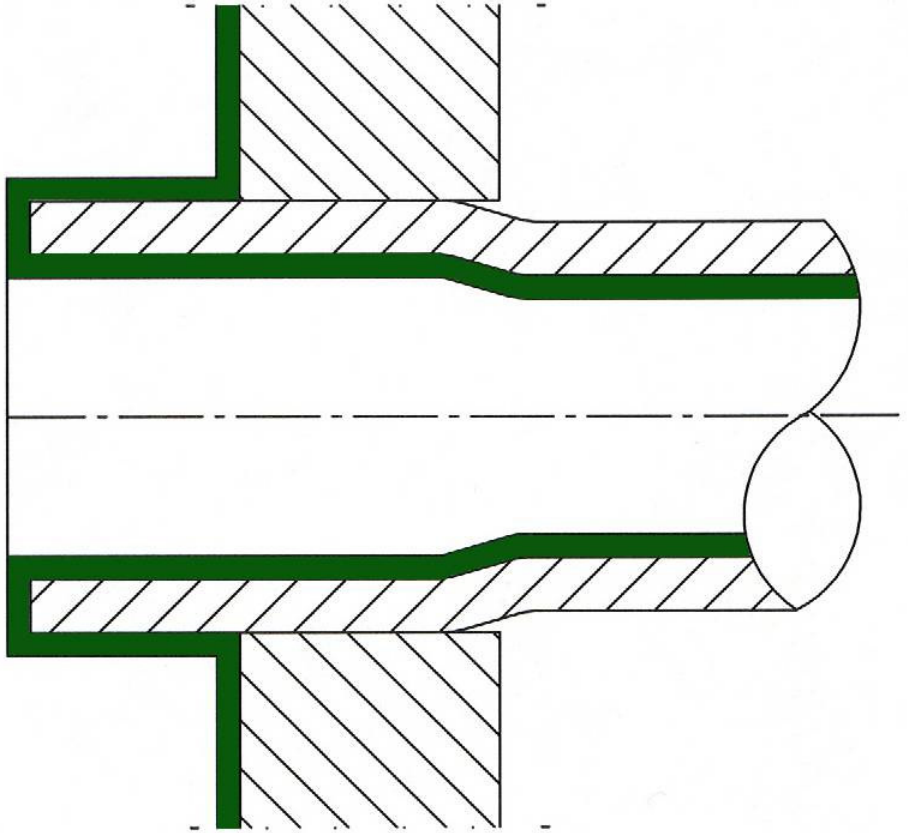
4

Tube bundle with expanded tube on the tube sheets



Poorest solution

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

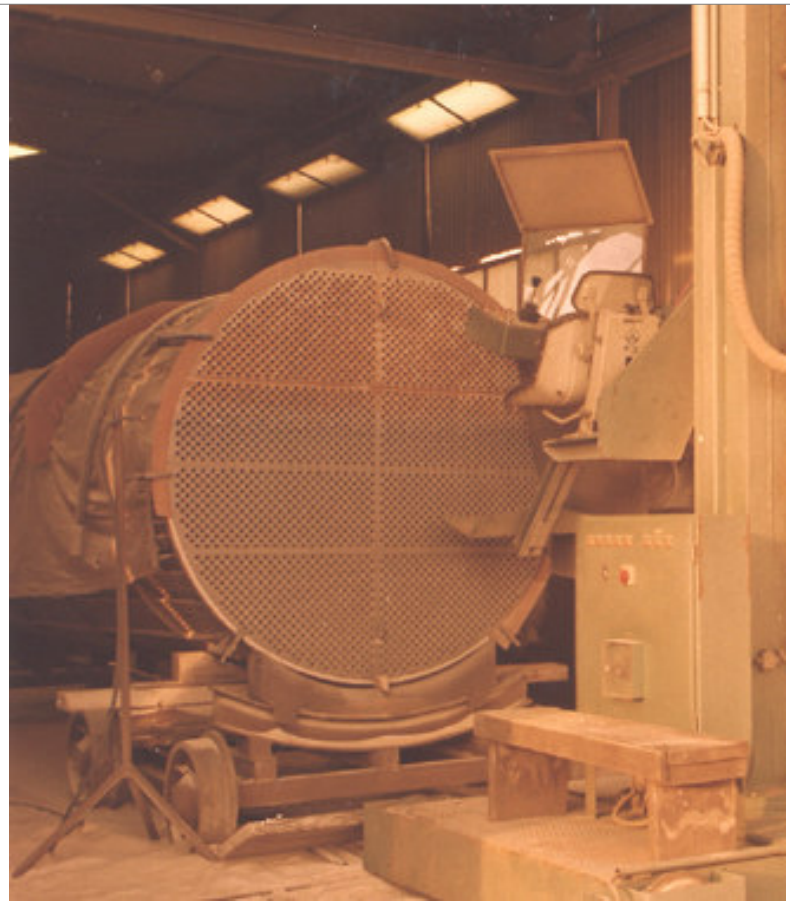


5

Surface preparation by sand blasting

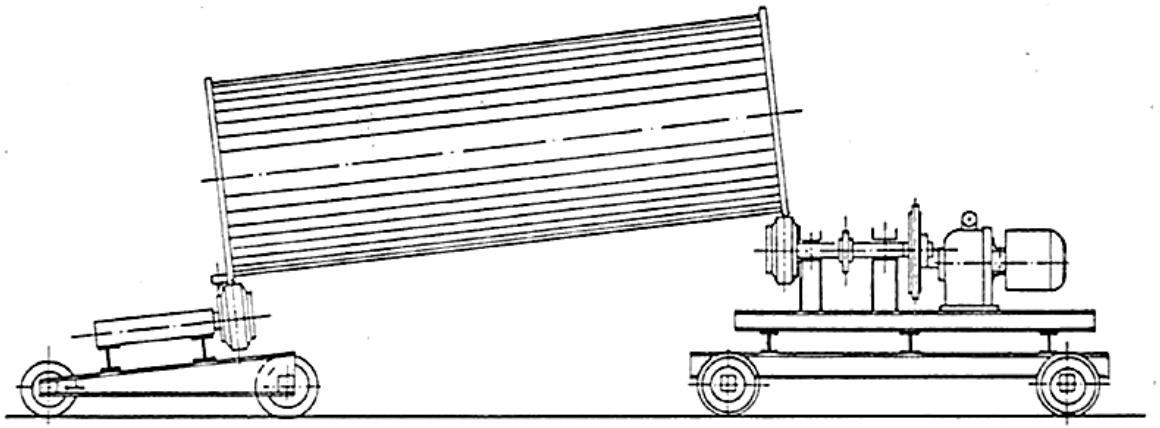
Before starting the surface preparation by sandblasting the construction, the welding and the metal surface of the unit to be protected, have to be inspected in accordance with the DIN norms, especially the DIN 28051 and 28053.

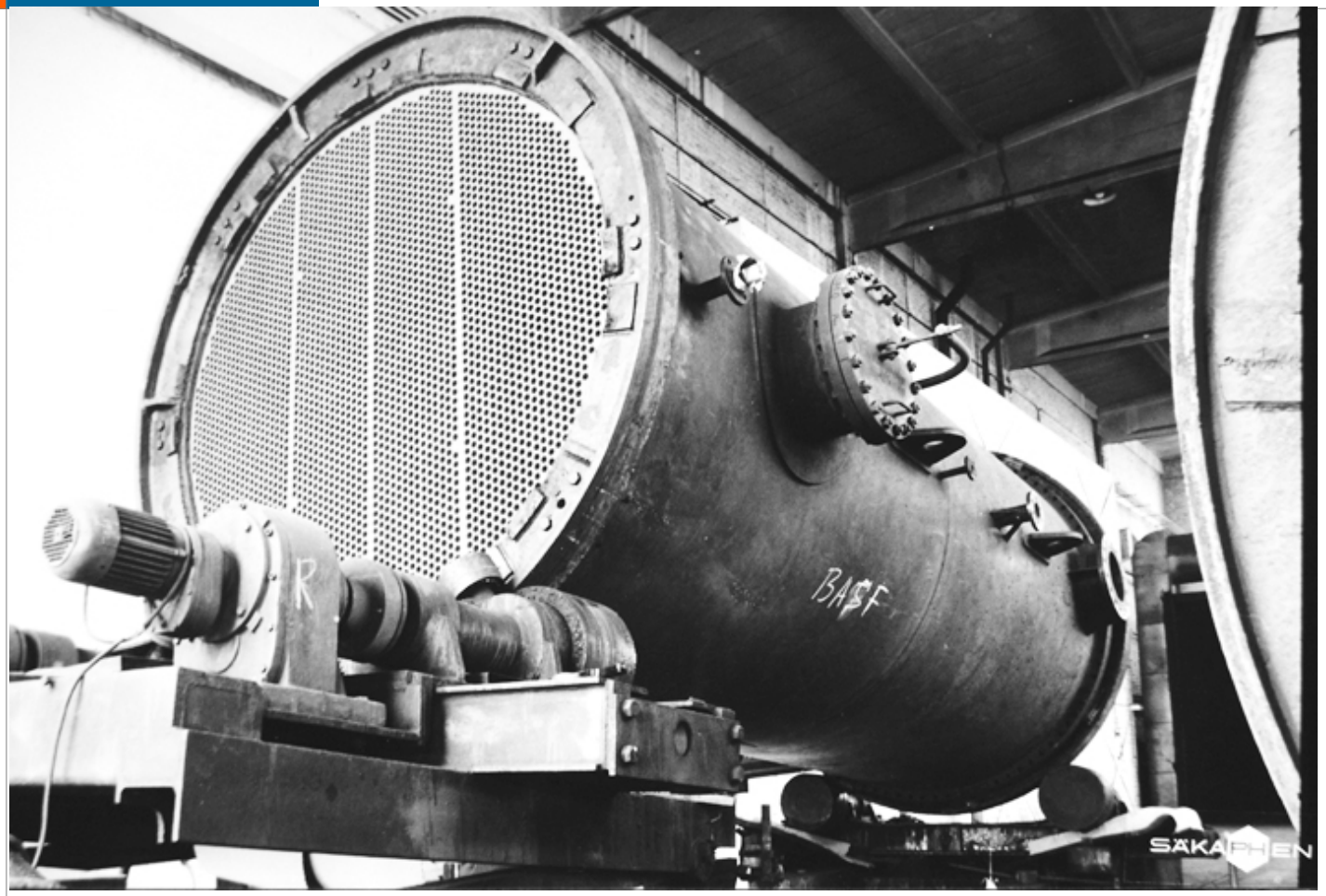
The internal surface of the tubes shall be sandblasted tube by tube either by hand or with an automatic sandblasting machine by three lances side by side (see the picture). The sandblasting grade shall be Sa 3 with a roughness of 40 - 60 micrometer guaranteeing high adhesion of the SAEKAPHEN coating.

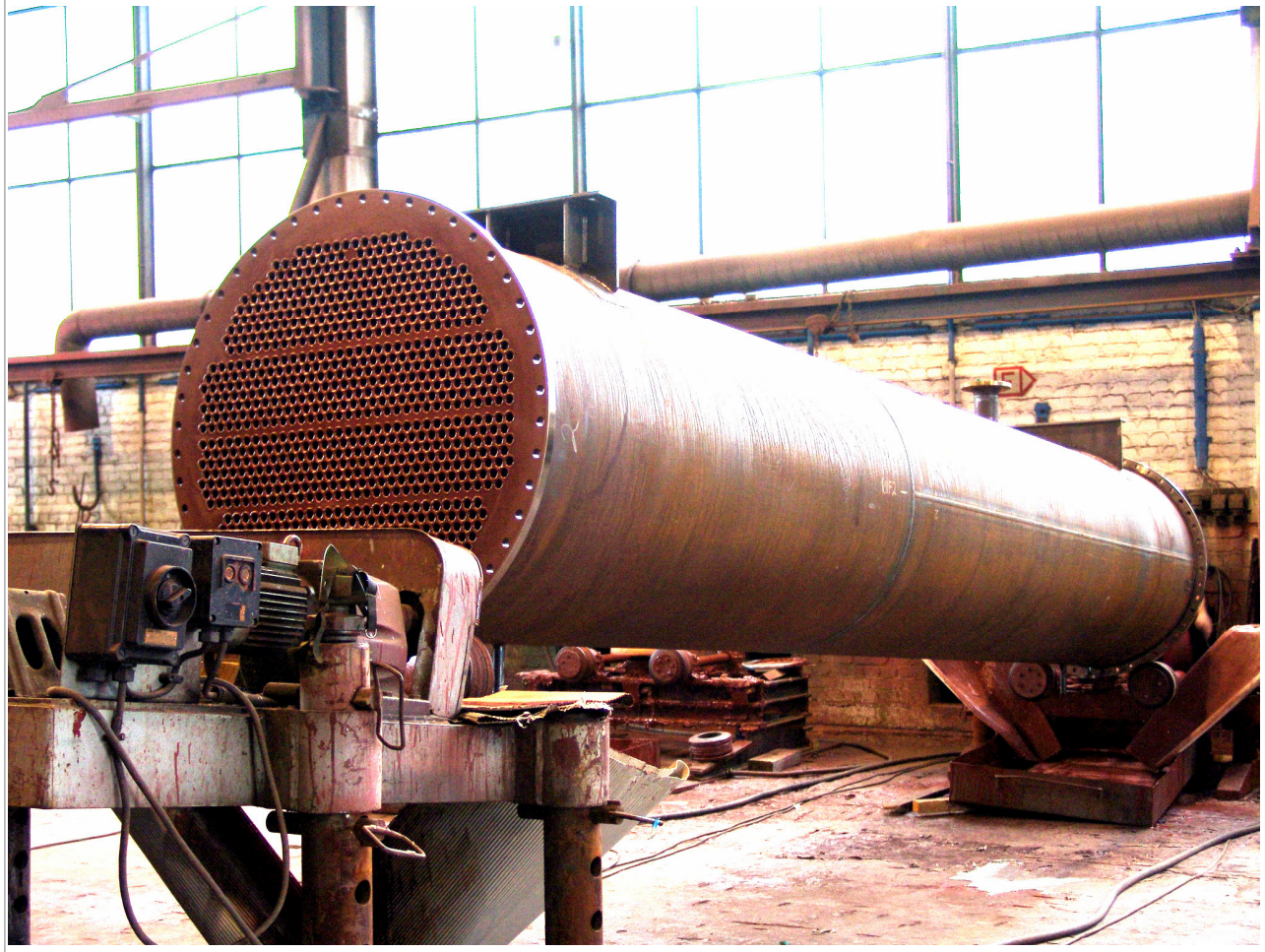


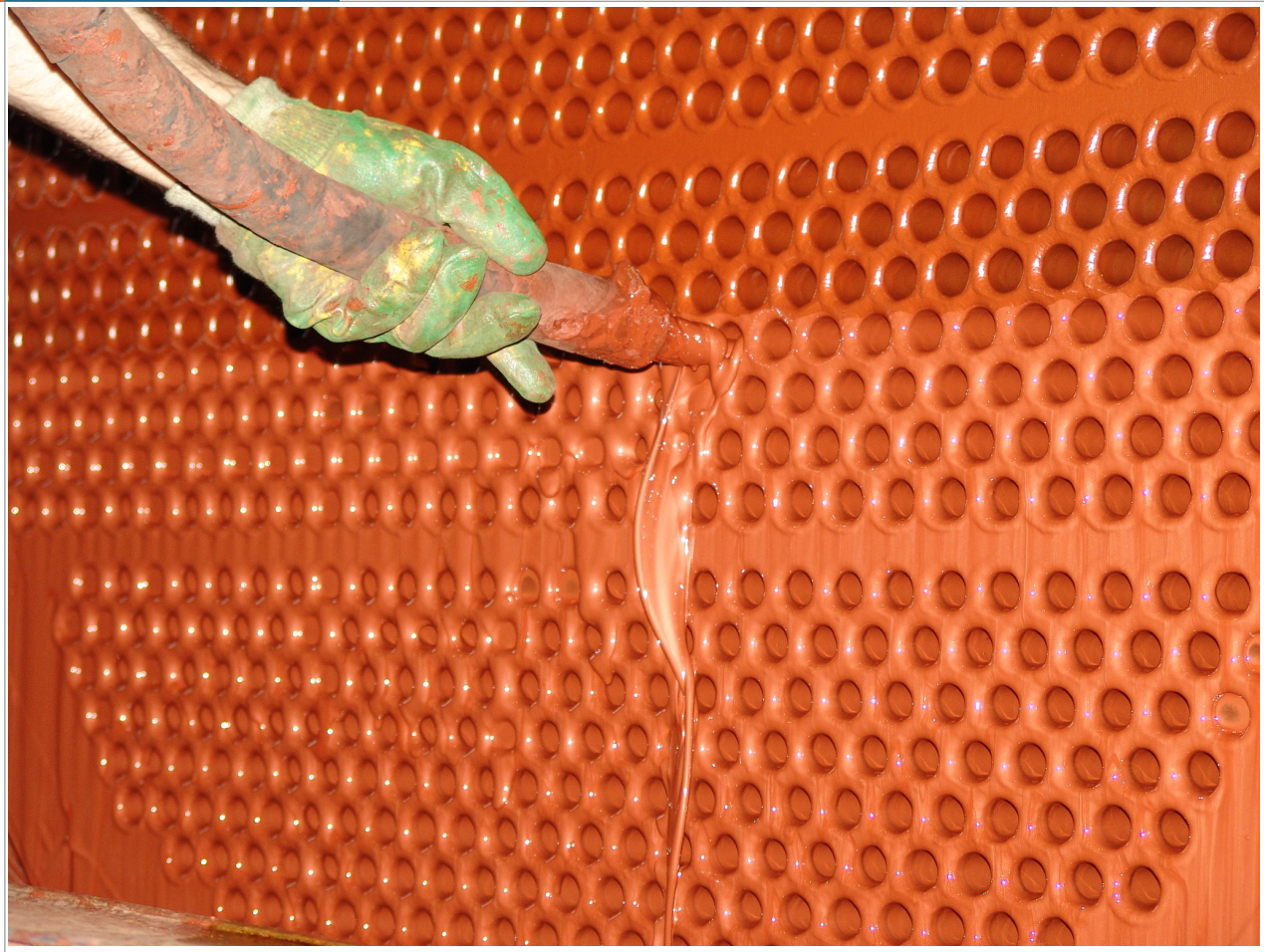
sand blasting, manual and mechanical

Flooding technology




BASF





Baking process

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

Prebaking temperature: 160 - 180 °C, final baking: 180 - 220 °C.

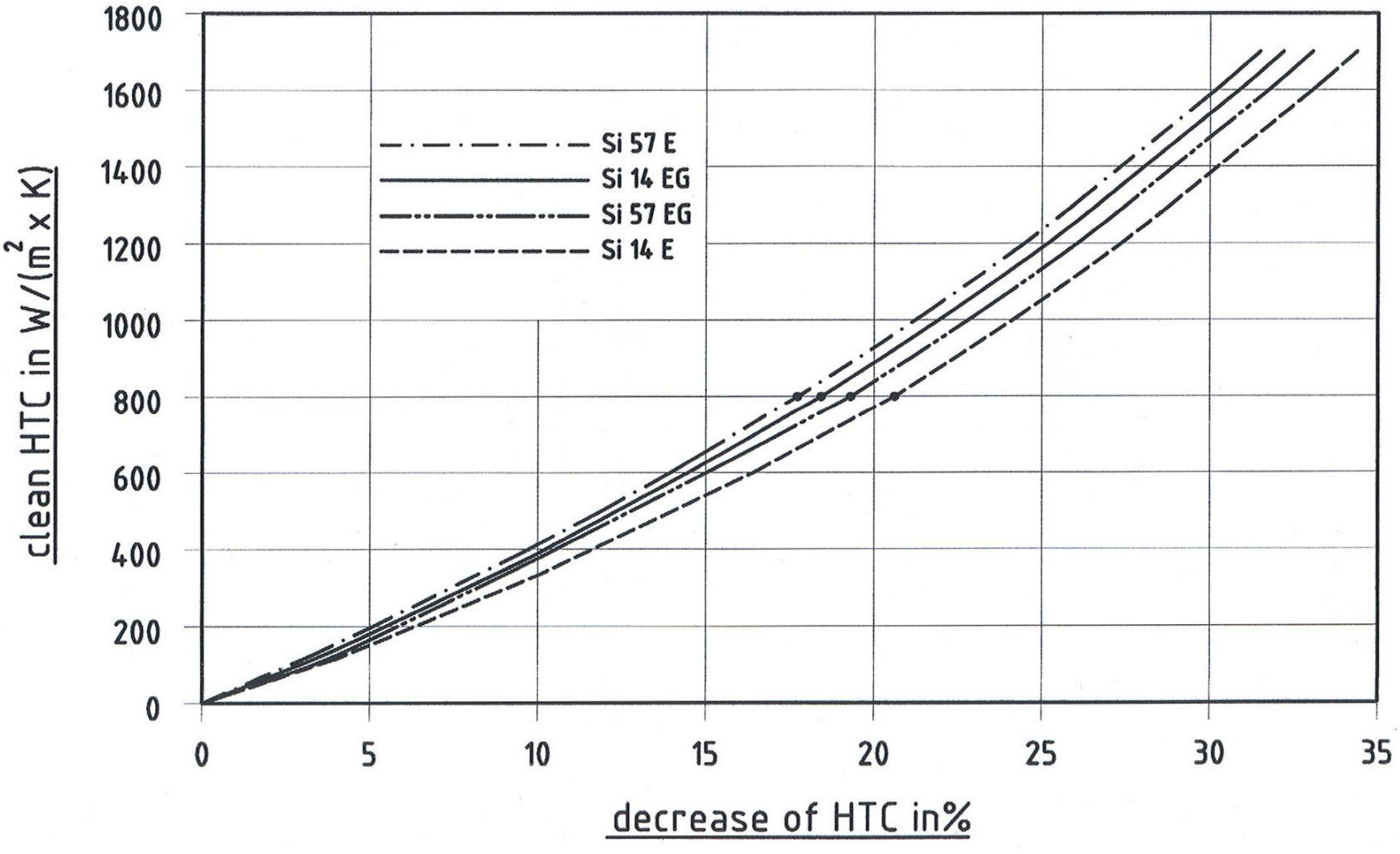
The number of layers can change from five to eight, depending on the steel quality of the unit, the temperature and the umidity (see the pictures).

Specification of Diagram Heat-Transfer-Coefficient (HTC)

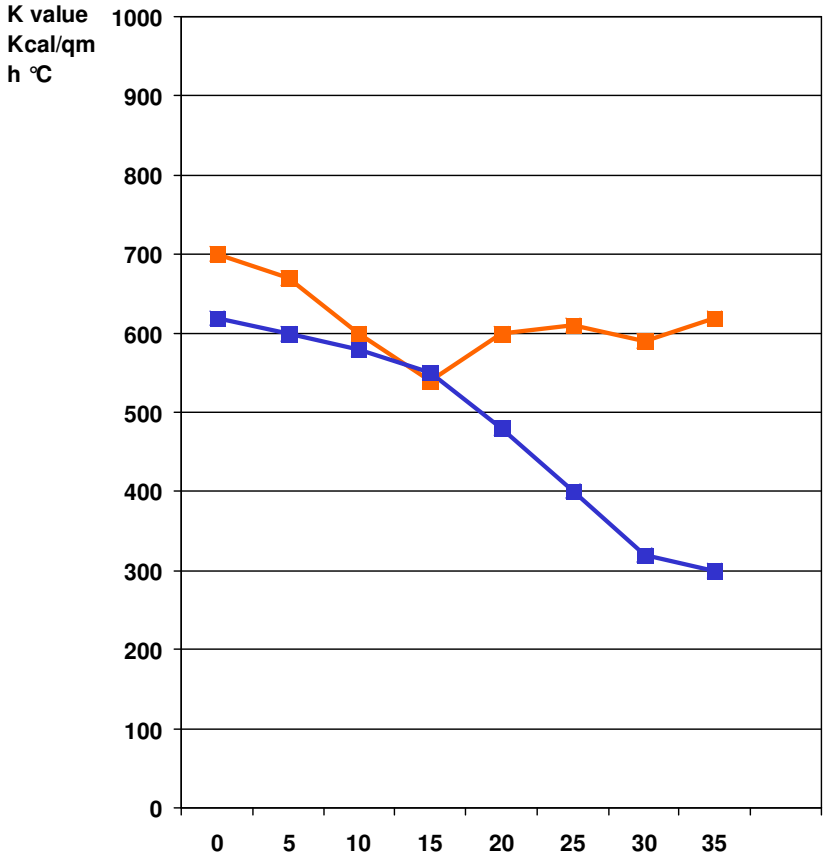
The geometry and the materials to be used for fabrication of a heat exchanger are determined according to requirement of capacity, of corrosion resistance as well as of the fouling grade - on principle nearly all heat exchanger surfaces are provided with a proportional safety factor in addition to the fouling factor by the engineering company or by the fabricator. All these three factors are influencing to a high degree the thermodynamic design and the calculation of heat transfer. Beside the resistance of the tube material itself to the heat transfer, the resistances of fouling and/or possible coatings have to be added up.
With the result that during the engineering phases on principle engineering companies are providing an over-dimensioning of heat exchanger surfaces.

In case that a heat exchanger surface is affected by fouling and incrustation the over-dimensioning will be decreased, and, if the worst comes, a drop of heat transfer capacity can occur. The enclosed diagram is showing the approximate drop of heat transfer (HTC) of a heat exchanger subsequently SAEKAPHEN coated. Only in case that the uncoated heat exchanger was designed without any fouling factor or increased factor of safety the drop of heat transfer (HTC) is corresponding to a drop of capacity.

But in practise this drop can be balanced totally or partially with usual fouling and safety factors. In case of an average K-value (HTC) of approx, 800 W (m^2 x K) a reduction of 17 % caused by SAEKAPHEN coating with Si 57E is the result. This little heat transfer loss is nearly of no consequence. Also significant is the fact that fouling/incrustation at the hydrophobic and smooth SAEKAPHEN coated surface is getting less and occurring only later, in some cases only years later with the result that the cleaning intervals can be prolonged.


1800
1600
1400
1200
1000
800
600
400
200
0
clean HTC in W/(m² x K)
Si 57 E
Si 14 EG
Si 57 EG
Si 14 E
0
5
10
15
20
25
30
35
decrease of HTC in%

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.

with SÄKAPHEN coating
without SÄKAPHEN coating

A practical example

The heat transfer of a new uncoated heat exchanger amounted to 800 kcal/qm h °C. After an operating of approx. 2 months, the heat transfer was reduced to 600 kcal/qm h °C 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 kcal/qm h °C.

The heat exchanger was then decommissioned. The new installed heat exchanger again showed a heat transfer of only approx. 375 kcal/qm h °C after approx. 20 months.

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 kcal/qm h °C.

This heat transfer corresponds to the heat transfer of an uncoated tube after approx. 2 months of operation.

SAEKAPHEN
- the optimum solution against corrosion

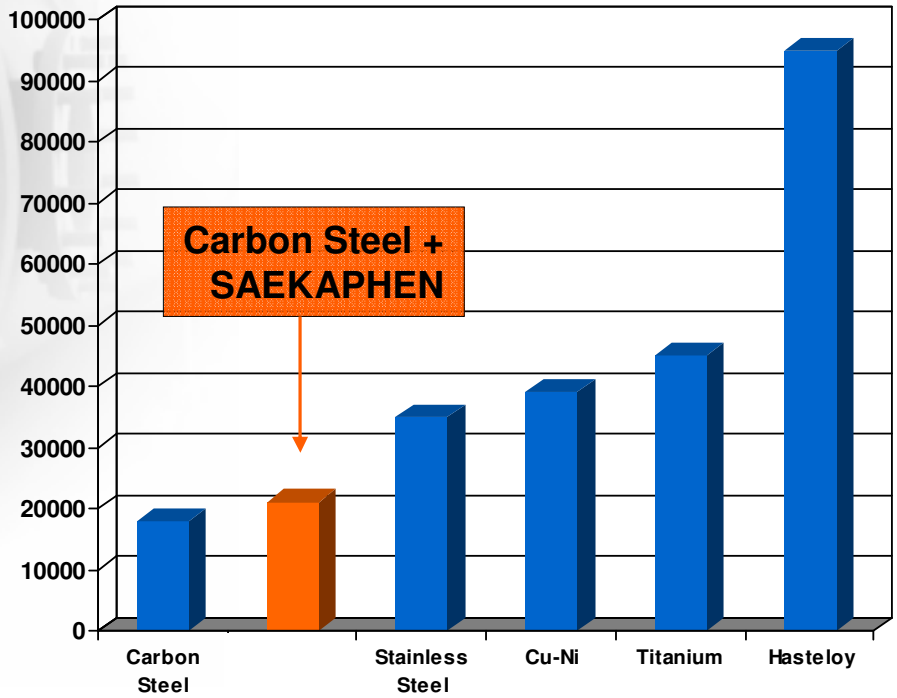
Economic Benefits

Application

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

Operational costs are reduced as incrustration on the tube surfaces of the heat exchanger is prevented.

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



such as: 100 tubes (25 x 2 x 2500 mm), fixed tube sheet bundle, diameter: 400 mm, ST 35.8, tubeside coated with SAEKAPHEN

Advantages of SAEKAPHEN on heat exchanger surfaces

Manufacturers and operators of heat exchangers have the task of protecting the surfaces of heat exchangers against corrosion not only for economic reasons - i.e. during production, the repair or replacement of units and the resulting investment and production shut down costs during the repair period - but also of operational dependability.

This task can be solved in two ways:

1. By using materials such as non-ferrous metals like cupper-nickel or titanium considerably more expensive than a coating.
2. By protecting the surfaces with a heat cured SAEKAPHEN coating, i.e. applying a passive corrosion protection.

Also the effiency of condenser and other heat exchanger tubes are adversely affected over time as a result of the influence of fouling and incrustation, corrosion and/or erosion.

Where damaged tubes considerably impair the performance of the heat exchanger or its availability, tubes have to be replaced.Replacing tubes takes time and is consequently expensive.

Cost Comparison of Fabricating Heat Exchanger

Surface Area	Fabrication Cost			Cost Comparison	
	Carbon Steel	Stainless Steel	Carbon Steel + *SAEKAPHEN* Coating	SS	CS + *SAEKAPHEN* Coating
25 m^2	€ 118.500	€ 533.000	€ 134.500	450%	113%

- The fabrication cost using carbon steel with SAEKAPHEN coated is 8% to 15% extra from the normal carbon steel.

- It is 4 times cheaper from using stainless steel.

Cost Comparison of Cleaning Heat Exchanger

Cost of cleaning: **€ 2,20 per tube**

No. of tube: **44**

Cleaning exercise: **4 times p.a.**

Within 2 years € 765,50 is spent for cleaning exercise.

	Initial Investment €	After 4 years of operation	Cost €	Total Investment €
Replacement	6.522		6.522	13.044
Cleaning	6.522		1.531	8.053
SAEKAPHEN Coated	6.522		0	6.522

Tag No.	E 2352	SHELL & TUBE	Job No.			
Location	OXO C4	HEAT EXCHANGER	Page	4/14	Rev	0
Datasheet Ref. No	TCP/OXO/E2352/2004					

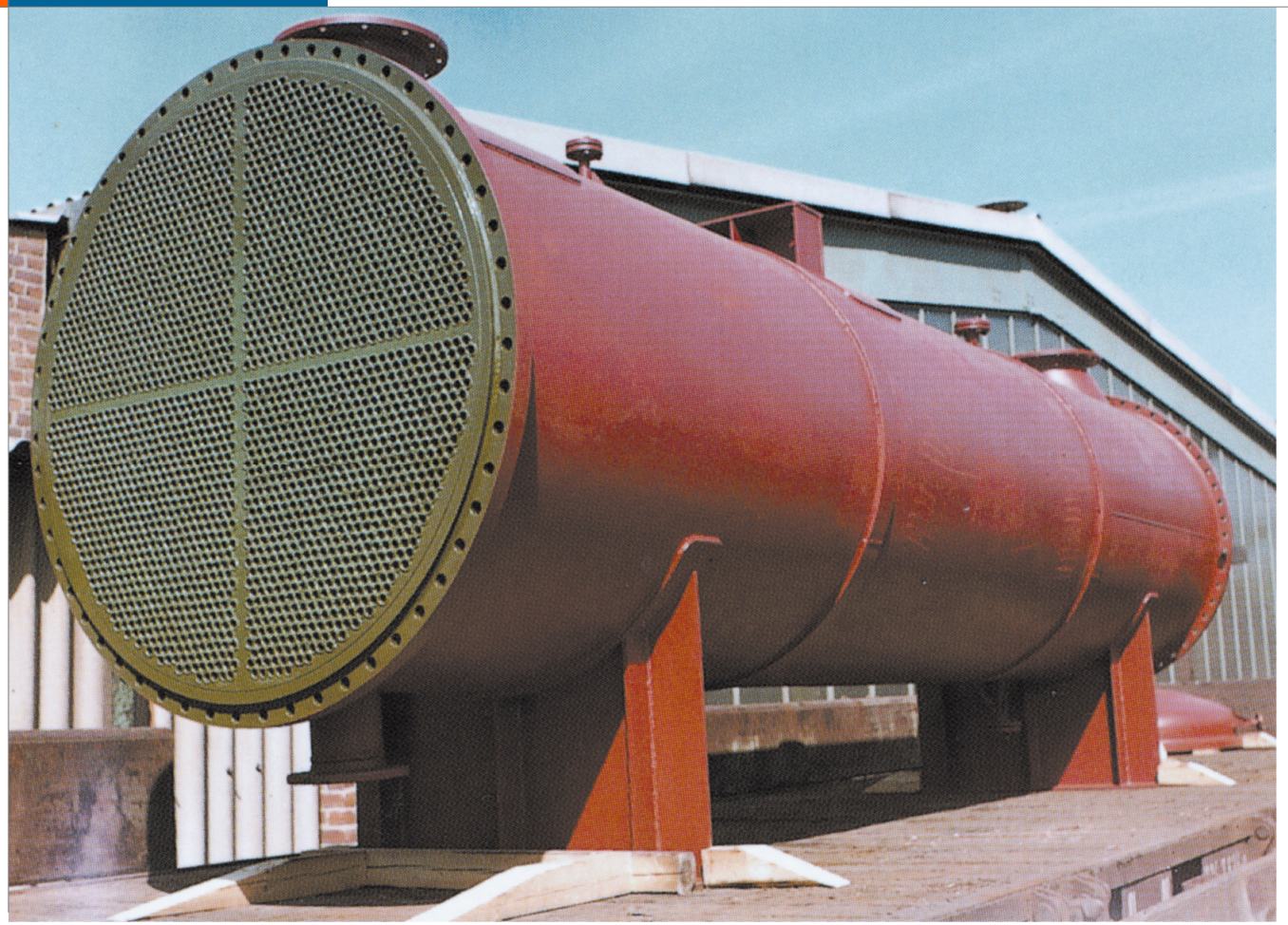
Construction Of One Shell

	Rev			Shell	Tube
1		Design Pressure, internal	barg	3	6
2		Design pressure, external	barg	FV	
3		Max Design Temperature	°C	200	200
4		Min Design Temperature	°C	5	5
5		Test Pressure (hydrostatic)	barg	4.5	9.0
6		Stress factor, design		Acc. to code	Acc. to code
7		Stress factor, test		Acc. to code	Acc. to code
8		No. Passes per shell		1	2
9		Corrosion allowance	mm	1.6	1.6
10		Corrosive component in fluid			
11		Joint efficiency	%	100	100
12		Radiographic examination		Acc. to code	Acc. to code
		Nozzle Loads		See page 9	See page 9
		Other Loads			
15		Pressure design to		ASME VIII DIV. 1 / TEMA CL.B	ASME VIII DIV. 1 / TEMACL.B
16		Material to		ASME	ASME
17		Heat treatment		Acc. to code	Acc. to code
18		Non destructive testing		Acc. to code	Acc. to code
19		Shot-blasting / Painting		3)	
20		Surface Treatment		3)	SAKAPHEN
21		Cladding/Lining			
22		Construction tolerances		Acc. to TEMA / BC Standard 14-710-01	
23		Type of welded joints		Refer to BC Standard 14-133-01 and page 10 of this specification	
24		Rating of welded joints		Acc. to code	
25		Support type			

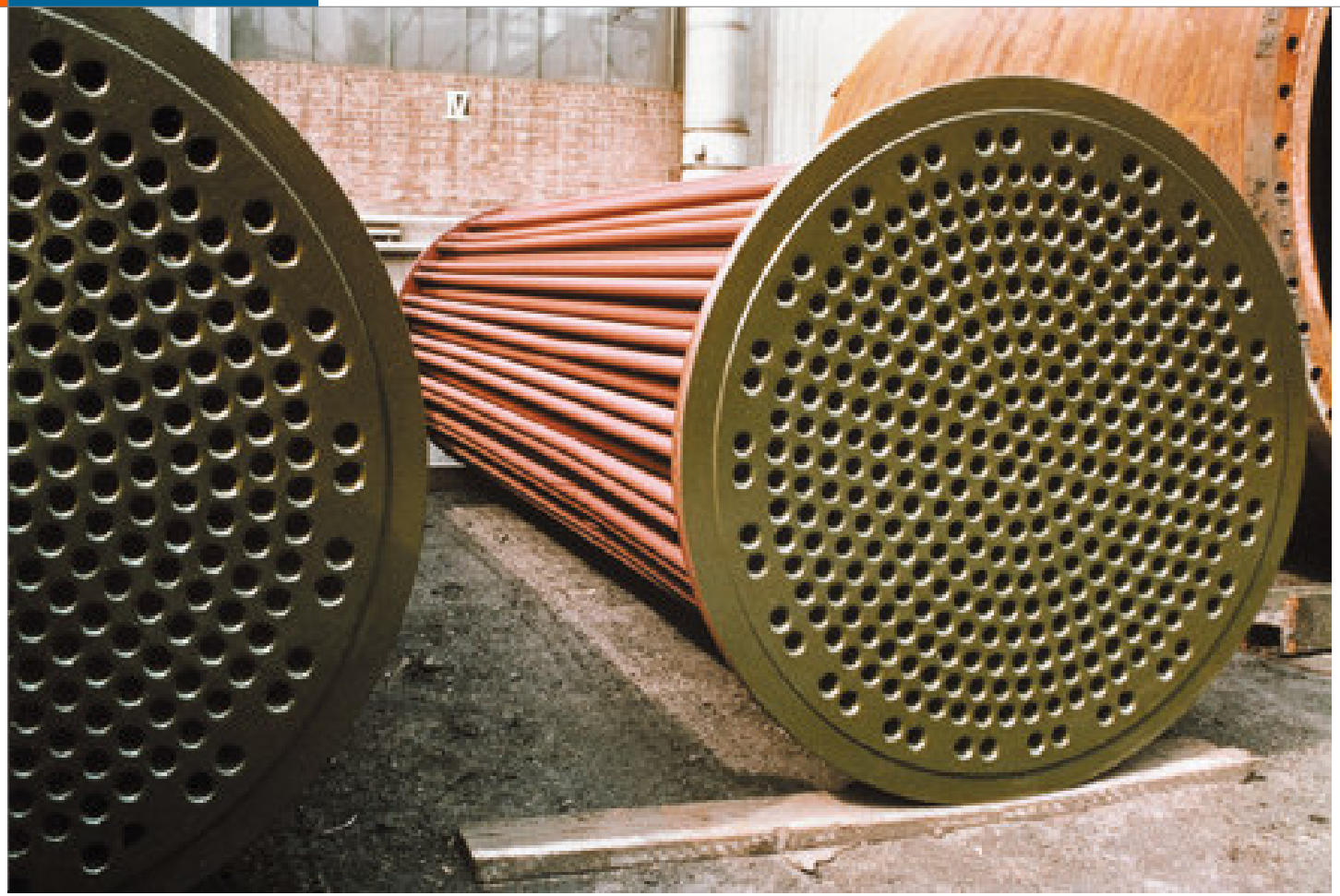
26		Shell diameter	mm	219	56		Cross baffles		Yes
27		Shell nominal diameter	mm	200	57		No of baffles		13
28		Shell wall thickness	mm	4	58		Baffles type		Segmental
29		Type of shell cover			59		Cut (Vertical/horizontal)		Horizontal

6) According to TEMA Class B

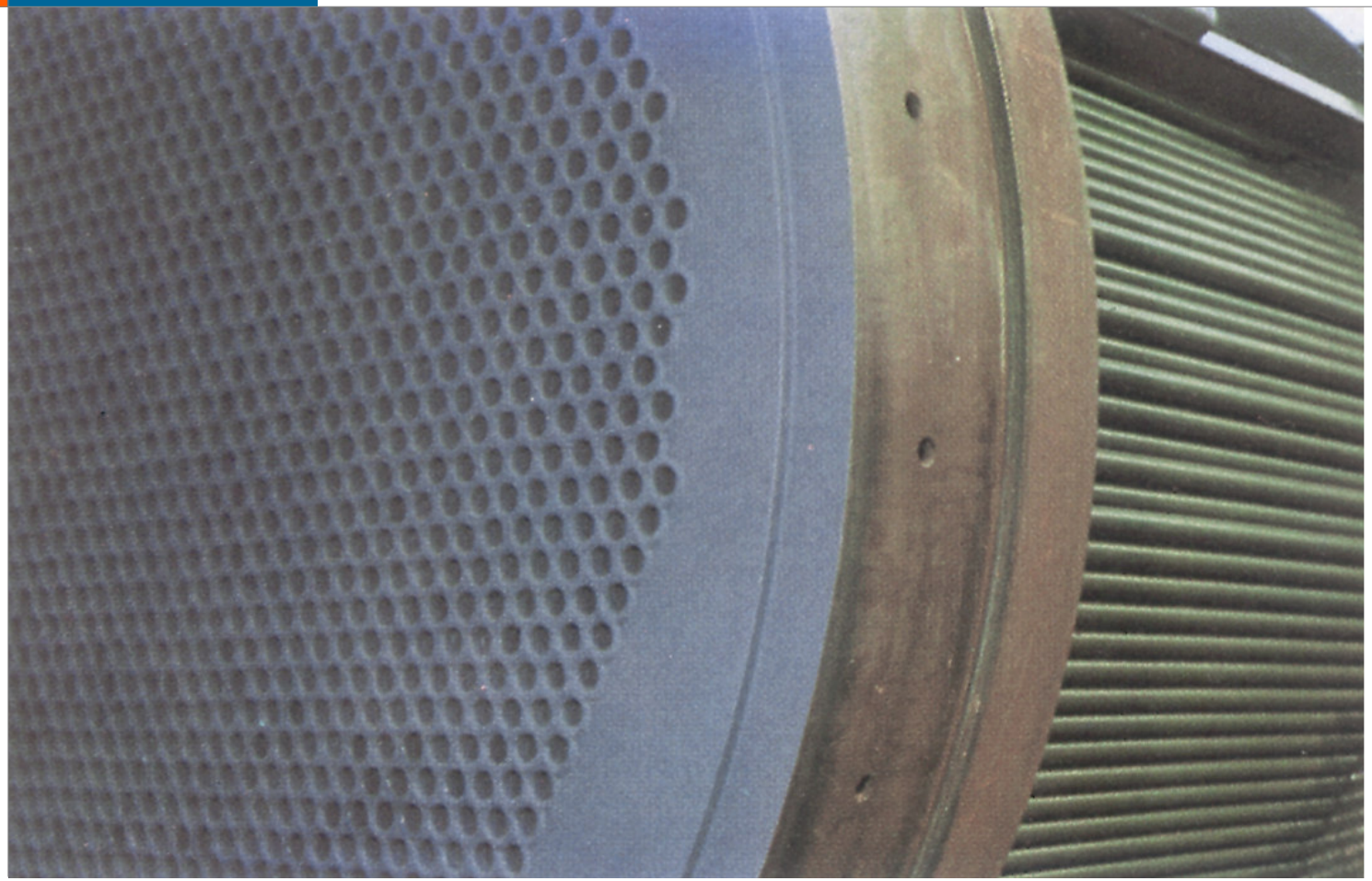
BASF Petronas Chemicals specify SAEKAPHEN



circulation water condenser, ordered by Fertilizer Plant, Kuwait

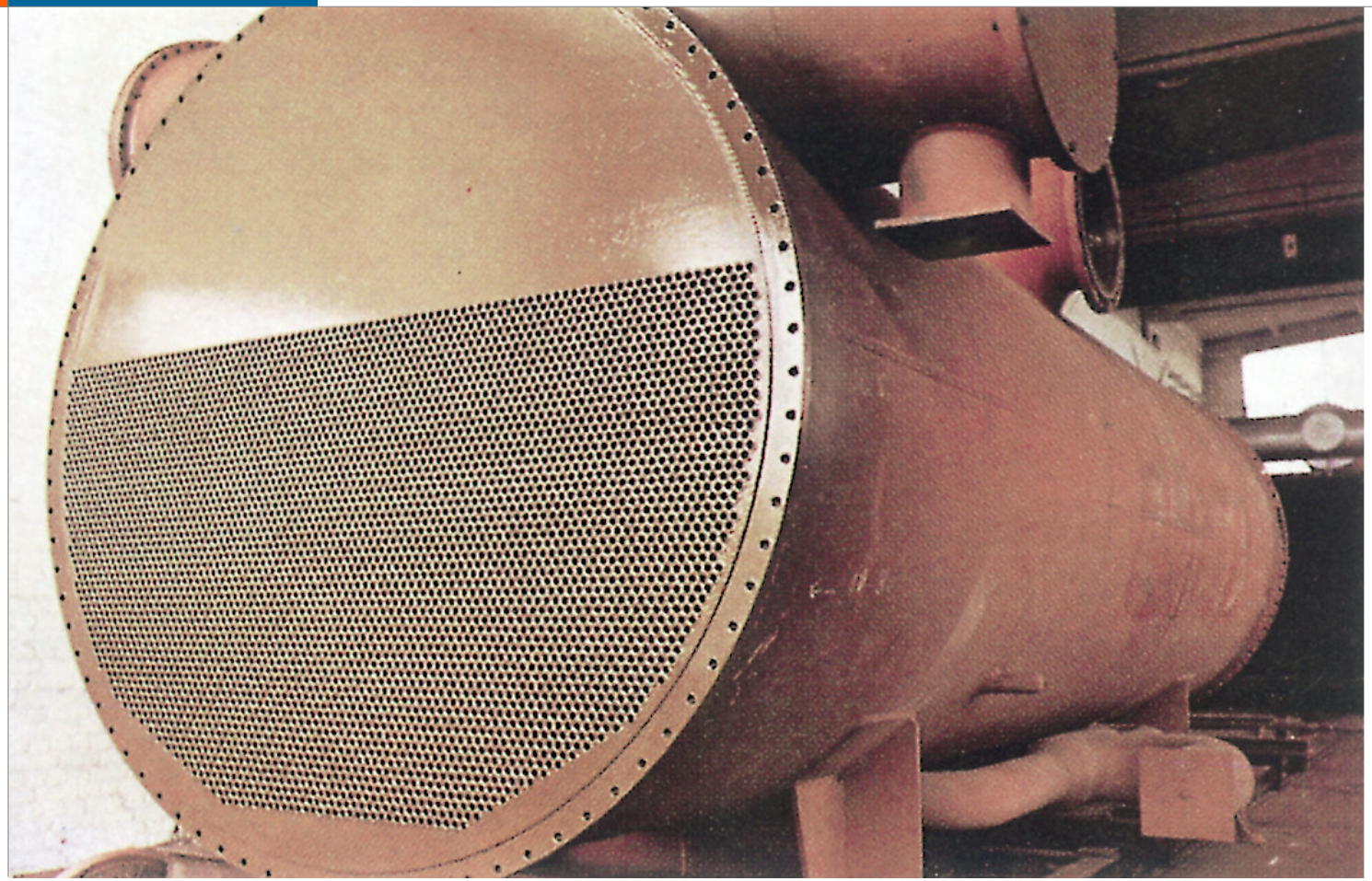


some tube bundles (shell- and tube-side coated)



heat exchanger (tube-side coated), ordered by

Erdölraffinerie Lingen, Germany

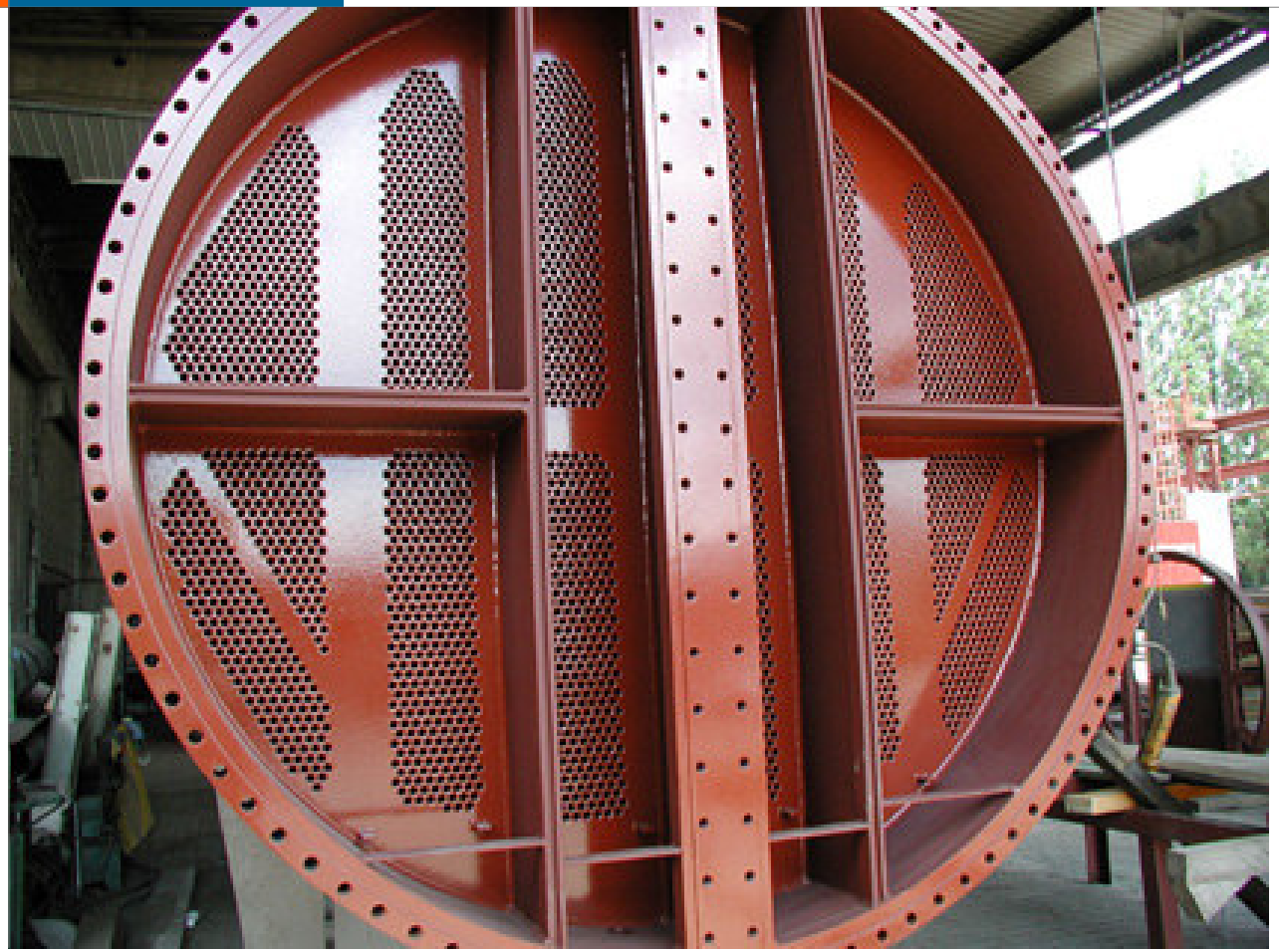


turbine condenser (tube-side coated), ordered by

VEBA AG, Germany

condenser (tube-side coated), ordered by BASF AG, Germany

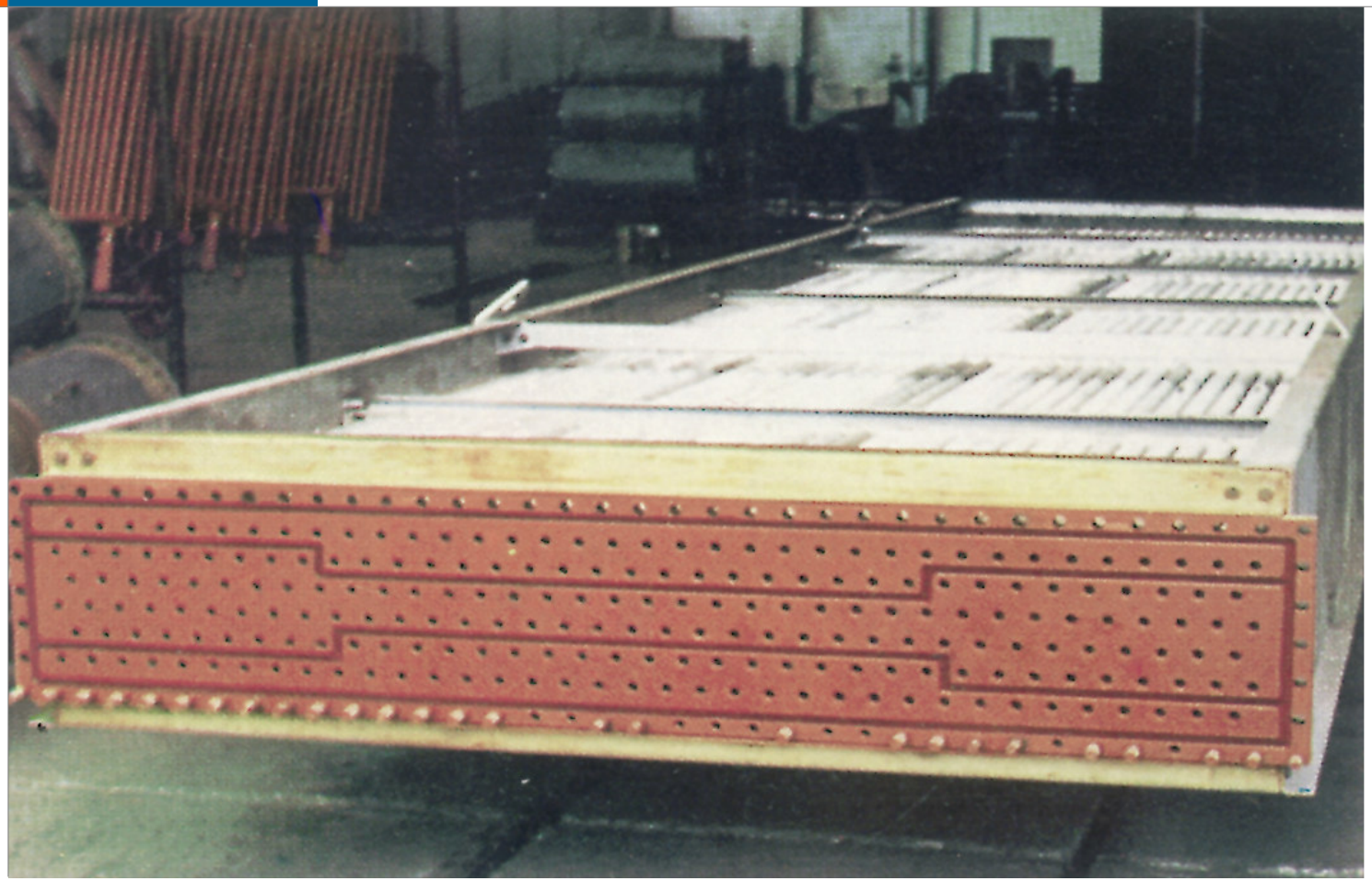
condenser for power plant (ordered by Siemens AG; before coated)



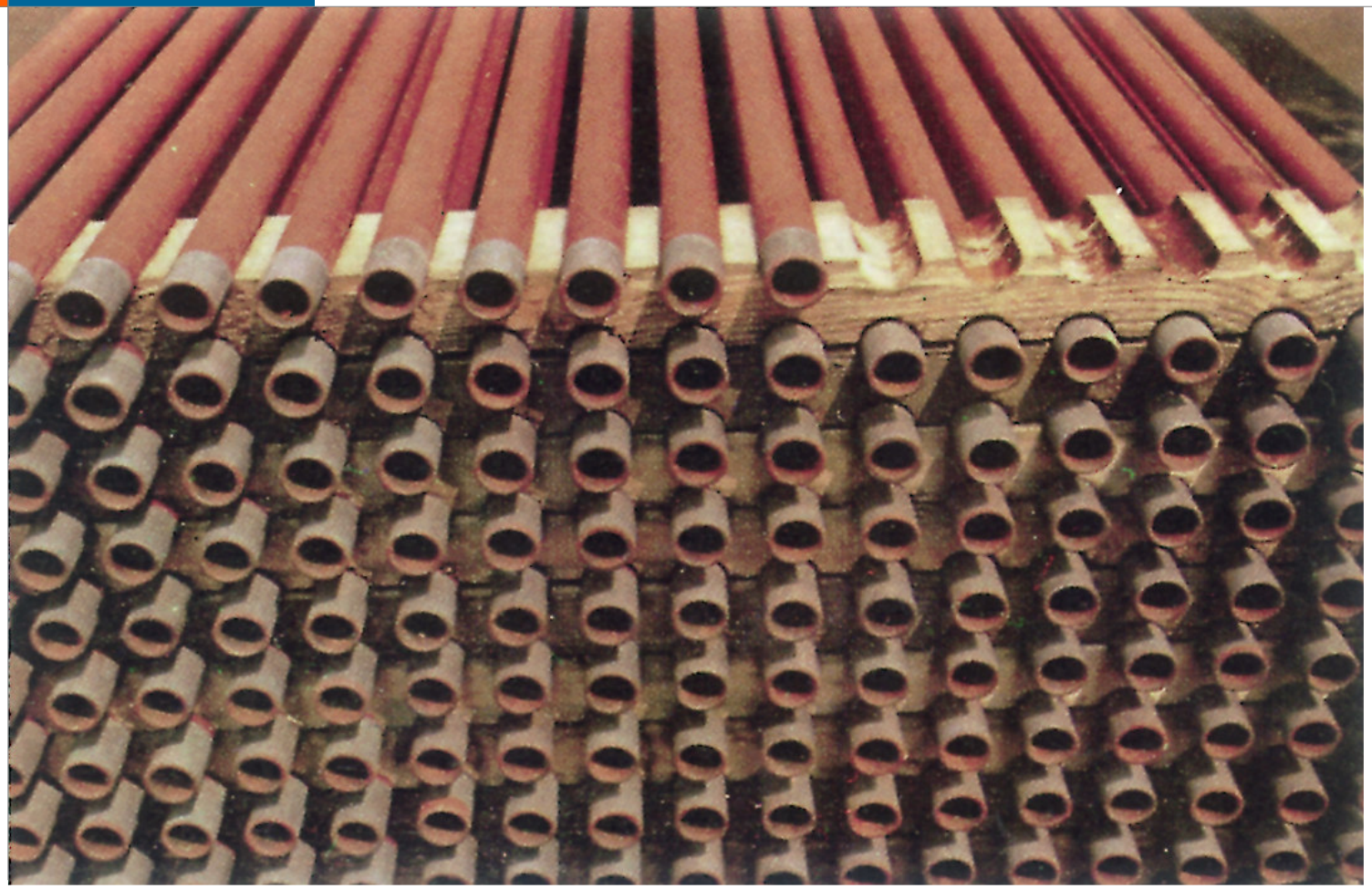
condenser after tube-side coating

condenser ready for shipment

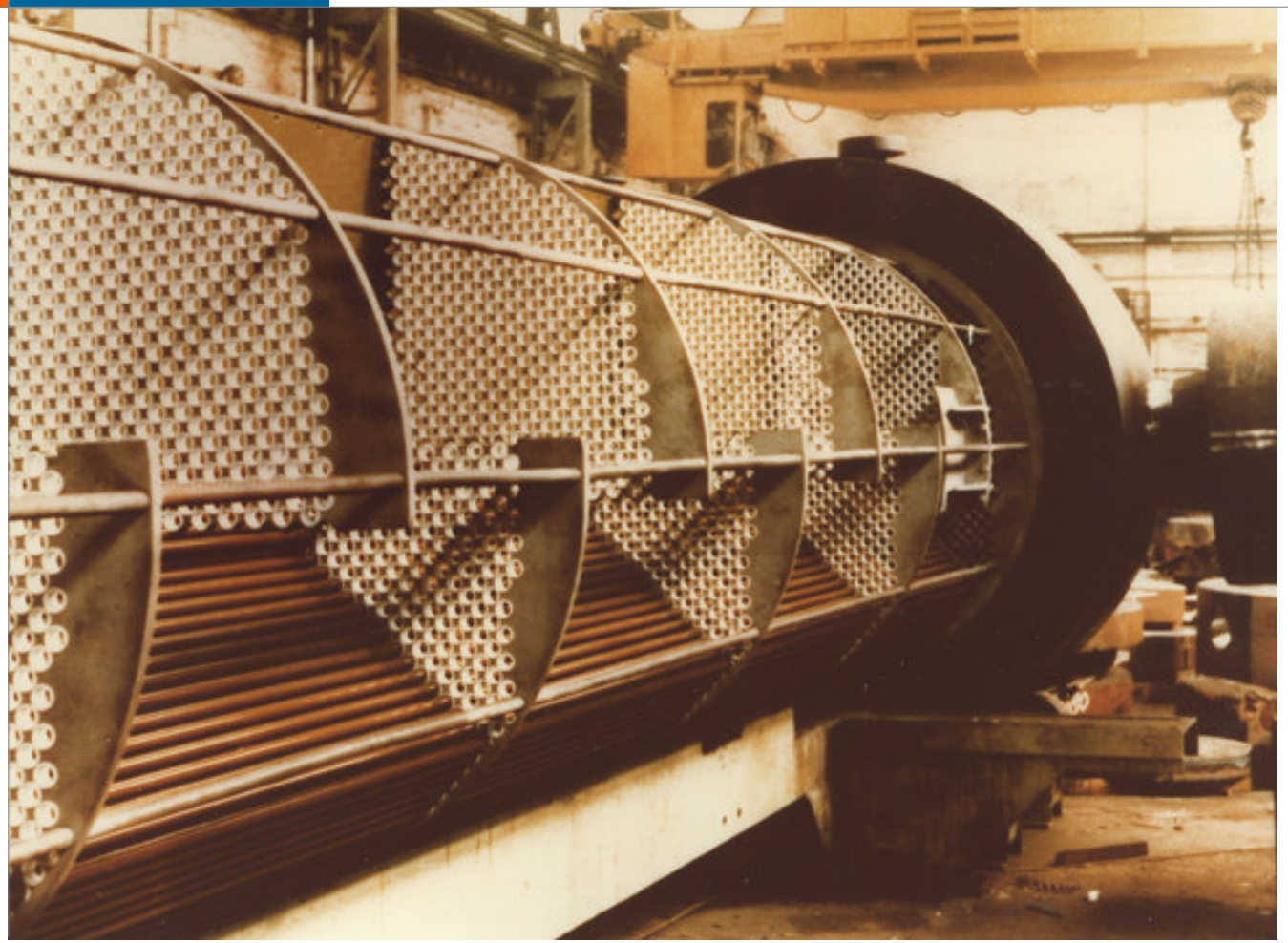
internal heat cured coating Si 57E



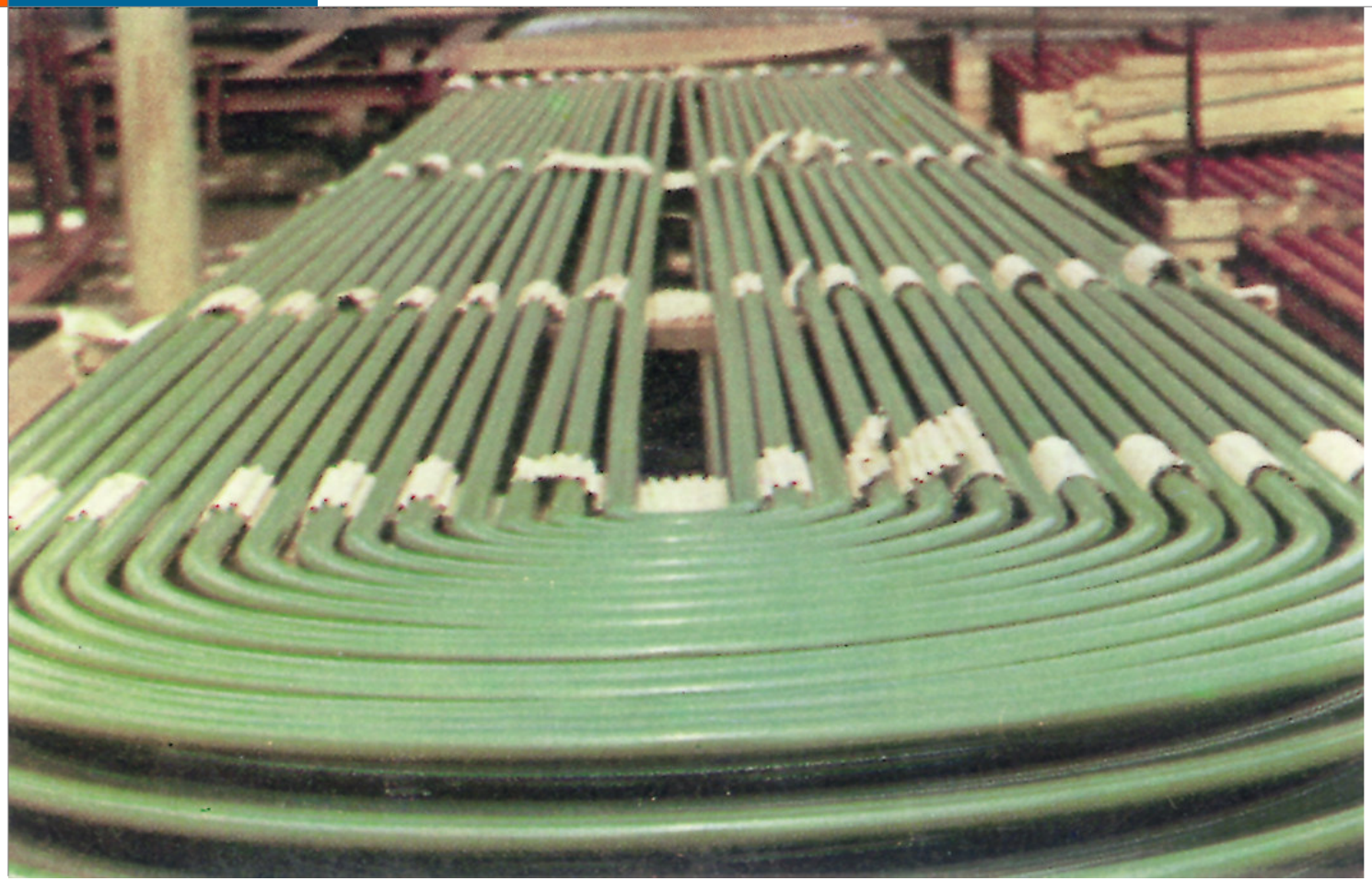
air cooler (tube-side coated), odered by Caltex, Germany



shell-side coated tubes (tube by tube)



assembling of shell-side coated tubes and tube sheets



shell-side coating of U-tube bundle

SAEKAPHEN coating technology

The coating technology, especially under the use of the heatcured coating material - 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. Max. size, coated at the workshop of SAEKAPHEN, Gladbeck:

4,0 m in diameter, 18,0 m in length

Heatcured coating of longer units requires a special movable polymerisation oven, available only at the workshop of the belgian licencee.

The heatcured and the coldcured coating as well of vessels and tanks covers a big range of long and safe protection against aggressive chemical attack and high temperature up to max. 180 °C.

Main operation fields: storage tanks for PP and PE, cruide oil, hydro carbon, chemical substances and beverages.

Vessels, absorber, chimney parts and flue gas channels, coated in FGD plants (Flue Gas Desulfurization Process) against flue gas. Road- and railway containers are protected against a lot of different chemical substances, cloride and against due point corrosion for long distance transportation on roads and railways.

heat cured coating Si 14E of road container

another road container coated

heat cured coaing Si 57E Truck container

heat cured coating Si 14E of railway container

heat cured coating Si 14E of a storage tank

road container 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

testing equipment

minitest 4.100

testing equipment

Pinhole or sparkling test

SAEKAPHEN - leading manufacturer of special coating

Material and applicator of special coating technologies

Range of products and services:

Heat cured coatings

Application by flooding, spraying, also electrostatic, multi-layer lining (up to 8 individual layers), curing by baking in polymerisation ovens, intermediate baking up to 150oC. After each individual layer, final baking at up to 220oC

1. **Spark test after last intermediate baking**
2. **Spark test after final baking.**

Guaranty: heat cured coating, 100% free from pores; total thickness (DFT) 180 – 250m

Application: **only at the workshop of our licensees**

Cold cured coatings

Application by spraying, also electrostatic, rolling (up to 4 individual layers), curing by
chemical reaction between two components of the coating material

1. **Spark test prior to application of final layer**
2. **Spark test after prior application of final layer**

Guaranty: cold cured coating, 100% free from pores;
Total thickness (DFT) 500 – 800m (Säka-Flake 1.500 – 2.100m)

Application: **at the workshop of our licensees and on domestic and international building sites**

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 rolled-in or welded tubes, U-tube bundles, condensers, tube sheets, air coolers, preheaters, storage tanks, vessels, 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.

SAEKAPHEN product mix

heat cured material

SAEKAPHEN material type	colour	surface	dry film thickness µ	density g/m³	solid volume ltr./ 100 kg	hardness (König) Imp./sec.	resistance	field of application
Si 14 E	dark-green	hydrophob, smooth	200	1,39	27,41	190	high acid to slightly alkaline, salt solutions, cooling water, gases, organic liquids	heat exchangers, air coolers, condensers, evaporators, tanks
Si 14 EG	red-brown	matte	250	1,30	29,32	134	water vapour diffusion, slightly acid a. alkaline liquids and vapour	heat exchangers, condensers, condensate containers, thermal degasers
Si 17 E	red-brown	hydrophob, smooth	200	1,44	30,13	143	liquid or gaseous KW, salt solutions, oils, acid to slightly alkaline mediums to PH8	inside coating of tanks for storage of flammable liquids, class of risk AI/AII and B, alphatic hydrocarbon
Si 57 E	red-brown	hydrophob, smooth	200	1,16	30,10	200	high alkaline to acid, all cooling waters incl. brackish- a. sea-water	heat exchangers, condensers, evaporators, vessels, water treatment plants
Si 57 EG	grey-olive	matte	250	1,24	29,52	120	water vapour diffusion in alkaline to low acid liquids	condensers, condensate containers, degasers a. boilers

SAEKAPHEN product mix

cold cured material

SAEKAPHEN material type	colour	surface	dry film thickness µ	density g/m³	solid volume ltr./ 100 kg	hardness (König) Imp./sec.	resistance	field of application
HR 60 extra G	green, red, grey	smooth, glossy	400-500	1,50	60,3	120	high alkaline to acid mediums, brackish, sea a. deionized water as well as inorganic salt solutions	tanks, silos, filters, vessels
HR 60 extra TG	red, grey, red-brown	matte	300-350	1,40	33,1	100	slightly acid to alkaline aqueous mediums water to 100°C a. water vapour diffusion	desalization plants, condensation tanks, process water tanks, metal pipelines
Säkatonit K 80 LS	red-brown	satin-finished	400-max. 800	1,40	66,4		acids to high alkaline mediums, sea- a. brackish-water, cooling water a. salt solutions	water tanks in power stations, turbine condensers, heat exchangers, coolers, evaporating a. cooling water pipelines
Säkaline	red-brown, white	smooth, glossy	mind. 700	1,55	64		water to 100°C a. temperature drop to the surface, temperature difference up to 80°C	boilers a. other water heaters for drinking a. nondrinkable water, KTW recommendation a. all ranges of cold a. heat water
Säkaflake 1042	black	matte	700-3000	1,42	46,09	ca. 120	aggressive mediums of chemical industry, high acid ranges a. high temperatures	flue gas desulfurizing plants, tanks, pipelines, tanks, vessels, pipes
Säkaflake 1052	black-grey	matte	700-3000	1,43			slightly alkaline to high acid mediums, sea-water, inorganic salt solutions, fue gas, electrostatic derivation ability	storage tanks, containers, flue gas channels, process tanks, washing towers, gas purifying plants
Säkatar D extra	black, red-brown	matte	mind. 500	1,5	79,5	74	good chemical resistance, high temperature load, higher water vapour diffusion	power stations, nuclear power stations, cooling water pipelines, tanks