

# Graphite Heat Exchangers and Components

Annular-groove Condenser NB/HB/KB

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cGMP Annular-groove Condenser NB/GMP / HB/GMP

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Annular-groove Vent Condenser GN/GH

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Annular-groove Heat Exchanger G1

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Annular-groove Heat Exchanger R/WA

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Annular-groove Dilution Cooler R-K

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Wavy-groove Heat Exchanger W

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Conti-Reactor

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Block Heat Exchanger

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Annular-groove Absorber

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Quench

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Reactor / Agitated Vessel

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Column Internals

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Other Components

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# GAB Neumann

For more than 40 years GAB Neumann have designed and manufactured heat exchangers, equipment and components for applications in the chemical, pharmaceutical, steel coating and environmental industries.

Providing the highest quality and maintaining a strong customer focus are the foundation of our organisation. This is demonstrated by the longevity of more than 15,000 units that have been delivered to a loyal customer base. Our staff are our key, they are highly skilled, well experienced and dedicated, ensuring the success of our products and our company.

Across the world, our staff and agents develop solutions with our clients for their specific applications to optimise overall performance and cost.

Our experienced staff assist in thermal and physical sizing of units using customised software (e.g. finite element analysis) which is translated into the automated manufacturing process to ensure continuity throughout the chain.



40 years of experience with more than 15,000 units delivered

Priority to quality and customer focus

Satisfied customers worldwide

ISO 9001:2000 certified

Design following DGRL and other recognised standards

## The Material: Graphite

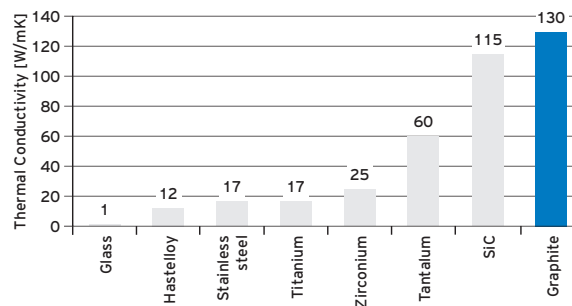
The critical success factors for high quality graphite processing are: an homogeneous texture, a uniform grain structure, a perfect graphite impregnation process and consistent mechanical and thermal processing. Providing these, ensures that our products meet the most demanding requirements (e.g. cGMP capabilities).

Graphite is characterised by its wide ranging and high level of corrosion resistance. It resists nearly all acids, solvents, chlorides and other halogen compounds as well as their corresponding alloys.

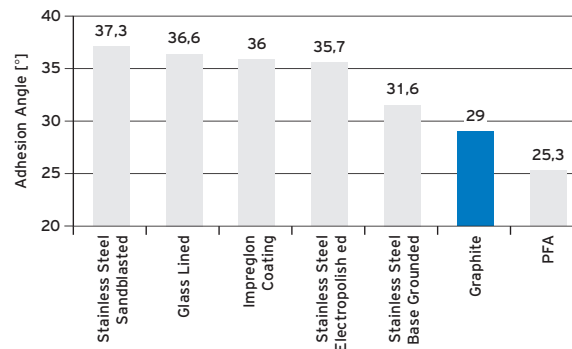
Graphite's thermal conductivity is much greater than most comparable corrosion resistant materials.

A very low tendency to foul compliments and helps qualify the material for use in one-ous applications

Comparison of the thermal conductivity of various corrosion resistant materials used in the chemical processing industry



A comparison of the adhesion angle as an indicator for the adherence tendency of various corrosion resistant materials



Duties as extreme as quenching flue gas at 1,300°C can be accommodated with graphite as it is capable of withstanding wall temperatures within the range of -60°C to +200°C.

Diverse processes can be accommodated with the large available pressure envelope -1 bar to +16 bar .

Different raw material manufacturing processes provide for differing graphite grades, i.e. mechanical strengths, allowable operating temperatures and chemical resistance.

The main criteria for the quality are the texture, the grain structure, the impregnation resin and the impregnation process

Providing the highest corrosion resistance against acids, solvents, chlorides and other halogenated compounds

Excellent thermal conductivity

Graphite is non-adhesive

A maximum temperature range of -60°C to +200°C allows process temperature of up to 1,300°C

A maximum pressure envelope of -1 bar to +16 bar

We have 3 graphite qualities serving different requirements

| G16-5-180

| G18-5-180 resp. G18-8-200

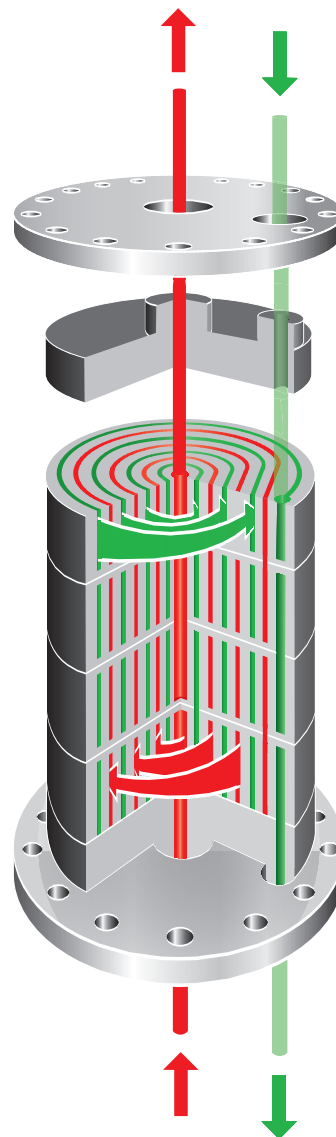
| G20-5-180 resp. G20-8-200

## The Design: Annular-groove

This unique design developed by GAB Neumann enables us to adapt the heat exchanger to the specific needs of the customer's operating requirements.

The geometry and design provides high turbulence, resulting in low fouling, automatic cleaning and high heat transfer.

Potential leak paths and cross contamination is minimised by eliminating or reducing gasketed joints.



Highly turbulent forced flow provides excellent automatic cleaning

Minimum fouling and high thermal conductivity provides best heat transfer

Leak paths minimised with no or few gaskets

## The Result

The combination of high performance graphite material and our unique annular-groove design provides a heat exchanger that meets perfectly the needs of our customers specialised and multipurpose units.

The annular groove heat exchanger combines an outstanding thermal performance with a small overall size. More than 20 m<sup>2</sup> transfer area per m<sup>3</sup> volume can be easily achieved.

The material and design permit the operation of our units under cGMP conditions. This model complies with the challenging requirements of API (active pharmaceutical ingredients) manufacturing in hundreds of cGMP plants worldwide.

Compared with other corrosion resistant materials our heat exchangers are characterised by their low cost price, their low maintenance requirements and therefore their low lifetime costs leading to higher profitability.



### **Technically perfect**

Use in single or multipurpose plants

High thermal performance

Small overall size

cGMP-compliant / qualified for API-production

Long lifetime

### **Economically outstanding**

Low cost price

Short delivery time

Low operating expenses

## Annular-groove Condenser NB/HB/KB

- Condensers for highly corrosive applications with high heat transfer
- Corrosion resistant on both service and product side
- Vertical or horizontal installation
- Dephlegmation applications possible
- Carbon fibre reinforcement (optional)
- Detachable header and bottom for mechanical cleaning of product side (optional)

### Applications (Examples)

- Condensing of chlorinated solvents and acidic chlorides in pharmaceutical, agrochemical or dyestuff industries
- Condensing vapours in inorganic processes (e.g. sulphuric-acidic vapours, hydrochloric vapours)



### Special Features

Both flow cross-sections are variable, thus resulting in high heat transfer rates and self-cleaning

No gaskets and therefore no risk of leakage

No critical swelling stress caused by the use of organic solvents

### Benefits

High operational safety

High operational availability

Minimised maintenance needs

Small heat transfer area requirements

Small special needs

## Annular-groove Heat Exchanger G1

- Heat exchanger for highly corrosive applications
- For direct vertical installation in columns
- Corrosion resistant both on the service and product side
- cGMP design (optional)

### Applications (examples)

- Use as a dephlegmator in the partial condensation of solvents
- Heat input into a column (e.g. as an evaporator "Robert" type)
- Application as a head condenser in a column with reflux separator

### Special Features

Direct access to product grooves

Extremely small overall height

### Benefits

Easy to clean on the product side

Small required space in column

## cGMP Annular-groove condenser NB/GMP / HB/GMP

- Condenser for cGMP applications (e.g. in pharmaceuticals synthesis)
- For highly corrosive applications at a high thermal efficiency
- Corrosion resistant both, service and product side
- Vertical or horizontal installation
- For applications where FDA or other special food processing requirements need to be met
- Carbon fibre reinforcement (optional)

### Applications (examples):

- Condensing of solvents in synthesis plants, especially in multi-purpose plants in the pharmaceutical and speciality chemical industry
- Condensing duties within the production of APIs (active pharmaceutical ingredients)
- Use within the production of food and food ingredients (i.e. flavours and fragrances)



### Special Features

Detachable header and bottom

Rotating cleaning device (PTFE)

No gaps, crevices and dead corners

Bonded construction without gaskets between product and service media

Inspection glass

### Benefits

Cleaning in Place (CIP) and mechanical cleaning possible

Completely drainable

In situ inspection with access for endoscopes and swab testing

No batch or cross contamination

No black particles due to special mechanical processing and cleaning

## Annular-groove Vent Condenser GN/GH

- Condenser for highly corrosive applications
- Corrosion resistant both, service and product side
- Vertical or horizontal installation
- Dephlegmation applications possible
- Inclusion of demister possible
- Carbon fibre reinforcement (optional)

### Applications (examples):

- Vent cooling of exhaust gas or vent condensing of corrosive vapours, e.g. for complying with VOC regulations (volatile organic compounds)
- Condensing and separation of corrosive vapours at the inlet or outlet of vacuum pumps



### Special Features

Large flow cross section

cGMP design (optional)

### Benefits

Excellent separation efficiency, e.g. for complying with exit air regulations

Small required space

Completely drainable

No batch or cross-contamination risk

## Annular-groove Heat Exchanger R/WA

- Heat exchanger for heating or cooling of highly corrosive media
- Corrosion resistant one side: R series
- Corrosion resistant both sides: WA series
- Carbon fibre reinforcement (optionally)

### Applications (examples):

- Heating or cooling of hydrochloric or sulphuric acids and solvents
- Heat transfer between two corrosive media
- Use as feed preheater for sump of column



### Special Features

Both flow cross-sections are variable, thus resulting in high heat transfer rates and self-cleaning

No gaskets and therefore no risk of leakage

Small overall height

### Benefits

Excellent heat transfer performance

Self cleaning

No cross-contamination

Low maintenance cost

High plant availability



## Annular-groove Dilution Cooler R-K

- Dilution and cooling unit for the dilution of sulphuric acid
- Separate inlets for concentrated acid and dilution water
- Inlet of acid through PTFE tube
- Carbon fibre reinforcement (optional)

### Applications (examples)

- Production of battery acid
- Dilution of concentrated acids in chemical production plants or fertiliser production
- Sulphate production for water treatment



### Special Features

Dilution and cooling combined in one unit

Dilution directly in the cooled segments

Continuous dilution and mixing process

### Benefits

Achieving final dilution and final temperature in one single process

High efficiency

## Wavy-groove Heat Exchanger W

- Special groove design for the application of annular-groove heat exchangers of R and WA series (single or both sides corrosion resistant)
- Qualified for media with a high fouling tendency
- Carbon fibre reinforcement (optional)

### Applications (examples)

- Cooling of process media in the bio-fuel production process
- Heating and cooling applications in the production of synthetic fibres



### Special Features

Special groove design for achieving maximum turbulent flow

Other features see R/WA series

### Benefits

Extremely low fouling risk

Excellent automatic cleaning properties

Very low maintenance needs

Highest plant availability

## Annular-groove Evaporator UB/FB

- Evaporator with forced or thermosiphon circulation: UB series
- Falling film evaporator with special distribution disc design: FB series
- Corrosion resistant on both service and product side
- Carbon fibre reinforcement (standard)
- Detachable header and bottom for mechanical cleaning of product side (optional)
- cGMP design (optional)

### Applications (examples)

- Evaporating organic media in continuous and batch processes (e.g. distillation, fractionation)
- Concentration of diluted sulphuric or hydrochloric acids
- Desorption of hydrochloric acid

### Special Features

Compact design

Easily and completely drainable

### Benefits

Small required space

High operational safety

## Conti-Reactor

- Mixing, heating and cooling of two or more process media reacting exothermically or endothermically within one continuous process
- Multiple heating and cooling circuits possible
- Maximum dwell time / reaction time depending on size of unit and volume flow (e.g. 15 min at 0,7 m<sup>3</sup>/hr)
- All circuits are corrosion resistant

### Applications (examples)

- Synthesis of active ingredients in agro-chemical industry by three separate, individually controlled steps
- Continuous chlorination (Cl<sub>2</sub>+HCl+Educt)



### Special Features

Designed for specific processes

Controlled input and output of heat at any stage of the process

Measuring of process data at any stage of the unit

### Benefits

Controllable, continuous mixing and heat exchanging processes with isothermal dwell sections in one unit

High process efficiency and recovery

Avoiding both overheating and subcooling means careful product protection

Significantly lower equipment cost by combining reactor, heat exchanger and controlling devices in one single unit

## Block Heat Exchanger

- All-purpose unit for cooling, heating, condensing and evaporating duties
- Vertical or horizontal installation

### Applications (examples)

- Heating pickling baths in steel industry
- Cooling of galvanising baths in steel finishing processes
- Condensing and cooling of hydrochloric acid in adiabatic absorption operations
- Evaporation of organic solvents



### Special Features

Single or double-row borings at the product side

Robust construction

Modular design

Easy to disassemble

### Benefits

Large transfer areas and comparatively low pressure drop on the product side

High operational safety

Mechanical cleanability

## Annular-groove Absorber

- For absorbing HCl and other halogenated-hydrogen based gases
- Use in scrubbing applications
- Co or counter current flow options
- Design for small, medium and large inert gas content
- Capacity for 40 kg/hr to 1,000 kg/hr HCl gas at 100 % concentration

### Applications (examples)

- Production of high purity hydrochloric acid

### Special Features

Cross sectional flow corresponding to decreasing gas volume

High mass transfer

Robust construction

### Benefits

Wide load area at highest absorption

High performance

Great operational safety

## Quenching duties

- Quench with spray lances
- For gases up to 15,000 m<sup>3</sup>/hr volumetric flow
- For gases up to 1,300°C inlet temperature
- Suitable for gases with halogens (e.g. Cl<sub>2</sub>, Br<sub>2</sub>) and NO<sub>x</sub>

### Applications (examples)

- Quenching of exhaust gas containing HCl, HBr and Cl<sub>2</sub> within organic polymer production
- Quenching in ore refining processes with approx. 15 kg/hr of solids content
- Quenching of CFC vent gas containing PTFE dust

### Special Features

Two or more spray lances

Excellent cooling due to continuous water film on wall surfaces and the cooling grooves in the wall

### Benefits

Suitable even with large gas volume variations

Treatment of highly oxidising gases

## Reactor / Agitated Vessel

- Vessel volumes from 5 L to 1,000 L
- Design pressures from -1 bar to +6 bar
- Heated or cooled vessel walls
- Carbon fibre reinforcement (optional)

### Applications (examples)

- Heating and reacting of thermally sensitive materials
- Storage of highly corrosive liquids



### Special Features

Extremely good heat transfer

### Benefits

Minimised heating and cooling times

Excellent heat transfer at low agitation power

Efficient and low cost alternative to small and medium sized glass lined or exotic alloyed vessels

## Column Internals

Based on customer's drawings and requirements we manufacture

- distribution trays
- sieve trays
- bubble-cap plates
- cascades
- supporting trays
- hold-down plates

On request, or if necessary we perform strength calculations (e.g. finite element analysis).

### Applications (examples)

- distribution trays for column (Ø400 mm - Ø600 mm)
- supporting and hold-down trays for packing (Ø600 mm)



Internals for vessels up to DN 800

Strength calculations (e.g. finite element analysis)

## Other Components

Based on customer's drawings and requirements we manufacture

- jet nozzles
- steam and water jets
- thermowells
- wiper blades (for thin film evaporators)
- inlet pipes for liquids, gases and vapours

On request, or if necessary, we perform strength calculations (e.g. finite element analysis).

### Applications (examples)

- jet nozzles for corrosion resistant vacuum jet pump (e.g. Δ38)
- overflow cartridge for distribution tray (e.g. Δ92 x 115mm)



Wide range of applications

Strength calculations (e.g. finite element analysis)

## Product and Application Overview

	Annular-groove Condenser NB/HB/KB	cGMP Annular-groove Condenser NB/GMP/HB/GMP	Annular-groove Vent Condenser GN/GH	Annular-groove Heat Exchanger G1	Annular-groove Heat Exchanger R/WA	Annular-groove Dilution Cooler R-K	Wavy-groove Heat Exchanger W	Annular-groove Evaporator UB/FB	Conti-Reactor	Block Heat Exchanger	Annular-groove Absorber	Reactor / Agitated Vessel	Quench	Separation Cooler
Condensation	●	●	○	●						○				○
Partial Condensation	●	○	●	●						○				○
Cooling of Corrosive Media	○	○	○	○	●	○	●			●		○	○	●
Heating of Corrosive Media	○	○	○	○	●	○	●			●		○		
Heat Exchange of two Corrosive Media	○	○	○	○	●		●			○				
Dilution Cooling (Sulphuric Acid)					○	●	○		○	○		○		
Mixing (+Cooling/Heating)						●			●			●		
Circulating Evaporation	○	○	○	○				●		●				
Falling Film Evaporation	○	○	○	○				●		●				
Absorption										○	●	○	○	
Other Mass and Heat Transfer Processes									●		○	●	●	
Liquid-Gas-Separation														●

● recommended

○ suitable

## We have successfully delivered to:

- | Ajinomoto Omninchem
- | BASF
- | Bayer
- | Boehringer Ingelheim
- | Clariant
- | Ciba
- | Degussa
- | DSM
- | Egis
- | Glaxo Smithkline
- | Hindustan Insecticides
- | H.C. Starck
- | IFF
- | Lanxess/Saltigo
- | Merck
- | Roche
- | Sanofi-Aventis/Chinoin
- | Symrise
- | Syngenta
- | Wacker Chemie

Please ask us for detailed references

Details on corrosion resistance, materials, designs and products can be found in our product information, work standards and SPOTs on the internet.

[www.gab-neumann.de](http://www.gab-neumann.de)