Reduce Fugitive Emissions
Save Environment

revoseal

Increase Plant Availability
Reduce downtime

Our Mission

1. revoseal stands for plant safety and highest plant availability at the maximum technological level.

2. We stay side by side with the international process industry as partner for seals and sealing systems.

3. We assure customer satisfaction and product quality with engineering and development in Germany

4. Our products exceed current state of technology in particular in regard of emission reduction.

Milestones

- Development of the fine cam profile gaskets (still state-of-the-art technology today).
- Development of the “JG” encapsulated flat profile gasket.
- Development of the “JP” flat profile gasket and the Vario centering system.
- Development of the “ECO +” gasket.
- Development of the “REVOLUTION” gasket.
- Development of the “VISIO” gasket.

Awards

- Cologne Environmental Award 2002
- VDI Award 2003
- German Environmental Award 2004
- Cologne Innovation Award 2006
- Finalist Innovation Award of the German Industry 2007
- Innovation Award of the German Industry 2008

Know-how for Process chains

- Refineries
- Chemical and Petrochemical
- Oil and Gas
- Machine Building
- Plant Engineering
- Power Generation
- Steel
- Renewable Energy
- Pharma and Food
- Ship and Submarine
- Automotive Industry
- Aerospace
- Astronautics
- Defence
- And many more

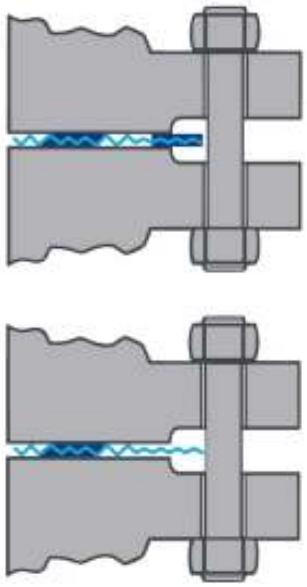
revoseal Revolution

- **Temperature** -200°C to +500°C
- **Pressure** From Vacuum to 64 bar / 400 lbs
- **Material** 1.4571 (316Ti) with Graphite or PTFE layers
- **Thickness** 1.6 mm +/- 0.1mm
- **Leackage class** Over-achieves TA-Luft and VDI 2290 in connection with a leakage check acc. to EN 1591-1 (also at using screws of minor quality)
- **Test results** $2.3x10^{-7}$ mbar x l/(s x m)

The Revolution gasket is an embossed flat profile gasket consisting of a flexible stainless steel carrier and encapsulated graphite or PTFE on both sides. By the revolutionary construction and flexibility of the embossed cog height double metallic sealing as well as encapsulation of the graphite or PTFE is guaranteed. Owing to its wide application range, Revolution is the alternative to all conventional flat gasket types.
Easy installation due to thin metal foil thus no graphite damage.
Excellent spring characteristics balance for pressure and temperature variations.
No retorquing.

revoseal Revolution: The Advantages

- **Easy Disassembly**
  No sticking due to encapsulation of the Graphite layers
- **Double metallic seal**
  without damaging the sealing faces
- **No Product contamination**
  Graphite encapsulation
- **Reduced Maintenance cost**
  excellent price performance ratio

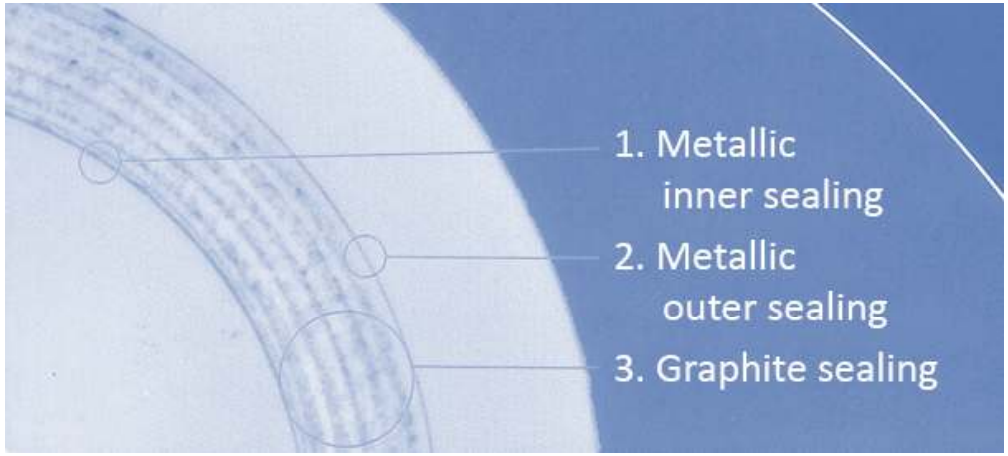


The Revolution Top has the same properties as the Revolution. It additionally provides a secondary sealing with low density graphite or PTFE. The secondary seal prevents from flange corrosion as often seen with carbon steel flanges.
The revoseal REVOLUTION reduces the number of different sealing types and cost of ownership and avoids misinstallation.

revoseal Revolution tested with fuji paper

During compression the graphite is uniformly pressed into the metal profiles. The metal “Teeth” get in contact with the rough flange surfaces.

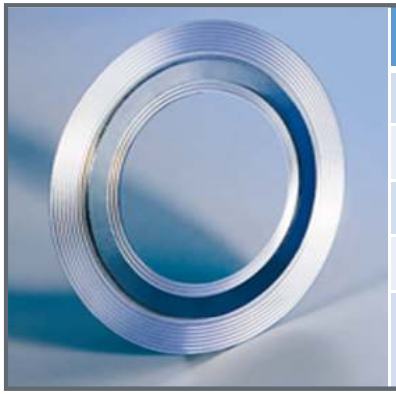
The secondary graphite or PTFE sealing element is limiting the maximum applicable load of the metal cogs and avoids intrusion deeper than the surface roughness of the flanges. Damaging the flange surface is impossible.



> the primary metallic seal is activated

> a concentric, uniform sealing load is guaranteed

revoseal Revolution in comparison with tanged graphite with metal inner eyelets



revoseal Revolution	
Temperature	-200°C to +500°C [1]
Pressure	max. 64 bar / 400 lbs [2]
TA-Luft results	2.3 x 10^{-7} mbar l / (s x m)
Material	1.4571 [3]
Thickness	1.6 mm (2 x 0.5 mm graphite + 0.6 mm SS)

- Metal seal with encapsulated graphite
- Reduced bolt torque requirements
- Higher flange load even with low bolt qualities
- Better handling as of flexible metal foil
- Compensation for pressure and temperature variations
- Best cost-benefit ratio
- Increased plant availability and safety

Tanged graphite with metal eyelets	
Temperature	-200°C to +500°C
Pressure	max. 160 bar / 900 lbs
TA-Luft results	2.1 x 10^{-4} mbar l / (s x m)
Material	1.4571[3]
Thickness	2.3 mm (2.0 mm Graphit with 0.1 mm tanged metal + 2 x 0.15 mm inner eyelet)

- No graphite shield/encapsulation
- Higher torque necessary
- Reduced flange load even with high quality bolts
- Higher risk of injury during installation
- Poor handling
- Flange sticking of graphite

[1] For temp. > 450°C consultation with manufacturer necessary
[2] theoretically up to max. 160 bar / 900 lbs possible
[3] Tanged insert in 1.4404 ; Inner Eyelet in 1.4571

revoseal Eco+

- **Temperature** -200°C to +500°C
- **Pressure** from vacuum to 160 bar / 900 lbs
- **Material** 1.4571 (316Ti) with graphite or PTFE layers (other materials on request)
- **Thickness** 1.6 mm +/- 0.1mm
- **Leakage rate** Over-achieves TA-Luft and VDI 2290 in connection with a leakage check according to EN 1591-1 (also by using bolts of inferior quality)
- **Result** 8 x10^{-8} mbar x l/(s x m)

revoseal Eco +:The Advantages

- **Robust Material combination: Stainless Steel with graphite or PTFE**
  The revoseal ECO + gasket has a solid stainless steel carrier with thin Graphite or PTFE layers on both sides.

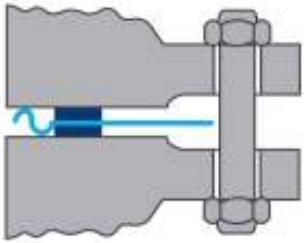
- **No Deformation: Elastic behavior at alternating forces**
  On the medium side, a resilient cog is embossed, which seals metallically on both sides of the flange.
  The resilient cog can balance forces caused by pressure and temperature fluctuations without being plastically deformed.

- **Less Maintenance: No bolt retorquing required**
  Due to the resilient design, retightening of the screws is no longer necessary even at strong pressure and temperature fluctuations.

revoseal Eco+: Model Diversity

Eco+

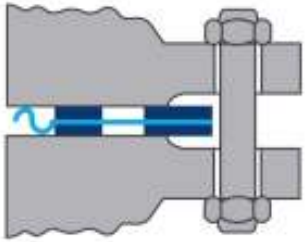
- Cog hight and graphite thickness and density are harmonized
- Absolute component and blow-out safety
- No product contamination with graphite
- Fire Safe



Eco+ TOP

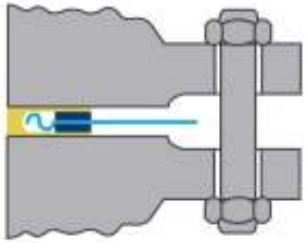
2nd seal with reduced density

- The secondary seal prevents from flange corrosion as often seen with carbon steel flanges.
- Non standard dimensions available up to 1.480 mm

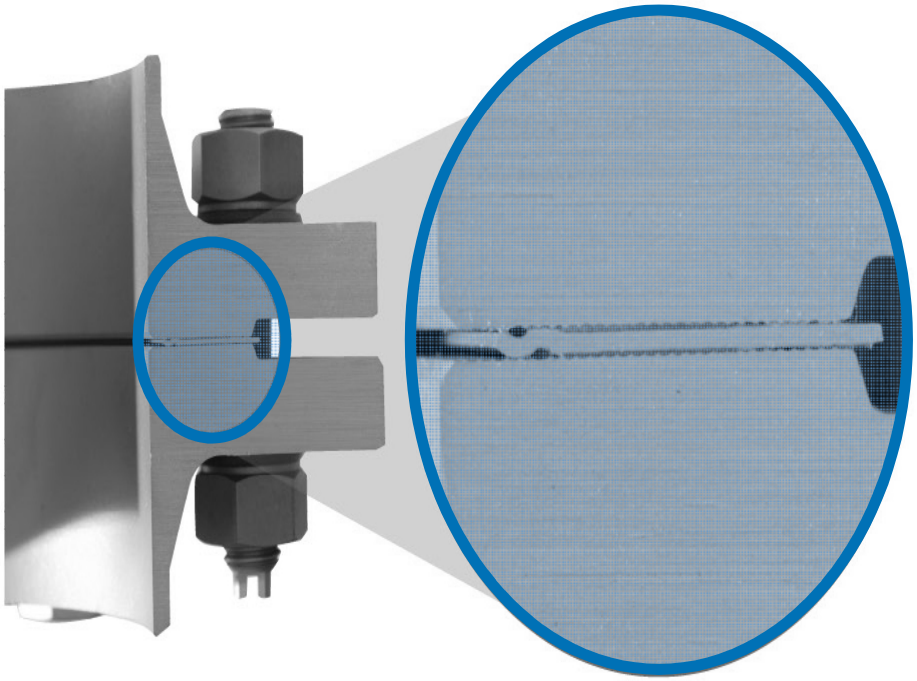


Eco PU

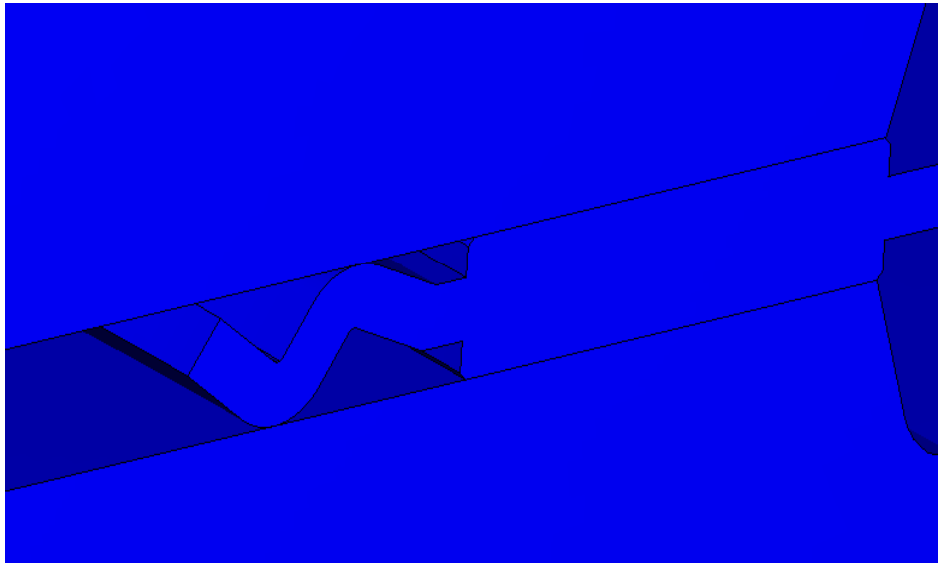
- The Eco PU has a PTFE-U–jacket with diffusion barrier. Therefore, it is best suited for aggressive media in plastic and enamel flanges.
- Even with low bolt torque forces high surface pressures can be realized. Thickness 2.7 mm



revoseal Eco+: The metal contact seal



The metal contact seal



Force and Flexibility

revoseal Eco+ in comparison to corrugated metal seals

	revoseal Eco+
Temperature	-200°C to +500°C
Pressure	max. 160 bar / 900 lbs
TA-Luft results	8 x 10^{-8} mbar l / (s x m)
Material	1.4571
Thickness	1.6mm (2 x 0.5 mm graphite + 0.6 mm SS)

- Metal seal with encapsulated graphite
- Reduced bolt torque requirements
- Higher flange load even with low bolt qualities
- Better handling as of flexible metal foil
- Compensation for pressure and temperature variations
- Best cost-benefit ratio
- Increased plant availability and safety

	Corrugated metal seal
Temperature	-200°C to +500° C [1)]
Pressure	max. 160 bar / 900 lbs
TA-Luft result	3.2 x 10^{-6} mbar l / (s x m)
Material	1.4571
Thickness	3.0 mm [2)]

- No graphite containment
- Higher bolt torque necessary
- Lower sterss even with high quality bolts
- Poor handling
- Graphite sticking
- No further densification of graphite in the grooves
- No permanent wave tension[3)]

[1)] For temp. > 450°C consultation with manufacturer necessary
[2)] Graphite pre-compressed
[3)] The gasket looses its sealability and the bolts have to be retightend. This process is limited.

revoseal Visio

- **Temperature** -200°C to +500°C
- **Pressure** from vacuum to 160 bar / 900 lbs
- **Material** 1.4571 (316Ti) with graphite or PTFE layers (additional materials on request)
- **Thickness** 1.6 mm +/- 0.1mm
- **Application** Pipes, heat exchangers, accessories, filters
- **Leakage rates** Over-achieves TA-Luft and VDI 2290 in connection with a leakage check according to EN 1591-1 (also by using bolts of minor quality)

revoseal Visio: The Advantages

- **Stainless Steel with graphite or PTFE**
  Solid stainless steel base with embossed inner and outer tooth and a graphite layer on both sides.

- **Additional metallic seal**
  A resilient tooth, which seals metallically on both flange faces, is embossed at the medium and the atmospheric side.

- **Easy Installation**
  The thin design avoids graphite damage.

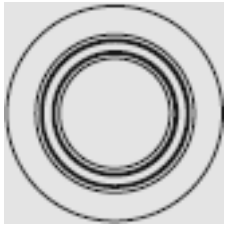
- **Compensation for Variations**
  These “flexible” cogs can handle alternating forces and temperatures without elastic deformation. No bolt retightening.

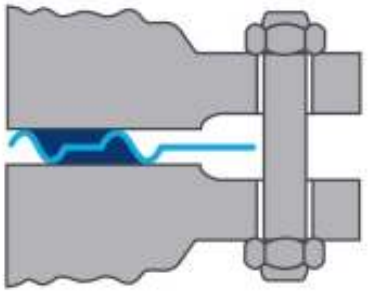
Seals are fire safe in accordance to API 607 and blow out safe to VDI 2200 requirements.

revoseal Visio

- **No plastic deformation**
  Cog height, graphite density and thickness are perfectly adjusted.Plastic deformation of the metal cogs during installation is impossible.

- **Double metallic seal**
  Avoiding damages of the flange surfaces and guarantees additional sealing.





Available in all dimensions with or without centering ring and with all standard partitions. (special dimensions on request)

revoseal Visio compared to camprofiles

revoseal Visio	
Temperature	-200°C to +500°C
Pressure	max. 160 bar / 900lbs
TA-Luft results	8 x 10^{-8} mbar l / (s x m)
Material	1.4571
Thickness	1.6mm (2 x 0.5mm Graphite + 0.6mm SS)

- Metal seal with encapsulated graphite
- Reduced bolt torque requirements
- Higher flange load even with low bolt qualities
- Better handling as of flexible metal foil
- Compensation for pressure and temperature variations
- Best cost-benefit ratio
- Increased plant availability and safety
- Higher blow out safety

Camprofiles	
Temperature	-200°C to +500°C [1]
Pressure	max. 160 bar / 900 lbs
TA-Luft results	3.2 x 10^{-6} mbar l / (s x m)
Material	1.4571
Thickness	3.5 mm

- Rigid connection
- No flexibility
- No spring characteristics
- No graphite encapsuation
- Poor handling
- Graphite sticking
- Shearing of graphite during installation

[1] For temp. > 450°C consultation with manufacturer necessary

revoseal JG / JP

- **Temperature** — -200°C to +1000°C (depending on the material)
- **Pressure** — Up to 400bar
  Dimensions — available in DIN and ANSI and with dimensions up to 4000mm
- **Materials** — 1.4571 (316Ti) with graphite or PTFE
  (other materials on request)
- **Thickness** — JG-1 ab 2.0mm - JP-1 ab 2.5mm
- **Applications** — Tongue and groove, Heat exchanger, appliances, filter etc.
- **Leakage class** — Over-achieves TA-Luft and VDI 2290 in connection with a leakage check according to EN 1591-1
  (also by using bolts of minor quality)
- **Test results** — Up to 1 x 10^{-11} mbar x l/(s x m)

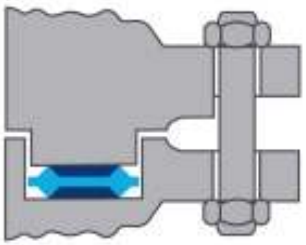
revoseal JG / JP – 1: The advantages

- Encapsulated stainless steel flat profile gasket with graphite or PTFE layers
- Tongue and groove principle in one solid gasket
  The hight of the inner and outer metal tooth is calculated based on optimized thickness and density of the graphite layers.
- Combined advantages
  Advantages of metal and soft gaskets were combined
- Extreme temperature and pressure resistance
  JG-1/2 to 160 bar and +500°C
  JP-1/2 from 160 to 400 bar and from > +500°C to +1000°C

revoseal JG / JP:Model Diversity

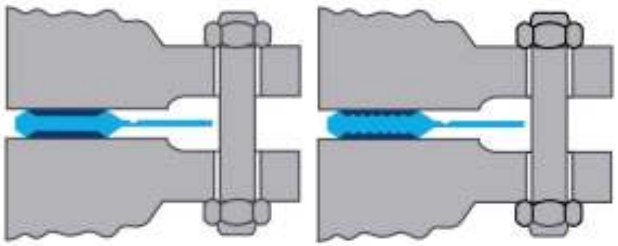
JG/JP 1

- Cog hight and graphite thickness and density are harmonized
- Absolute component and blow-out safety
- No shearing of graphite during installation, only minor graphite residues during removal



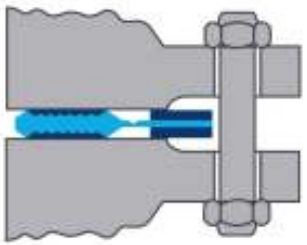
JG/JP 2

- In addition to the features of JG/JP-1 equipped with a centering ring with predetermined breaking groove or with a loose centering ring according to DIN EN 1092-1 and ANSI B 16.5/B 16.47 and B 16.47-B



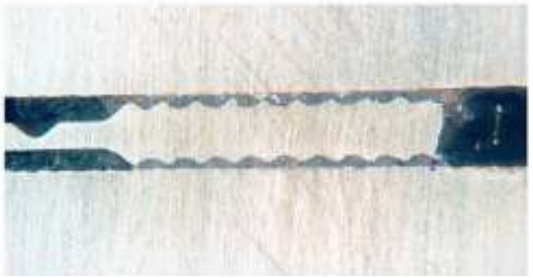
JP Top

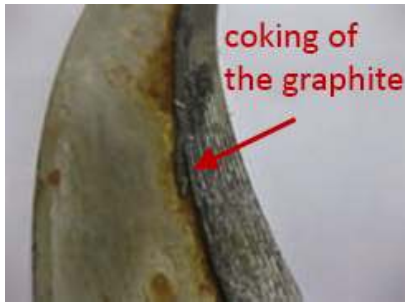
- Also available with a secondary seal suited for cold chemicals building a corrosive media in contact with air (atmosphere). Aggressive chemicals like Phosgen.
- Preventing flange corrosion



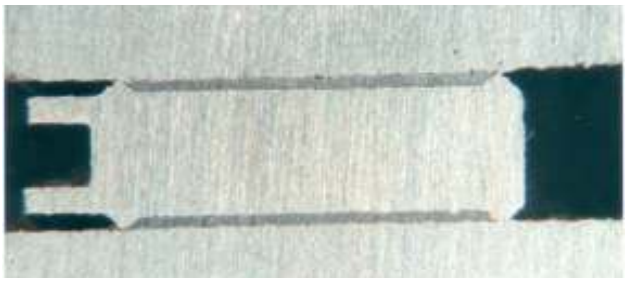
revoseal JG / JP – 2: Advantage of containment

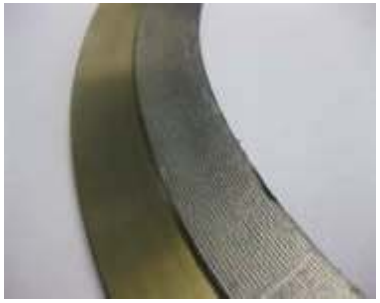
Camprofile

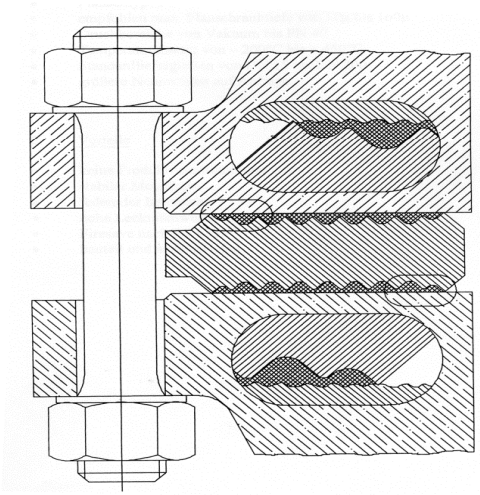




JG 2





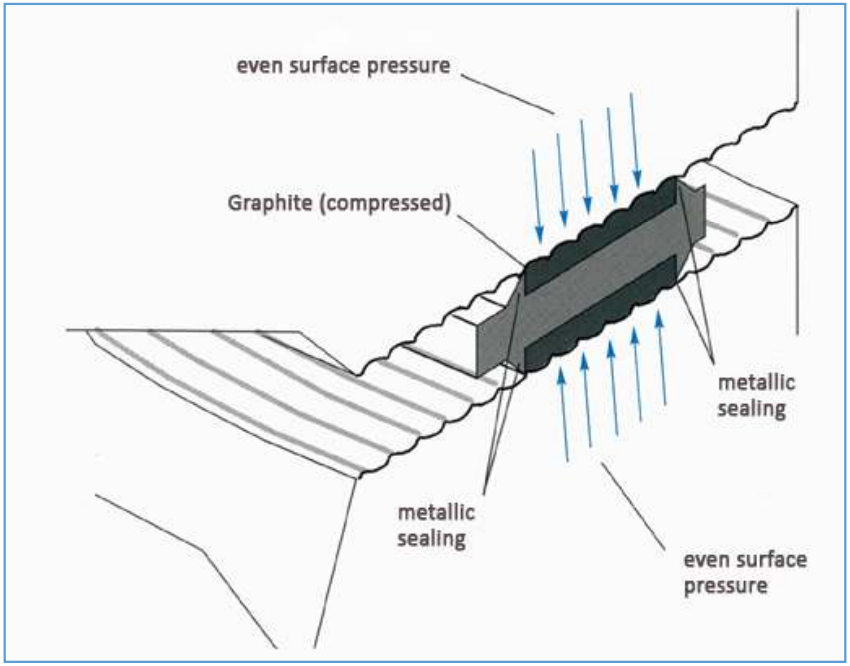


JP 2

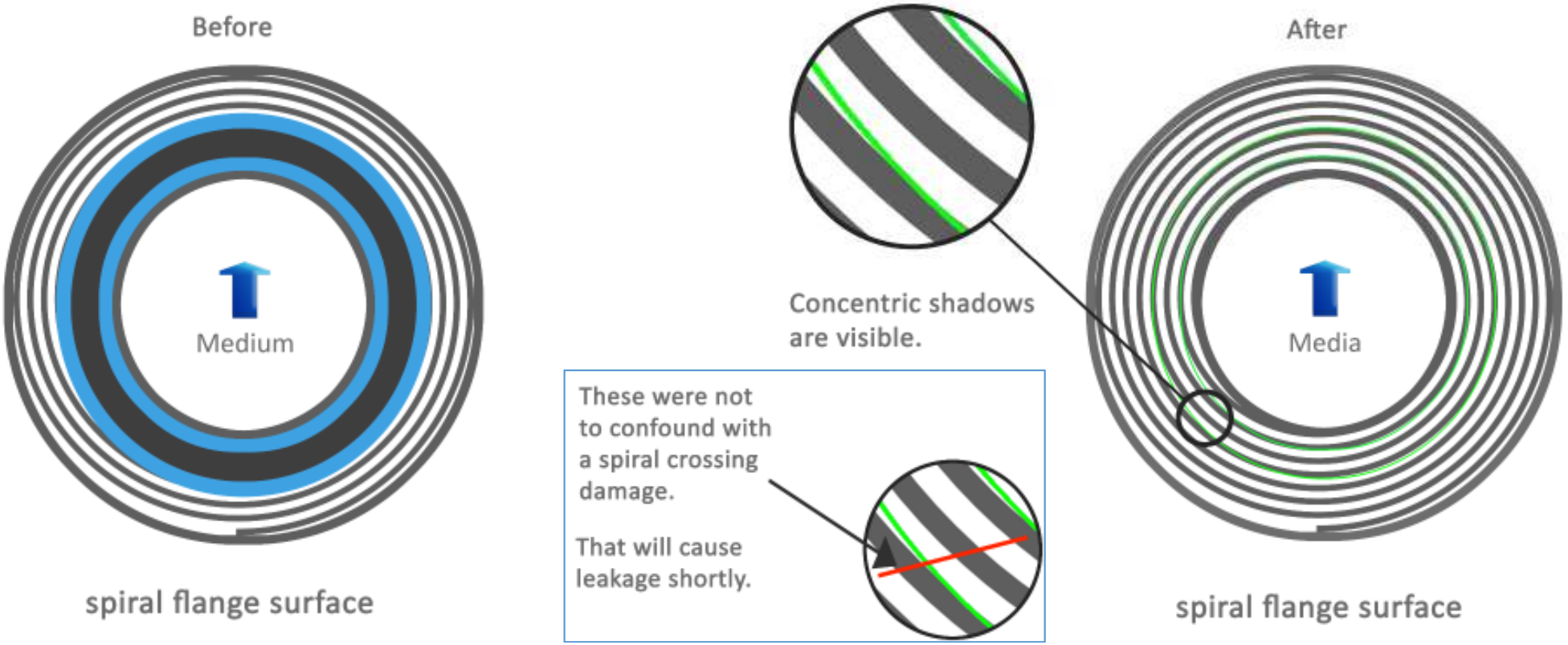
revoseal JG/JP - Functionality

The adjustable[1)] geometry of the teeth primarily seals in connection with the flange surface (roughness). A destructive penetration of the flange face will be prevented by the secondary sealing element graphite[2)].

1 Depends on metallic surface
2 Finally compressed graphit



revoseal JG/JP - Functionality



revoseal JG/JP – expert report of MPA Stuttgart

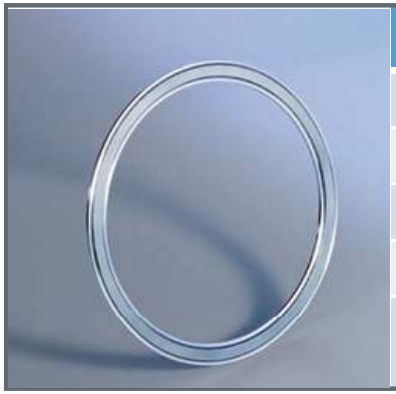
The MPA Stuttgart created a sealing performance report of 10x JG-2 gasket which were mounted on the same flange (successively).

Following leakage rate has been measured: 1st Mounting 4 x 10^{-10} mbar l/s
10th Mounting 15 x 10^{-10} mbar l/s

- Strict interpretation of test parameters → 40bar instead of 1bar (acc. to VDI2440)

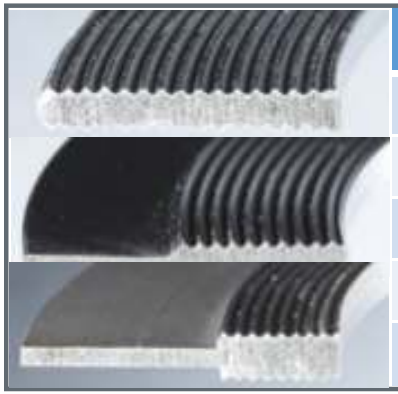
Result of the shadow lines on the flange → No relevant effect on sealability

revoseal JG/JP-1/2 (Picture JG/JP-1) in comparison to cams



revoseal JG/JP-1/2	
Temperature	-200°C to +1000°C [2)]
Pressure	max. 400 bar / 2500 lbs
TA-Luft results	1 x 10^{-11} mbar l / (s x m)
Materials	1.4571 oder 1.4541 (Standard)
Thickness	3.8 mm + 2 x 0.5 mm Graphite

- Metal seal with encapsulated graphite
- Reduced bolt torque requirements
- Higher flange load even with low bolt qualities
- Better handling as of flexible metal foil
- Compensation for pressure and temperature variations
- Best cost-benefit ratio
- Increased plant availability and safety
- Higher blow out safety



Camprofiles	
Temperature	-200°C to +550°C [1)]
Pressure	max. 400 bar / 2500 lbs
TA-Luft results	1.3 x 10^{-8} mbar l / (s x m)
Materials	1.4571 (Standard)
Thickness	4.0 mm + 2 x 0.5 mm Graphite

- No graphite containment
- Higher bolt torque necessary
- Lower stress even with high quality bolts
- Poor handling
- Graphite sticking
- No further densification of graphite in the grooves
- Shearing of graphite during installation

[1)] For temperatures > 450°C consultation with manufacturer necessary; PTFE layer suitable up to 250°C
[2)] Depends on metal type

revoseal JG/JP-1/2 (Picture JG/JP-2) in comparison to SWG

revoseal JG/JP-1/2	
Temperature	-200°C to +1000°C [2]
Pressure	max. 400 bar / 2500 lbs
TA-Luft results	1 x 10^{-11} mbar l / (s x m)
Materials	1.4571 oder 1.4541 (Standard)
Thickness	3.8 mm + 2 x 0.5 mm Graphite

- Metal seal with encapsulated graphite
- Reduced bolt torque requirements
- Higher flange load even with low bolt qualities
- Better handling as of flexible metal foil
- Compensation for pressure and temperature variations
- Best cost-benefit ratio
- Increased plant availability and safety
- Higher blow out safety

Spiral Wound Gaskets	
Temperature	-200°C to +550°C [1]
Thickness	max. 400 bar / 2500 lbs
TA-Luft results	1.3 x 10-8 mbar l / (s x m)
Material	1.4571 (Standard)
Thickness	4.0mm + 2 x 0.5 mm Graphite

- No graphite containment
- Higher bolt torque necessary
- Lower stress even with high quality bolts
- Poor handling
- Graphite sticking
- No further densification of graphite in the grooves
- Shearing of graphite during installation
- Strong leakage variations
- Risk of springs popping out

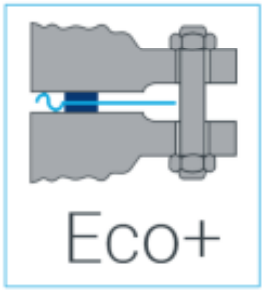
[1] For temperatures > 450°C consultation with manufacturer necessary; PTFE layer suitable up to 250°C
[2] Depends on metal type

Multiple Benefits of revoseal Gaskets

The experience of a well know chemical company reveals that the technology of revoseal gaskets provide multiple benefits at the same time.
The following facts were analysed during and after large scale plant shutdowns.
Record:
Since unique commissions frequest leakage was caused by utilization of standard "tanged graphite" gaskets.

- Alarm the plant fire brigade
- Instant shutdown of the unit
- Hydraulic retorque of the bolts – safeguarded by the fire brigade
- Costs per incident about USD 13,000

After installation of revoseal “Eco+” gaskets – the unit has started up 3 times *leakage-free*



Economic impact of fugitive emission loss

Fugitive emissions (also known as “invisible leakage") are not only a major environmental issue. Every year 3,30,000 tons of fugitive emissions (in the US alone) generate high costs for operating companies - which are mostly preventable.

An impressive example of an ethylen plant:

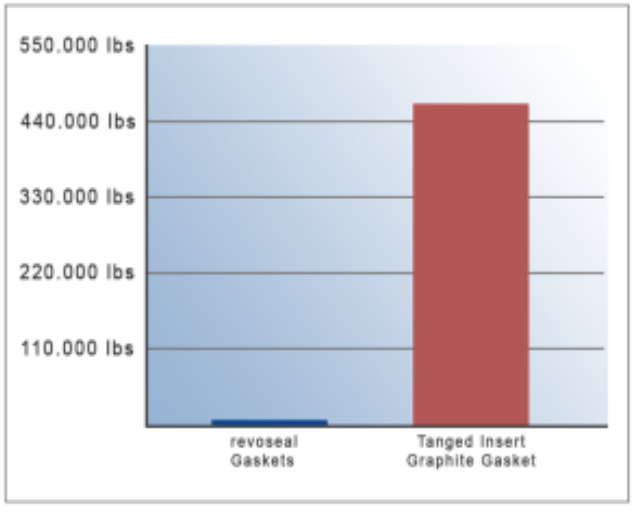
- **25,000 ANSI 6" Class 150 flanges**
- **25,000 ANSI 12" Class 150 flanges**
- **Maintenance interval 4 years**
- **Average pressure 360psi**

The plant losses over 4,80,000lbs of media in 4 years alone
The usage of extremely tight revoseal gaskets can reduce the loss to a tiny fraction of just 7,000lbs. Dramatically reduced media loss by 68.57 times.

Related to the value of the produced media this is a saving potential of over USD 1,00,000 per maintenance interval.

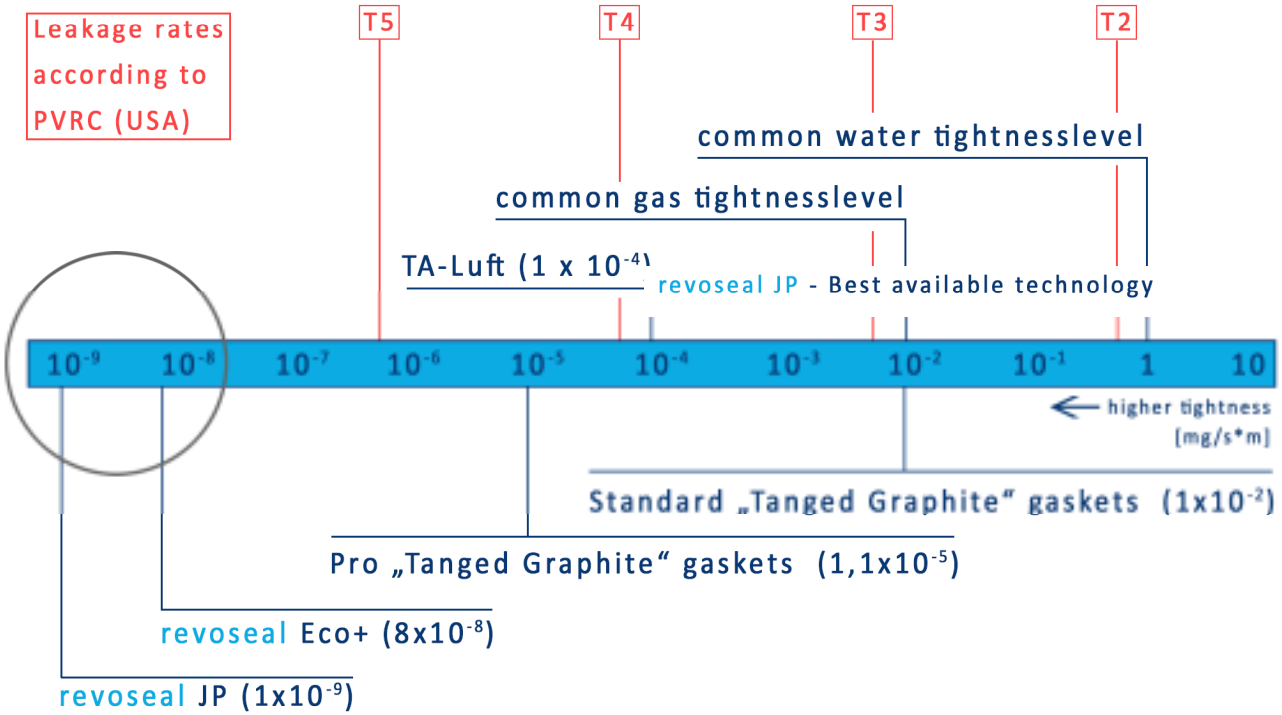
It shows that revoseal gaskets could help save the environment and also reduce the operators cost at the same time.

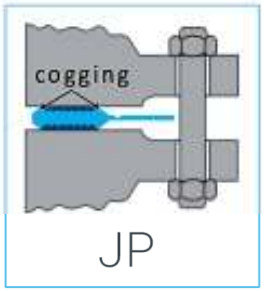
The diagramm compares the fugitive emissions of a standard and a revoseal gasket.



Leakagerate of industrial gaskets - state of the art

A high tightness class makes the difference between saving and wasting produced media as well as protect or pollute the environment.





revoseal JP - Best available technology

revoseal System Vario

The universal centering system can replace a variety of gaskets with different pressure ratings but the same standard dimensions in DIN or ANSI.

- **It offers a 100% centricity without mistakes.**

- **Available in combination with all encapsulated revoseal JG / JP gaskets and with serrated gaskets (cams).**

The advantages

- **Considerable reduction of type variations**
- **Accurate centering of the gaskets**
- **Huge cost savings in procurement and storage**
- **Always proper installation**
- **Easy assembly at using fatigue shaft bolts**

revoseal System Vario

- Using DIN flanges up to PN 160, customer can replace all four gasket dimensions with one gasket equipped with the Vario centering system.
- The same can be done with ANSI-flanges up to 600lbs.
- Customers using DIN as well as ANSI flanges in above mentioned pressure ratings can replace eight different dimensions with two Vario centering devices.

How does the Vario-system work?

If a customer has only DIN-flanges up to PN 160, he can replace four gaskets by one gasket with the Vario-centering system. If a customer has only ANSI-flanges up to 600 lbs, he can also replace four gaskets with the Vario-centering system. The customer using DIN as well as ANSI flanges in a.m. pressure ratings can replace eight dimensions of two different standards!

ANSI-flanges

DIN-flanges

Problems using Graphite

Time consuming cleaning of flange surfaces

Increased maintenance cost

Problems

The media has undercut the graphite.

- Sealing surfaces are corroded and unusable without refurbishment (machining).
- Flange was only one year in operation.

Safeguarding of a leaking flange connection.

- During production leakage had to be sealed by a specialized company.
- Generated enormes extra cost.

Product loss of a leaking flange connection.

- Graphite washed out by the media
- Product must be contained with special device.

The Solution

- All revoseal sealing solutions with graphite layers leave no or only minor graphite traces on the sealing surface.

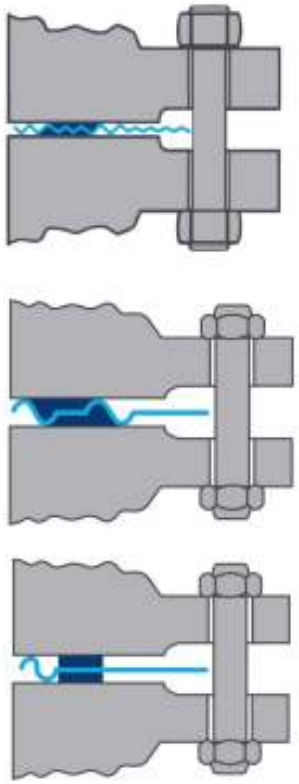
Why revoseal ?

- Remarkable reduction of diffuse emissions
- Higher plant availability and safety > Higher productivity, higher profit
- Unique technology globally > based on metal to metal seal with graphite or PTFE containment
- No bolt retorquing
- Extermely low graphite residues due to encapsulation > Enables quick gasket replacement and reduced maintenance cost.
  - … no bolt retorquing necessary; due to excellent spring characteristics
  - … no leaking flanges as of best in class technology and metallic sealing systems

Benefits of using revoseal gaskets

- Metal sealing with encapsulated graphite
- Reduced bolt torque requirements
- Higher flange load - even with low quality bolts
- Better handling as of flexible metal foil
- Compensation for pressure and temperature variations
- Best cost-benefit ratio
- Increased plant availability and safety
- Higher blow out safety
- Unmatched plant availability; e.g. in a steam cracker from originally 72 % to 99 %
- Dramatically reduced media loss resulting in enormous cost saving potentials
- Higher Safety, no accidents, no unexpected shut downs
- Environmental friendly, extremely high tightness level
- No graphite sticking, easy refurbishment and reduced time for regular shut downs
- Temperature capacities up to 1,000°C (1,800°F) without graphite oxidation. Can replace expensive metal seals like RTJ.
- Performs and meets highest environmental standards also with low grade bolts.
- Huge cost saving potential

revoseal



Revoseal Media References

Media	Pressure bar	Temp. °C	Media	Pressure bar	Temp. °C
Acetic acid	6	80	Acetic acid (gas)	1	> 700
Acetylene		> 550	Amine	3 to 32	-10 to 250
Bitumen + crude oil	25	400	C3, C4, gas/petrol	15 to 30	~ 240
Chloric Gas, Oxygen, hydrochloric acid (gas)		400	Cryogenic (highly flammable and poisonous gas)	16	-175
Steam, condensate, nitrogen, isocyanate, solvents, alcohol, off gas	up to 16		Explosive “ex" media (evaporating temp. 120°C)	fluctuating (down to no flow rate)	120 to 140
Hydrocarbons, Corrosive Comp. , Gases , Ammonia		550	Steam, Propylene (fluid+gas), Ethylene, Hydrogen	15 to 60	30 to 350
Syngas	320	90	Steam, nitrogen	4 to 15	250 - 430
Hydrogen chloride (HCL), Dichloroethane (DCE), Vinyl chloride (VC), Steam	40	700	R134a / R133a (coolant); Hydrogen chloride; Oxygen; Hydrogen fluoride	10	200 to 430
Steam	30	320	& many more applications. Detailed references available on request.		

REVOSEAL CLIENT REFERENCES	
Air Liquide Large	Bayer
Bayer Coatings	Bayer Material Sc.
Clariant	Daikin
Degussa	Elenac GmbH
Henkel	ISP GmbH
Kronos Titan GmbH	LanXess
Linde	Methanex
Norddeutsche Affinerie AG	Ruhr ÖL GmbH
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