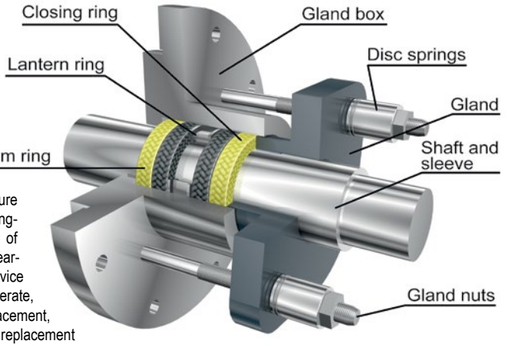
Technical parameters and conversion rates for the most common SINOGRAF's gland packings designed for industrial equipment

The group of packings	Base on modified expanded graphite				Made from PTFE fluorocarbon				Base on aramid synthetic fiber				Made of carbon and carbonized fiber			
The general features of base material	The black, metallic glossy material with high chemical and thermal resistivity and excellent conductivity. It has good self-lubricating properties.				The PTFE is special white plastic with the best chemical and thermal resistance. What is more this material has the extremely low coefficient of friction.				The aramid is a fiber with characteristic yellow colour. It has extremely high strength as well good wear and tear properties and thermal resistance.				Black and light fiber with excellent mechanical strength and good thermal conductivity. Moreover, high purity carbon has a good chemical resistance.			
Brand, type of packings	Grafopak GRA 450	Grafopak GRP 420	Inkograf IGR 600	Inkograf HTR 650	Tefapak TGR 260	Tefapak BOL 210	Tefapak PUR 200	Tefapak COR 230	Arampak XG 340	Arampak ZG 320	Arampak XP 310	Arampak AP 300	Karbon HR 660	Karbon XR 640	Karbon KA 400	Karbon KP 250
External appearance type of braid kind of impregnation																
More images and info on www.sinograf.com																
Construction materials	Flexible graphite + inhibitor	Flexible graphite in PTFE impr.	Flexible graphite + inconel	Flexible graphite + metal mesh	ePTEF + graphite dispersion	ePTFE and lubricants combination	100% purity virgin ePTFE	ePTEF + elastomer core	Aramid + graphited + ePTFE	Aramid + graphited + ePTFE	Aramid corners + + ePTFE	Aramid PTFE impregnated	High purity carbon fiber C98	Graphite + carbon corners	Carbonized fiber + flake graphite	Carbonized fiber + PTFE impregnated
Minimal temperature [°C]	-200	-200	-100	-100	-200	-100	-260	-40	-100	-100	-100	-100	-200	-200	-40	-40
Maximal temperature [°C]	450	280	600	600	260	260	260	260	260	260	260	280	600	600	400	250
Pressure in rotating [bar]	40	30	20	10	20	20	20	20	30	30	30	30	30	30	25	25
Rotatory linear speed [m/s]	40	20	10	10	25	15	15	10	20	20	10	20	20	30	15	15
Pressure reciprocating [bar]	30	60	30	60	400	100	400	40	600	200	600	300	200	200	300	100
Piston linear speed [m/s]	1	2	1	2	3	2	3	2	4	6	3	6	2	3	4	3
Pressure in valves [bar]	200	100	320	400	200	150	150	40	200	200	200	200	320	320	100	100
Coefficient pV [bar*m/s]	600	300	200	100	300	150	150	150	400	400	300	400	400	500	200	300
Chemical resistance [pH]	0-14	0-14	0-14	0-14	0-14	2-12	0-14	1-13	3-12	3-12	3-12	3-12	0-14	0-14	2-13	2-13
Min. sleeve hardness [HRC]	–	–	40	50	–	–	–	–	50	50	60	60	50	40	–	–
Average density [g/cm³]	1.1-1.3	1.1-1.3	1.1-1.3	1.35-1.5	1.45-1.7	1.55-1.6	1.4-1.65	1.5-1.6	1.4-1.55	1.4-1.55	1.4-1.55	1.4-1.5	1.2-1.4	1.1-1.3	1.25-1.35	1.25-1.35
Conversion rate from kg	**GRA 450**	**GRP 420**	**IGP 600**	**HTR 650**	**TGR 260**	**BOL 210**	**PUR 200**	**COR 230**	**XG 340**	**ZG 320**	**XP 310**	**AP 300**	**HR 660**	**XR 640**	**KA 400**	**KP 250**
Square 6 x 6mm [m]	21	21	21	18	17	17.2	18.4	17.2	17.2	17.2	17.2	18	19	21	20	20
Square 8 x 8 mm [m]	12	12	12	10.4	10.4	10	10.8	10	10.4	10.4	10.4	10.8	11	12	12	12
Square 10 x 10 mm [m]	8.0	8.0	8.0	6.8	6.6	6.4	6.8	6.4	6.6	6.6	6.6	6.8	7.2	8.0	7.6	7.6
Square 12 x 12 mm [m]	5.6	5.6	5.6	4.8	4.6	4.4	4.8	4.4	4.8	4.8	4.8	5.0	5.0	5.6	5.2	5.2
Square 14 x 14 mm [m]	4.2	4.2	4.2	3.6	3.5	3.2	3.6	3.4	3.5	3.5	3.5	3.6	3.8	4.2	4.0	4.0
Square 20 x 20 mm [m]	2.0	2.0	2.0	1.8	1.7	1.6	1.8	1.7	1.8	1.8	1.8	1.8	1.8	2.0	1.9	1.9
Square 25 x 25 mm [m]	1.4	1.4	1.4	1.2	1.1	1.0	1.14	1.1	1.12	1.12	1.12	1.12	1.26	1.4	1.2	1.2
Range of sizes	3 x 3 to 40 x 40 mm		4 x 4 to 25 x 25 mm		4 x 4 to 30 x 30 mm		4 x 4 to 30 x 30 mm		6 x 6 to 30 x 30 mm		4 x 4 to 30 x 30 mm		6 x 6 to 25 x 25 mm		6 x 6 to 25 x 25 mm	
Standard of packaging	spool 2.5 / 5 / 25 kg		spool 2.5 / 5 / 25 kg		spool 2.5 / 25 kg		spool 2.5 / 25 kg		spool 2.5 / 25 kg		spool 2.5 / 25 kg		spool 2.5 / 25 kg		spool 2.5 / 25 kg	
Areas of applications (Restricted to professional users for industry and technology.)	It is self-lubricant stuff, no wear of shaft, high thermal resistance. High speed dynamic seals of water and pure media.		The standard seal for high pressure steam valves, especially for power plant as well as industrial installation.		Soft and easy to use popular packing. In dynamic application it gives low wear of shaft and long time of work.		The clean and white stuff for food, pharmaceutics and chemical industry. Has FDA or EU 10/2011 cert for food contact.		High strength material for sewage, waste water, abrasive media. To apply in rotary and piston pumps also valves.		Not contaminate media seal. Clear and high strength seal for food, pharmaceutical also for pulp or paper industry.		The strongest graphited carbon fibre material to use combine with other as a closing ring of pumps seals and valves.		Special carbon fiber for seals with lower friction. For economic seals to use with sewage and light abrasive media.	

The pV coefficient indicate the intermediate parameters between extreme value of pressure and shaft speed, it shows correlation between seal load and degree of wear for the various kind of gland packings. All properties and application parameters shown throughout this table are approximate and may be mutually influenced. Your specific application should not be undertaken without independent study and evaluation of qualification. The conversion rates are approximate in large range, according to tolerances of size and density value cumulation, in extremal situation can deviate in range ±20%. All technical information and advices are based on our experience and will be given most conscientiously but without any liability. Before apply the indication and figures should be examined by the user and consult with ours specialist or technical advisor. We reserve the right to modify specifications at any time.

Packing Installation Instructions



Glands with soft packing are traditional and still primary means of sealing industrial equipment in rotating motion. They are characterized by simple design, low manufacturing cost, ease of install and deinstall, and minimal risk of sudden breakdown. Users may select suitable sealing material and optimise the solutions according to pressure, temperature and type of working medium. Despite its seemingly outdated concept, soft packing has a number of advantages, since in the majority of cases its wear-and-tear accumulation is currently signalled, a device with an expanding leakage may continue to operate, the can easily foresee and schedule packing replacement, the replacement is quick and downtime short, the replacement packing can be quickly delivered or is in own stock. Furthermore, soft packing's life has radically increased through the use of high performance flexible graphite, PTFE and aramid based materials, and its durability is currently equal to that of mechanical seals, while still superior to them in economic aspects. Soft packing's durability is even greater, because in modern pump gland solutions packing protection systems are used that consist of setting a lantern ring and providing a flushing fluid inside the sealing package thereby relieving the seal and preventing penetration of solid particles. More advanced solutions include also a particle deflector, autonomous system of barrier fluid, lubricating, flushing, cooling or sometimes a seal heating system.

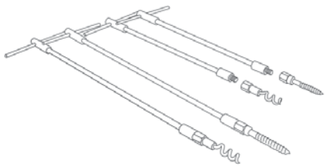
1. SAFETY CONSIDERATIONS

Packing itself contains no substances that under normal use could be harmful to health or the environment. However, during installation security measures should be always taken as appropriate for the device's operation. Prior to packing installation the device must be switched off and disconnected from the mains, with de-pressurised system, closed valves, and it must be made sure that no moving parts would endanger the operator. If a device operates with hazardous substances, the system should be pre-flushed, and the operator should use appropriate personal protective equipment.

As regards waste and worn-off soft package components, it should be taken into account that polymeric materials, including PTFE, aramids, silicones and most of elastomers, are resistant to biodegradation and can last long in the environment. Therefore, this kind of waste must be handled with care, and when dismantled must be disposed of or recycled by the packing supplier. It must never be burned or heated above 340°C. In high temperatures they may release dioxins, furans, fluorine compounds and other harmful fumes. This also applies to seemingly safe materials, plant fibre or expanded graphite based , which, even if made of safe and natural materials, also may contain harmful compounds captured from the working media.

2. DISPOSAL OF WORN-OFF PACKING

When removing worn-off packing, precautions should be taken so as not to scratch or otherwise damage the gland surface. Where working medium is clean and safe, after loosening a gland the worn-off package is easily pushed out by pressure in the system. In other cases a special extractor with a corkscrew shaped tip should be used. Extractors are screwed in at least two opposing locations in the old package, so that no seizure occurs, and then worn rings are pulled out evenly on the corkscrewing principle. Both when dismantling, as well as installing a new packing package, it's recommended to use specialized tools to facilitate the work, minimize the risk, and save time and money. Gland should be cleaned of corrosion and the media's crystallized residues.



Shaft or shaft sleeve should have clean and smooth surface without carbon deposits, nicks or cracks, any unevenness and cracks can lead to very rapid wear of the packing. In an extreme case, the shaft should be welded and polish up, or the shaft sleeve replaced. Newest packing solutions include a protective shaft sleeve with high hardness, which can be replaced or repeatedly polish.

3. GLAND INSPECTION

Quality and condition of the surfaces dynamically mating with packing has a significant impact on the packing wear rate. Because glands without the protective shaft sleeves are already rare, the term "shaft" will mean both a shaft and a shaft with a sleeve. Requirements for the shaft are similar to those for plain bearings,

i.e. surface roughness at the fine grinding level Ra≤0.63. Roughness of the remaining elements of the interface with packing does not matter, surface quality at the precise machining finish Ra≤5 level is sufficient. To avoid excessive shaft abrasion, suitable surface hardness of 60 HRC should be provided. For packing with a low friction coefficient, such as those PTFE based, these requirements are lower, and for flexible graphite the minimum hardness is not required at all, because the shaft is covered with a graphoid film, and friction from the shaft transforms into laminar friction inside the graphite, like in greases. However, any kind of packing can absorb abrasive particles from the working medium and thus indirectly wear the shaft.
The gap between the shaft and housing should not exceed the assumed standards, or at least of 0.5mm. For particularly worn-out devices, wherein this value may be exceeded, sealing rings can be used, made of packing with high mechanical strength, or packing reinforced in its corners with carbon or aramid. Shaft runout should be kept in the standard range and not exceed 0.1 mm or 1/100 of the packing width. If shaft runout is larger, it can be prevented by using a packing with elastomer core, which, with its greater flexibility, may take over vibrations off the shaft, and consequently enhance the packing durability despite more difficult operating conditions.

4. GENERAL RULES FOR PACKING SELECTION

Issues related to packing selection for specific operating conditions can be divided into two groups. The first group are the parameters which are treated arbitrarily, such as medium type and degree of its aggressiveness pH, temperature range and the right size (in short MTR - medium, temperature, right size). Their usefulness' assessment must also take into account the fact that some working media can react with, or possibly dissolve, the packing components. These criteria must be strictly observed, otherwise the packing will be destroyed or worn-off very quickly.

When choosing a packing in terms of temperature resistance one should be aware that the allowable operating temperature is not equivalent to the temperature. Due to friction, a gland operates at a temperature than the working medium, and thus a margin should be taken of at least 50°C. Where there is high pressure or high rotation, or possibly when gland operates on insufficient leakage, the temperature margin should be even greater. The second group are the parameters to a large extent relative, such as pressure, flow velocity and application type (abbreviated as pVA - pressure, velocity, application). This parameter group differentiates packings primarily in terms of strength and substantially does not determines the acceptable ranges of application. Soft packing material structure is not destroyed under the influence of only one of these factors, and only their concurrent action causes wear. So it is good, in assessing a material's suitability for gland packing, to employ dynamic load factor - pV, i.e. product of the velocity and pressure, which might concurrently occur in the application, without causing too rapid degradation. It is a reliable parameter that pretty well indicates at which pressures p and flow velocities V the packing material will retain comparable durability.

Another criterion that determines the packing selection is the type of application. In this case, specific conditions of the device's operation should take into account, such as high shaft speed in centrifugal pumps, high friction area in piston pumps, high pressure in valves, or large radial stresses in mixers. For most packings the limits are defined of operating parameters for a specific application type, e.g. maximum pressure in centrifugal pumps, in reciprocating, in valves and in static conditions.


centrifugal pumps

reciprocating pumps


valves and disc valves


flange or static seals

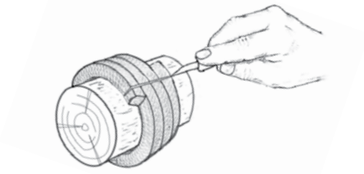
Also referred to application type are sanitary requirements for the packing material. In the food, pharmaceutical, and cosmetic industries most of the installations must meet high quality requirements imposed by standards and directives, including European Commission Regulation (EC) No 10/2011 on health standards for materials intended for contact with food. In such cases the materials should be used that have been tested on migration into simulants and have a Health Quality Certificate 10/2011. One can be guided by Polish NIH and/or US FDA certificates, or similar, but they are not sufficient criteria to meet current regulations on the EU market.

5. RING PREPARATION

Packing size should be so selected that after its formation the ring can be freely inserted into the gland's working gap, and at the same time does not leave too much play. In general, device manufacturers indicate the packing size and quantity required for replacement. This also can be easily determined by direct measurement of the gland's working gap or the shaft diameter and the inner diameter of the stuffing box. Half of the difference between these diameters is the size of the gap. Final packing dimension should take into account a margin for the twist and a slight installation play, generally 10-20% of the thickness, but this depends greatly on the packing type and assembler skills. Most packings are produced in size range from 4x4mm to 30x30mm with the progress of about 20%, giving it ample opportunity to adjust the size because of good flexibility. Whenever in doubt, a size lower in the same line should be chosen, because it is much easier to compensate for excessive installation play by pushing the gland than to repair assembly damage to ill-fitting rings.

In order to better match packing's profile, it can be slightly rolled out with a cylindrical tool without detriment to its properties, even if the profile will adopt a slightly rectangular shape. It's good to slightly roll out aramid or carbon fibre based packing to a trapezoidal shape, so that after rolling it in a ring and installing the packaging turn offset the trapeze and aligns the profile. This will cause a greater static pressure on the perimeter, and eliminate free space between packing rings on the gland's outside, and most importantly will relive the shaft surface. This assembly reduces sleeve's wear, accommodates lubricating film on the shaft and consequently prolongs the packing's life in the case of application of a packing with high mechanical strength.

Packing rings can be trimmed in several ways: by wrapping the packing around the shaft with the same diameter as the required one, using an instrument with a slider and computing scale, and by trimming sections based on theoretical calculations. Unfortunately, this method is most difficult and unreliable because the length of a section is not calculated by a simple formula, and packing's after-turn compression should be always taken into account, which varies depending on packing material and structure. A reliable method is to wrap the packing around a shaft, the diameter of which can be easily adjusted to the required one by wrapping a sheet of cardboard or flexible plastic around it. The ring should be slightly larger than the actual shaft diameter, so that the rings' trim is slightly oversized and consequently the installation play is between the shaft and the package. Packing on the shaft can be easily cut either at right angles or obliquely. Cutting at 45° angle is important for better seal of the lock ring, which is recommended for valves. Unfortunately cutting at right angles after rolling the ring does not produce exact contact of the lock surface. To remedy this, after marking the cut location and removing the packing from the shaft, each section should be cut at a slight slant on both sides. Depending on the packing structure and shaft diameter, to obtain proper bevel, the cut should be tilted by ca. 10° to 20° respective to the right angle.



However, the fastest and very precise method of section preparation is to use an instrument with a slider and computing scale. The instrument determines the section lengths based on the calculation slider principle, it takes into account the shaft diameter and packing size and defines cut locations taking into account the bevel for accurate lock setup. Packing should be cut with a sharp knife with a safe handle, by one decisive stroke. In order to maintain the blade's performance it should be sharpened periodically using tools, the use of which gives rise to small teeth on the blade to facilitate cutting. Many packings include, however, hard fibre or metal reinforcement, and some of them are made of aramid fibres, which are used also for ballistic cloth. For these reasons, cutting them is extremely difficult and normal tools quickly blunt. The ideal solution to this problem is to use a guillotine trimmer for packing, which not only enables easy and precise cutting of every packing type, but also measures section lengths and sets proper cut angle.

6. INSTALLATION OF RINGS

Correctly trimmed packing section should be rolled into a ring, so that its both ends match and form a tight lock without space. The first step is to insert the ring's connection into the chamber, and then gently slide the remainder in. It should be made sure that the ring is properly seated, by pushing it with the gland or a special tool in the form of a roll of flexible plastic. Persistent resistance and the degree of the pressing tool caving verify the

ring's proper settlement. Locks of each ring have to be each time moved by a certain angle, so as to distribute them evenly in the whole space and level formation of the package's weak points. To ensure gland's proper conduct, once the last ring is set, a place should remain, high at least at half the packing thickness.

Rings should be arranged closer to the packing box, with a slight clearance left at the interface with shaft. This aims at directing more pressure to the packing box's outer wall, and at relieving the shaft at start up. This facilitates liquid film formation and reduction in friction on the shaft, and prevents the risk of the whole package's rotation. Packing assumes its ultimate fit and form at its start-up and initial compression of the whole package.

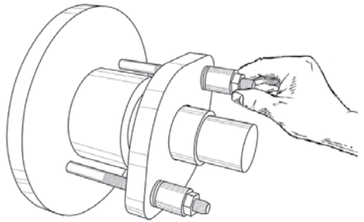
7. GLAND STARTING AND ADJUSTING

Once all rings are seated in the chamber, set up the gland and slightly tighten the screws. After releasing the shut-off valves and flooding, start the pump. In the first phase after start, the package should enable continuous leak of the pumped medium. At this time, the packing's volume is increasing due to the medium's absorption. This results with initial self-sealing by thickening of the packing and producing a gradual pressure in the shaft slot. For proper packing operation the leak is necessary, if it's stopped, loosen the gland to get the leak back.

After an hour the gland should be gradually and evenly tighten. Gland screws should be tightened gradually in intervals of several minutes, constantly keeping the drip. Repeat the process until it leaks at rate of 60 drops per minute or more, but the resulting leak may be largely dependent on the type of medium, pressure, temperature, shaft non coaxiality, and the packing type. Gland temperature cannot unnaturally increase at this, maximum increase of 50°C above the medium's temperature is allowed, otherwise the pump must be stopped, the gland loosen, and the start up process repeated.

If gland is equipped with a system of barrier and/or coolant fluid or lubricant, which is an increasingly common practice of manufacturers of impure and/or hazardous pumps and pumps operated in suction mode, remove all debris from supply ducts and lines, and check their patency. Package should include a special lantern ring, usually between 2. or 3. packing rings, placed so as

to ensure free flow of liquid from the input opening in the packing body. Barrier fluid pressure only slightly exceeds the medium pressure and every dirt can easily clog the ducts. Flushing ring has to maintain a certain distance and patency of the duct between the packing's both parts, and if it underperforms or is excessively worn, it should be replaced.



Throughout packing life the leak/ drip should be controlled and accordingly adjusted. Particular attention should be paid in the event of changes in pump's operating parameters, if the pressure drops, the drip may be interrupted, and packing temperature rapidly increase, which will ultimately lead to seizure and damage to the package. Total package's wear in one operating cycle should not exceed 50% of its initial height. A package so worn out should be replaced. Setting new rings in order to prolong life is not recommended. Packing makes most harm in the final period of operation, when its structure is degenerated and contains a lot of particulates and wear products intercept from medium.

8. PACKING INSTALLATION IN VALVES

Seal tightness requirements are higher in glands in industrial fittings. In this case, almost complete tightness is expected, whereas in pumps a small leakage is intentionally allowed. The movable member of fitting seal node performs relatively slow rotation or axial motion and due to the small friction energy higher gland pressures can be applied, and, consequently, the gland operates virtually with no leak. At the same time, however, the increased pressure with sometimes significant gaps between the gland's spindle and housing can cause sealant extrusion of through the gaps. Therefore, sealing packages used in valves should have a more compact structure or special metal reinforcement.

In the case of packing installation in power plant fittings, where operating pressure and temperature are very high. In power plants steam pressure can be up to 300 bar at temperature up to 650°C. Such high operating parameters significantly limit the range of materials used for graphite-metal seals, the installation of which requires a slightly different procedure. In order to properly install seals in fittings, properly trimmed rings should be prepared and set in the packing box, as is the case in pumps with that oblique cut provides a better seal of locks on the rings. Press the gland until resistance is clearly felt, at the same time unscrew the valve spindle so as to determine the possibility of the valve's adjustment. Graphite packing with initial density 1.1g/cm^3 should be compressed to density at least 1.4g/cm^3, that's why after filling the box the gland should be pressed and the package compressed to 70% of its original volume, or, possibly, 1 or 2 packing rings might be added sealant and the compression operation repeated. Static pressure up to 70% of the original package height takes into account the installation play of 10% resulting from the difference between packing size and the actual size of the gland's working gap, and if the play increases, also the static pressure must increase, e.g. with installation play 20% the required static pressure increases to 63%. If a valve gland is originally provided with disc springs, the correct gland pressure should be achieved after closing the disc springs. It's good to use rings of composite sealant braided with HTR metal mesh or of carbon fibre. After installing the valve in the process line the leak should be checked, and after one day the operation the gland should be tightened, even if there has been no leak.

A common practice is to use ready-made packages of preformed flexible graphite rings with density 1.4-1.6 g/cm^3. In this case there is no need for packing pre-compression and it is enough to press the gland after the ring package installation with proper force specified by the valve manufacturer, or applied by the disc springs. Generally graphite packing in a valve requires pressure of 60 to 120 N/mm^2 and it's easy to estimate the bolts tension dividing this value by the horizontal cross-sectional area of the sealing ring.

Flexible graphite rings may also be made in-house of graphite tape (ribbed tape preferably), which after winding onto the valve spindle has to be compressed with the gland to density above 1.4 g/cm^3. Graphite tape gets this dense upon application and release of pressure 30-50 N/mm. Tape quantity used for a ring should be so selected that, once formed, the ring has square cross-section.

Where low pressure valves, water and gas fittings, all kinds of gate valves and plumbing equipment are sealed, anywhere where operating conditions are not so extreme as in power plant fittings, more types of sealing materials may be used. Many suppliers differentiate between valve and pump packings, but as regards these seals it can be assumed that any pump packing can also serve as valve packing, the general selection criterion for is the pressure, temperature and resistance to specific medium. Low pressure fitting seals are also leak-free, but the sealing package does not require pre-compression, as in the case of flexible graphite. Gland has to be so tightened at start up as to stop the leak completely, and then, after some time, the screws should be re-tighten to gain some pressure margin.

As regards fittings, much higher gland pressures should be always applied than in pumps, generally 2 or even 3 times the service pressure. In practice it is known that higher contact pressure gives more reliable seal without the need for adjustment in the long term but, unfortunately, the seal under such conditions wears more quickly. These aspects depend largely on the type of sealant and operators' skills. Maintenance staff's experience and expertise in specifics of the maintained equipment is an invaluable best practice of packing installation and cannot be substituted with even the most detailed instructions.