

PACKINGS FOR CONTROL VALVES

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INTRODUCTION

The selection of stem (or shaft) packing for a control valve must be done taking into account very important factors such as:

- temperature of process fluid
- characteristics of fluid
- working pressure

The **temperature** of process fluid is the most important parameter which affects the selection of type of packing. It fixes in fact which materials can be used for packing construction independently from other factors.

For example pure PTFE cannot be used for continuous duty when temperature is higher than 200 °C as well as pure graphite is mandatory when temperature exceeds 250 °C.

The **characteristics of fluid** may be determinant in the selection of valve packing when controlled fluids are highly abrasive or viscous. In these particular cases the lifetime of packing can really be very short if special reinforced packing rings are not used.

High working pressures (above 100 bar about) make necessary to select stiffer packing rings which are not easily subject to be extruded or to be excessively packed. Pure PTFE V-rings for example can be used up to a maximum working pressure of 150 bar, while for higher pressures glass loaded PTFE V-rings have to be selected.

On vacuum service packing rings have to grant a perfect sealing to avoid the reduction of the efficiency of various connected equipments.

The necessary qualifications of a valve packing for a PARCOL control valve, are in order of importance as follows:

- 1) sealing capability
- 2) low friction
- 3) lifetime
- 4) wide range of use

1) Sealing capability of a valve packing is strictly related to:

- the intrinsic characteristic of the sealing rings
- the design and construction of metallic parts of packing assembly.

The following factors are particularly important by the point of view of sealing:

- a) the proper alignment** of stem and metallic parts of packing;
- b) the clearances** between stem and other metallic parts of packing. When clearances are very narrow the stem may be scratched and consequently leakages can occur; for this reason usually non metallic scrape ring are used;
- c) the surface finishing** of stem and packing box chamber as well as of follower, lantern ring and spacers must be as smooth as possible (max roughness $R_a = 0,4\mu\text{m}$);
- d) the number of rings** which assure the sealing.

A reduced number of rings requires high compression thrust with possible damages of packing rings (extrusion and over-pack).

An excessive number of rings does not allow the correct compression of bottom sealing rings; these additional rings produce an increasing of stem friction without improving packing sealing.

The ideal packing should include the appropriate number of rings in order to get maximum sealing by minimizing the required follower compression and stem sliding friction.

Practically the number of packing rings to be used is defined on the basis of various tests and experiences in

order to reach the best compromise between sealing properties and friction.

2) Low friction

The packing compression must not exceed in any case the strictly necessary value to obtain sealing.

The construction using spring loaded PTFE V-rings avoids excessive compression strength, as the only possible additional one is caused by the increased pressure of fluid. The friction on stem is a conditioning factor for the performance of a control valve as if it is too high, the operation of the complete control loop can be compromised. The addition of valve positioner will guarantee a constant relationship between input signal and valve plug position, but possible dead times in valve positioning cannot be completely avoided.

The work of research to find out a low friction packing has caused the wide use of PTFE as basis material for packing rings (V-ring, braided split, ring etc.)

The following factors will help in reducing packing friction:

a) material used for sealing part construction.

PTFE has a very low friction coefficient on polished steel (about 0,03) and negligible starting friction. The pure graphite has a higher friction coefficient than PTFE (about 0,07) and may have higher starting friction when used in the form of die-formed solid rings obtained by wrapping up a graphite ribbon.

b) constructive shape of sealing ring.

PTFE V-rings can be manufactured in various shapes and with different stiffness. More flexible rings cause lower friction and better sealing properties at low pressures.

Pure graphite rings consist of solid die-formed rings obtained by wrapping up a graphite ribbon. They have rectangular shape with different size depending on the stem diameter.

c) lubrication

Generally packing rings made of pure PTFE or pure graphite do not require lubrication.

d) number of rings

A large number of sealing rings should be the cause of the excessive friction due to an incorrect compression adjustment.

As stated above it is impossible to give strict rules because of the large varieties of available packing rings. In general the more the operating pressure increases, larger number of rings is requested.

e) finishing of stem

The more the surface roughness of plug stem is reduced, lower packing compression is required with consequent low break away and dynamic friction coefficient.

3) Lifetime

It depends upon the wear of sealing rings and stem.

The possible causes of excessive wear are excessive stem surface roughness high sliding velocity of plug stem, presence of solid particles, excessive compression of packing rings.

The stem can be scratched by a wrong contact with metallic parts of packing assembly due to mechanical misalignments or reduction of clearances because of differential thermal expansions.

To avoid damages of stem on heavy duty services hardened materials or chromium plated stainless steel can be used.

Fig.1,2 - ISO 15848-1 QUALIFICATION TEST ON PARCOL GLE 200 AND GLE 400 PACKINGS



Table 1 - THERMAL DIFFERENTIAL BETWEEN PROCESS FLUID AND PACKING ACCORDING TO FLUID TYPE AND BONNET STYLE

Fluid type	Bonnet style		
	Plain	Extension	Finned
Gas	0	100	135
Superheated vapour	0	100	135
Saturated vapour	0	0	0
Liquid	0	140	185

Table 2 - PRESSURE AND TEMPERATURE LIMITS FOR PACKINGS

Packing Type	Temperature limits - °C ^{(1) (2)}		Max pressure - bar		Vacuum service	PH range
	continuous	peak	continuous	peak ⁽³⁾		
TFK - PTFE aramid fibers reinforced	-200 ÷ +250	-220 ÷ +260	150	225	Yes	2 ÷ 12
TFP - Pure braided PTFE ⁽⁴⁾	-200 ÷ +200	-220 ÷ +250	150	225	Yes	0 ÷ 14
GRF - Pure Flexible Graphite ⁽⁵⁾	-150 ÷ +650 ⁽⁶⁾	-200 ÷ +650 ⁽⁶⁾	400	450	Yes	0 ÷ 14
VTC - 25% glass loaded PTFE V-ring ⁽⁷⁾	-100 ÷ +210	-120 ÷ +250	250	400	No	0 ÷ 14
VTC 200 – ISO 15848-1 Class C certified ⁽⁷⁾	-29 ÷ +210	-29 ÷ +210	250	250	No	0 ÷ 14
TLE - PTFE + Graphite - TA-Luft compliant	-50 ÷ + 250	-70 ÷ +260	250	400	Yes	1 ÷ 13
GLE 200 - ISO 15848-1 Class B certified	-29 ÷ + 200	-29 ÷ +200	250	250	Yes	0 ÷ 14
GLE 400 - TA-Luft & ISO 15848-1 Class C certified ⁽⁹⁾	-200 ÷ + 400 ⁽⁸⁾	-220 ÷ +420	300	450	Yes	0 ÷ 14

⁽¹⁾ Minimum working temperatures are not limiting factor against icing on the stem at the bonnet coming out (-10 °C).

⁽²⁾ Inlet valve fluid temperature.

⁽³⁾ Applicable for hydrostatic pressure test only.

⁽⁴⁾ Pure braided PTFE lubricants free for oxygen service.

⁽⁵⁾ Die-formed solid rings obtained by wrapping up a graphite ribbon.

⁽⁶⁾ Max operating temperature for oxidizing fluid service is 400 °C.

⁽⁷⁾ Due to high dead bands the use of positioner is suitable to get a good and correct control.

⁽⁸⁾ 550°C for steam service.

⁽⁹⁾ See page 9 for ISO 15848-1 temperature and pressure limits.

Type TFK

Composition : Parcol packing TFK type is composed by precision cut, die-formed rings, made of braided multi-filament high quality, aramid fibers reinforced, PTFE. At the top and bottom of packing rings set are supplied two special solid rings made of glass loaded PTFE which avoid the extrusion of sealing rings and, at the same time, clean the plug stem from foreign materials. Packing compression is allowed through packing flange, follower and suitable bolting.

Advantages : Packing friction of stem is very low. Longer trouble free working life even with slightly high working temperatures.

Maximum working Pressure : 150 bar (peak 225 bar)

Minimum working Pressure : Due to the symmetric shaped seal rings, this packing is suitable also when vacuum sealing is required.

Maximum working Temperature : 250°C (peak 260°C)

Minimum working Temperature : -200°C (peak -220°C)

PH range: 2 ÷ 12

Fluid compatibility : No particular limitations except for strong oxidizing acids (nitric and sulphuric ones) and other highly oxidizing fluids, such as permanganates, chromates, etc. - Not to be used on oxygen service.

Lubrication : Not required.

Type TFP

Composition : The same of TFK except for sealing rings made of pure braided PTFE.

Maximum working Pressure : 150 bar (peak 225 bar)

Minimum working Pressure : Due to the symmetric shaped seal rings, this packing is suitable also when vacuum sealing is required.

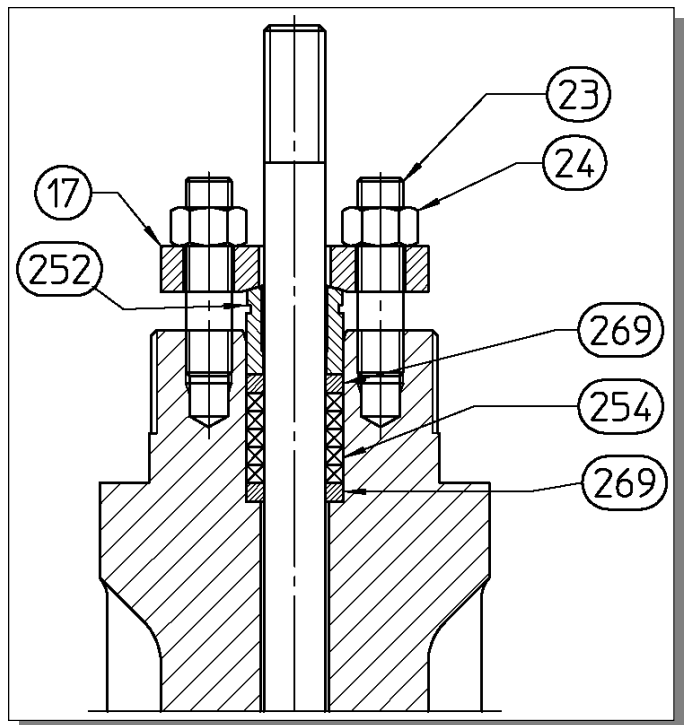
Maximum working Temperature : 200°C (peak 250°C)

Minimum working Temperature : -200°C (peak -220°C)

PH range: 0 ÷ 14

Fluid compatibility : Parcol TFP packing is compatible with all process fluids and suitable for oxygen service or when pure PTFE is required.

Lubrication : Not required.



ITEM	PART NAME
17	PACKING FLANGE
23	STUD
24	NUT
252	PACKING FOLLOWER
269	END RING
275	PACKING RING (nr. 5)



Type GRF

Composition : Parcol packing GRF type consists of solid die-formed rings of pure graphite obtained by wrapping up a corrugated ribbon into suitable matrix die. Among the three sealing rings intermediate scraper rings made of solid graphite are fitted. Packing compression adjustment can be obtained through packing flange, follower and suitable bolting. Nuts for packing compression adjustment are provided with lock nuts.

Advantages : The packing type grants high mechanical strength and a very long working life with minimum maintenance. In addition it is suitable for all chemical compounds and maintains the same flexibility and homogeneity even at very high temperatures and pressures.

Maximum working Pressure : 400 bar (peak 650 bar)

Minimum working Pressure : Due to the symmetric shaped seal rings, this packing is suitable also when vacuum sealing is required.

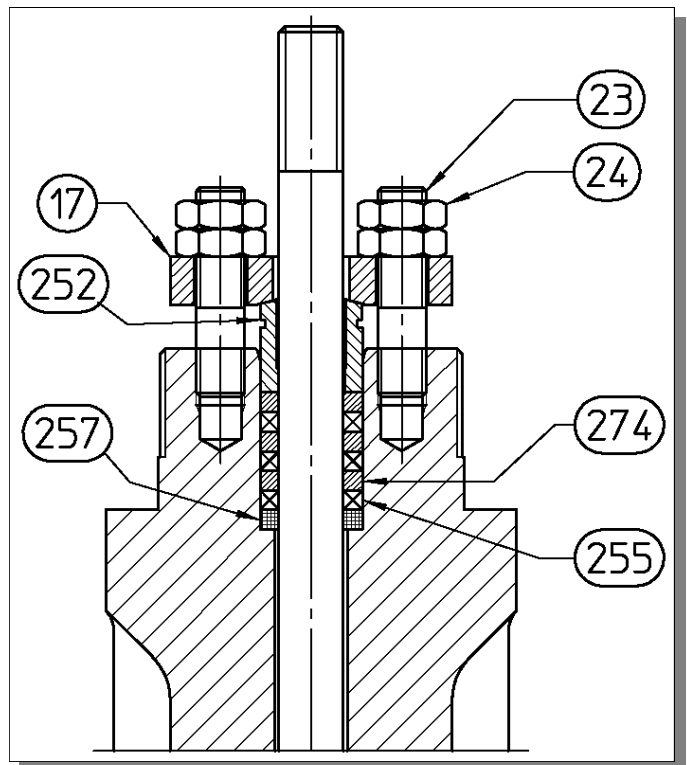
Maximum working Temperature : No practical limit is given. When used on superheated steam the maximum temperature can be assumed 650 °C.

Minimum working temperature : -150 °C (peak -200 °C).

PH range : 0 ÷ 14

Fluid compatibility : No important limitations are known. Caution has to be adopted on appliances including strong concentrated acids (such as nitric and sulphuric ones) as well as other chemical compounds heavily oxidizing such as permanganates, chlorates and chromates at temperatures over 50 °C. It is also suitable for gaseous oxygen up to a temperature of 200 °C and liquid oxygen without any pressure limitation.

Lubrication : Not required.



ITEM	PART NAME
17	PACKING FLANGE
23	STUD
24	NUT
252	FOLLOWER
255	PACKING RING (nr. 3)
257	END RING
274	INTERMEDIATE RING (nr. 3)



Type VTC / VTC 200

Composition : Parcol packing VTC type is composed by sealing V-rings (264) plus two end rings (263) and (265), supported and compressed by upper and lower bushings (266) and (267). All packing rings, both sealing and end ones, are made out of glass loaded PTFE which assure sufficient strength and stability at high pressure. The packing compression is adjustable by suitable packing bolting through packing flange and packing follower (252).

Advantages : This type of packing is suitable for valves working on high pressure fluids preserving the same form and flexibility together with an acceptable working friction.

Maximum working pressure : 250 bar - Maximum peak pressure 400 bar; if higher pressure is applied the rings start to irreversibly stick together and loose their flexibility.

Minimum working Pressure : Due to the asymmetric shaped seal rings, this packing can not warrant a proper sealing when vacuum seal is required.

Maximum working temperature : 210 °C (peak 250 °C)

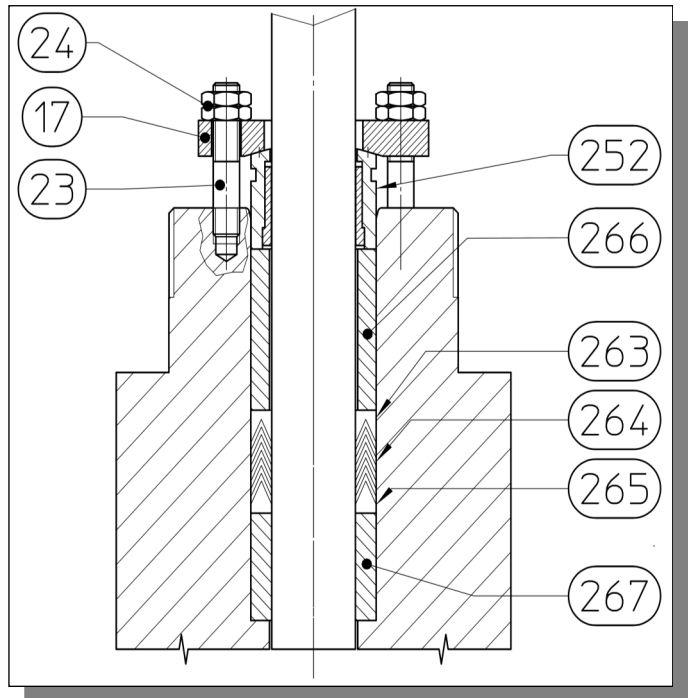
Minimum working temperature : -100 °C (peak -120 °C).

PH range: 0 ÷ 14

Certification : Parcol VTC 200 is also available with certification ISO FE CH-CC2-SSA0-t (RT,200°C)-PN250-ISO15848-1.

Fluid compatibility : All type of fluids excluding molten alkali, fluorine and its components at high temperatures. Not suitable for nuclear applications.

Lubrication : Not required.



ITEM	PART NAME
17	PACKING FLANGE
23	STUD
24	NUT
252	PACKING FOLLOWER
263	PACKING END RING
264	PACKING RING
265	PACKING END RING
266	UPPER BUSHING
267	LOWER BUSHING

ISO 15848-1 Certification Operative limits

Parcol VTC 200 has been certified:

ISO FE CH-CC2-SSA0-t(RT,200°C)-PN250-ISO15848-1

With following conditions:

Temperature	Rt	200	[°C]
Pressure	250	200	[bar]
Achieved Leakage class	C	C	[-]
Endurance class CC2	60 000 strokes		
SSA (stem sealing adjustment)	0		
Ø Stem tested	38.1		[mm]
Ø Stem limits	19.05 < Ø stem < 76.2		[mm]

The maximum certified leakage rate is 2.8×10^{-3} [mbarl/(s×m)], with a stem Ø38.1[mm] and a limit of 6.7×10^{-3} [mbarl/(s×m)].



Type TLE

Low emission TA-Luft compliant PTFE based packing for low and moderate temperature service

Parcol TLE is a low emission PTFE based packing for low and moderate service temperatures ($T = -50^{\circ}\text{C} \div +250^{\circ}\text{C}$) especially designed for control valves where lowest friction and maximum tightness conforming to TA-Luft requirements are required.

Composition : Parcol TLE is completely made of high-grade impregnated non-woven materials. Two end rings made of carbon fibre non-woven material are impregnated with a special PTFE/graphite mixture. The rings in the middle consist of aramid non-woven material with a PTFE impregnation with high cross-sectional density. TLE is always supplied complete with Live Loading and sand protection systems in order to ensure maximum reliability with reduced maintenance.

Advantages : Universally suitable for all valves in chemical and process industry, warrants:

- very low leakages, due to excellent cross-sectional density;
- very low friction coefficient;
- very good performance under temperature cycles in a wide temperature range;
- low gap extrusion and reduced cold flow.

Maximum working Pressure :

250 bar (peak 400 bar)

TA-Luft performed tests:

- without Live Loading System: 30 bar
- with Live Loading System: 63 bar

Maximum working Temperature :

250°C (peak 260 °C)

Minimum working Temperature :

-50°C (peak -70 °C)

PH range :

1 ÷ 13

Forms of supply :

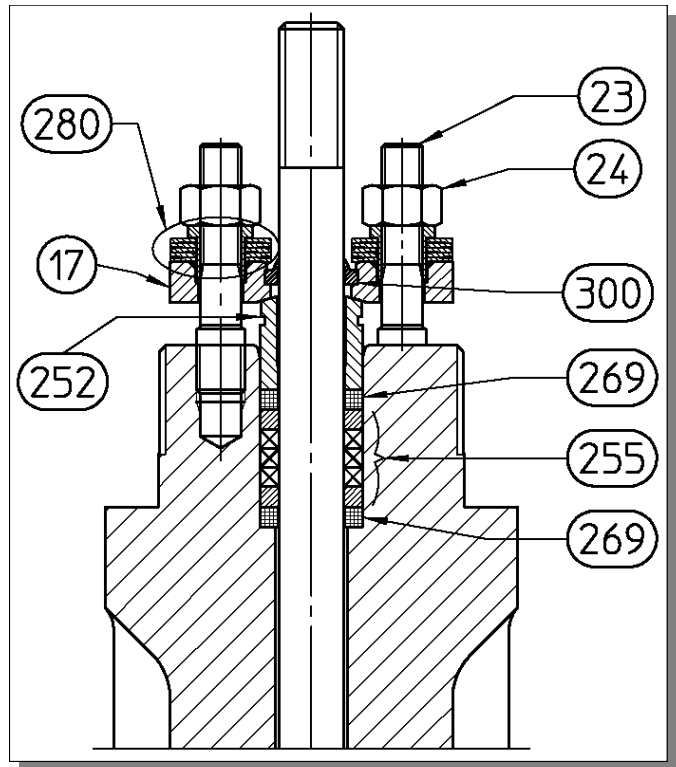
Complete packing sets with Live Loading System.

Certification :

Parcol TLE, without Live Loading System, has been tested and certified by MPA Stuttgart at 250 °C and with 1000 strokes.

Media resistance :

Resistant to many chemicals (solvents, hydrocarbons, alkalis, acids), alcohols, water, oils, etc. except: highly concentrated acids and alkalis, fluorine and concentrated fluorine-compounds.



ITEM	PART NAME
17	PACKING FLANGE
23	STUD
24	NUT
252	PACKING FOLLOWER
255	TLE PACKING SET
269	END RING
280	BELLEVILLE WASHER KIT
300	SCRAPER



Type GLE 200

Low emission ISO 15848-1 class B compliant
Graphite based packing for high temperature service.

Parcol GLE is a Low emission valve packing for high pressure and high temperature service, designed to comply with TA-Luft & with ISO 15848-1 requirements

Composition : GLE is a completely new developed packing composed by the following components:

- braided end rings made of expanded pure graphite with reinforced edges of carbon fibre yarn;
- sealing rings made of very high density expanded pure graphite to ensure cross-sectional density;
- especially impregnated adapter rings made of high density expanded pure graphite;
- sealing ring with lower density, made of expanded pure graphite with a friction reducing coating.

GLE is always supplied complete with Live Loading system in order to ensure maximum reliability with reduced maintenance.

Advantages : Suitable for all chemical, petrochemical and refinery applications, warrants:

- extremely low leakage rate for the application temperature range;
- reduced friction compared to standard graphite-based sealing systems;
- very low decrease of radial sealing forces on spindle due to the new and very special construction of the set, even without Live Loading System;
- excellent resistance to gap extrusion and no cold flow in contrast to PTFE-packing sets.

Maximum working Pressure : 300 bar (peak 450 bar)
TA-Luft performed tests:
• without Live Loading System: 40 bar

Maximum working Temperature : 200°C

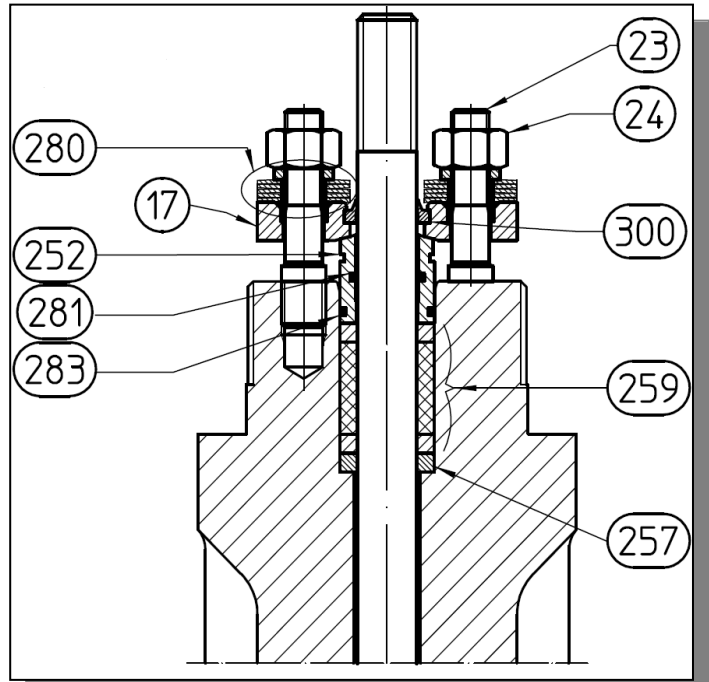
Minimum working Temperature : -29°C

PH range : 0 ÷ 14

Forms of supply : Pre-commissioned sealing sets, with Live Loading System.

Certification : Parcol GLE, without Live Loading System, has been tested and certified by MPA Stuttgart for up to 400 °C, 40 bar and 1000 strokes.

Media resistance : Resistant to most chemicals (solvents, hydrocarbons, acids, alkalis), steam, alcohols, oils, water etc.



ITEM	PART NAME
17	PACKING FLANGE
23	STUD
24	NUT
252	PACKING FOLLOWER
257	END RING
259	GLE PACKING SET
280	BELLEVILLE WASHER KIT
281	SEAL RING
283	SEAL RING
300	SCRAPER

ISO 15848-1 Certification Operative limits

Parcol GLE with Live Loading System has been certified:

ISO FE BH-CC2-SSA0-t(RT,200°C)-CL1500-ISO15848-1

With following conditions:

Temperature	Rt	200	[°C]
Pressure	250	200	[bar]
Achieved Leakage class	B	B	[-]
Endurance class CC2	60 000 strokes		
SSA (stem sealing adjustment)	0		
Ø Stem tested	19.05		[mm]
Ø Stem limits	10 < Ø stem < 38.1		[mm]

The maximum certified leakage rate is 6.6×10^{-6} [mbar/(s×m)], with a stem Ø19.05[mm] and a limit of 3.5×10^{-5} [mbar/(s×m)].

Type GLE 400

Low emission TA-Luft & ISO 15848-1 class C compliant Graphite based packing for high temperature service.

Parcol GLE is a Low emission valve packing for high pressure and high temperature service, designed to comply with TA-Luft & with ISO 15848-1 requirements

Composition : GLE is a completely new developed packing composed by the following components:

- braided end rings made of expanded pure graphite with reinforced edges of carbon fibre yarn;
- sealing rings made of very high density expanded pure graphite to ensure cross-sectional density;
- especially impregnated adapter rings made of high density expanded pure graphite;
- sealing ring with lower density, made of expanded pure graphite with a friction reducing coating.

GLE is always supplied complete with Live Loading system in order to ensure maximum reliability with reduced maintenance.

Advantages : Suitable for all chemical, petrochemical and refinery applications, warrants:

- extremely low leakage rate for the application temperature range;
- reduced friction compared to standard graphite-based sealing systems;
- very low decrease of radial sealing forces on spindle due to the new and very special construction of the set, even without Live Loading System;
- excellent resistance to gap extrusion and no cold flow in contrast to PTFE-packing sets.

Maximum working Pressure : 300 bar (peak 450 bar)

TA-Luft performed tests:

- without Live Loading System: 40 bar

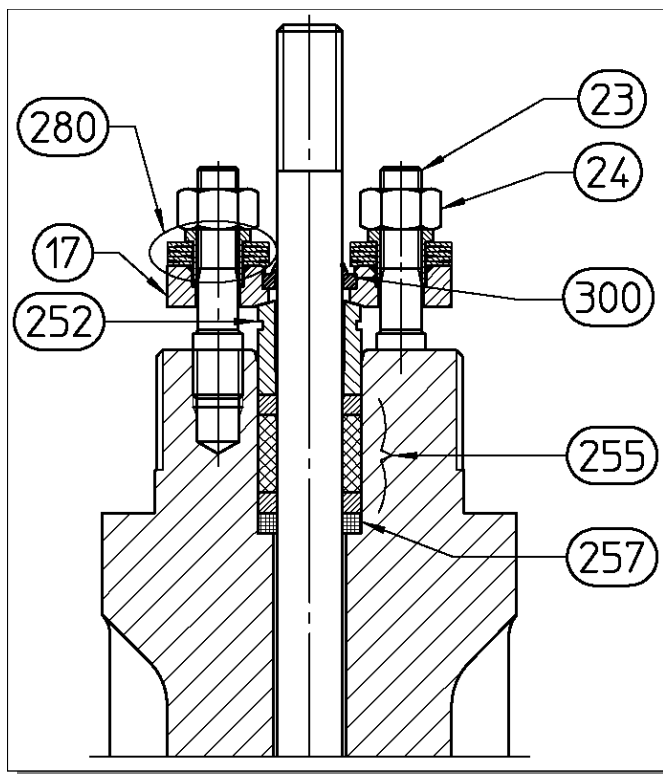
Maximum working Temperature : 400°C (550°C for steam service)

Minimum working Temperature : -200°C (peak -220 °C)

PH range : 0 ÷ 14

Forms of supply : Pre-commissioned sealing sets, with Live Loading System.

Media resistance : Resistant to most chemicals (solvents, hydrocarbons, acids, alkalis), steam, alcohols, oils, water etc.



ITEM	PART NAME
17	PACKING FLANGE
23	STUD
24	NUT
252	PACKING FOLLOWER
255	GLE PACKING SET
257	END RING
280	BELLEVILLE WASHER KIT

TA LUFT Certification operative limits

Without Live Loading System, has been tested and certified with following conditions:

Temperature	20	425	[°C]
Pressure	100	57	[bar]
Leakage rate	< 10 ⁻⁴		[mbarl/(s×m)]
Mechanical cycles	100 000 strokes		

ISO 15848-1 Certification Operative limits

Parcol GLE with Live Loading System has been certified:

ISO FE CH-CC2-SSA1-t(RT,400°C)-CL1500-ISO15848-1

With following conditions:

Temperature	Rt	400	[°C]
Pressure	250	170	[bar]
Achieved Leakage class	C	C	[-]
Endurance class CC2	60 000 strokes		
SSA (stem sealing adjustment)	1		
Ø Stem tested	19.05		[mm]
Ø Stem limits	10 < Ø stem < 38.1 [mm]		

The maximum certified leakage rate is 9.6×10⁻⁵ [mbarl/(s×m)], with a stem Ø19.05[mm] and a limit of 3.5 ×10⁻³ [mbarl/(s×m)].

OPTIONS

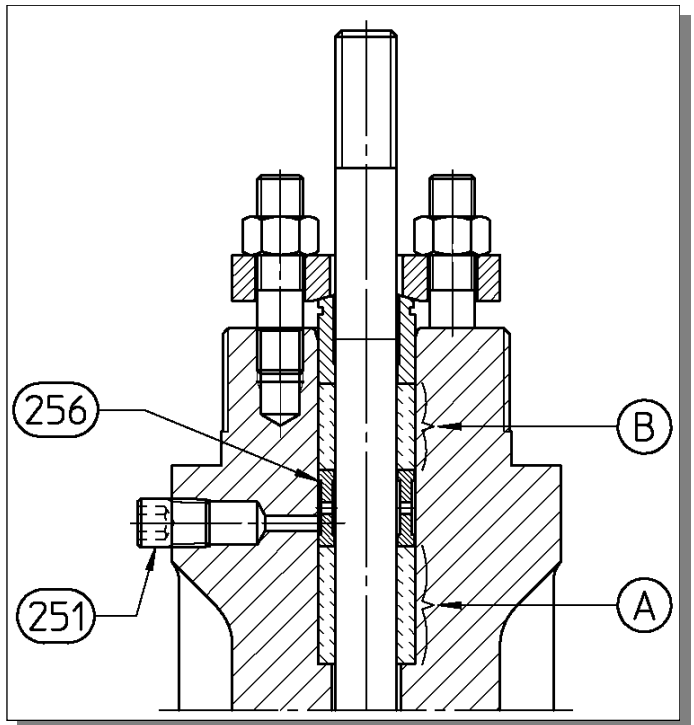
LEAK-OFF

When leak-off is required, main seal (A) is installed in the bottom area of packing box while an auxiliary seal (B) is installed on the upper area.

A lantern ring made of AISI 316 is properly installed between two packing sets to provide a leak-off through the suitable 1/4" NPT connection on the valve bonnet.

Leak-off option is available for all Parcol packings, auxiliary seal materials are the same of main seal.

Special material lantern ring can be provided on request according to valve body and stem materials.



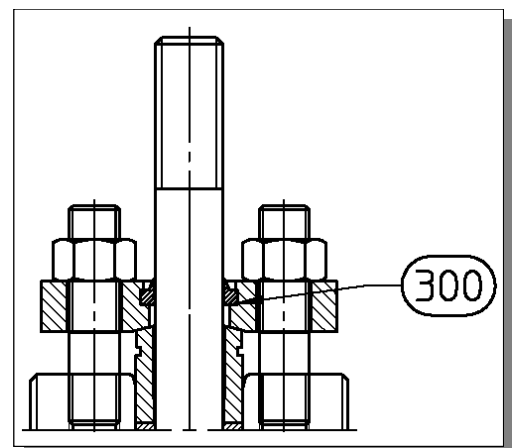
ITEM	PART NAME
251	PLUG 1/4" NPT
256	LANTERN RING
A	LOWER SEAL (Main Seal)
B	UPPER SEAL (Auxiliary Seal)

SAND PROTECTION

For service in dusty environment stem protection is suitable to avoid stem scratching.

Sand protection is performed by a special scraping ring made of pure PTFE installed on packing flange.

Parcol sand protection is suitable for temperature fluid up to 250 °C, for higher service temperatures please contact Parcol Technical Department.



ITEM	PART NAME
300	SCRAPER

LIVE LOADING SYSTEM

In order to prevent packing loosening, Live Loading System option can be supplied on request.

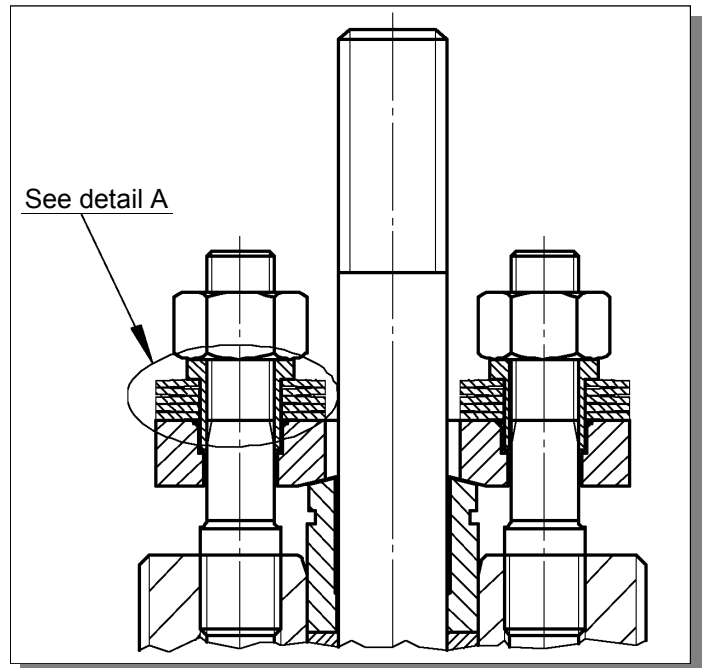
Live Loading System consists of Belleville washer stacks installed on packing stud to warrant a continuous load on valve packing.

Spring stacks are specially designed to allow appropriate load in case of packing settling by minimizing initial load and friction.

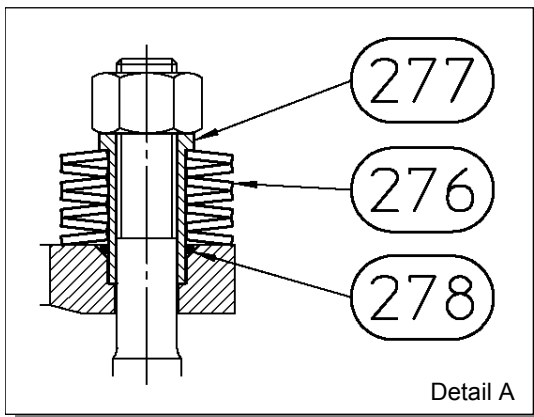
Belleville washers are supplied pre-assembled on a guide bushing with the function of stroke limiter to avoid excessive spring load.

Except for VTC type, Live Loading System is applicable to all Parcol packings up to 250 bar.

Standard material for Belleville springs is nickel plated CrV steel for standard service. Inconel 718 can be provided for high temperature or corrosive environment service.



ITEM	PART NAME
276	BELLEVILLE WASHER
277	GUIDE BUSHING
278	STOP RING



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VECTOR

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