Potrubné systémy
PIPING SYSTEMS

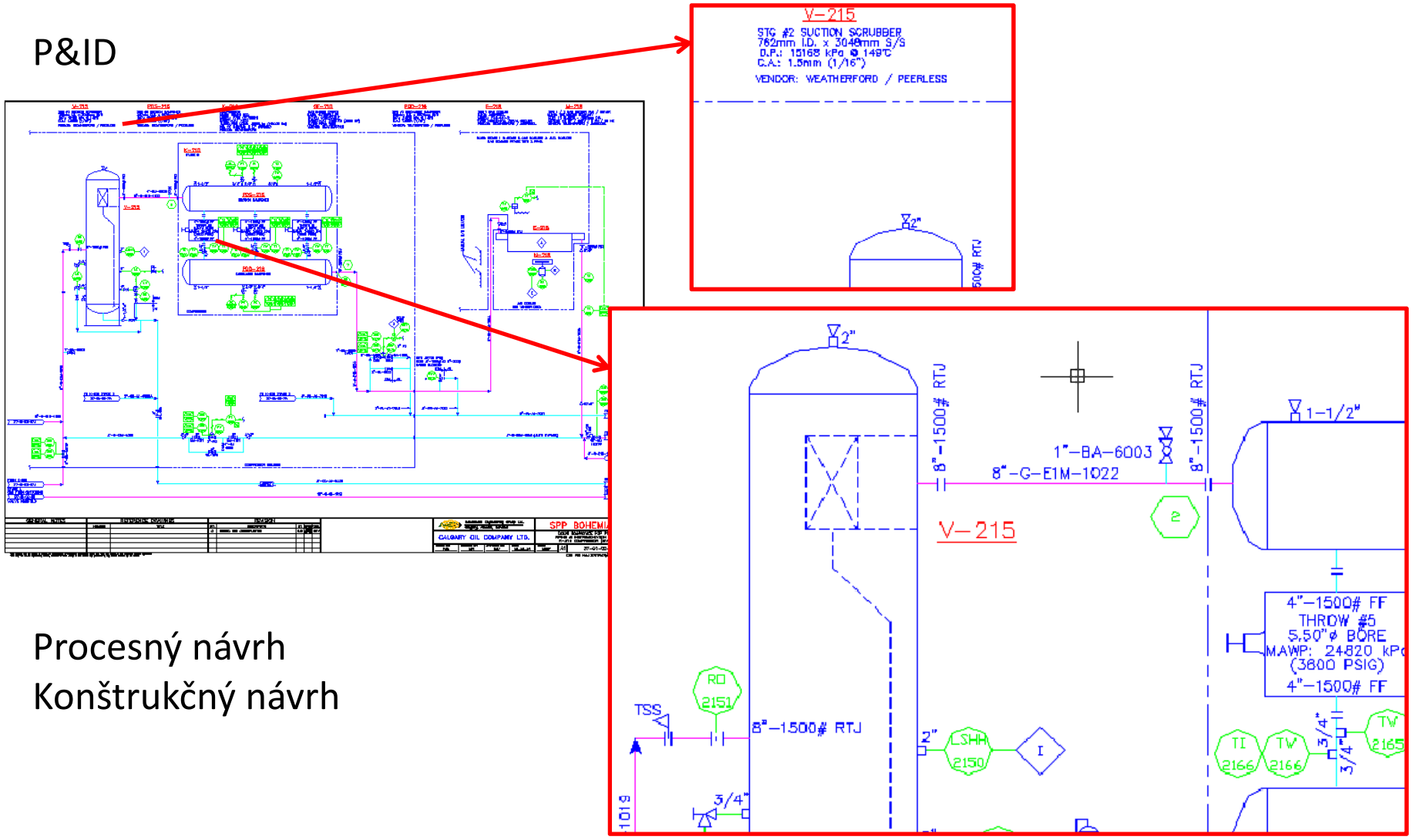
Prednáška

Vypracoval: Ing. Martin Juriga, PhD.

Bratislava, jún 2013

Potrubný systém.

P&ID



Procesný návrh

Konštrukčný návrh

Potrubný systém. Procesný návrh

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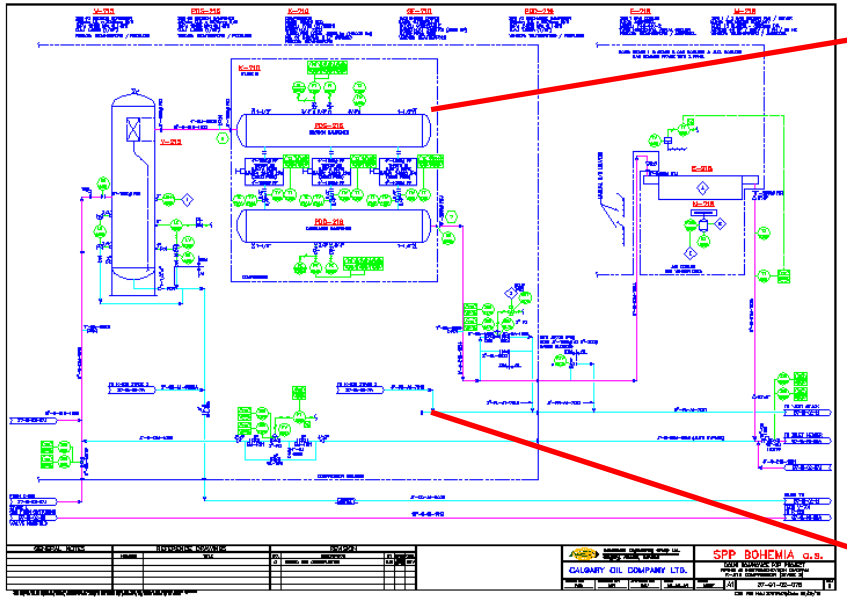

Procesný návrh pre potrubia

Výpočet tlakových strát potrubia

Návrh a optimalizácia nosných armatúr :
-regulačné ventily
-poistné ventily atď.

Návrh a optimalizácia zdrojov energie v potrubných systémoch (čerpadlá, kompresory, atď.)

Energetické aspekty dopravy v potrubiach (straty energie do okolia atď.)

Potrubný systém. Konštrukčný návrh

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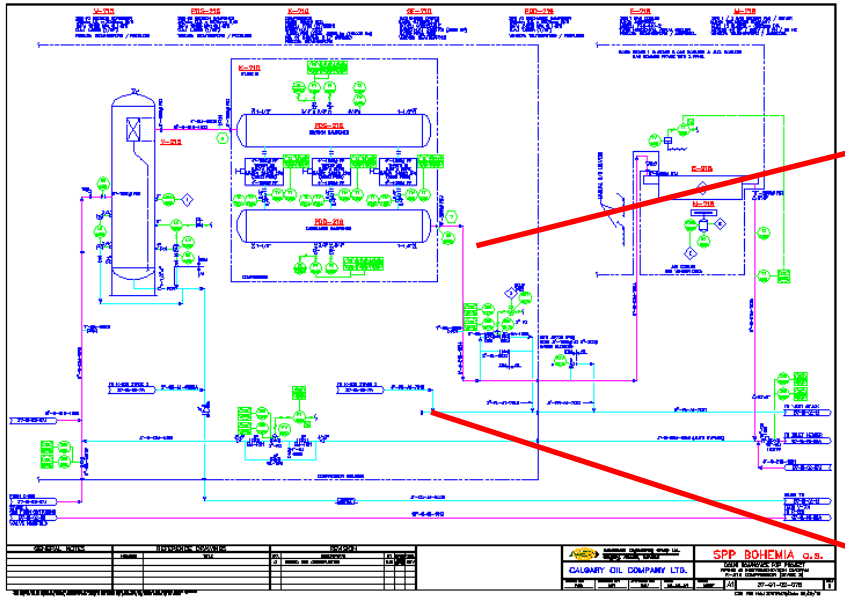


Konštrukčný návrh potrubia

Návrh a optimalizácia potrubnej triedy

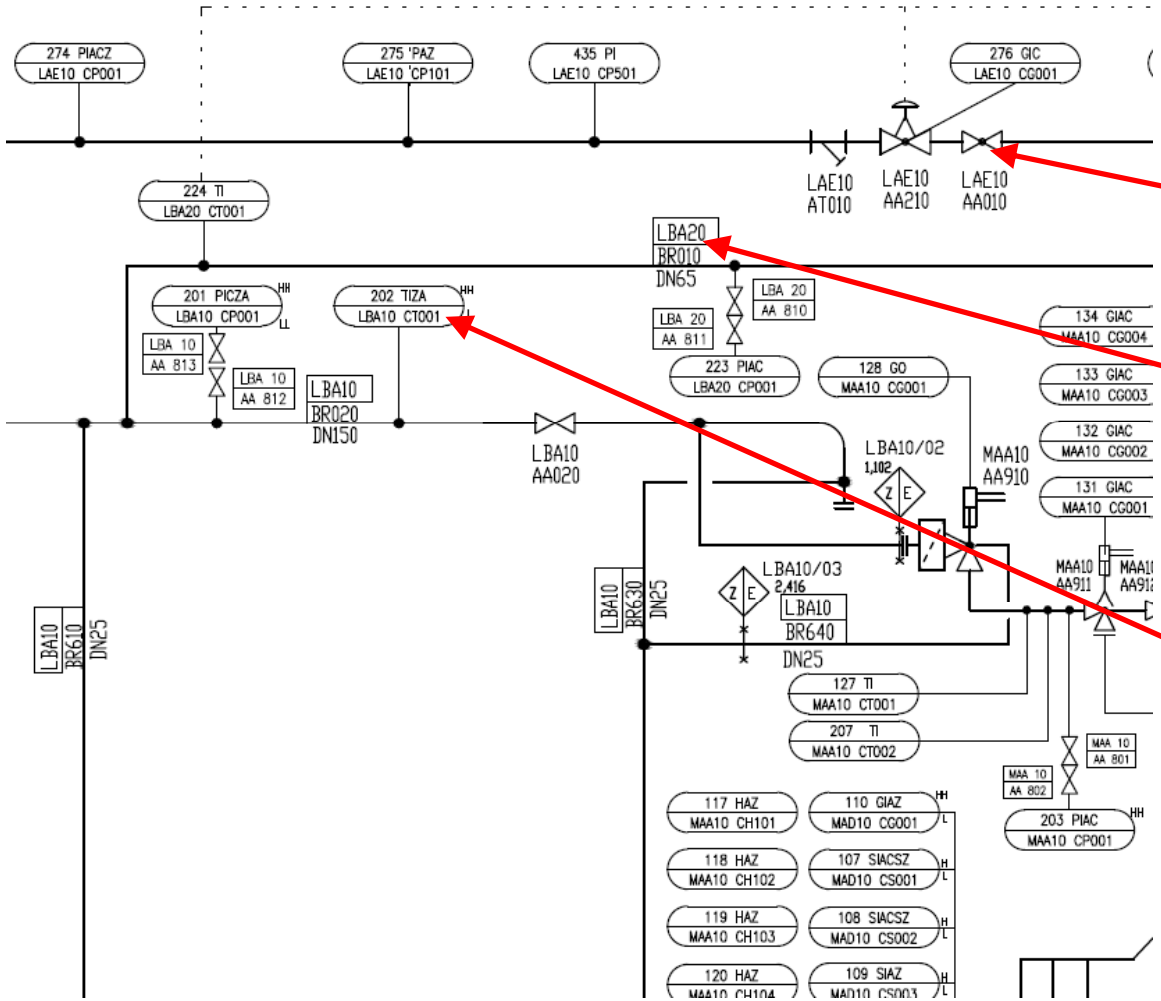
Výpočet hrúbok stien pre jednotlivé potrubné komponenty vzhľadom na zvolenú výpočtovú normu (Európa: EN 13 480, USA: Power Piping 31.1, Process Piping 31.3)

Kompletný konštrukčný návrh – 3D model (zostavné, výrobné výkresy)

Pevnostný návrh potrubí, určenie napätostných polí, reakcií do uložení, kontrola síl na hrdlá aparátov.

Riešenie dynamických úloh v potrubiach (vodný ráz, vibrácie atď. ...)

Potrubný systém. Konštrukčný návrh



Zoznam armatúr

Zoznam potrubných vetiev

Zoznam MaR

Potrubný systém. Konštrukčný návrh

	Údaje potrubnej vetvy								Potrubná trasa	
Poradové číslo	Názov vetvy	Vetva	Podvetva	Označenie média	Men svetlosť DN	Potrubná trieda	Izolácia	Nová / Existujúca	<Z>	do
1	LAE10_BR010_40	LAE10	BR010	KO	40	-	N	nová	<PBS> LAE 10/01	<Z> LBA20 AA510
2	LBA10_BR020_150	LBA10	BR020	VTP	150	-	A	nová	<PBS> LBA10/01	<E> LBA10/02
3	LBA10_BR620_25	LBA10	BR620	VTP	25	-	A	nová	<Z> LBA10 BR20	<E> LBA10/04
4	LBA10_BR630_25	LBA10	BR630	VTP	25	-	A	nová	<Z> LBA10 BR20	<E> LBA10/06
5	LBA10_BR640_25	LBA10	BR640	VTP	25	-	A	nová	<Z> LBA10/03	<E> LBA10 BR630

Označenie

				Návrh. podm.		Skúšobné podmienky				Doplňujúce údaje		
Max. pretlak [MPa]	Min. pretlak [MPa]	Max. teplota [°C]	Min. teplota [°C]	PS [bar g]	TS [°C]	Skúš. médium	Skúš. pretlak [kPa]	Skúš. teplota [°C]	Druh náteru	Označenie	PT	Poznámka
0,8	0	90	10	16	90	voda	-	5až25	-	chladenie bypasu	KO	Rev. C
6,7	0	470	10	75,5	490	RTG	-	5až25	-	hlavny parovod	VTP01	Rev. B
6,7	0	470	10	75,5	490	voda	-	5až25	-	odvodnenie hlavneho parovodu	VTP01	Rev. B
6,7	0	470	10	75,5	490	voda	-	5až25	-	odvodnenie hlavneho parovodu	VTP01	Rev. B
6,7	0	470	10	75,5	490	voda	-	5až25	-	odvodnenie turbiny	VTP01	Rev. B

Potrubná trieda

Potrubný systém. Konštrukčný návrh

STAVBA: BIOELEKTRÁREŇ ŽARNOVICA

Označenie PT	Menovitý tlak PN	Rozsah teplôt [°C]	Limitujúci tlakoteplotný rozsah vzhľadom na zákl. materiál potrubia						
VTP01	**160**	**10 až 490**	Pracovná teplota	[°C]	10	490			
			Max.prac.pretlak	[MPa]	7,55	7,55			

Základný materiál			Prírubový spoj - druh		
rúry/tvarovky	tesnenia	skrutky/matice	príruby	tesn.plochy	tesnenia
13CrMo4-5	1.4571 / grafit	21 CrMoV 5 7 (GA)	krkové	form E / form F	špirálovo-vinuté

MÉDIUM	Ozn.	Názov	PS [MPa]	TS [°C]
	VTP	Vysokotlaká para	0 až 7,55	10 až 490

POUŽITÉ POTRUBNÉ KOMPONENTY

Názov položky	Rozsah DN	PN	Pripojenie	Materiál	Rozm.norma	TDP
RÚRKY Rúrka bezošvá	20 - 150	-	BW	13CrMo4-5	EN 10216-2	EN 10216-2

DN				20	25	32	40	50	65	80	100	125	150				
D_{ord}	[mm]			26,9	33,7	42,4	48,3	60,3	76,1	88,9	114,3	139,7	168,3				
e_{ord}	[mm]			2,9	3,2	x	x	5,6	x	x	10,0	x	12,5				
c_o	[mm]			0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5				

TVAROVKY

Potrubná trieda

Tmax.
Pmax.

Rúra
DN
s=??

Potrubný systém. Konštrukčný návrh

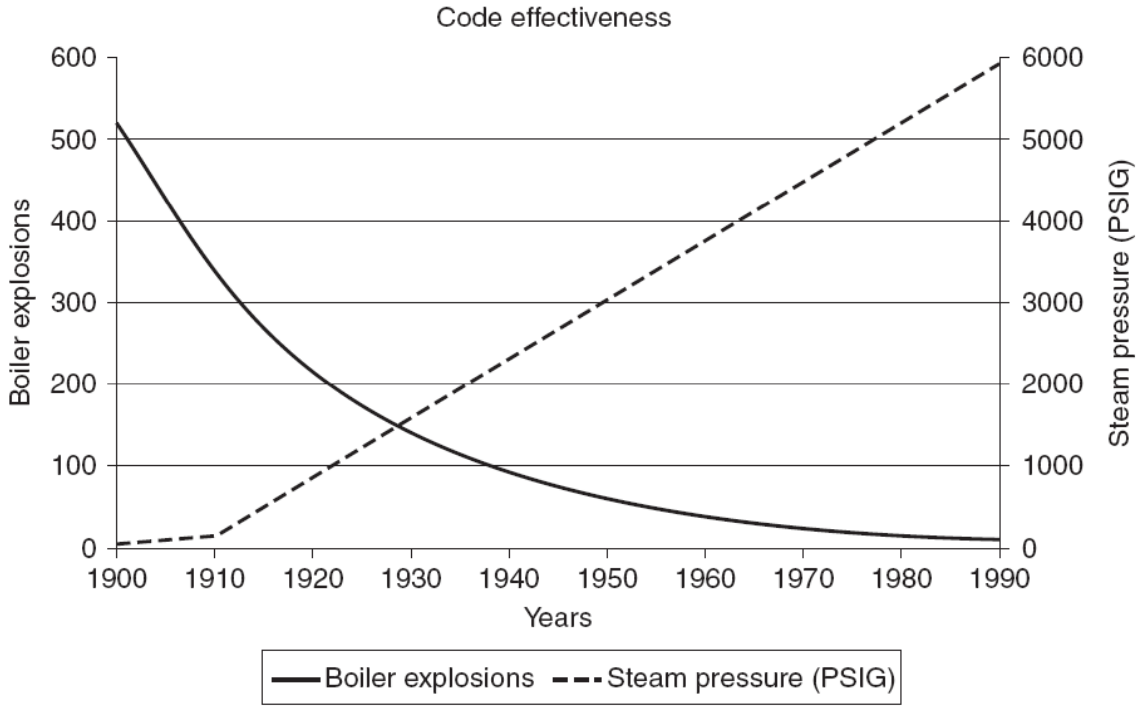
TVAROVKY						
Ohyb 90° R=500mm, 17,5mm	150	-	BW	13CrMo4-5	EN 13480-3	EN 10253-2
Ohyb 45° R=500mm, 17,5mm	150	-	BW	13CrMo4-5	EN 13480-3	EN 10253-2
Oblúk 90°, type5 series5	20 - 100	-	BW	13CrMo4-4	DIN 2605-2	DIN 2609
T-kus, typeB series5	150 x 150	-	BW	13CrMo4-4	DIN2615-2	DIN 2609
T-kus reduk., typeB series5	150 x 100	-	BW	13CrMo4-4	DIN2615-2	DIN 2609
Odbočka	20 - 150	-	BW	13CrMo4-4	EN 13480-3	-
PRÍRUBY						
Príruba krková, 11 form E	150	160	BW	13CrMo4-5	EN 1092-1	EN 1092-1
Príruba krková, 11 form F	150	160	BW	13CrMo4-5	EN 1092-1	EN 1092-1
PRÍRUBOVÝ SPOJ	150					
Tesnenie	-	160	SpV1I	1.4571 / grafit	STN EN 1514-1 SR	Rotatech
Svorník	-	-	-	1.7709	DIN 2510 L	DIN 267
Matica šesťhranná	-	-	-	1.7709	DIN 2510 NF	DIN 267
ARMATÚRY						
Ventil uzátvárací privarovací	25	160	BW	1.7335	V46 213	AG
Ventil uzátvárací privarovací	100	160	BW	1.7357	V46.32 232	AG
Ventil regulačný privarovací	25	160	BW	1.7335	V40 213	AG
Ventil regulačný privarovací	100	160	BW	1.7379	BR12B	POLNACORP
Odlučovač kondenzátu	25	160	BW	1.7335	BK 29	GESTRA

Tvarovky/ Fittingy

Príruba

PN/DN

Potrubný systém. Konštrukčný návrh



Štandardne používané normy:

B31.1 Power Piping

B31.3 Process Piping

EN 13480

Potrubný systém. Konštrukčný návrh

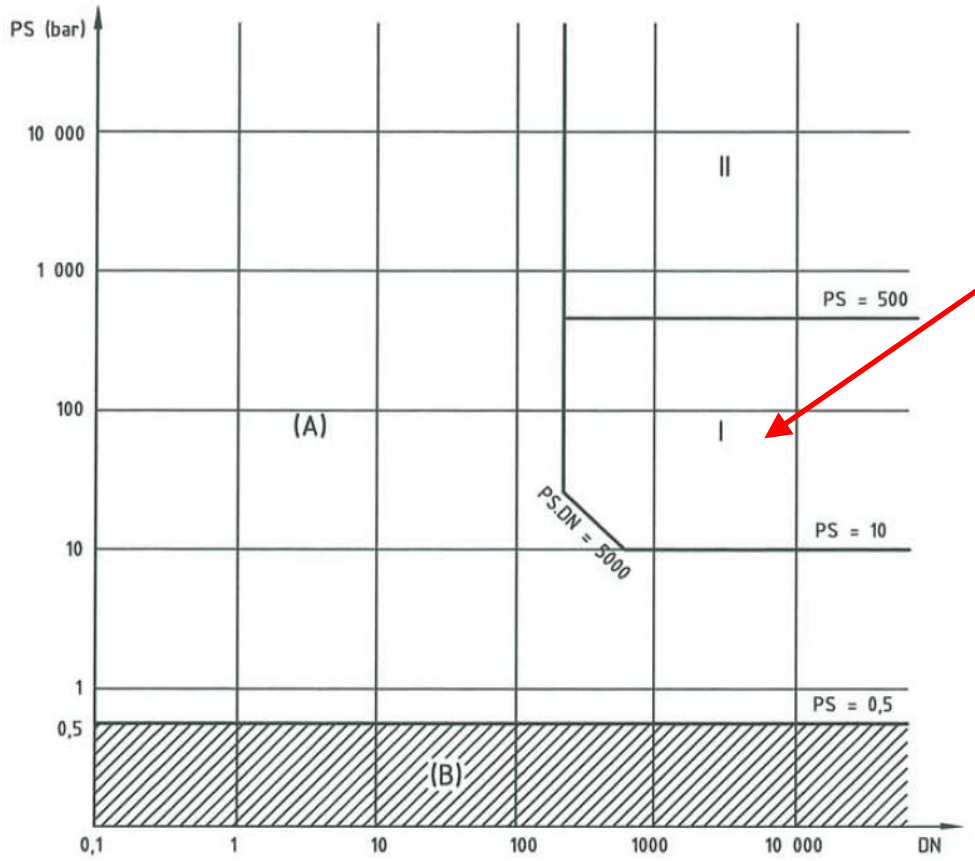
6.1 Rovné potrubia podľa EN 13480-3

D_o	# [mm]	323,90	vonkajší priemer potrubia.
e_n	# [mm]	7,10	menovitá hrúbka steny na výkrese.
D_i	! [mm]	309,70	vnútorný priemer potrubia
D_o/D_i	! [1]	1,046	podmnienka použitia vzťahu (6.1-1), Do/Di<1,7 je splnená
C_o	# [mm]	2,05	prídavok na koróziu a eróziu (prípadne aj na technologický úkos)
C_1	! [mm]	0,89	absolútna hodnota zápornej tolerancie príslušnej mat. normy
e_a	**! [mm]**	**4,16**	**analyzovaná hrúbka steny (podľa Obr. 4.3-1)**
f_H	! [MPa]	84,00	dolovené napätie pri maximálnej teplote pre **iné ako austenitické ocele**
z	# [1]	1,0	koeficient zvarového spoja
p_c	# [MPa]	0,20	výpočtový tlak
e	**! [mm]**	**0,39**	**minimálna hrúbka steny rovného potrubia podľa (6.1-1)**
e_{+c}	**! [mm]**	**3,32**	**minimálna hrúbka steny rovného potrubia s prídavkami**
$e_a > e$	! [mm]	splnená	4,163 > 0,385
e_a / e	! [1]	10,808	vhodné pre ohyby s R=3Do podľa tab. (6.2.3-1)
$e_n > e_{+c}$	! [mm]	splnená	**7,100 > 3,323**
bezpeč.	! [1]	2,137	koeficient bezpečnosti
využitie		**46,80**	**%**

Potrubný segment

Norma

Potrubný systém. Konštrukčný návrh



Liquids having a vapor pressure at the maximum allowable temperature of not more than 0,5 bar above normal atmospheric pressure (1013 mbar) for fluids in group 2.

(A) see 4.2 and (B) see 4.3

Figure A.4 — Classification for piping system for group 2 liquids

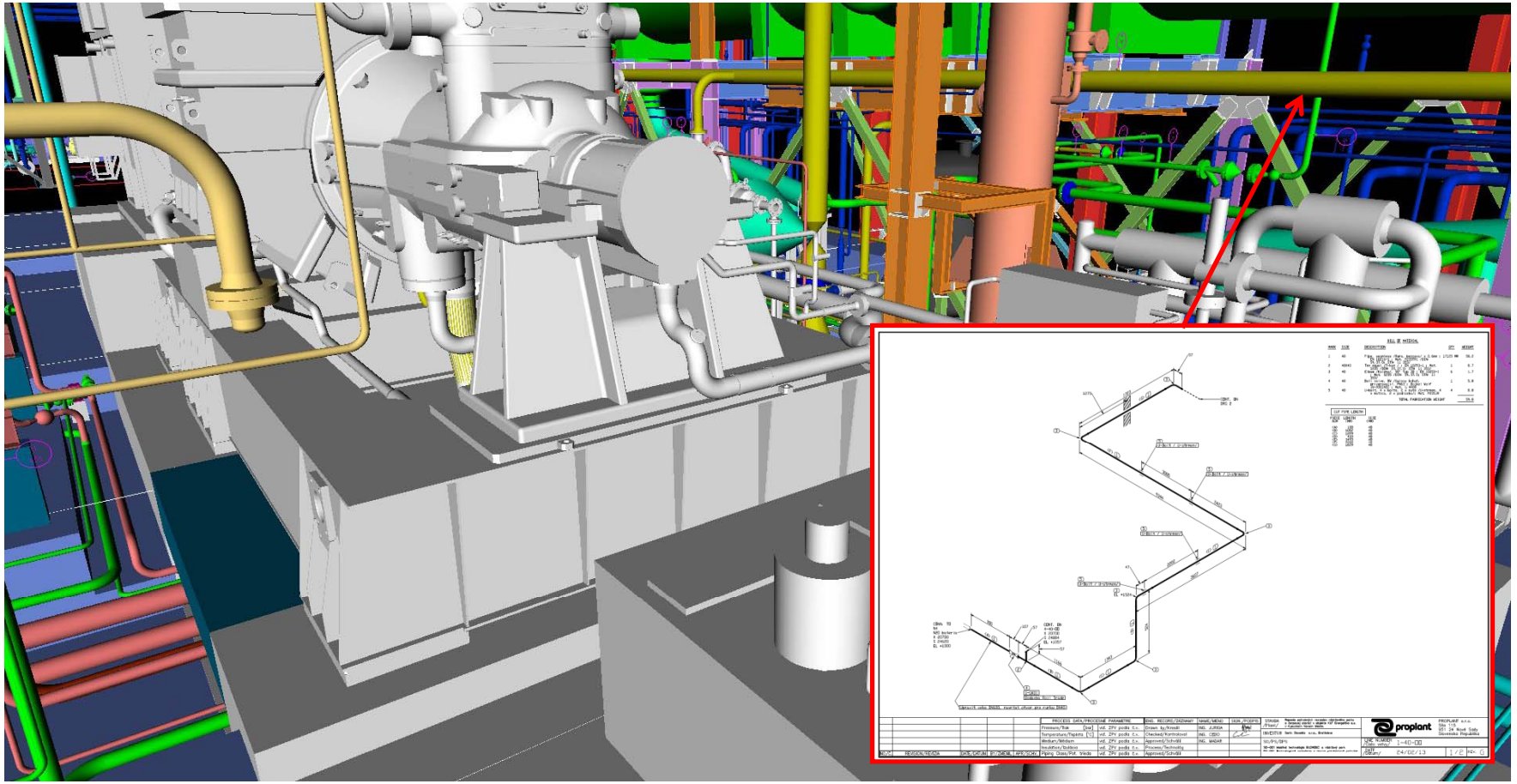
Kategorizácia potrubia podľa EN 13480-7

X – DN
Y – PS

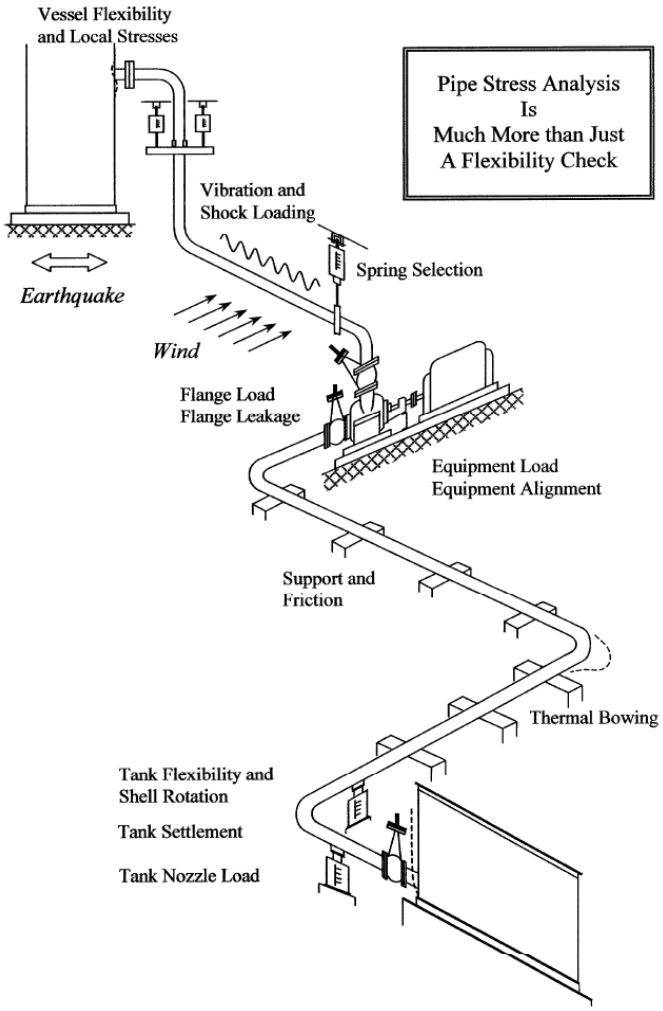
Médium L alebo G
Skupina 1 alebo 2

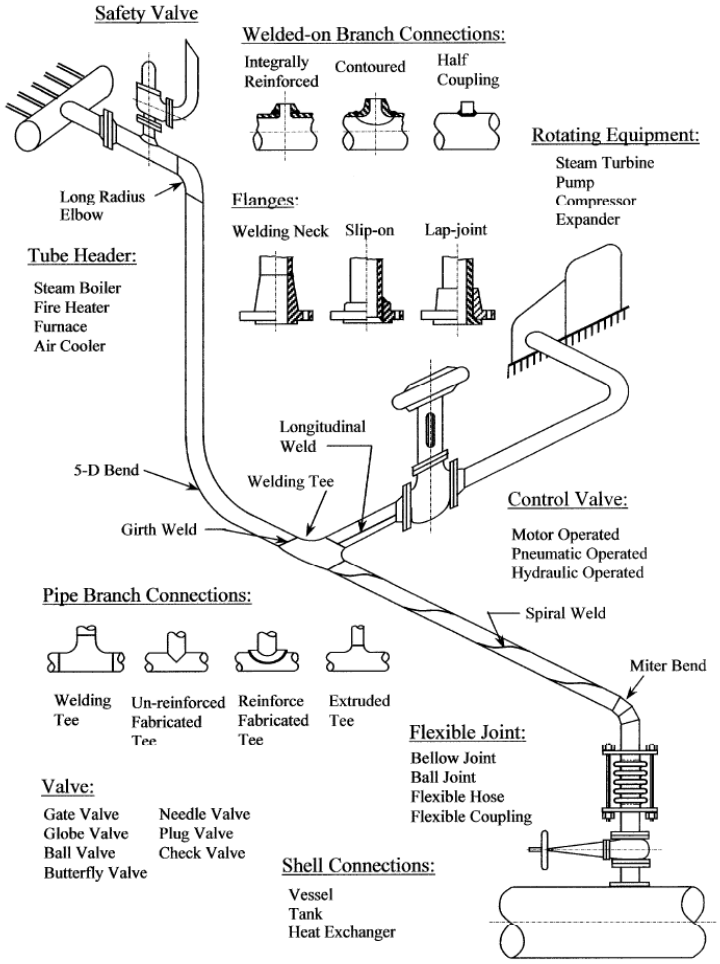
Potrubný systém. Konštrukčný návrh

3D model a výkresové výstupy



Potrubný systém. Pevnostný návrh potrubia





Potrubný systém. Pevnostný návrh potrubia

veľká pozornosť predovšetkým potrubia II. a III. Kategórie. (↑↑ vysoká teplota, ↑↑ vysoký tlak)

-pevnostný výpočet (EN, ASME, BS, …)

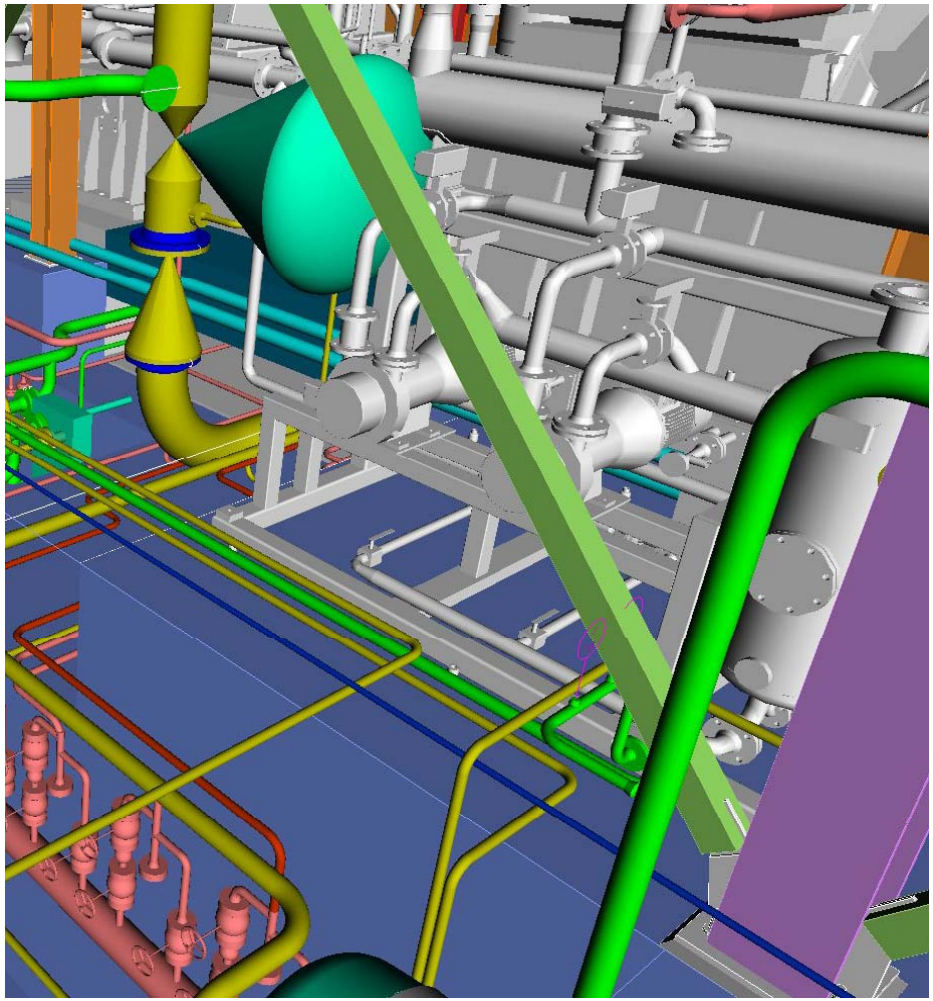
- optimalizácia

-návrh vhodných kompenzačných prvkov

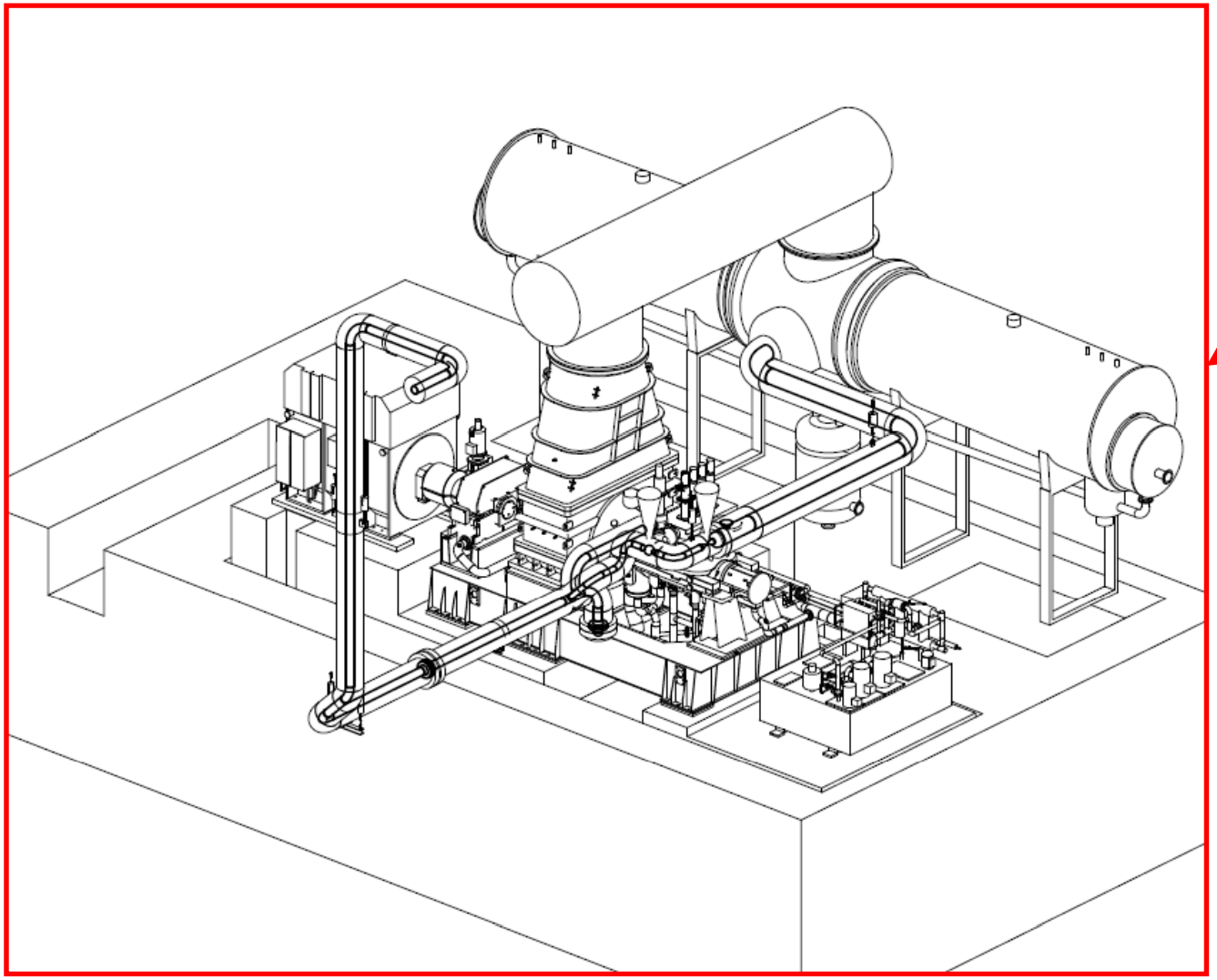
- presný návrh umiestnenia a uchytenia potrubia

- analýza vplyvu na pripájané aparáty (hrdlá)

-podrobná analýza možných zaťažujúcich stavov



Potrubný systém. Pevnostný návrh potrubia



- hrdlá
- potrubie
- návrh uchytenia
- -testovanie rôznych zaťažovacích stavov

Potrubný systém. Pevnostný návrh potrubia

EN 10216-2

-Creep

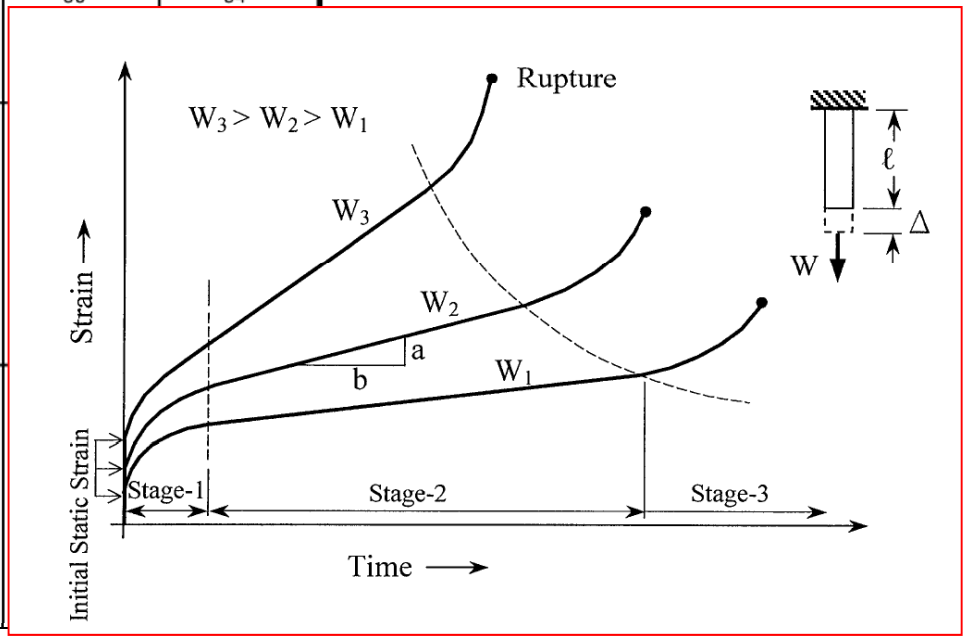
Potrubie pracujúce v oblasti creepu

Creep rupture strength values

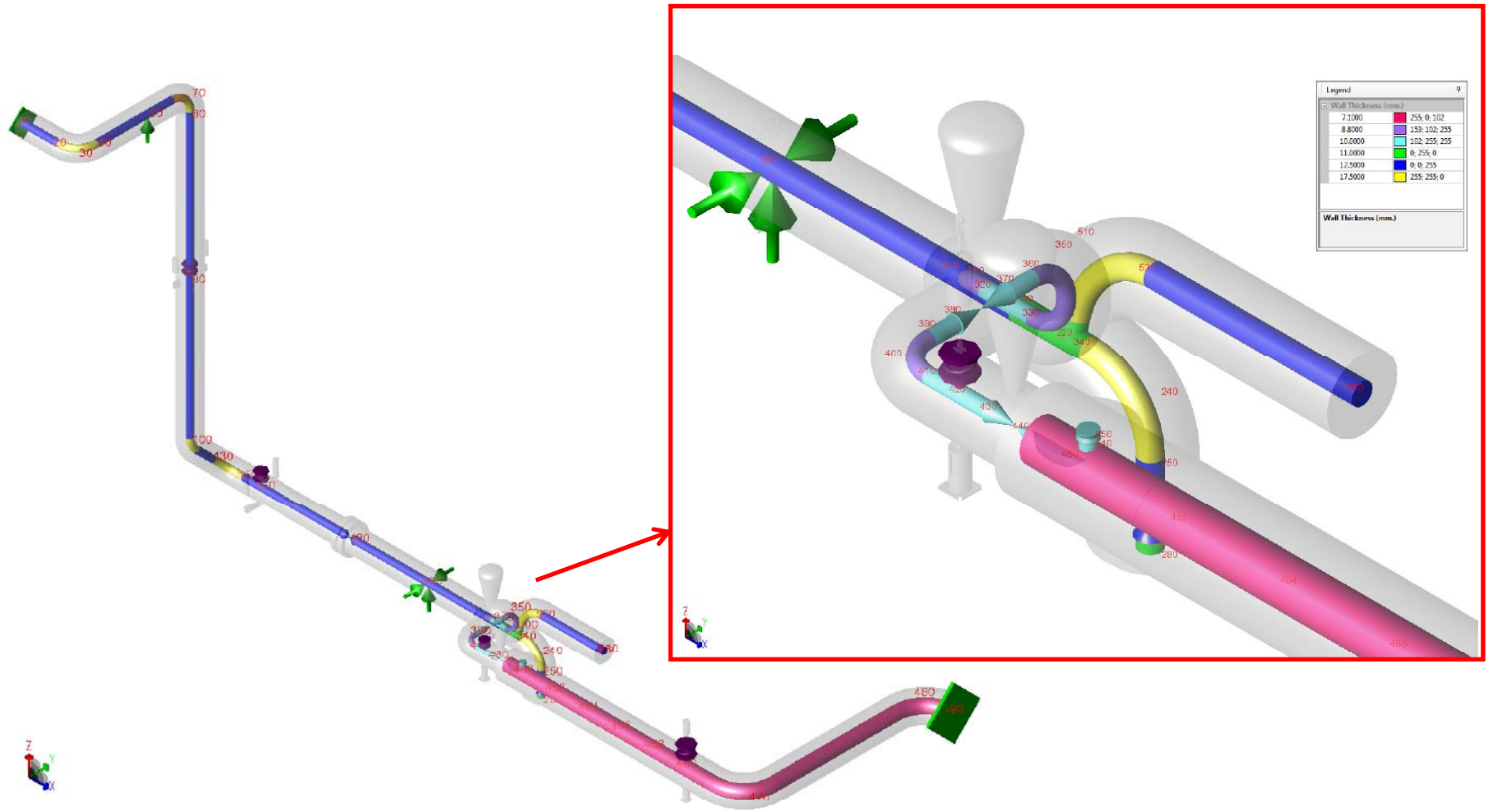
The creep rupture strength values of steel grades covered by this Part of EN 10216 are given in Table A1.

Table 17 Creep rupture strength values

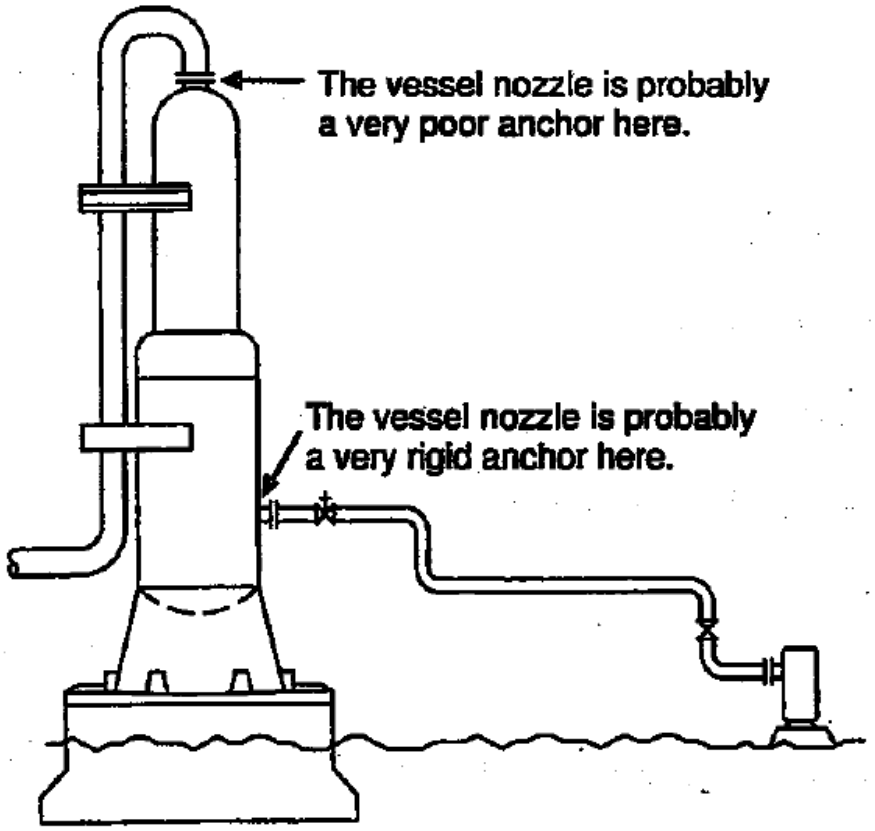
Steel grade		Temperature	Creep rupture strength values for (MPa) [a b c d]			
Steel name	Steel number	°C	10 000 h	100 000 h	200 000 h	250 000 h
P235GH		400	182	141	128	122
P265GH		410	166	128	115	109
		420	151	114	102	97
		430	138	100	89	86
		440	125	88	77	74
		450	112	77	66	64
		460	100	66	56	54
		470	88	56		
		480	77	47		
		490	67	39		
		500	58	32		
20MnNb6		400	243	179		
		410	221	157		
		420	200	136		
		430	180	117		
		440	161	100		
		450	143	85		
		460	126	73		
		470	110	63		
		480	96	55		
		490	84	47		
		500	74	41		
16Mo3		450	298	236		
		460	273	205		
		470	247	176		
		480	221	149		
		490	196	124		
		500	171	102		
		510	148	83		
		520	125	65		
		530	104	51		
		540	84	40		
		550	64	32		

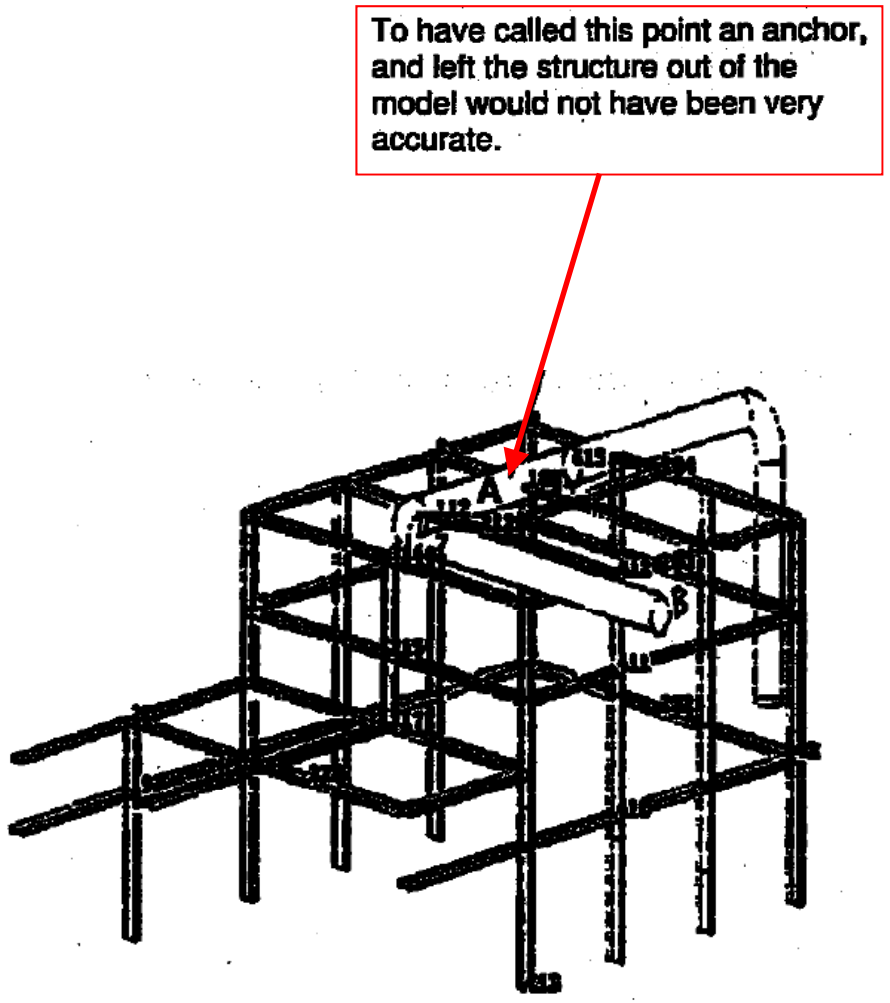


Potrubný systém. Pevnostný návrh potrubia

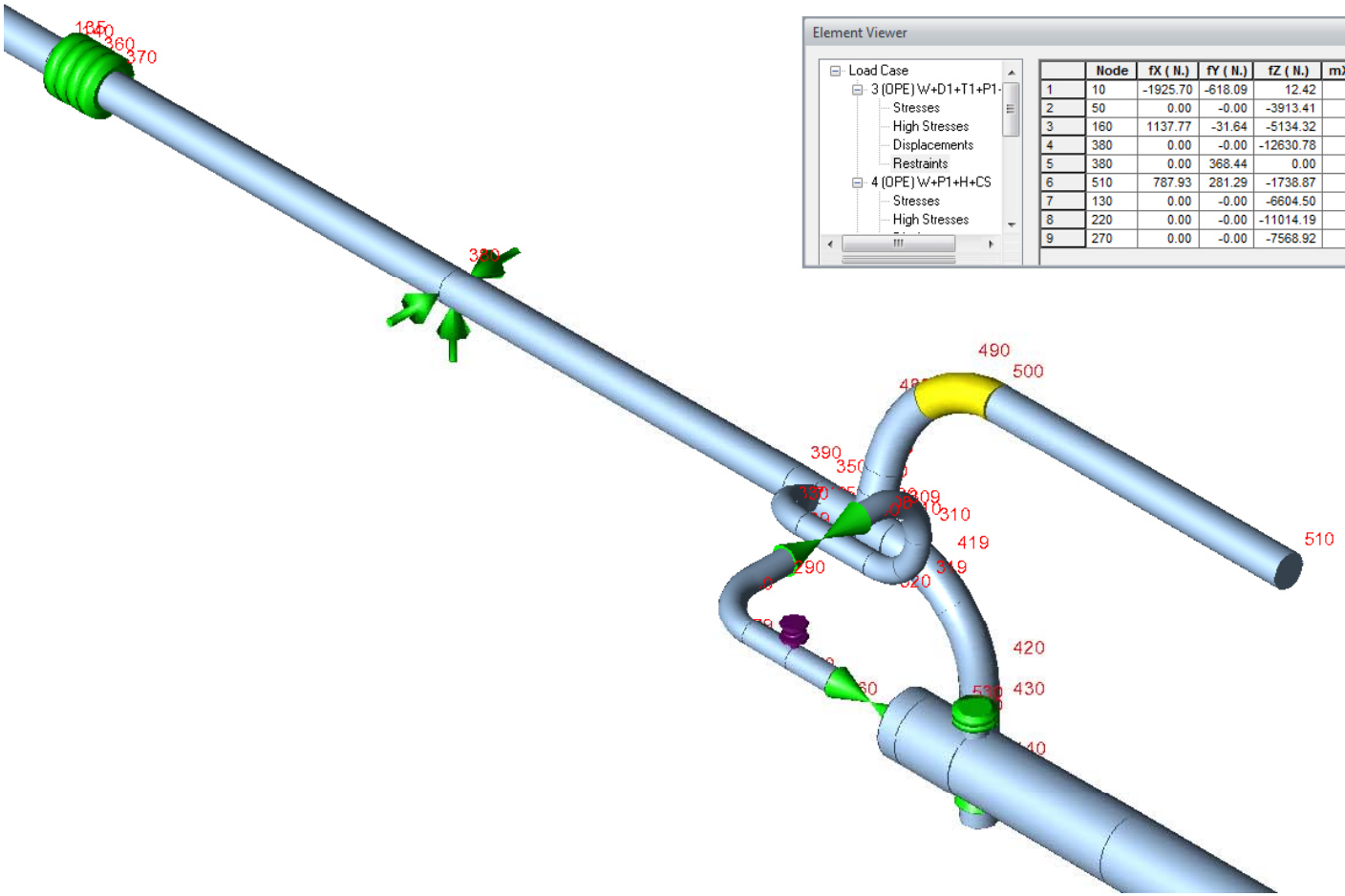


Potrubný systém. Pevnostný návrh potrubia





Potrubný systém. Pevnostný návrh potrubia



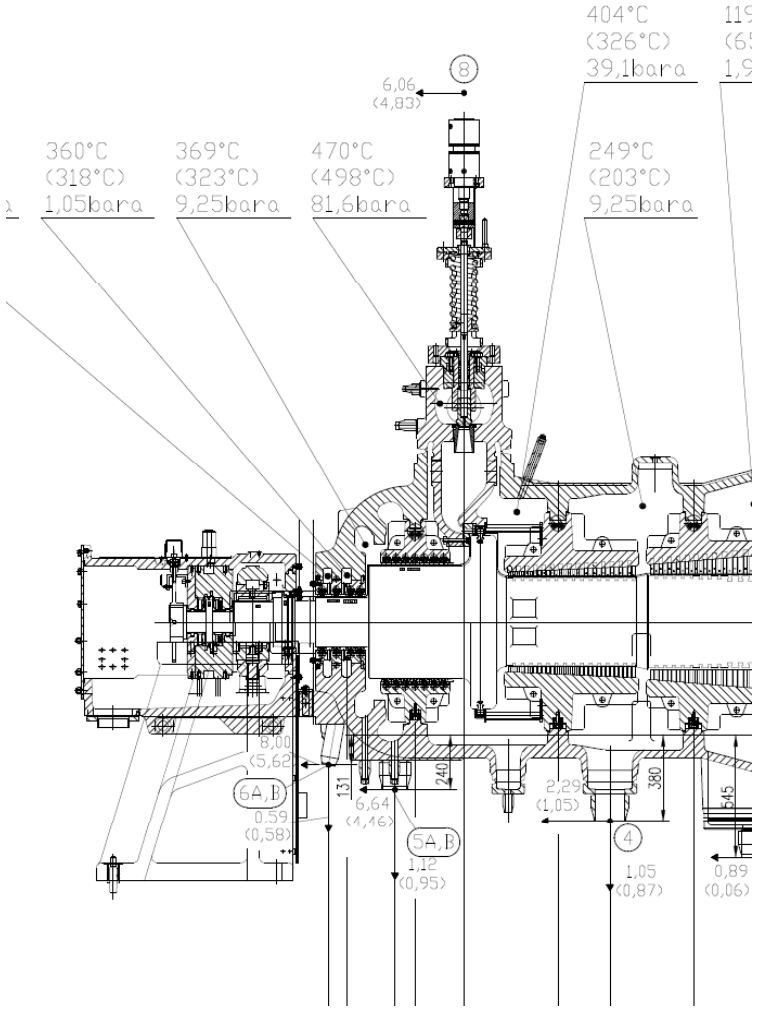
Element Viewer

- Load Case
  - 3 (OPE) W+D1+T1+P1-
    - Stresses
    - High Stresses
    - Displacements
    - Restraints
  - 4 (OPE) W+P1+H+CS
    - Stresses
    - High Stresses

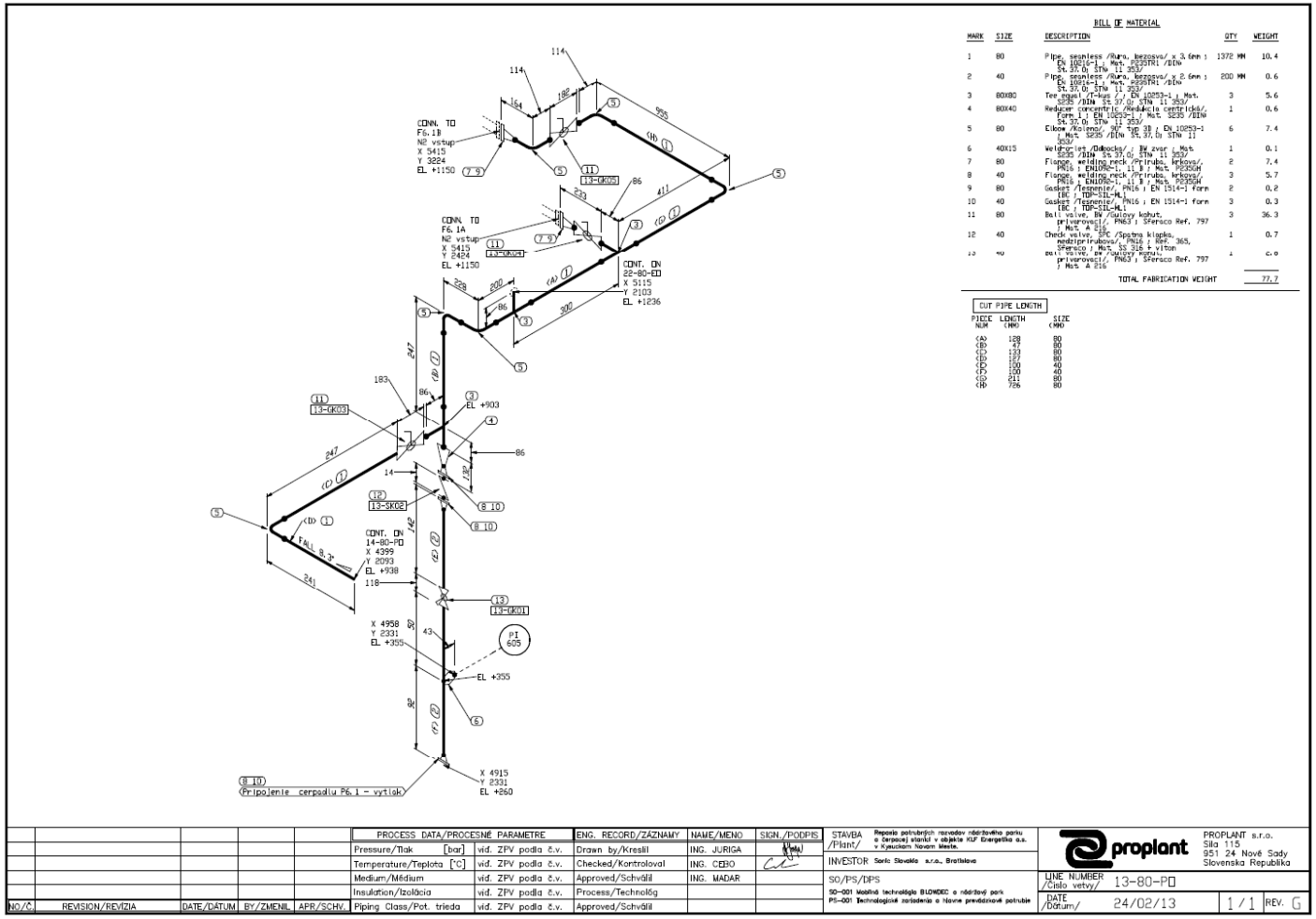
	Node	fX (N.)	fY (N.)	fZ (N.)	mX (N.m.)	mY (N.m.)	mZ (N.m.)	Type
1	10	-1925.70	-618.09	12.42	1090.04	3139.78	3578.97	Rigid ANC
2	50	0.00	-0.00	-3913.41	0.00	-0.00	0.00	Rigid +Z
3	160	1137.77	-31.64	-5134.32	1480.32	-821.32	4451.06	Rigid ANC
4	380	0.00	-0.00	-12630.78	0.00	-0.00	0.00	Rigid +Z
5	380	0.00	368.44	0.00	0.00	-0.00	0.00	Rigid Y
6	510	787.93	281.29	-1738.87	294.19	-2372.47	-2452.89	Displ. Reaction
7	130	0.00	-0.00	-6604.50	0.00	-0.00	0.00	Prog Design VSH
8	220	0.00	-0.00	-11014.19	0.00	-0.00	0.00	Prog Design VSH
9	270	0.00	-0.00	-7568.92	0.00	-0.00	0.00	Prog Design VSH

Potrubný systém. Pevnostný návrh potrubia

PRIPUSTNE SILY A MOMENTY NA HRDLA TURBINY								
HRDLO TURBINY	CISLO HRDLA	PRIPUSTNE SILY (N)			PRIPUSTNE MOMENTY (Nm)			POZNAMKY
		X	Y	Z	X	Y	Z	
VYSTUPNI HRDLO TURBINY DN1800 PN6	1	14400	14400	29000	21900	10800	10800	
HRDLO PRO NTO DN250 PN40	2	2850	2850	5500	4000	4000	2000	
HRDLO PRO ODPL. DN125 PN40	3A, 3B	1550	1550	3200	1200	1200	450	
HRDLO VYROV. PISTU DN125 PN40 – VSTUP	4	1550	1550	3200	1200	1200	450	
HRDLA VYR. PISTU DN100 PN40 – VYSTUP	5A, 5B	1350	1350	2500	520	520	200	
HRDLA UCP. PARY PREDNI DN50 PN40 – ZAHLCENI	6A, 6B	675	675	1250	300	300	200	
HRDLA UCP. PARY PREDNI DN50 PN40 – ODSAVANI	7A, 7B	675	675	1250	300	300	200	
VSTUPNI HRDLO DN150 PN160	8	1850	1850	3600	2600	2600	1300	
HRDLA UCP. PARY ZADNI DN65 PN40	9A, 9B	800	800	1600	360	360	200	
ODVODNENI VYSTUPNIHO HRDLA DN65 PN16	10	800	800	1600	360	360	200	



Potrubný systém.



BILL OF MATERIAL

MARK	SIZE	DESCRIPTION	QTY	WEIGHT
1	80	Pipe, seamless /Rura, bezosvo/ s.3.6mm ; EN 10216-1 ; Mat. P235TR1 /DIN St.35.0; STN 11 353/	1372 MM	10.4
2	40	Pipe, seamless /Rura, bezosvo/ s.2.6mm ; EN 10216-1 ; Mat. P235TR1 /DIN St.37.0; STN 11 353/	200 MM	0.6
3	80X80	Tee equal /T-kus / ; EN 10253-1 ; Mat. 3235 /DIN St.37.0; STN 11 353/	3	5.6
4	80X40	Reducer concentric /Redukcia centricka/, Form 1 ; EN 10253-1 ; Mat. 3235 /DIN St.35.0; STN 11 353/	1	0.6
5	80	Elbow /Koleno/, 90° type SR ; EN 10253-1 ; Mat. 3235 /DIN St.37.0; STN 11 353/	6	7.4
6	40X15	Weldolet /Odbocka/ ; BW zvar ; Mat. 3235 /DIN St.37.0; STN 11 353/	1	0.1
7	80	Flange, welding neck /Prirub. krkovy/, PN16 ; EN1092-1, 11 B ; Mat. P235GH	2	7.4
8	40	Flange, welding neck /Prirub. krkovy/, PN16 ; EN1092-1, 11 B ; Mat. P235GH	3	5.7
9	80	Gasket /Tesnenie/, PN16 ; EN 1514-1 form IBC ; TOP-SIL-ML;	2	0.2
10	40	Gasket /Tesnenie/, PN16 ; EN 1514-1 form IBC ; TOP-SIL-ML;	3	0.3
11	80	Ball valve, BW /Gulovy kohut, privarovaci/, PN63 ; Sferaco Ref. 797 / Mat. A 216	3	36.3
12	40	Check valve, SPC /Spatna klapka, medzipriruba/, PN16 ; Ref. 365, Sferaco ; Mat. SS 316 + viton	1	0.7
13	40	Ball valve, BW /Gulovy kohut, privarovaci/, PN63 ; Sferaco Ref. 797 / Mat. A 216	1	0.8
		TOTAL FABRICATION WEIGHT		77.7

CUT PIPE LENGTH

PIECE NUM	LENGTH (MM)	SIZE (MM)
(A)	128	80
(B)	67	80
(C)	133	80
(D)	127	80
(E)	150	40
(F)	150	40
(G)	211	80
(H)	726	80

PROCESS DATA/PROCESNÉ PARAMETRE			ENG. RECORD/ZÁZNAMY	NAME/MENO	SIGN./PODPIS
Pressure/Tlak	[bar]	vid. ZPV podla č.v.	Drawn by/Kreslil	ING. JURIGA	
Temperature/Teplota	[°C]	vid. ZPV podla č.v.	Checked/Kontroloval	ING. CEBO	
Medium/Médium		vid. ZPV podla č.v.	Approved/Schválil	ING. MADAR	
Insulation/Izolácia		vid. ZPV podla č.v.	Process/Technológ		
Piping Class/Pot. trieda		vid. ZPV podla č.v.	Approved/Schválil		

NO./Č. | REVISION/REVÍZIA | DATE/DÁTUM | BY/ZMENIL | APR/SCHV.

STAVBA /Plant/ Repasia potrubných rozvodov nádržového parku a čerpacej stanice v objekte KLP Energetika a.s. v Kysuckom Novom Meste.

INVESTOR Sorio Slovakia a.r.o., Bratislava

SO/PS/DPS

SO-001 Vodná technológia BLOWDEC a nádržový park

PS-001 Technologické zariadenie a hlavné prevádzkové potrubie

proplant

PROPLANT s.r.o. Sila 115 951 24 Nové Sady Slovenska Republika

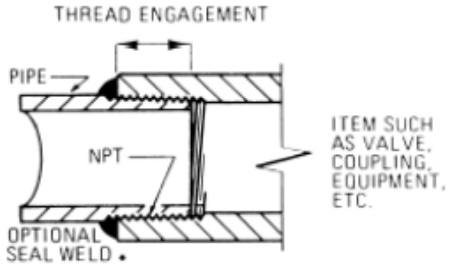
LINE NUMBER /Číslo vetvy/ 13-80-PD

DATE /Dátum/ 24/02/13 | 1/1 | REV. G

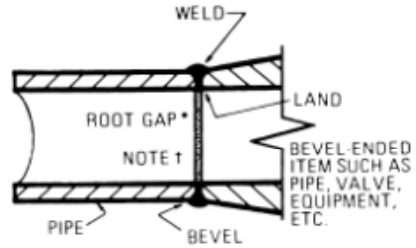
S čoho sa skladá potrubný systém ?

Jednotlivé položky potrubnej triedy ...

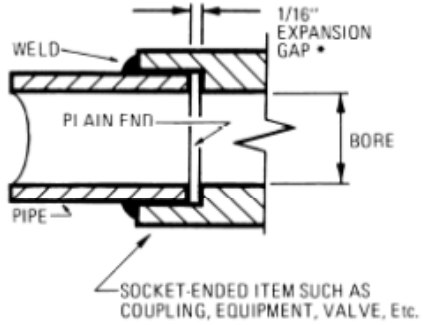
Potrubný systém. Základné spôsoby spájania potrubí.



Screwed Piping S
(prípade THD Thread)



Butt-Welded Piping BW



Socket-Welded Piping
SW

Potrubný systém. Rúra

Wall thickness = mm **Weight –kg/m (Plain end mass)**

Pipe Size (Inches)	Pipe OD (mm)	5S	10S	10	20	30	STD	40S	40	XS	80S	80	XXS
3/8	17.10		1.65 **0.64**				2.31 **0.84**	2.31 **0.86**	2.31 **0.84**	3.20 **1.10**	3.20 **1.12**	3.20 **1.10**	
1/2	21.30	1.65 **0.82**	2.11 **1.01**				2.77 **1.27**	2.77 **1.30**	2.77 **1.27**	3.73 **1.62**	3.73 **1.65**	3.73 **1.62**	7.47 **1.95**
3/4	26.70	1.65 **1.04**	2.11 **1.31**				2.87 **1.69**	2.87 **1.71**	2.87 **1.69**	3.91 **2.20**	3.91 **2.24**	3.91 **2.20**	7.82 **3.64**
1	33.40	1.65 **1.33**	2.77 **2.13**				3.38 **2.50**	3.38 **2.55**	3.38 **2.50**	4.55 **3.24**	4.55 **3.29**	4.55 **3.24**	9.09 **5.45**
1 1/4	42.20	1.65 **1.68**	2.77 **2.76**				3.56 **3.39**	3.56 **3.46**	3.56 **3.39**	4.85 **4.47**	4.85 **4.56**	4.85 **4.47**	9.70 **7.77**
1 1/2	48.30	1.65 **1.95**	2.77 **3.17**				3.68 **4.05**	3.68 **4.13**	3.68 **4.05**	5.08 **5.41**	5.08 **5.51**	5.08 **5.41**	10.15 **9.56**
2	60.30	1.65 **2.44**	2.77 **4.01**				3.91 **5.44**	3.91 **5.54**	3.91 **5.44**	5.54 **7.48**	5.54 **7.63**	5.54 **7.48**	11.07 **13.44**
2 1/2	73.00	2.11 **3.77**	3.05 **5.36**				5.16 **8.63**	5.16 **8.81**	5.16 **8.63**	7.01 **11.41**	7.01 **11.64**	7.01 **11.41**	14.02 **20.39**
3	88.90	2.11 **4.60**	3.05 **5.59**				5.49 **11.29**	5.49 **11.52**	5.49 **11.29**	7.62 **15.27**	7.62 **15.59**	7.62 **15.27**	15.24 **27.68**
3 1/2	101.6	2.11 **5.29**	3.05 **7.99**				5.74 **13.57**	5.74 **13.84**	5.74 **13.57**	8.08 **18.63**	8.08 **19.01**	8.08 **18.63**	
4	114.3	2.11 **5.96**	3.05 **8.52**				6.02 **16.07**	6.02 **16.40**	6.02 **16.07**	8.56 **22.32**	8.56 **22.77**	8.56 **22.32**	17.12 **41.03**
5	141.3	2.77 **9.67**	3.40 **11.82**				6.55 **21.77**	6.55 **22.20**	6.55 **21.77**	9.53 **30.97**	9.53 **31.59**	9.53 **30.97**	19.05 **57.43**
6	168.3	2.77 **11.55**	3.40 **14.13**				7.11 **28.26**	7.11 **28.83**	7.11 **28.26**	10.97 **42.56**	10.97 **43.42**	10.97 **42.56**	21.95 **79.22**
8	219.1	2.77 **15.09**	3.76 **20.37**		6.35 **33.31**	7.04 **36.81**	8.18 **42.55**	8.18 **43.39**	8.18 **42.55**	12.70 **64.64**	12.70 **65.95**	12.70 **64.64**	22.23 **107.92**
10	273.1	3.40 **23.08**	4.19 **28.34**		6.35 **41.77**	7.80 **51.03**	9.27 **60.31**	9.27 **61.52**	9.27 **60.31**	12.70 **81.55**	12.70 **83.19**	15.90 **96.01**	25.40 **155.15**
12	323.9	3.96 **31.89**	4.57 **36.73**		6.35 **49.73**	8.35 **65.20**	9.53 **73.88**	9.27 **75.32**	10.31 **79.73**	12.70 **97.46**	12.70 **99.43**	17.48 **132.08**	25.40 **186.97**
14	355.6	3.96 **35.06**	4.78 **42.14**	6.35 **54.69**	7.92 **67.90**	9.53 **81.33**	9.53 **93.27**		11.13 **94.55**	12.70 **107.39**		19.05 **158.10**	
16	406.4	4.19 **42.41**	4.78 **48.26**	6.35 **62.64**	7.92 **77.83**	9.53 **93.27**	9.53 **81.33**		12.70 **123.30**	12.70 **123.30**		21.44 **203.53**	
18	457.0	4.19 **47.77**	4.78 **54.36**	6.35 **70.57**	7.92 **87.71**	11.13 **122.38**	9.53 **105.16**		14.27 **155.80**	12.70 **139.15**		23.38 **254.55**	
20	508.0	4.78 **60.46**	5.54 **70.00**	6.35 **78.55**	9.35 **117.15**	12.70 **155.12**	9.53 **117.15**		15.09 **183.42**	12.70 **155.12**		25.19 **311.17**	
22	559.0	4.78 **66.57**	5.54 **77.06**	6.35 **86.54**	9.35 **129.13**	12.70 **171.09**	9.53 **129.13**			12.70 **171.09**		28.58 **373.83**	
24	610.0	5.54 **84.16**	6.35 **96.37**	6.35 **94.53**	9.35 **141.12**	14.27 **209.64**	9.53 **141.12**		17.48 **255.41**	12.70 **187.06**		30.96 **442.08**	

Schedule

Rozsah. Platí aj pre ostatné potrubné komponenty : T-kus, koleno ... Atď.)

STD- standard

XS- extra strong

XXS – extra extra strong

Potrubný systém. Fittingy

Druh.

Norma

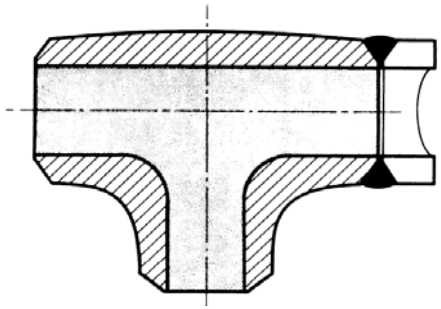
Materiál (Materiálová skupina)

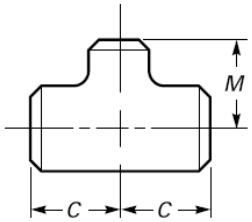
Fittings for welding DIN 2609

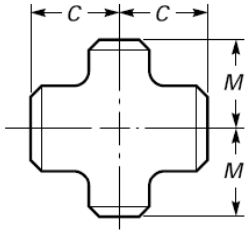
Table 2. base material, materials and form of manufacture

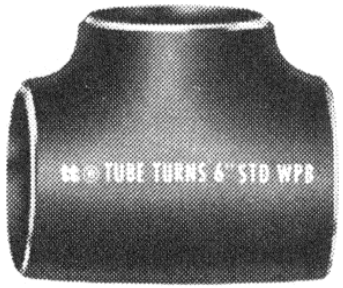
group of materials code-letter	nickname	base material material	material Nr.	form of manufacture *) 1	2	3	4	5	base material	application temperature *) •C
A	St 37.0	St 37.0	1.0254	x					DIN 1629	- 10 to 300
		St 37.0	1.0254		x				DIN 1626	
		RSt 37-2	1.0038			x	x	x	DIN 17 100	
B	St 44.0	St 44.0	1.0256	x					DIN 1629	- 10 to 300
		St44.0	1.0256		x				DIN 1626	
		St 44-2	1.0044			x	x	x	DIN 17 100	
C	St 52.0	St 52.0	1.0421	x					DIN 1629	- 10 to 300
		St 52.0	1.0421		x				DIN 1626	
		St 52-3	1.0570			x	x	x	DIN 17 100	
D	StE 290.7	StE 290.7	1.0484	x	x				DIN 17 172	- 10 to 50
E	StE 360.7	StE 360.7	1.0582	x	x				DIN 17 172	- 10 to 50
F	St 35.8 I	St 35.8 I	1.0305	x					DIN 17 175	- 10 to 420
		St 37.8 I	1.0315		x				DIN 17 177	
		H I	1.0345			x			DIN 17 155	
		H II	1.0425			x			DIN 17 155	
C		22.8	1.0460				x	x	DIN 17 243	
G	St 35.8 III	St 35.8 III	1.0305	x					DIN 17 175	- 10 to 420
		St 37.8 III	1.0315		x				DIN 17 177	
		H II	1.0425			x			DIN 17 155	
		C 22.8	1.0460				x	x	DIN 17 243	
H	15 Mo 3	15 Mo 3	1.5415	x					DIN 17 175	- 10 to 530
					x				DIN 17 177	
						x			DIN 17 155	
							x	x	DIN 17 243	

Potrubný systém. T-kus, Kríž /Tee, Cross/









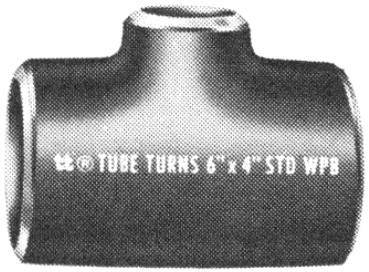
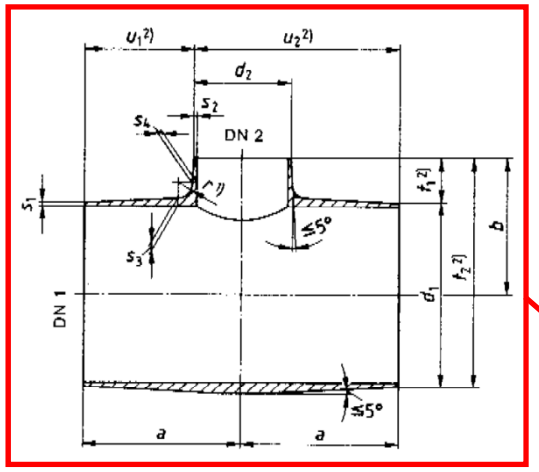
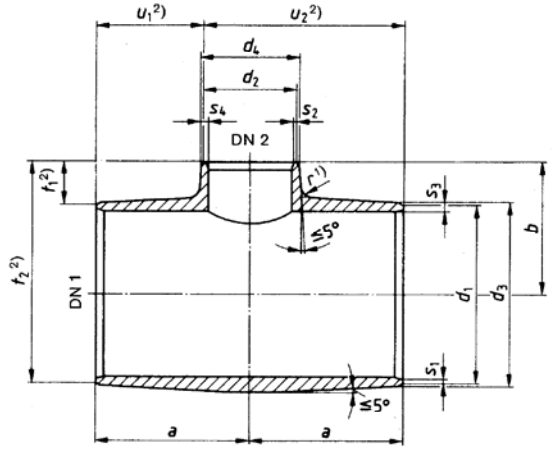


TABLE 9 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES

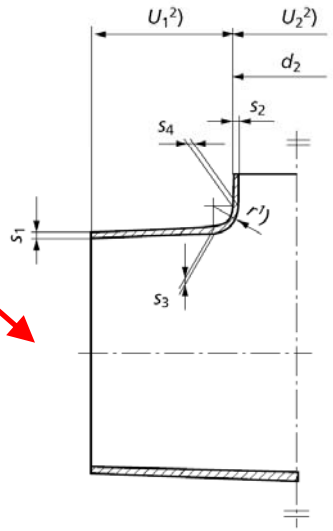
Nominal Pipe Size (NPS)	DN	Outside Diameter at Bevel		Center-to-End	
		Run	Outlet	Run, *C*	Outlet, *M* [Note (1)]
$\frac{1}{2} \times \frac{1}{2} \times \frac{3}{8}$	15 × 15 × 10	21.3	17.3	25	25
$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{4}$	15 × 15 × 8	21.3	13.7	25	25
$\frac{3}{4} \times \frac{3}{4} \times \frac{1}{2}$	20 × 20 × 15	26.7	21.3	29	29
$\frac{3}{4} \times \frac{3}{4} \times \frac{3}{8}$	20 × 20 × 10	26.7	17.3	29	29
$1 \times 1 \times \frac{3}{4}$	25 × 25 × 20	33.4	26.7	38	38
$1 \times 1 \times \frac{1}{2}$	25 × 25 × 15	33.4	21.3	38	38
$1\frac{1}{4} \times 1\frac{1}{4} \times 1$	32 × 32 × 25	42.2	33.4	48	48
$1\frac{1}{4} \times 1\frac{1}{4} \times \frac{3}{4}$	32 × 32 × 20	42.2	26.7	48	48
$1\frac{1}{4} \times 1\frac{1}{4} \times \frac{1}{2}$	32 × 32 × 15	42.2	21.3	48	48
$1\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{4}$	40 × 40 × 32	48.3	42.2	57	57
$1\frac{1}{2} \times 1\frac{1}{2} \times 1$	40 × 40 × 25	48.3	33.4	57	57
$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{4}$	40 × 40 × 20	48.3	26.7	57	57
$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{2}$	40 × 40 × 15	48.3	21.3	57	57
$2 \times 2 \times 1\frac{1}{2}$	50 × 50 × 40	60.3	48.3	64	60
$2 \times 2 \times 1\frac{1}{4}$	50 × 50 × 32	60.3	42.2	64	57
$2 \times 2 \times 1$	50 × 50 × 25	60.3	33.4	64	51
$2 \times 2 \times \frac{3}{4}$	50 × 50 × 20	60.3	26.7	64	44

Potrubný systém. T-kus, Kríž /Tee, Cross/

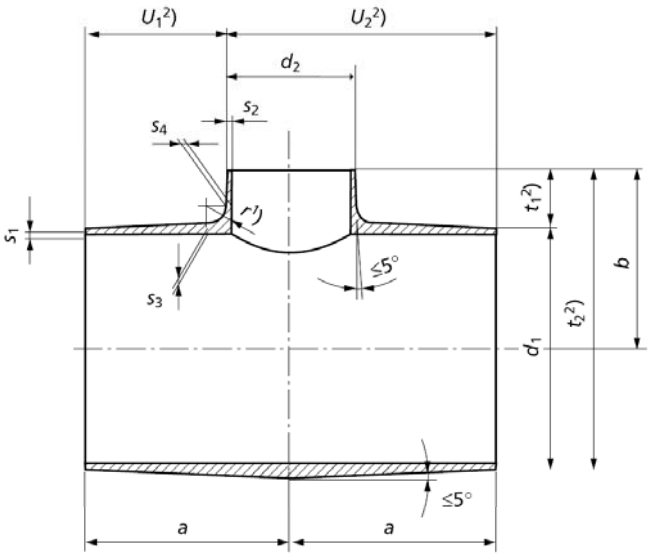




Accomplishment A
remaining dimensions see
accomplishment B



Accomplishment B
dimensions complyto
accomplishment A

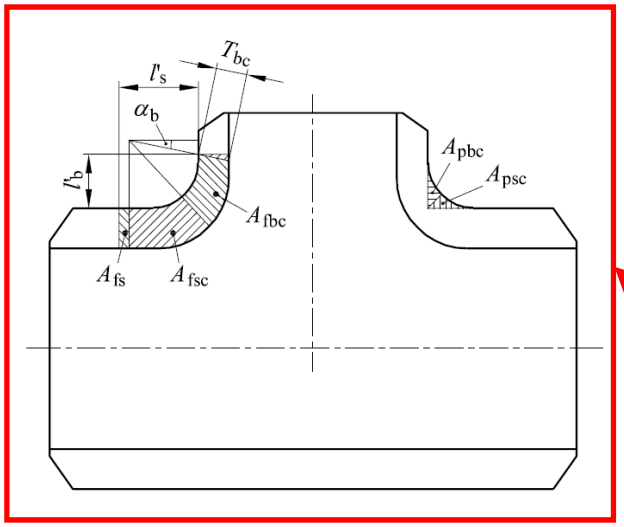


DIN 2615 – 1
DIN 2615 – 2, do plného tlaku

Steel butt-welding pipe fittings
Tees for use at full service pressure

DIN 2615 Part 2

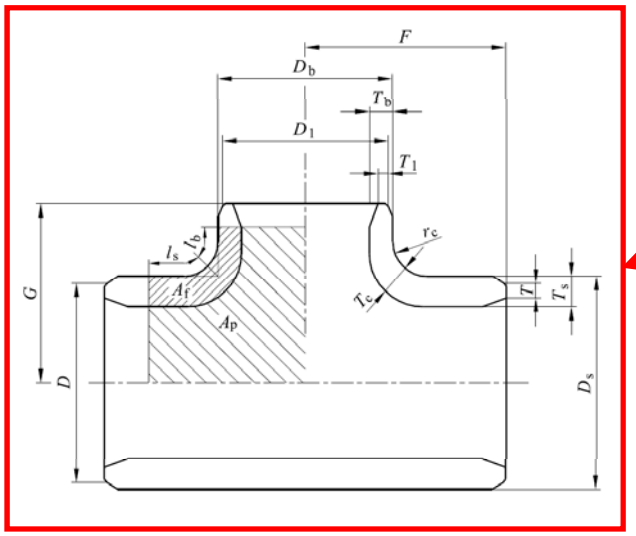
Potrubný systém. T-kus, Kríž /Tee, Cross/



$$X = \frac{\text{pressure resistance of fitting}}{\text{pressure resistance of pipe}} \cdot 100\ \%$$

EN 10253-2

TYP A – obmedzený tlak



TYP B – do plného tlaku

Potrubný systém. T-kus, Kríž /Tee, Cross/

nominal width DN	diametr. d_1 [1)]	wall thickness s_1 line 1	2	3	4	5	nominal width DN_2	diametr. d_2	wall thickness s_2 line 1	2	3	4	5	a	b	acceptable utilisation level in % at wall thickness lines 1	2	3	4	5
15	21,3	1,6	–	2,0	3,2	4,0	15	21,3	1,6	–	2,0	3,2	4,0	25	25	52	–	55	62	66
							10	17,2	1,6	–	1,8	2,9	–	–	25	60	–	59	73	–
20	26,9	1,6	–	2,3	3,2	4,0	20	26,9	1,6	–	2,3	3,2	4,0	29	29	49	–	54	59	62
							15	21,3	1,6	–	2,0	3,2	4,0	–	29	57	–	57	69	73
							10	17,2	1,6	–	1,8	2,9	–	–	29	65	–	61	73	–
25	33,7	2,0	–	2,6	3,2	4,0	25	33,7	2,0	–	2,6	3,2	4,0	38	38	49	–	52	55	59
							20	26,9	1,6	–	2,3	3,2	4,0		38	57	–	59	74	79
							15	21,3	1,6	–	2,0	3,2	4,0		38	57	–	59	74	79
32	42,7	2,0	–	2,6	3,6	4,0	32	42,4	2,0	–	2,6	3,6	4,0	48	48	46	–	49	54	55
							25	33,7	2,0	–	2,6	3,2	4,0		48	53	–	57	58	65
							20	26,9	1,6	–	2,3	3,2	4,0		48	53	–	61	66	74
							15	21,3	1,6	–	2,0	3,2	4,0		48	60	–	63	76	84
40	48,3	2,0	–	2,6	4,0	5,0	40	48,3	2,0	–	2,6	4,0	5,0		57	44	–	47	53	57
							32	42,4	2,0	–	2,6	3,2	4,0		57	48	–	52	54	59
							25	33,7	2,0	–	2,6	3,2	4,0		57	55	–	60	58	62
							20	26,9	1,6	–	2,3	3,2	4,0		57	55	–	60	58	62
50	60,3	2,0	–	2,9	4,5	5,6	50	60,3	2,0	–	2,9	4,5	5,6	64	64	41	–	46	52	55
							40	48,3	2,0	–	2,6	4,0	5,0		60	48	–	49	55	59
							32	42,4	2,0	–	2,6	3,6	4,0		57	52	–	54	56	56
							25	33,7	2,0	–	2,6	3,2	4,0		51	59	–	61	60	64
							20	26,9	1,6	–	2,3	3,2	4,0		44	58	–	64	68	72

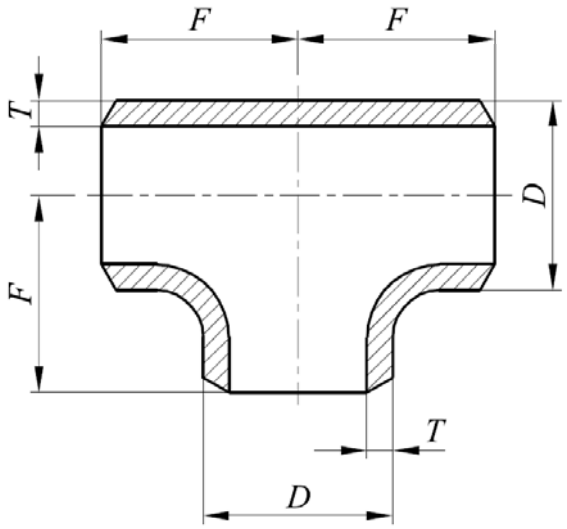
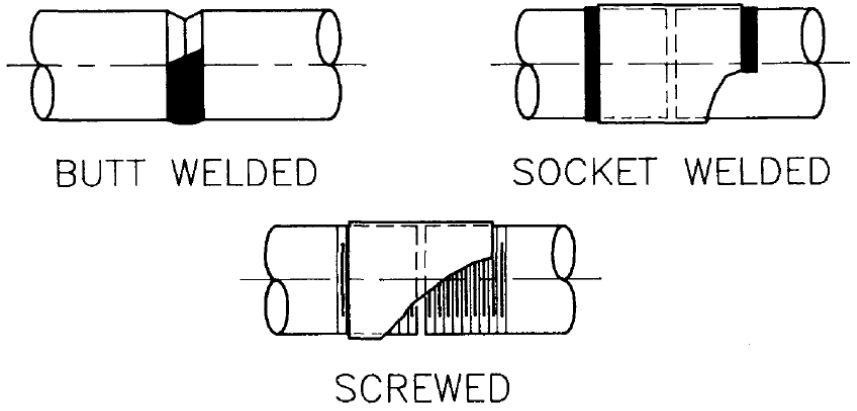


Figure 4 — Equal tee

DIN 2615 – 1, pressure factor

Potrubný systém. Odbočky /Outlet, Olet/



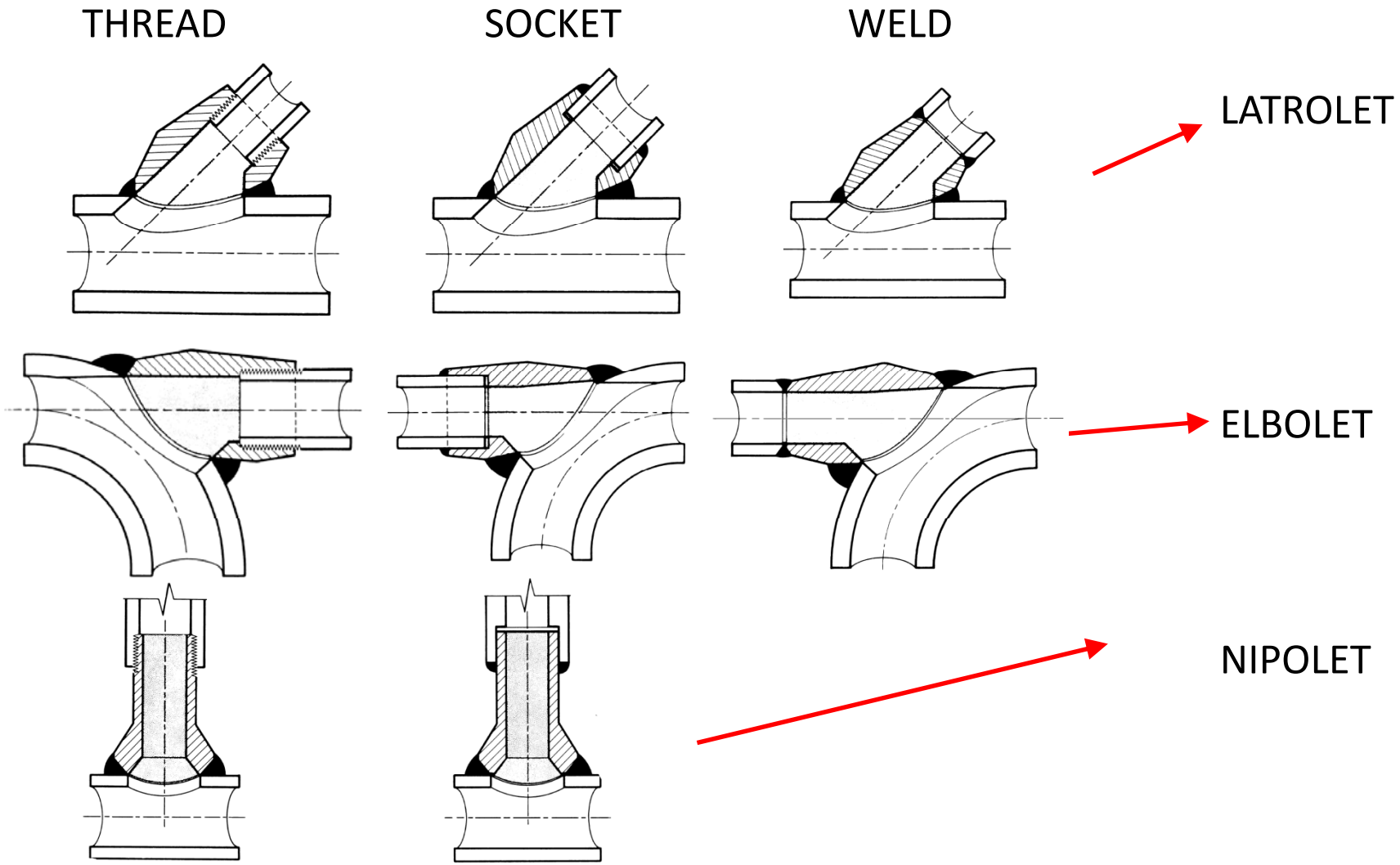
SOCK

WELD

THRED

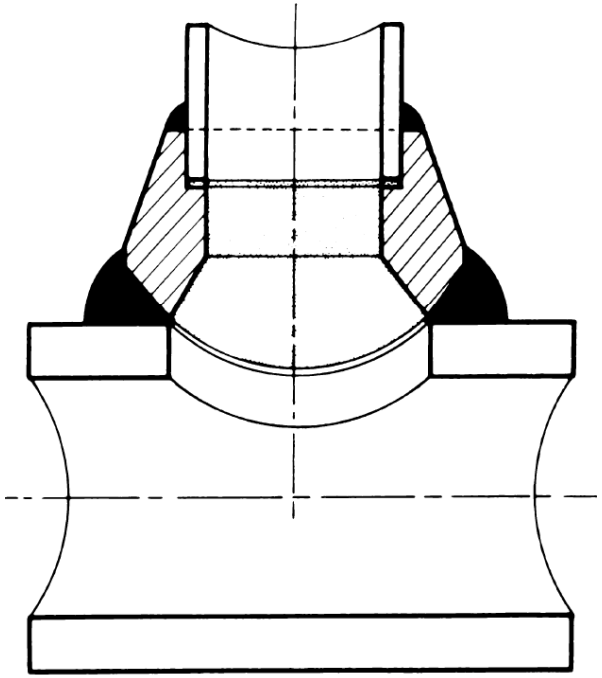
OLET

Potrubný systém. Odbočky /Outlet, Olet/



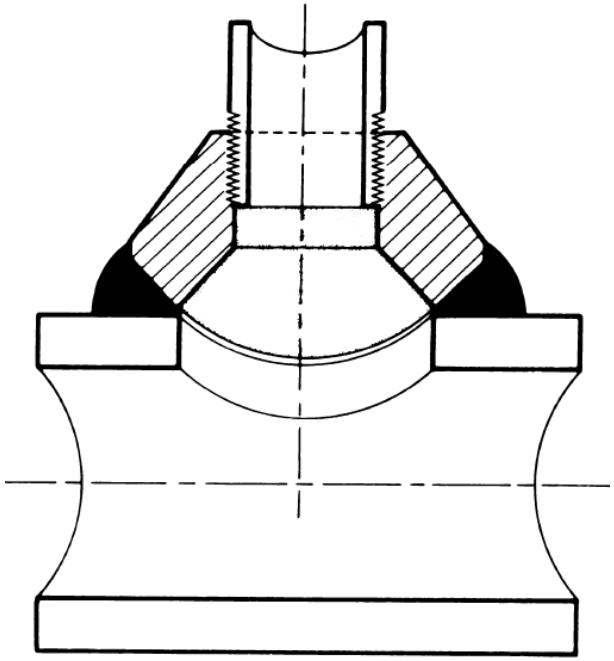
Potrubný systém. Odbočky /Outlet, Olet/

THREAD



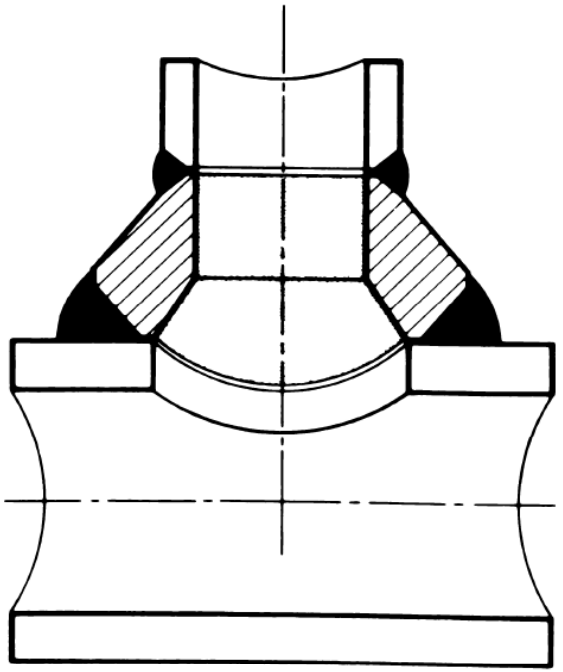
THREADOLET

SOCKET



SOCKOLET

WELD



WELDOLET

Potrubný systém. Odbočky /Outlet, Olet/

THREAD

THREADOLET

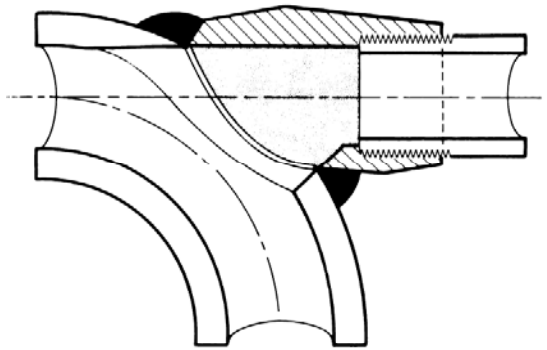
SOCKET

SOCKOLET

WELD

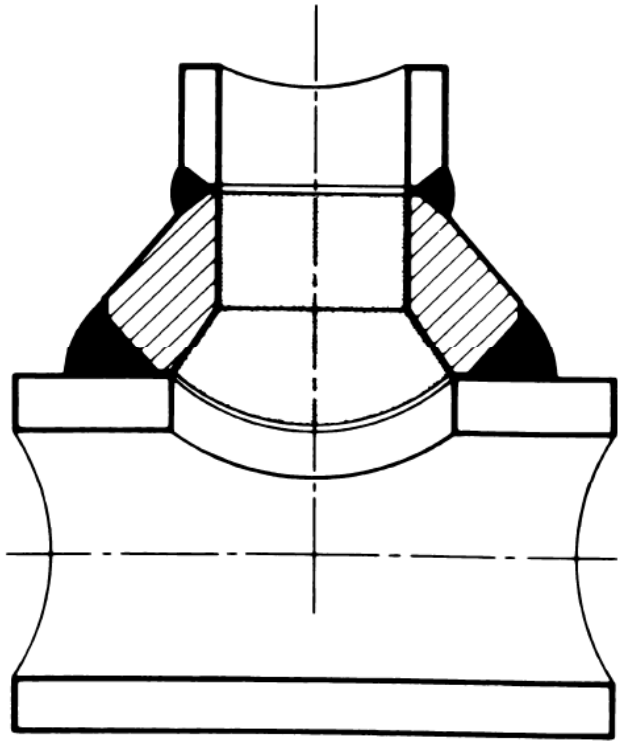
WELDOLET

Potrubný systém. Odbočky /Outlet, Olet/



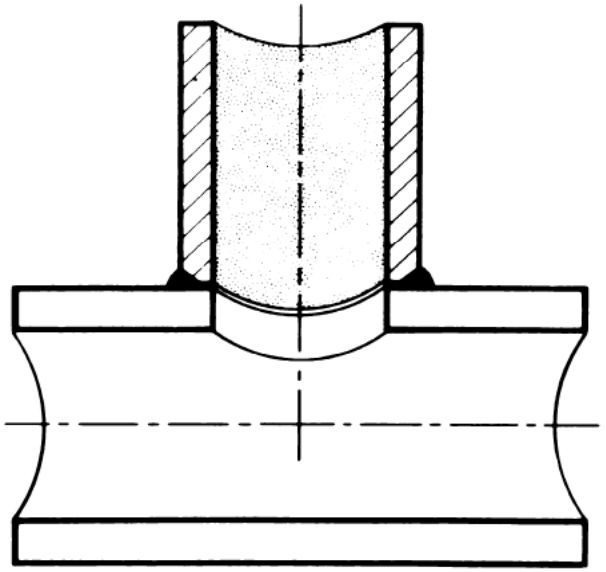
THREADED ELBOLET

Potrubný systém. Odbočky /Outlet, Olet/

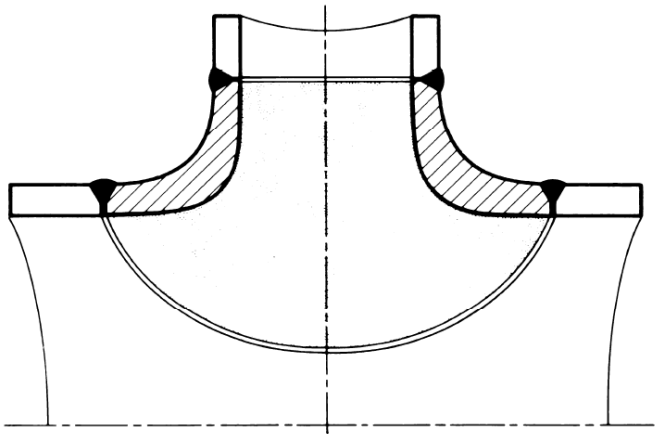


WELDOLET

Potrubný systém. Odbočky /Outlet, Olet/



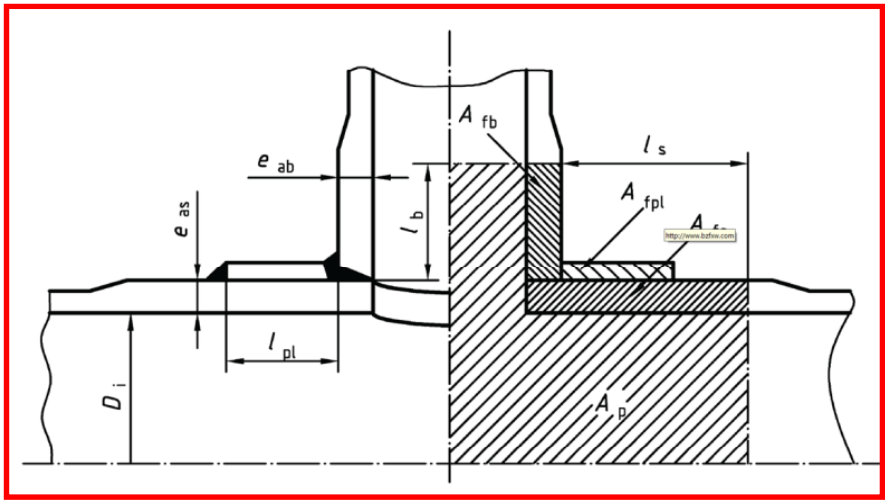
STUB-IN



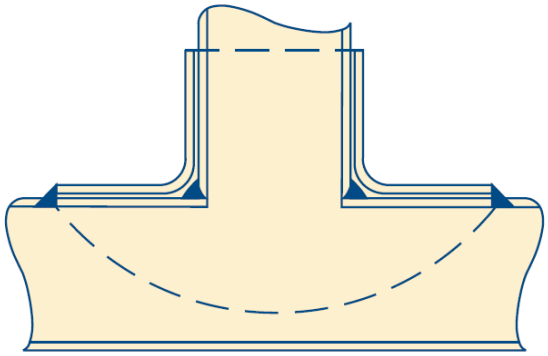
SWEEPOLET

WELDOLET

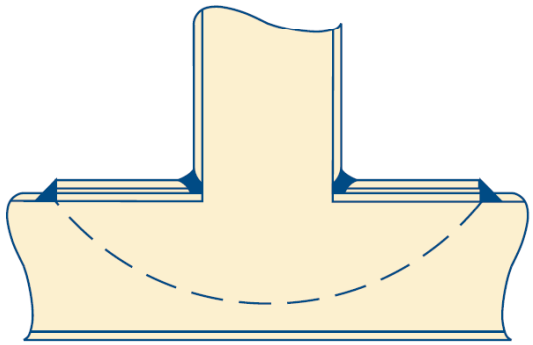
Potrubný systém. Odbočky /Outlet, Olet/



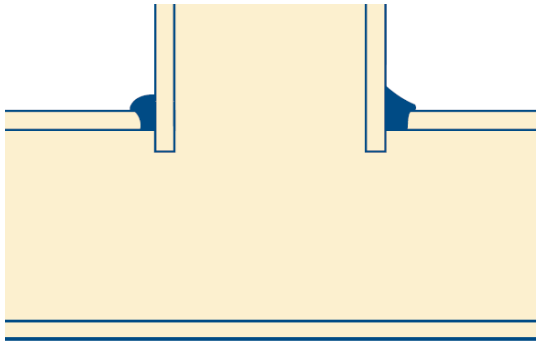
Vystuženie :
-Výstužný prstenec, rebro, hrúbka steny,
napr. STN EN 13 480-3



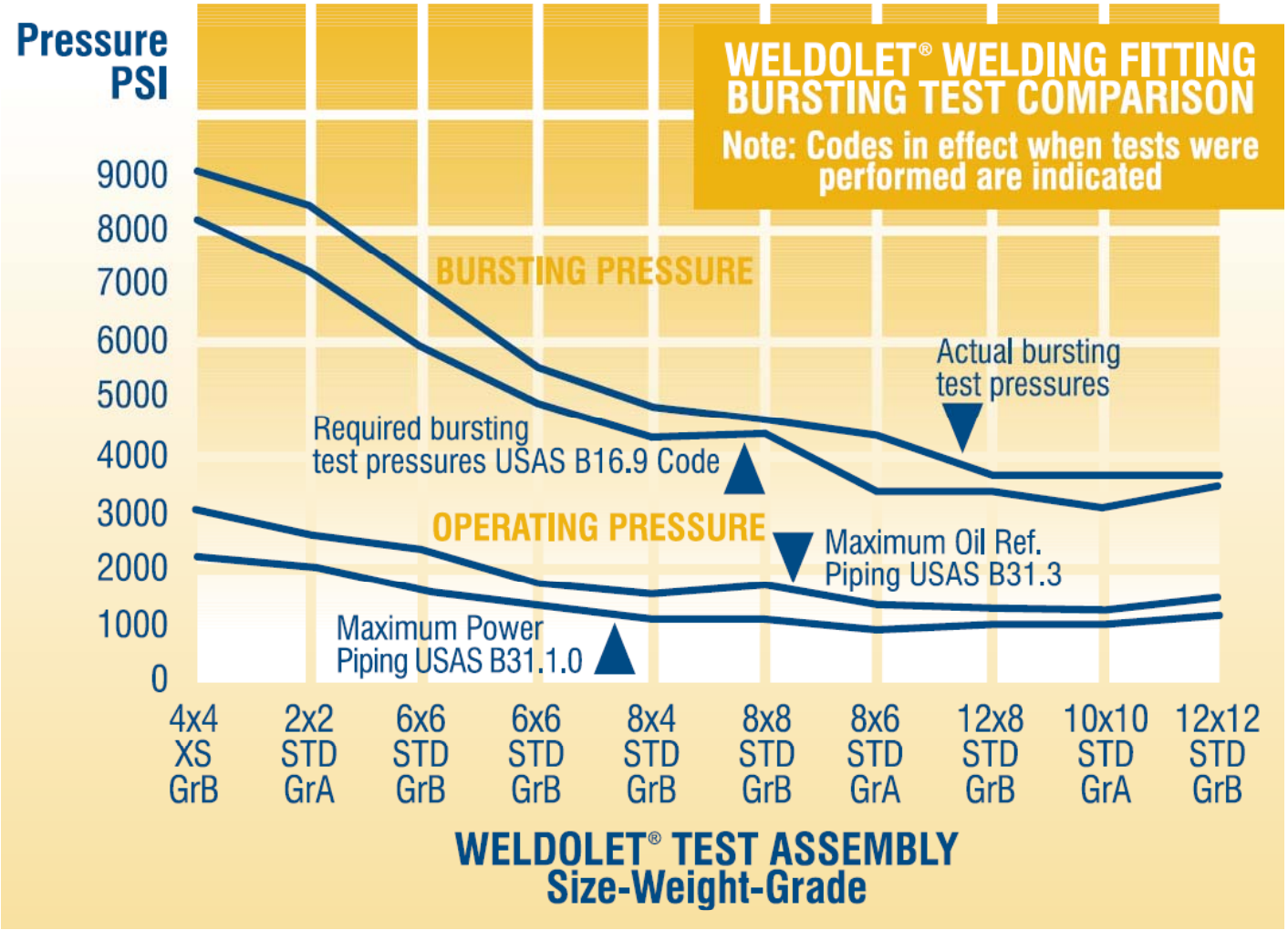
WELDING SADDLE



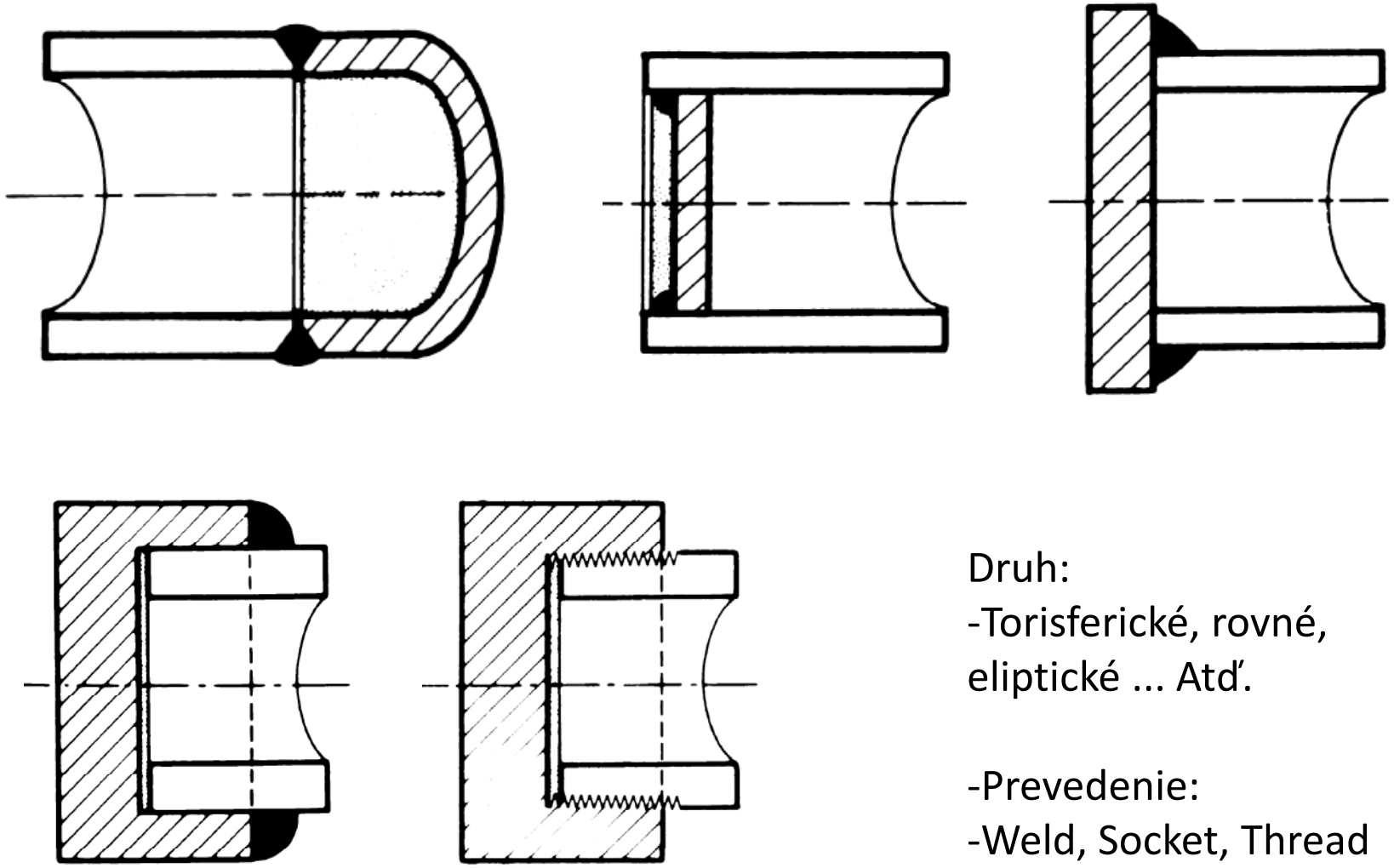
REINFORCING PAD



Potrubný systém. Odbočky /Outlet, Olet/



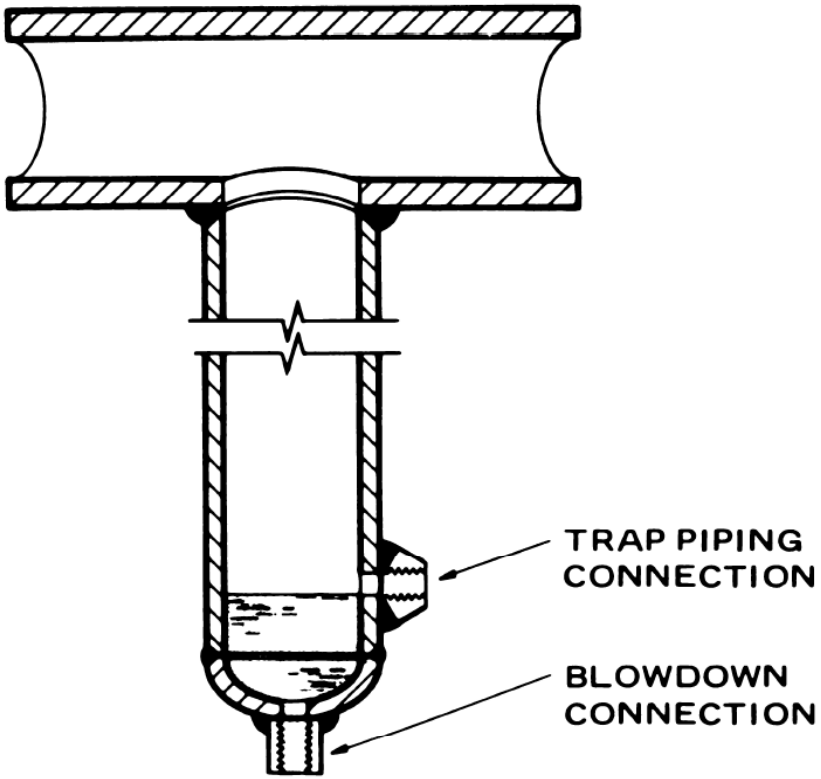
Potrubný systém. Uzáver /Cap/



Druh:
-Torisferické, rovné, eliptické ... Atď.

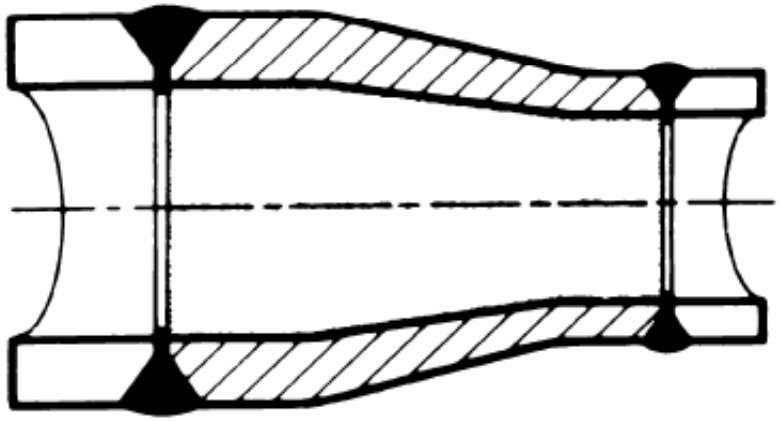
-Prevedenie:
-Weld, Socket, Thread

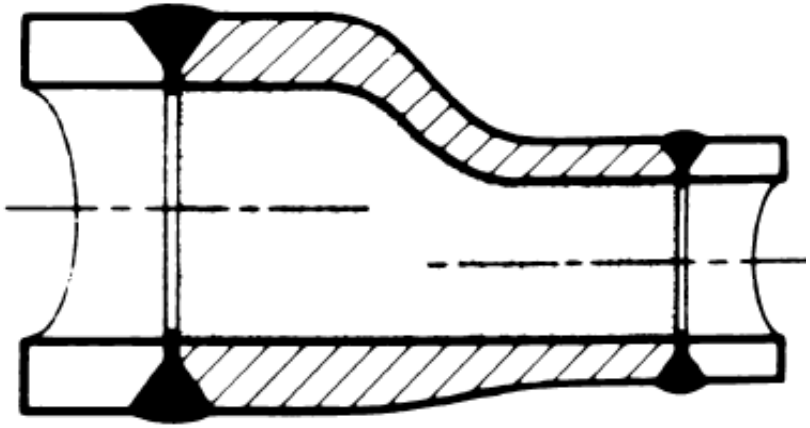
Potrubný systém. Uzáver /Cap/



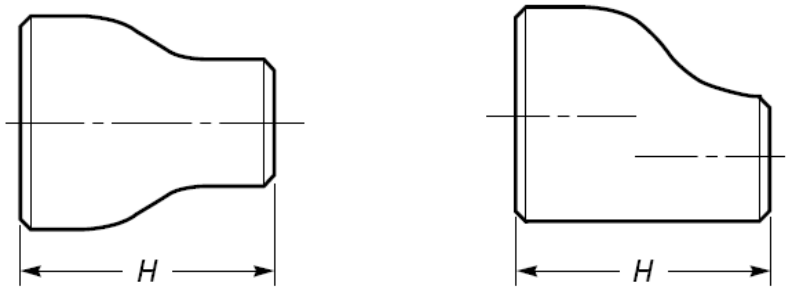
Použitie :
- Steam/Liquid Trap
- Steam distributor
-Separator

Potrubný systém. Reducia /Reducer CON, ECC/





Potrubný systém. Reducia /Reducer CON, ECC/



Note (1)

TABLE 12 DIMENSIONS OF REDUCERS

Nominal Pipe Size (NPS)	DN	Outside Diameter at Bevel		End-to-End, *H*	Nominal Pipe Size (NPS)	DN	Outside Diameter at Bevel		End-to-End, *H*
		Large End	Small End				Large End	Small End	
$\frac{3}{4} \times \frac{1}{2}$	20 × 15	26.7	21.3	38	5 × 4	125 × 100	141.3	114.3	127
$\frac{3}{4} \times \frac{3}{8}$	20 × 10	26.7	17.3	38	$5 \times 3\frac{1}{2}$	125 × 90	141.3	101.6	127
$1 \times \frac{3}{4}$	25 × 20	33.4	26.7	51	5 × 3	125 × 80	141.3	88.9	127
$1 \times \frac{1}{2}$	25 × 15	33.4	21.3	51	$5 \times 2\frac{1}{2}$	125 × 65	141.3	73.0	127

Potrubný systém. Reducia /Reducer CON, ECC/

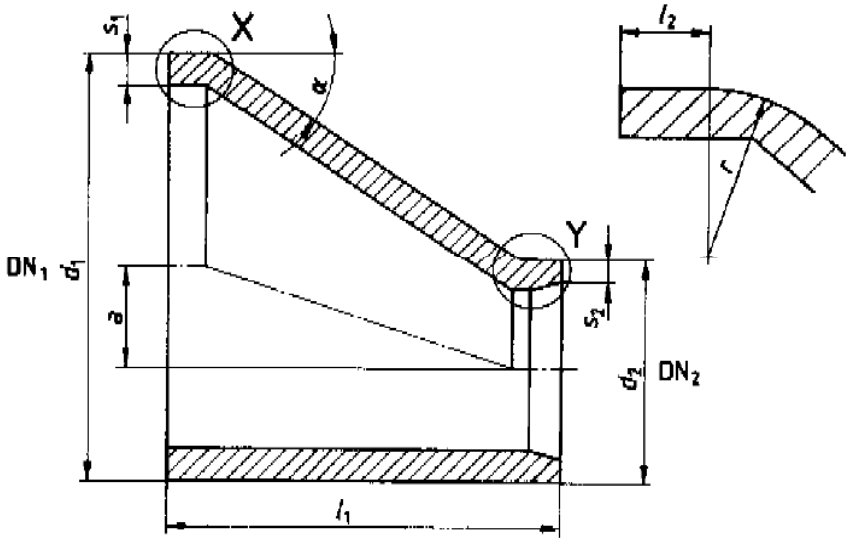
Steel butt-welding pipe fittings
Eccentric reducers with reduced pressure factor

DIN 2616 Part 1

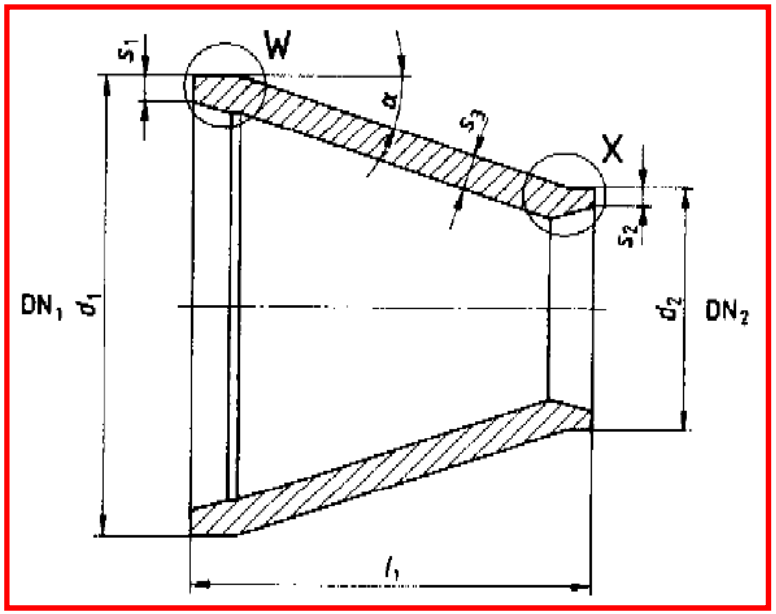
Steel butt-welding pipe fittings
Reducers for use at full service pressure

DIN 2616 Part 2

Do plného tlaku



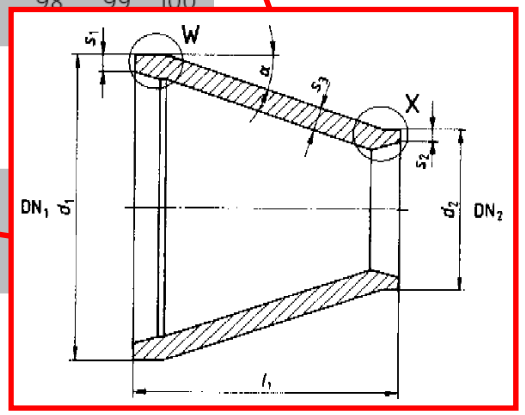
DIN 2616 – 1 , Excentrická



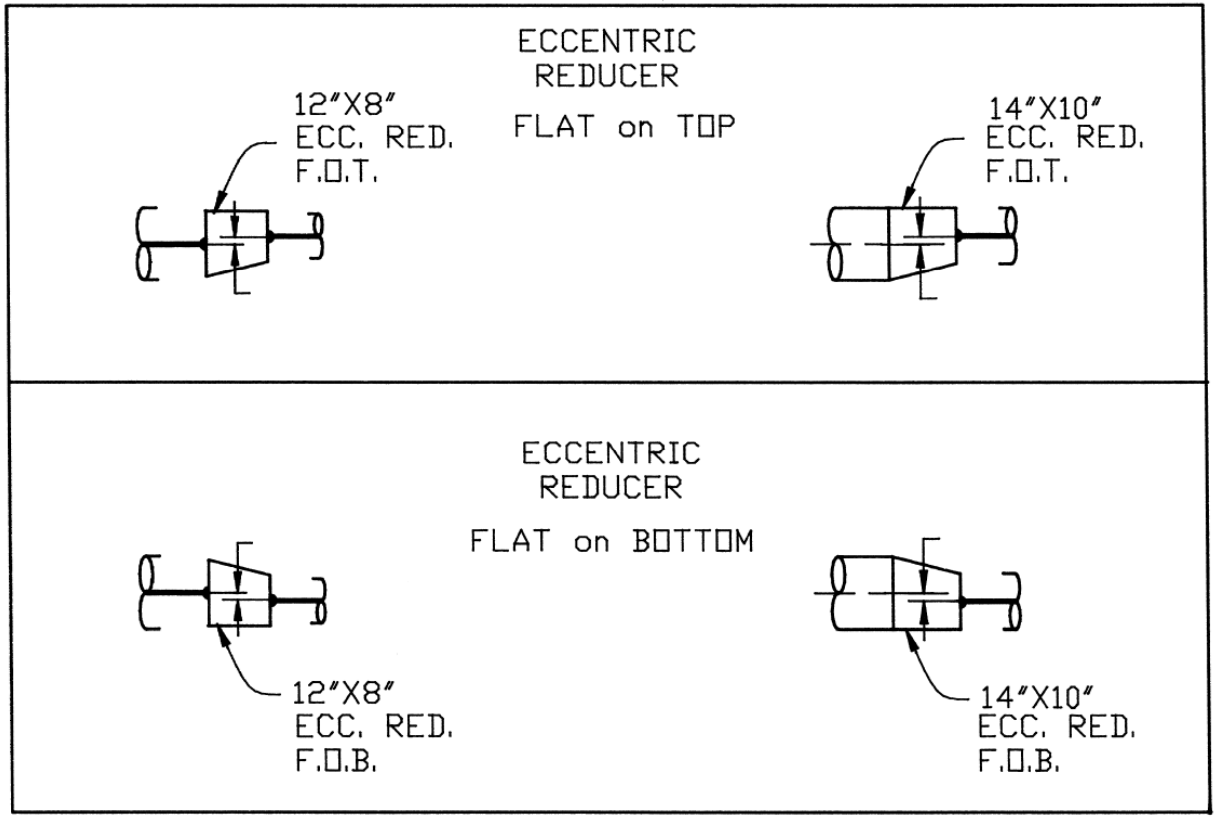
DIN 2616 – 2 , Centrická

Potrubný systém. Reducia /Reducer CON, ECC/

Nenn-weite DN	Durch-messer d_1 [1)]	Wanddicke s_1 Reihe 1	2	3	4	5	Nenn-weite DN_2	Durch-messer d_2	Wanddicke s_2 Reihe 1	2	3	4	5	l_1	Zulässiger Ausnutzungsgrad in % bei Wanddicken-Reihe 1	2	3	4	5
15	21,3	1,6	–	2,0	3,2	4,0	10	17,2	1,6	–	1,8	2,9	–	38	97	–	95	91	–
20	26,9	1,6	–	2,3	3,2	4,0	15	21,3	1,6	–	2,0	3,2	4,0	38	199	–	98	96	100
							10	17,2	1,6	–	1,8	2,9	–	38	100	–	100	100	–
25	33,7	2,0	–	2,6	3,2	4,0	20	26,9	1,6	–	2,3	3,2	4,0	50	98	–	97	96	100
							15	21,3	1,6	–	2,0	3,2	4,0	50	100	–	100	100	100
32	42,4	2,0	–	2,6	3,6	4,0	25	33,7	2,0	–	2,6	3,2	4,0	50	99	–	99	97	100
							20	26,9	1,6	–	2,3	3,2	4,0	50	100	–	100	100	100
							15	21,3	1,6	–	2,0	3,2	4,0	50	98	–	100	100	100
40	48,3	2,0	–	2,6	4,0	5,0	32	42,4	2,0	–	2,6	3,6	4,0	64	98	–	97	95	100
							25	33,7	2,0	–	2,6	3,2	4,0	64	99	–	99	98	100
							20	26,9	1,6	–	2,3	3,2	4,0	64	99	–	100	100	100
50	60,3	2,0	–	2,9	4,5	5,6	40	48,3	2,0	–	2,6	4,0	5,0	76	99	–	98	97	100
							32	42,4	2,0	–	2,6	3,6	4,0	76	99	–	99	98	100
							25	33,7	2,0	–	2,6	3,2	4,0	76	97	–	98	99	100
							20	26,9	1,6	–	2,3	3,2	4,0	76	95	–			
65	76,1	2,3	–	2,9	5,0	7,1	50	60,3	2,0	–	2,9	4,5	5,6	90	99	–			
							40	48,3	2,0	–	2,6	4,0	5,0	90	98	–			
							32	42,4	2,0	–	2,6	3,6	4,0	90	96	–			
							25	33,7	2,0	–	2,6	3,2	4,0	90	93	–			
80	88,9	2,3	–	3,2	5,6	8,0	65	76,1	2,3	–	2,9	5,0	7,1	90	99	–			
							50	60,3	2,0	–	2,9	4,5	5,6	90	92	–			
							40	48,3	2,0	–	2,6	4,0	5,0	90	89	–			
							32	42,4	2,0	–	2,6	3,6	4,0	90	83	–			



Potrubný systém. Reducia /Reducer CON, ECC/



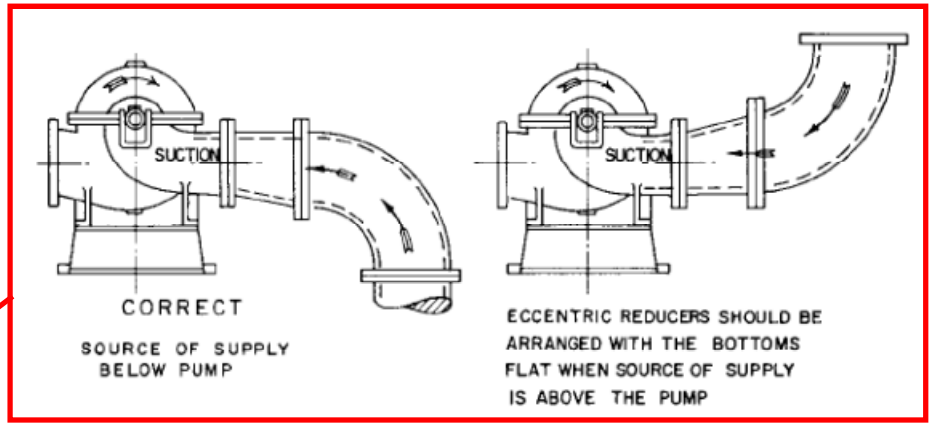
Umiestnenie excentrickej redukcie:

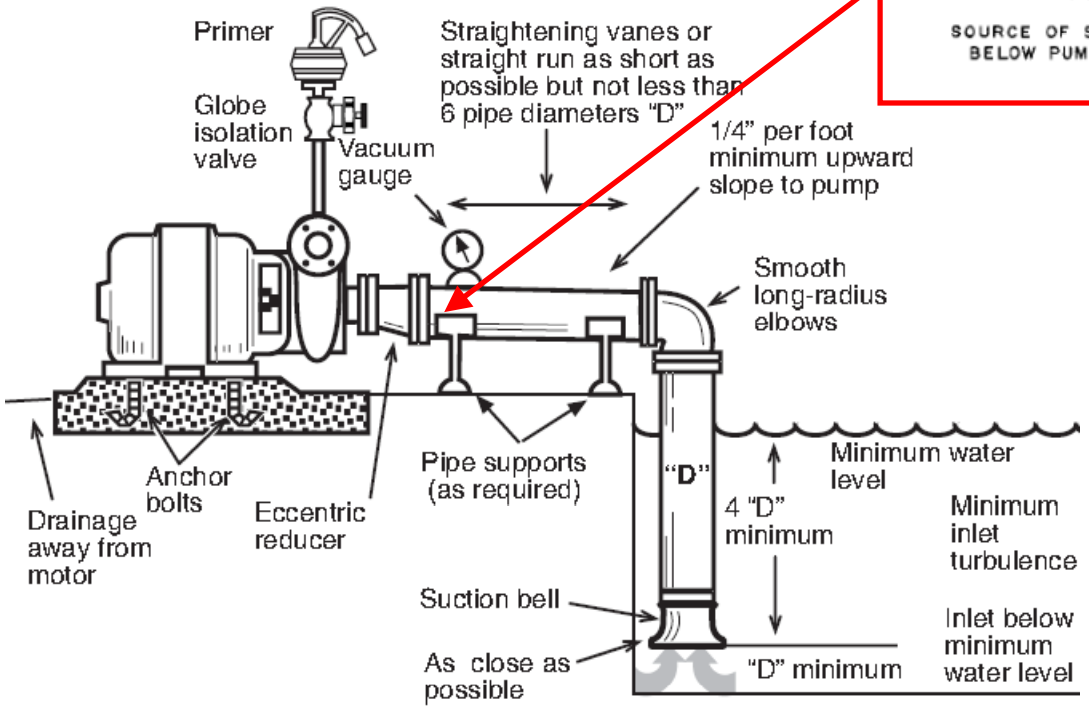
Flat Side Down - FSD
Flat Side Up - FSU

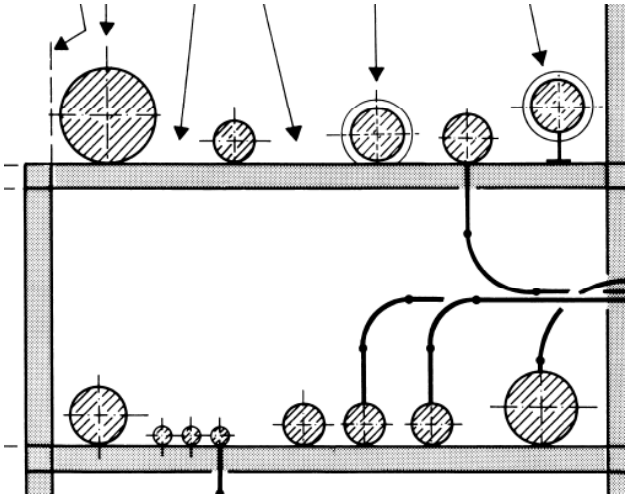
F.O.T - Flat on Top

F.O.B – Flat on Bottom

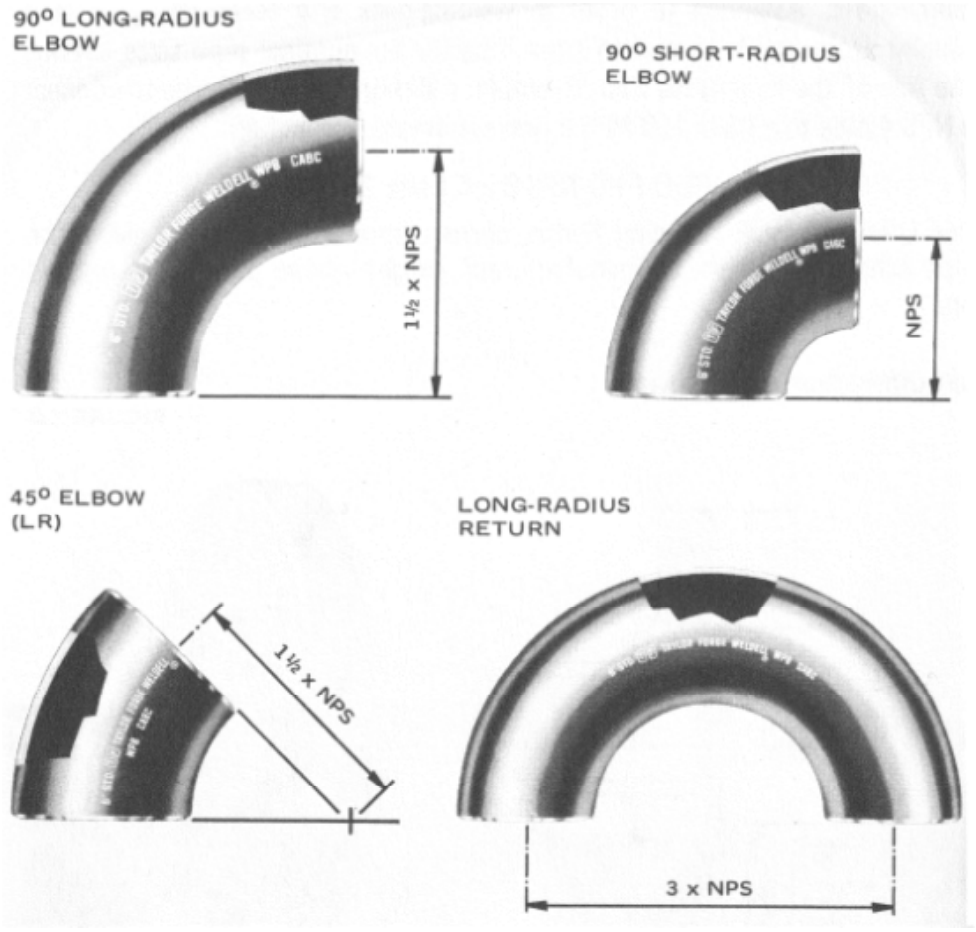
Potrubný systém. Reducia /Reducer CON, ECC/

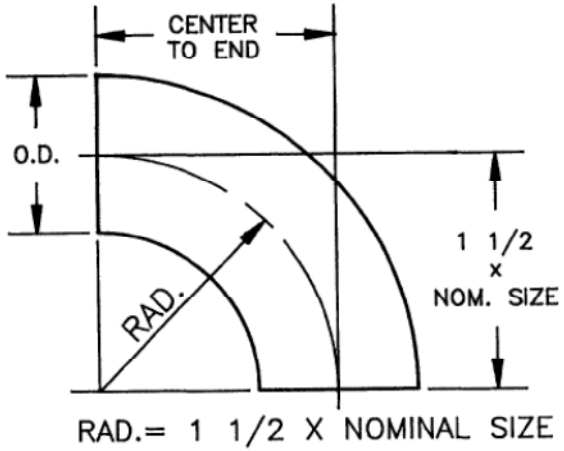


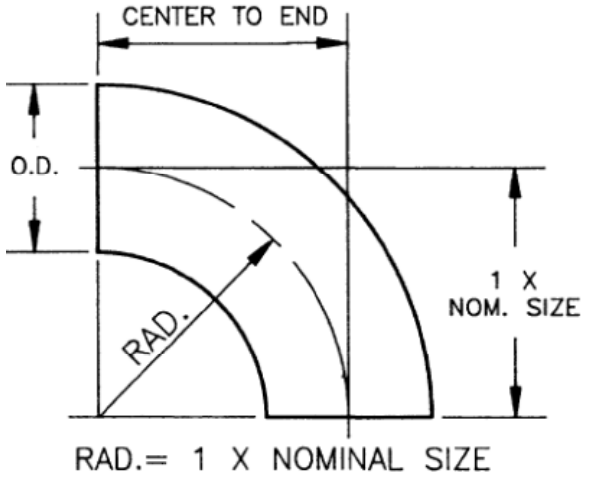




Potrubný systém. Koleno /Elbow, R=1D, R=1,5D/

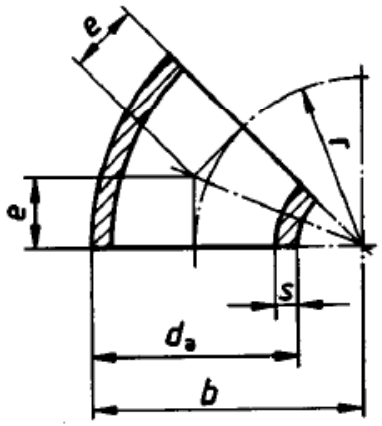




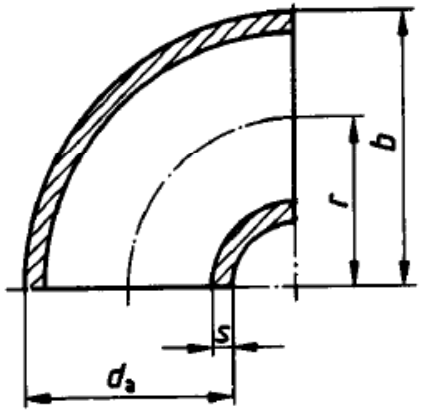


Potrubný systém. Koleno /Elbow, R=1D, R=1,5D/

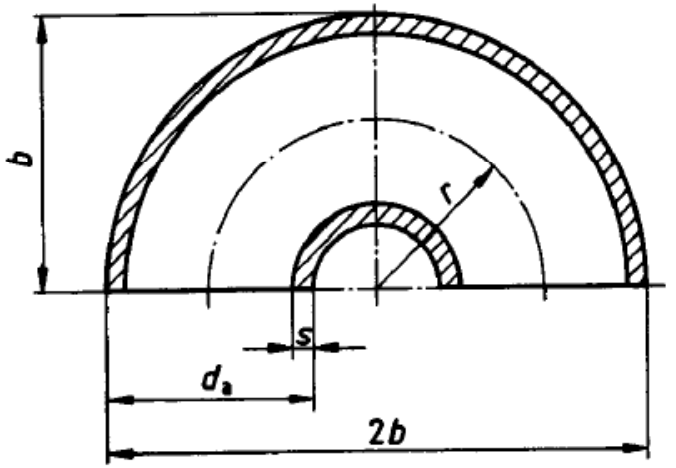
45° elbow



90° elbow



180° bend



r is to be calculated as follows:

type 2: $r \approx 1{,}0 \cdot d_a$

type 3: $r \approx 1{,}5 \cdot d_a$

type 5: $r \approx 2{,}5 \cdot d_a$

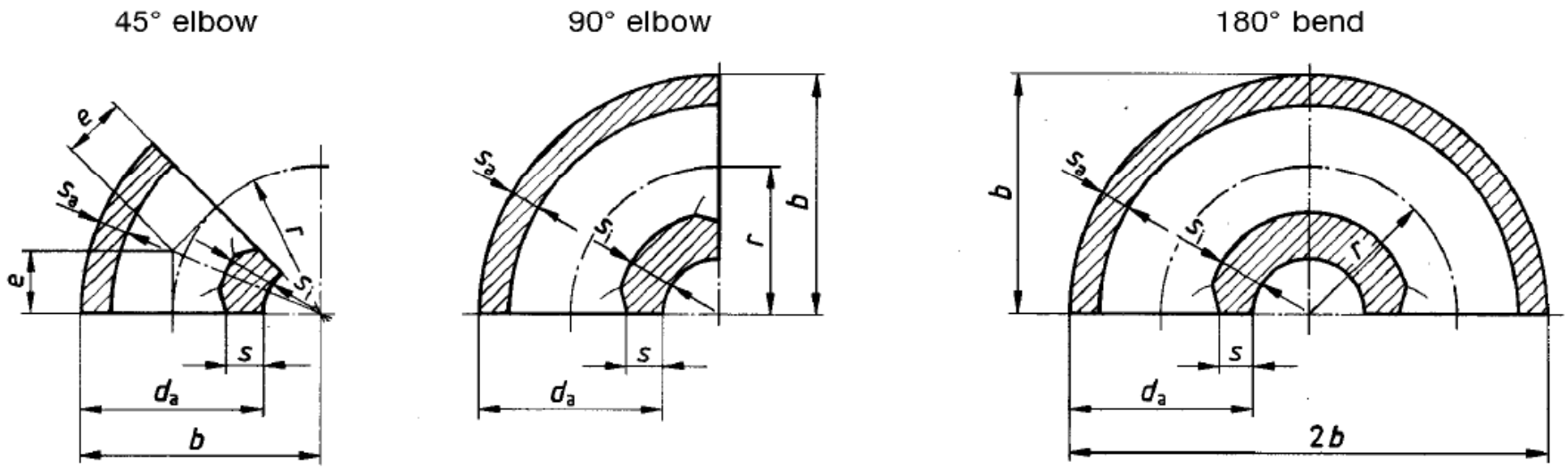
type 10: $r \approx 5{,}0 \cdot d_a$

type 20: $r \approx 10{,}0 \cdot d_a$

Steel butt-welding pipe fittings
Elbows and bends with reduced pressure factor

DIN 2605 Part 1

Potrubný systém. Koleno /Elbow, R=1D, R=1,5D/



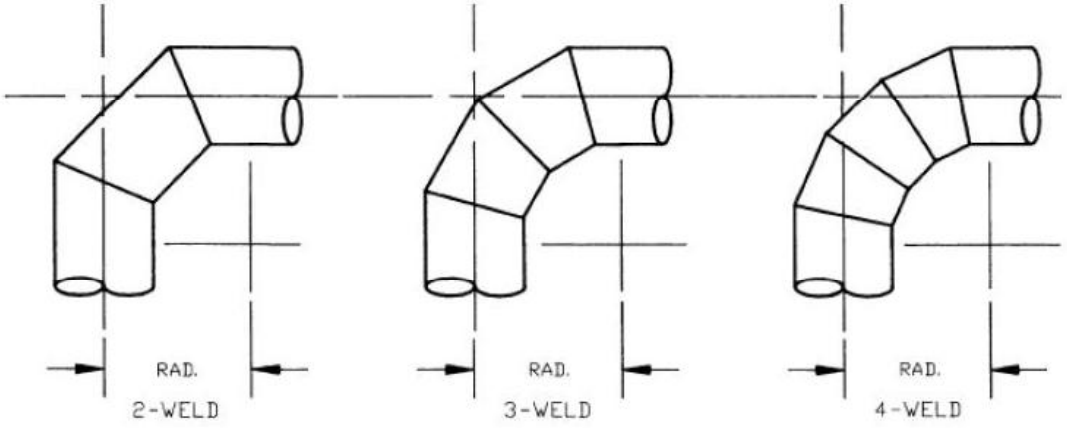
r is a design dimension, to be calculated as follows:

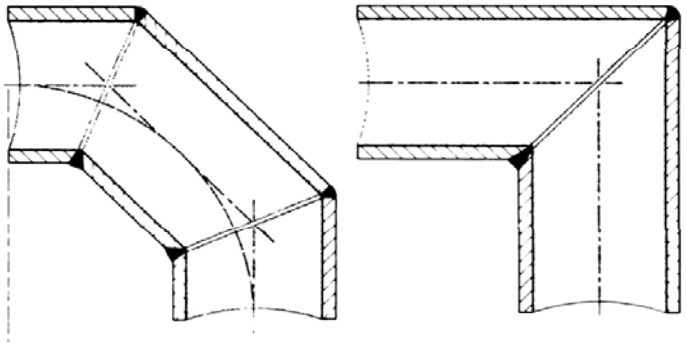
type 2: $r \approx 1{,}0 \cdot d_a$;
type 3: $r \approx 1{,}5 \cdot d_a$;
type 5: $r \approx 2{,}5 \cdot d_a$;
type 10: $r \approx 5{,}0 \cdot d_a$;
type 20: $r \approx 10{,}0 \cdot d_a$.

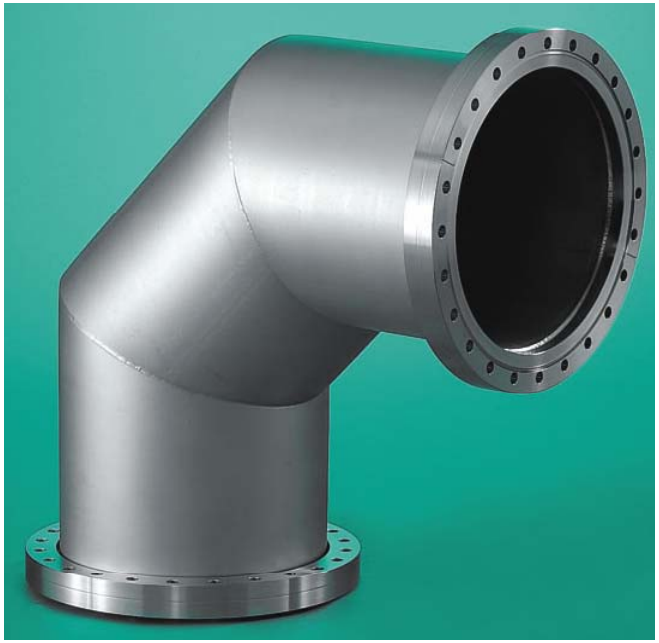
Steel butt-welding pipe fittings
Part 2: Elbows and bends for use at full service pressure

DIN
2605-2

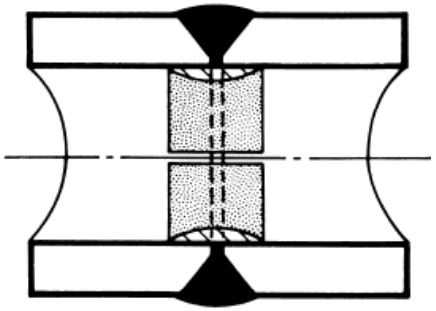
Potrubný systém. Seg. Koleno /Mitter Elbow/



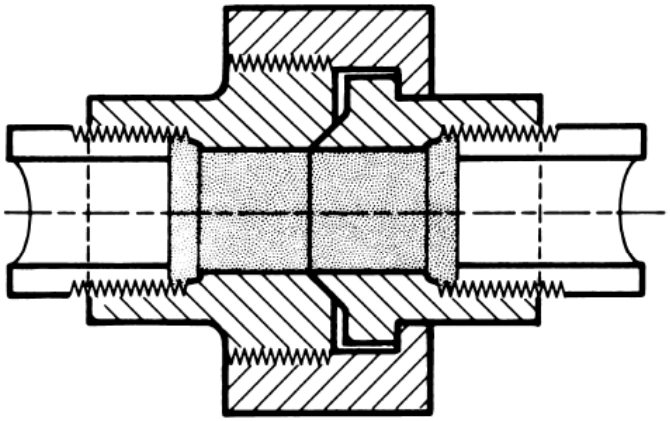


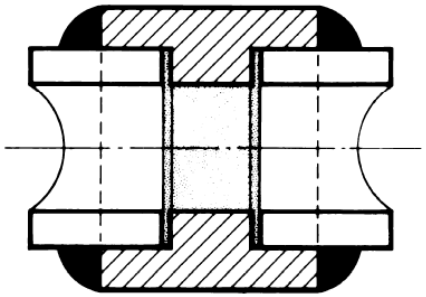


Potrubný systém. Spojky, /Coupling, Connector/

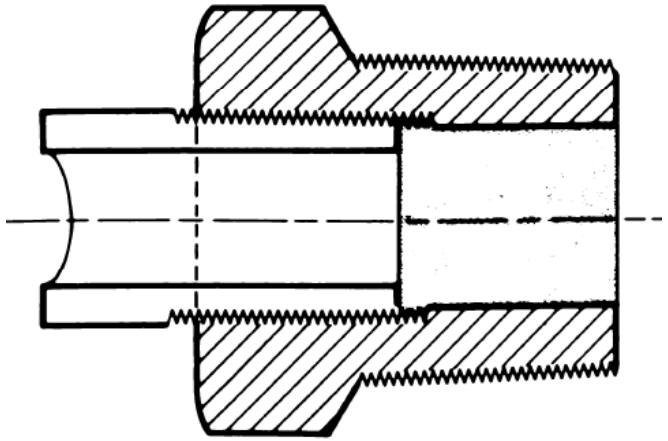


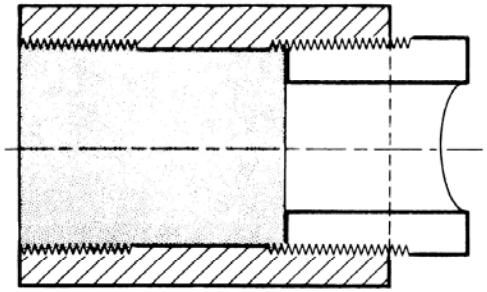
Butt-Welded
Piping BW





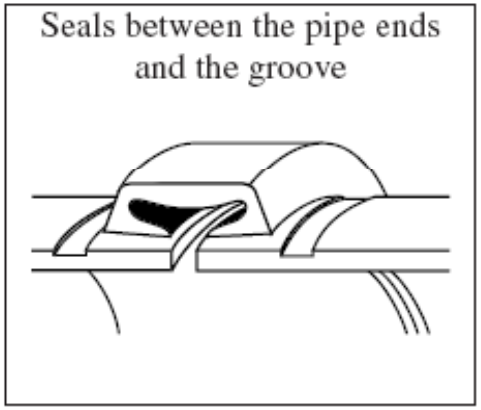
Socket-Welded
Piping SW

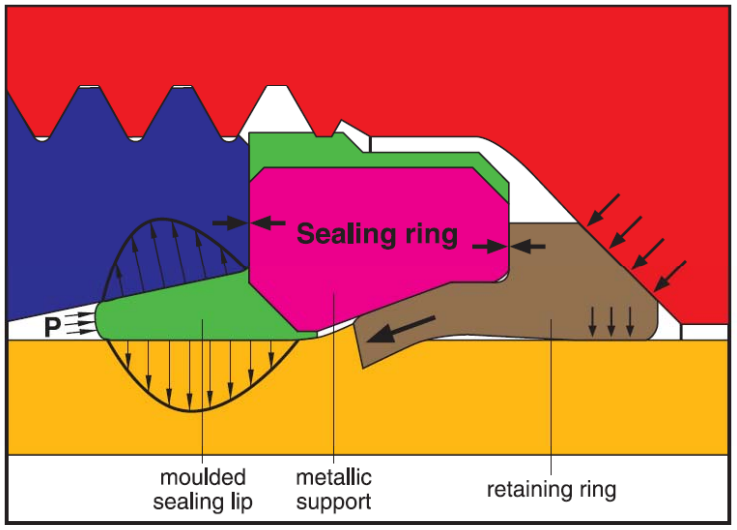




Screwed Piping S
(THD Thread)

Potrubný systém. Základné spôsoby spájania potrubí.



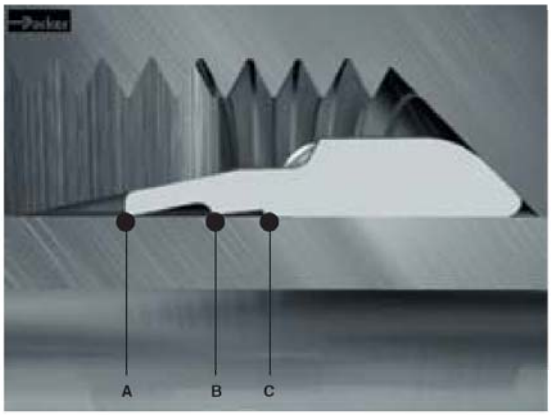


The metallic support of the sealing ring acts just like an integrated pre-assembly tool.

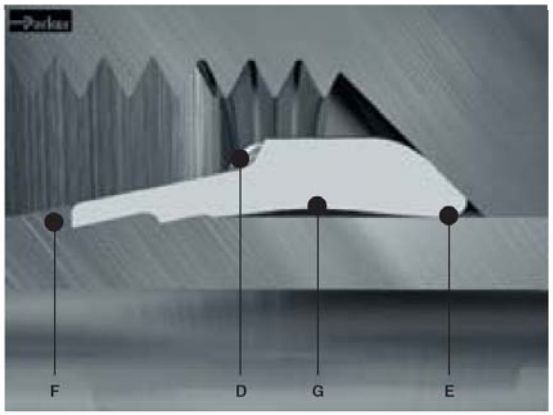
Ostatné typ spájania.

-pružný člen
-tvarový spoj

Victaulic
Parker
Swagelock atď.

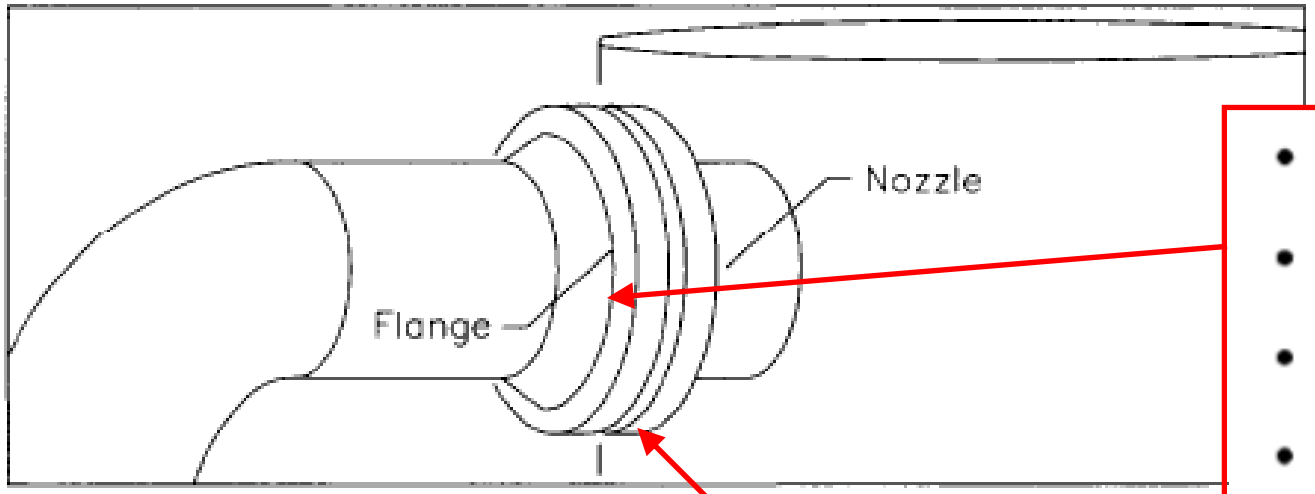


Before tightening the nut



After tightening the nut

Potrubný systém. Príruba /Flange/

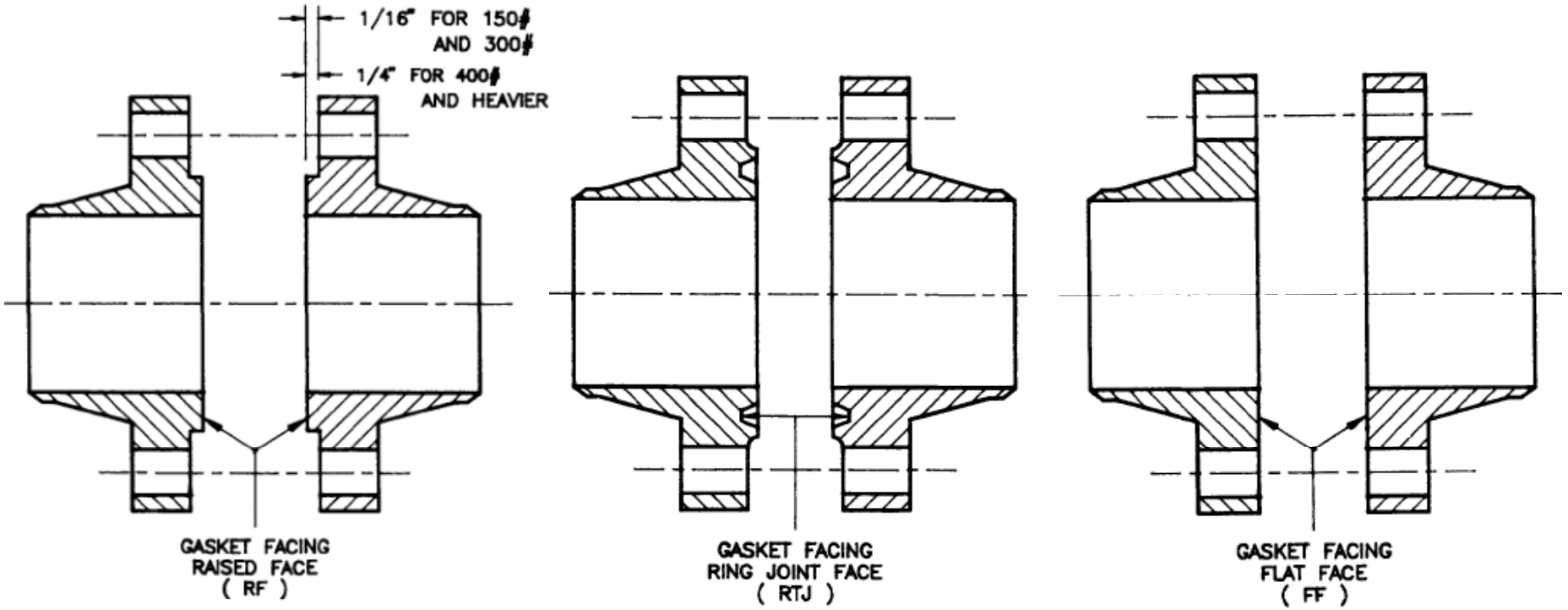


- weld neck
- threaded
- socket weld
- slip-on
- lap-joint
- reducing
- blind
- orifice

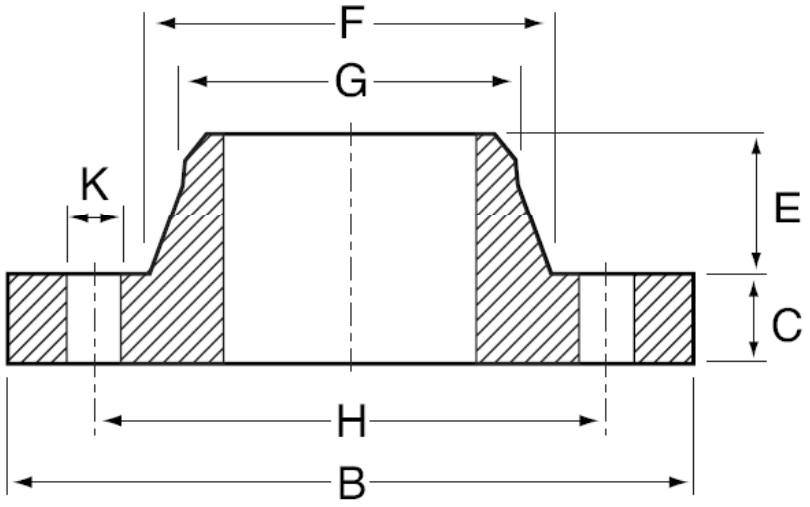
- flat face
- raised face
- ring-type joint

-Typ
-Rozmer
-Rating
-Tesniaca plocha

Potrubný systém. Príruba /Flange/



Potrubný systém. Príruba /Flange/



WELDING NECK

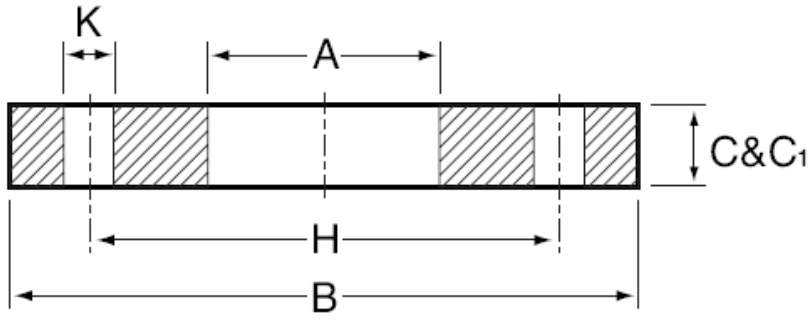
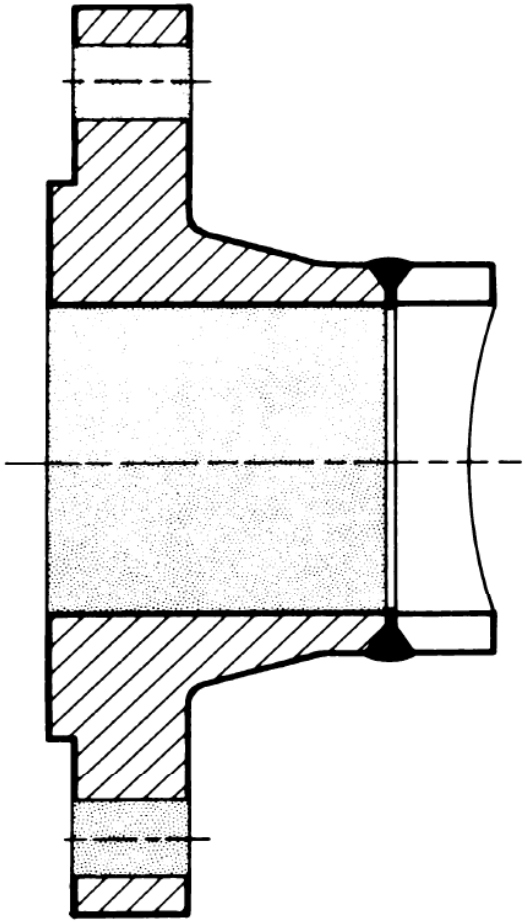
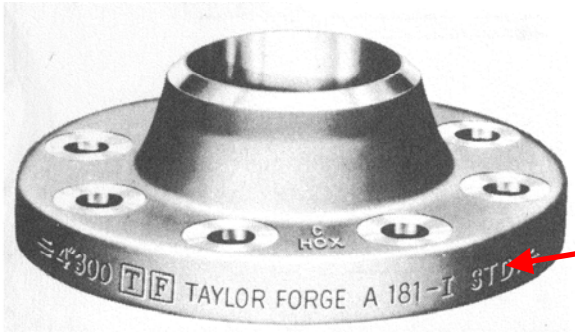


PLATE SLIP-ON WELDING

Hlavné rozmery:
-Rozstupová kružnica
-Počet a priemer pre skrutky
-Pripojovací rozmer

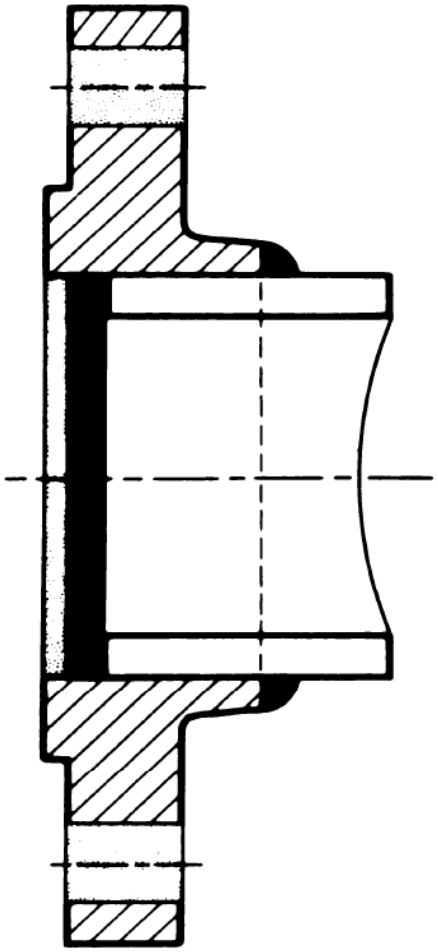
Potrubný systém. Krková príruba /Flange Welding Neck/

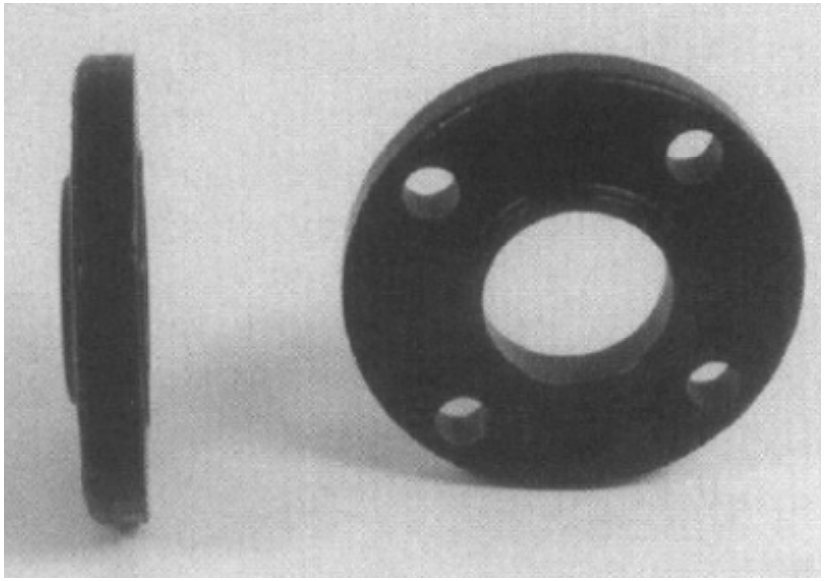


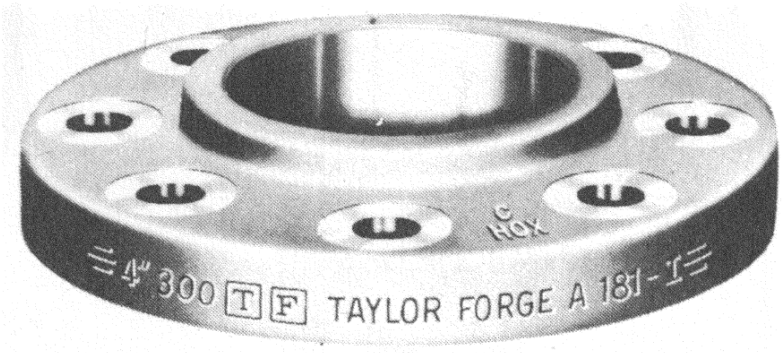


Identifikácia

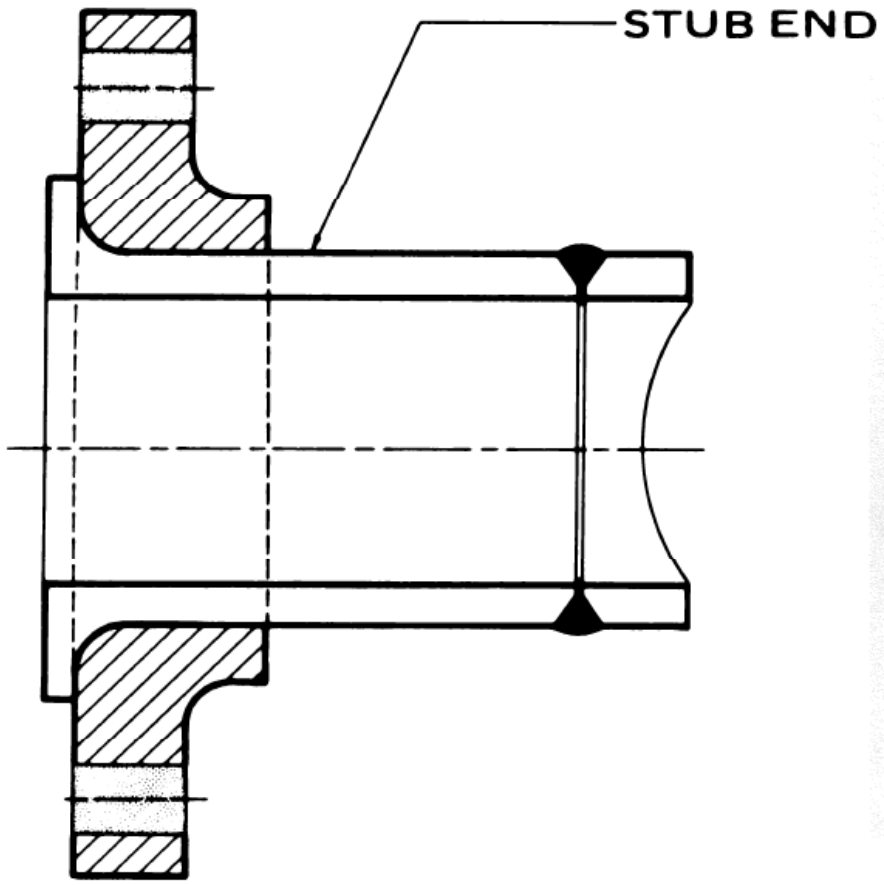
Potrubný systém. “Plochá” príruba /Slip-on flange/

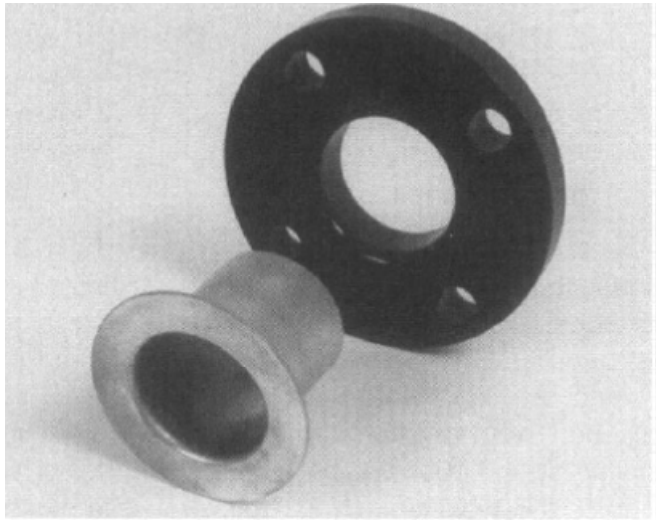




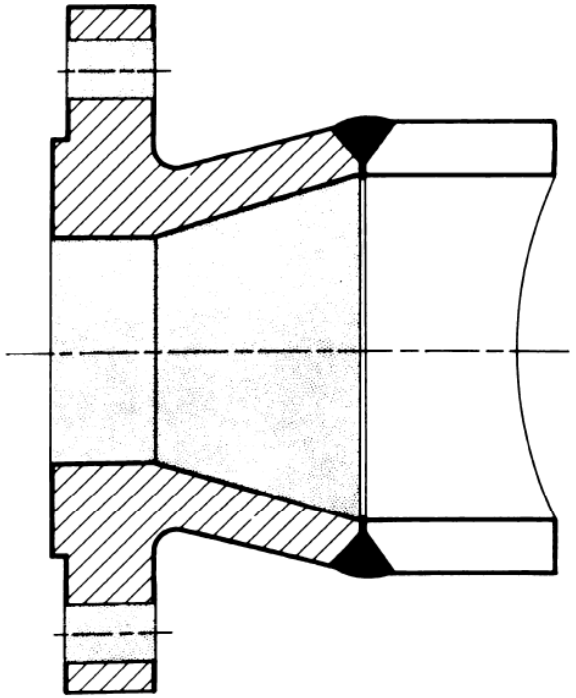


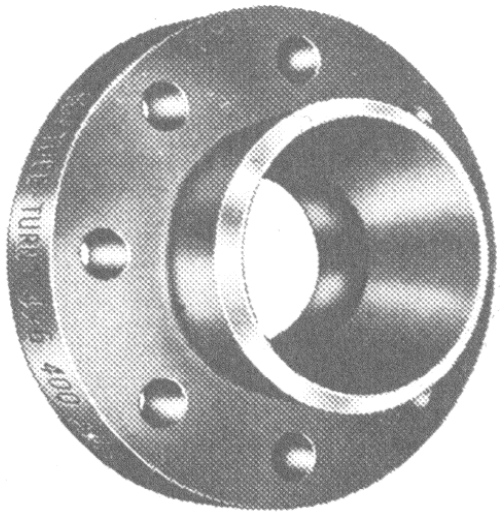
Potrubný systém. Otočná príruba /Lap-joint flange/

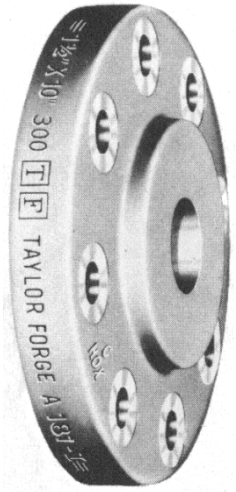


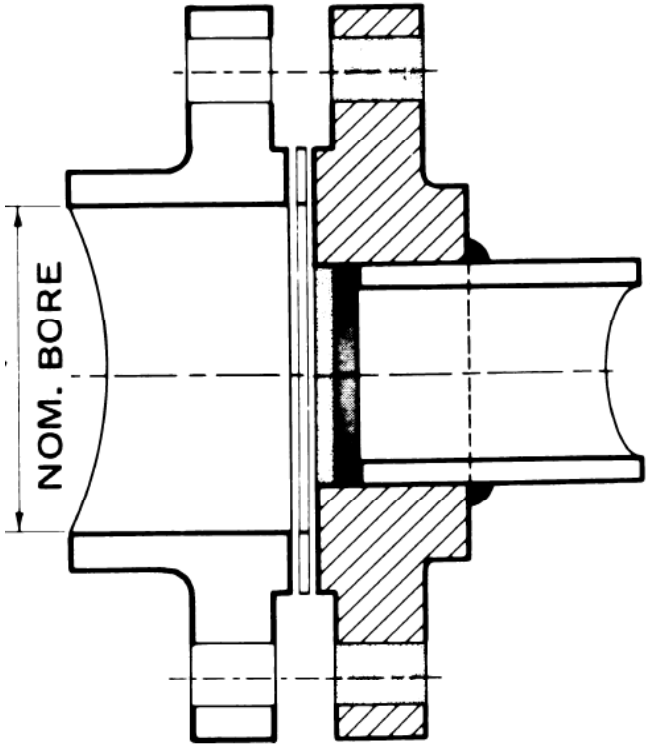


Potrubný systém. Redukčná príruba /Reducing flange/

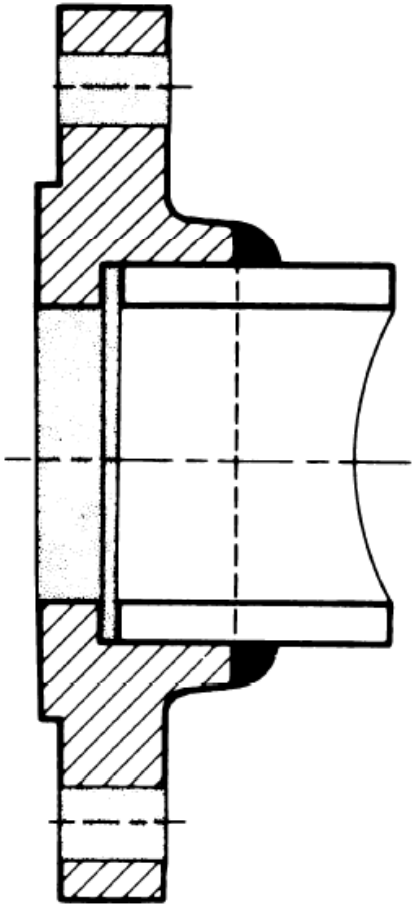


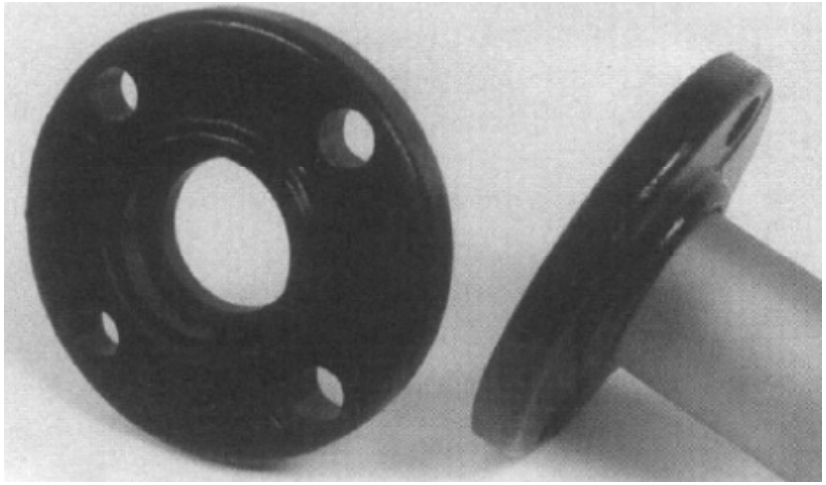


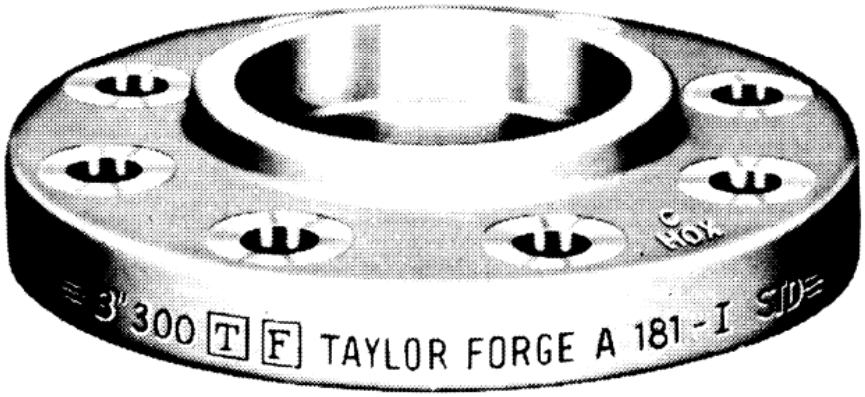




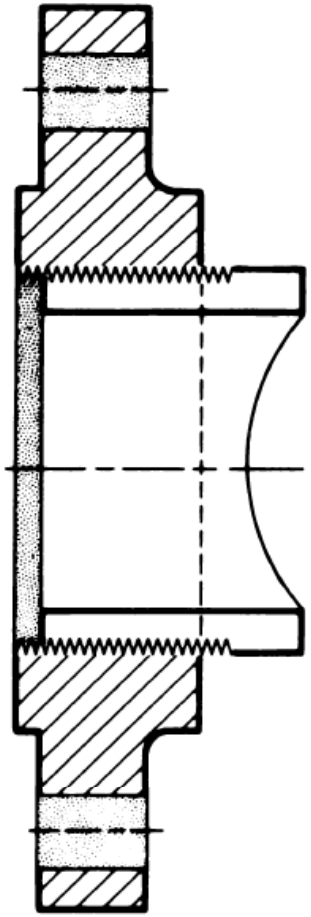
Potrubný systém. „Socket“ príruba /Socket-welding flange/

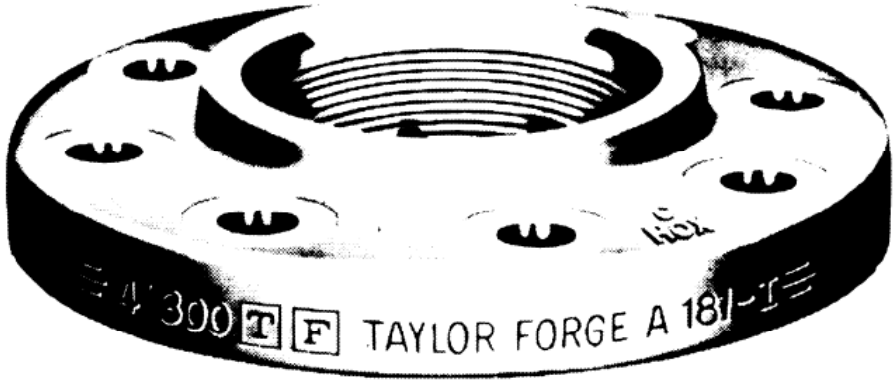




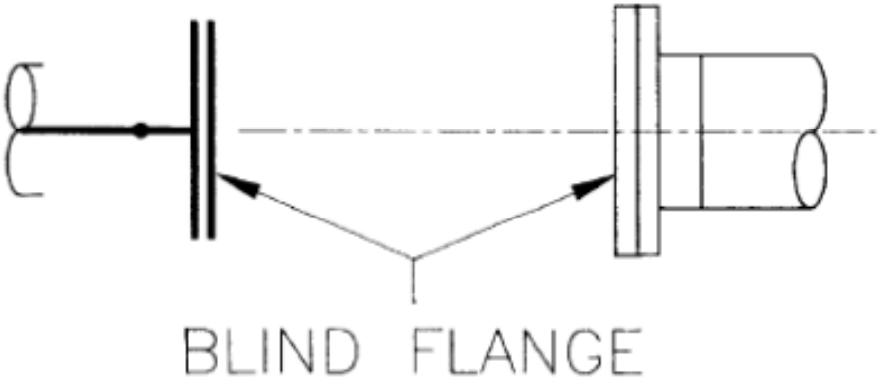


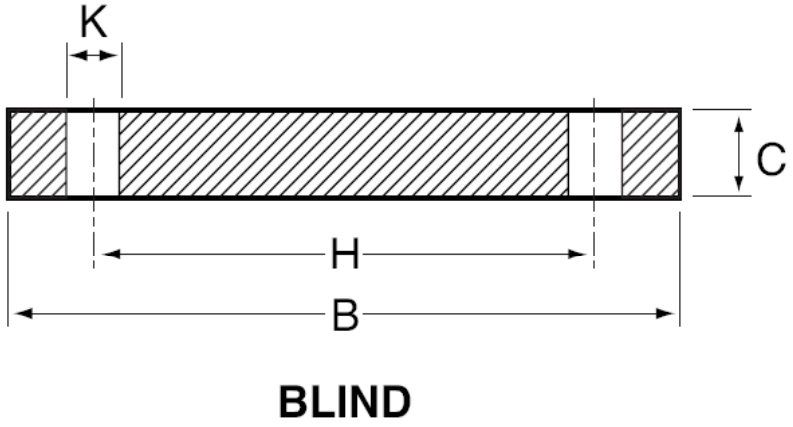
Potrubný systém. Závitová príruba /Threaded flange/





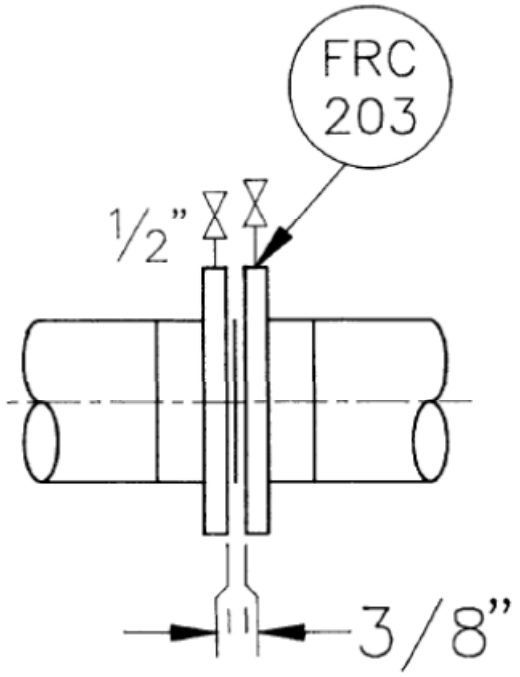
Potrubný systém. Zaslepovacia príruba /Blind flange/

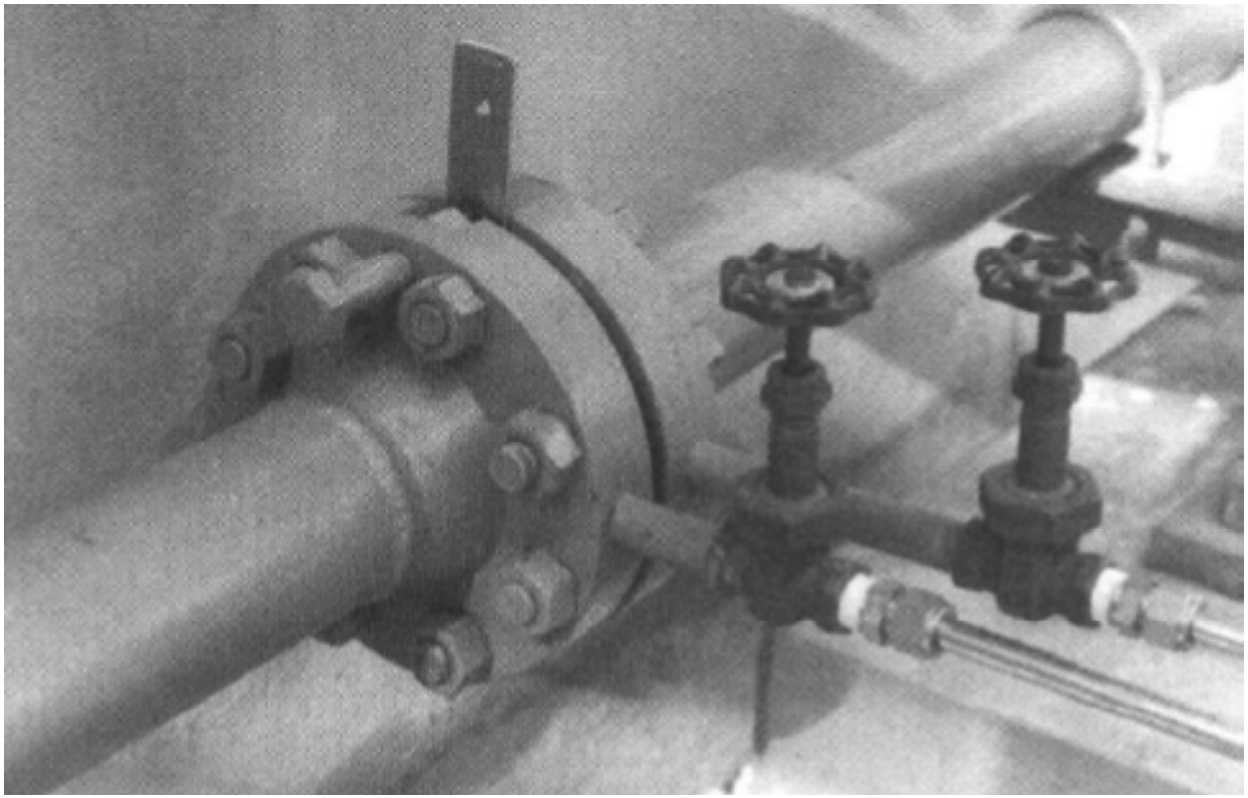




BLIND

Potrubný systém. Príruba pre clonu /Orifice flange/





Potrubný systém. Príruba /Flange/

Materiálová skupina

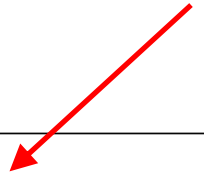


Table 1A List of Material Specifications

Material Group	Nominal Designation	Pressure–Temperature Rating Table	Applicable ASTM Specifications [Note (1)]		
			Forgings	Castings	Plates
1.1	C–Si	2-1.1	A 105	A 216 Gr. WCB	A 515 Gr. 70
	C–Mn–Si		A 350 Gr. LF2		A 516 Gr. 70
					A 537 Cl. 1
	C–Mn–Si–V		A 350 Gr. LF6 Cl. 1		
	3½ Ni		A 350 Gr. LF3		
1.2	C–Mn–Si	2-1.2		A 216 Gr. WCC	
				A 352 Gr. LCC	
	C–Mn–Si–V		A 350 Gr. LF6 Cl. 2		
	2½Ni			A 352 Gr. LC2	A 203 Gr. B
	3½Ni			A 352 Gr. LC3	A 203 Gr. E
1.3	C–Si	2-1.3		A 352 Gr. LCB	A 515 Gr. 65
	C–Mn–Si				A 516 Gr. 65
	2 ½Ni				A 203 Gr. A
	3 ½Ni				A 203 Gr. D
	C–½Mo			A 217 Gr. WC1	
				A 352 Gr. LC1	

Potrubný systém. Príruba /Flange/

Materiálová skupina, Materiál.

Tlako-teplotná trieda

Obmedzenia

Table 2-1.1 Pressure–Temperature Ratings for Group 1.1 Materials

Nominal Designation	Forgings	Castings	Plates
C–Si	A 105 (1)	A 216 Gr. WCB (1)	A 515 Gr. 70 (1)
C–Mn–Si	A 350 Gr. LF2 (1)		A 516 Gr. 70 (1), (2)
C–Mn–Si–V	A 350 Gr. LF6 Cl. (4)		
$3\frac{1}{2}$ Ni	A 350 Gr. LF3		A 537 Cl. 1 (3)

	Working Pressure by Classes, bar						
Class Temp., °C	150	300	400	600	900	1500	2500
−29 to 38	19.6	51.1	68.1	102.1	153.2	255.3	425.5
50	19.2	50.1	66.8	100.2	150.4	250.6	417.7
100	17.7	46.6	62.1	93.2	139.8	233.0	388.3
150	15.8	45.1	60.1	90.2	135.2	225.4	375.6
200	13.8	43.8	58.4	87.6	131.4	219.0	365.0
250	12.1	41.9	55.9	83.9	125.8	209.7	349.5
300	10.2	39.8	53.1	79.6	119.5	199.1	331.8
325	9.3	38.7	51.6	77.4	116.1	193.6	322.6
350	8.4	37.6	50.1	75.1	112.7	187.8	313.0
375	7.4	36.4	48.5	72.7	109.1	181.8	303.1
400	6.5	34.7	46.3	69.4	104.2	173.6	289.3
425	5.5	28.8	38.4	57.5	86.3	143.8	239.7
450	4.6	23.0	30.7	46.0	69.0	115.0	191.7
475	3.7	17.4	23.2	34.9	52.3	87.2	145.3
500	2.8	11.8	15.7	23.5	35.3	58.8	97.9
538	1.4	5.9	7.9	11.8	17.7	29.5	49.2

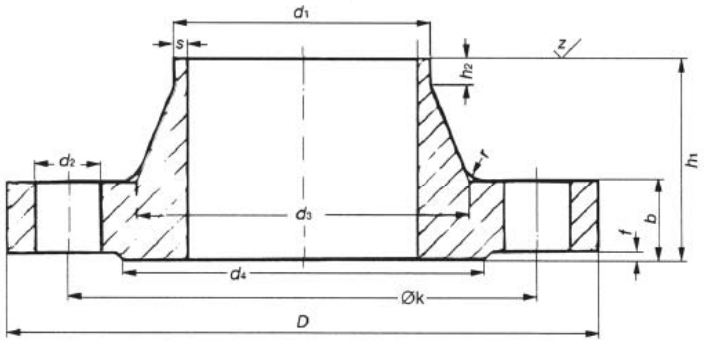
NOTES:
(1) Upon prolonged exposure to temperatures above 425°C, the carbide phase of steel may be converted to graphite. Permissible but not recommended for prolonged use above 425°C.
(2) Not to be used over 455°C.
(3) Not to be used over 370°C.
(4) Not to be used over 260°C.

Potrubný systém. Príruba /Flange/, EN, DIN

Welding Neck Flanges — DIN 2633

Material:

1.4541 / 1.4571



DIN 2633 PN 16

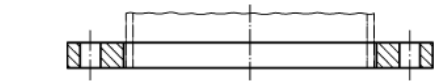
Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated —

Part 1: Steel flanges

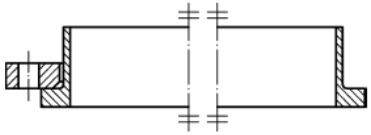
Európa:
DIN (DIN 25xx – 26xx)
Každá príruba typ iná norma (aj PN !!!)

Európska norma:
EN 1092-1 (komplexná)

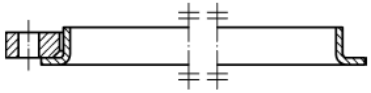
Potrubný systém. Príruba /Flange/, EN 1092-1



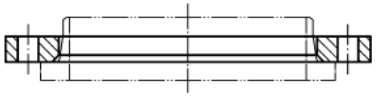
Typ 01
glatter Flansch zum Schweißen



Typ 02
Loser Flansch für Vorschweißring (siehe Typ 35)



Typ 02
Loser Flansch für Pressbördel (siehe Typ 37)

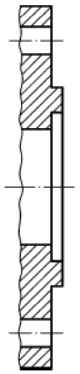


Typ 04
Loser Flansch für Vorschweißbund (siehe Typ 34)

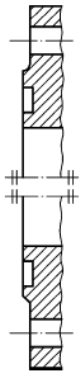
Typ 11
Vorschweißflansch

Form A
Glatte Dichtfläche

Form B
Dichtleiste (B1 und B2)
(siehe Tabelle 2)



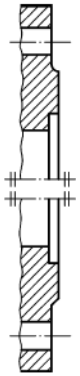
Form C
Feder



Form D
Nut

Form E
Vorsprung

Form F
Rücksprung



Form G
O-Ring-Vorsprung

Form H
O-Ring-Nut

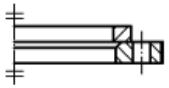
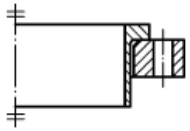
Rozmer
/DN/

Rating
/PN

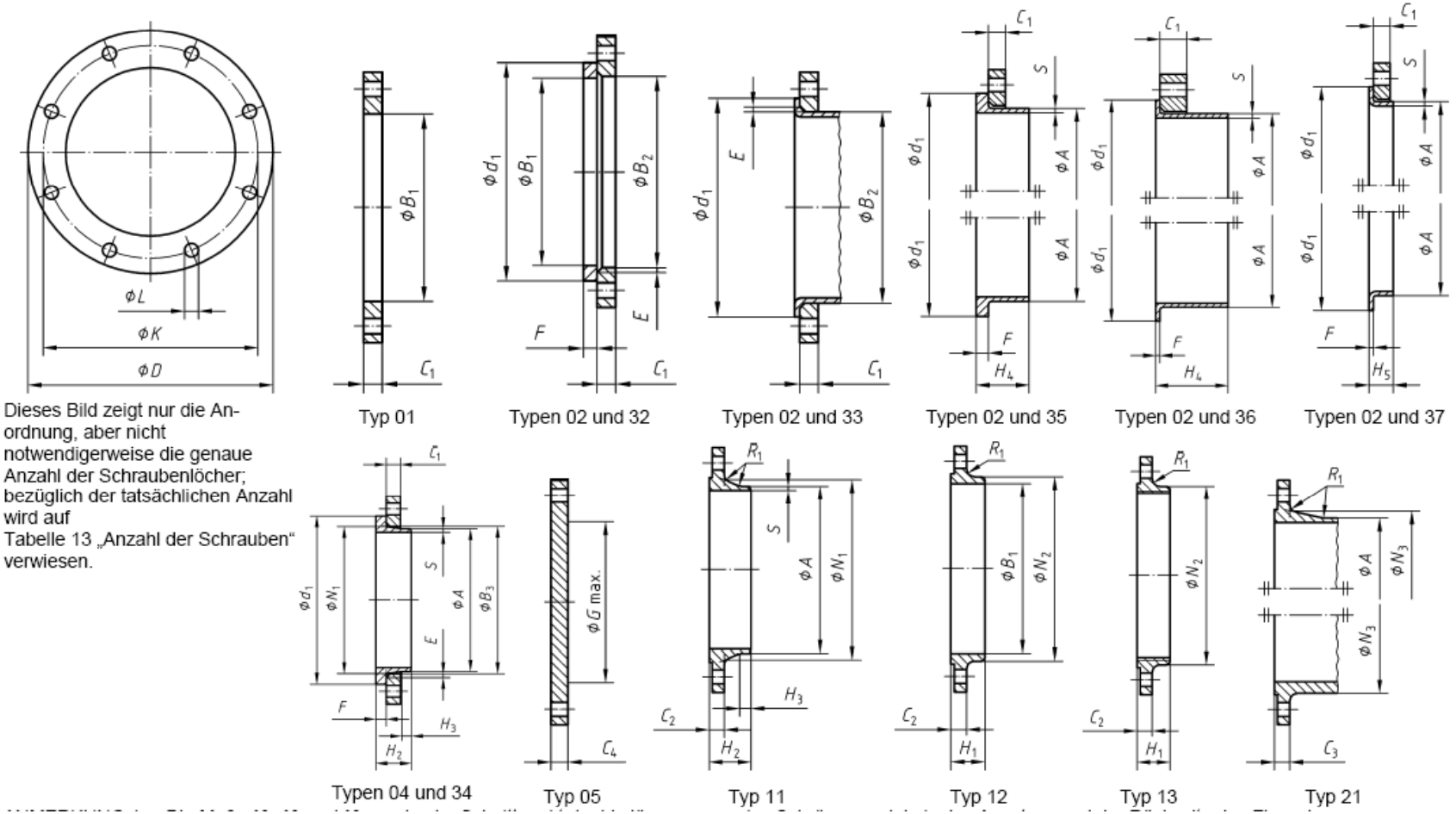
Typ príruby
/TYP/

Tesniaca plocha
/FORM/

Potrubný systém. Príruba /Flange/, EN 1092-1

Flansch- oder Bund- bzw. Bördeltyp	Tabelle	PN \ DN	10	15	20	25	32	40	50	65	80	100	125	150	200	250	300	350	400	450	500	600	700	800	900	1 000	1 200	1 400	1 600	1 800	2 000	2 200	2 400	2 600	2 800	3 000	3 200	3 400	3 600	3 800	4 000
 Typ 01	8	2,5	←PN 6 verw.→																								X	X	X	X	X										
	9	6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X															
	10	10	←PN 40 verw.→						←PN 16 verw.→						X	X	X	X	X	X	X	X																			
	11	16	←PN 40 verw.→						X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	12	25	←PN 40 verw.→												X	X	X	X	X	X	X	X																			
	13	40	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	14	63	←PN 100 verw.→						X	X	X	X	X	X	X	X	X	X																							
	15	100	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
 Typen 02 und 32	9	6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	10	10	←PN 40 verw.→						←PN 16 verw.→						X	X	X	X	X	X	X	X																			
	11	16	←PN 40 verw.→						X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	12	25	←PN 40 verw.→												X	X	X	X	X	X	X	X																			
	13	40	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
 Typen 02 und 35	8	2,5	←PN 6 verw.→																								X														
	9	6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X														
	10	10	←PN 40 verw.→						←PN 16 verw.→						X	X	X	X	X	X	X	X	X	X	X	X	X														
	11	16	←PN 40 verw.→						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X															
	12	25	←PN 40 verw.→						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																	
	13	40	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																							

Potrubný systém. Príruba /Flange/, EN 1092-1



Potrubný systém. Príruba /Flange/, EN 1092-1

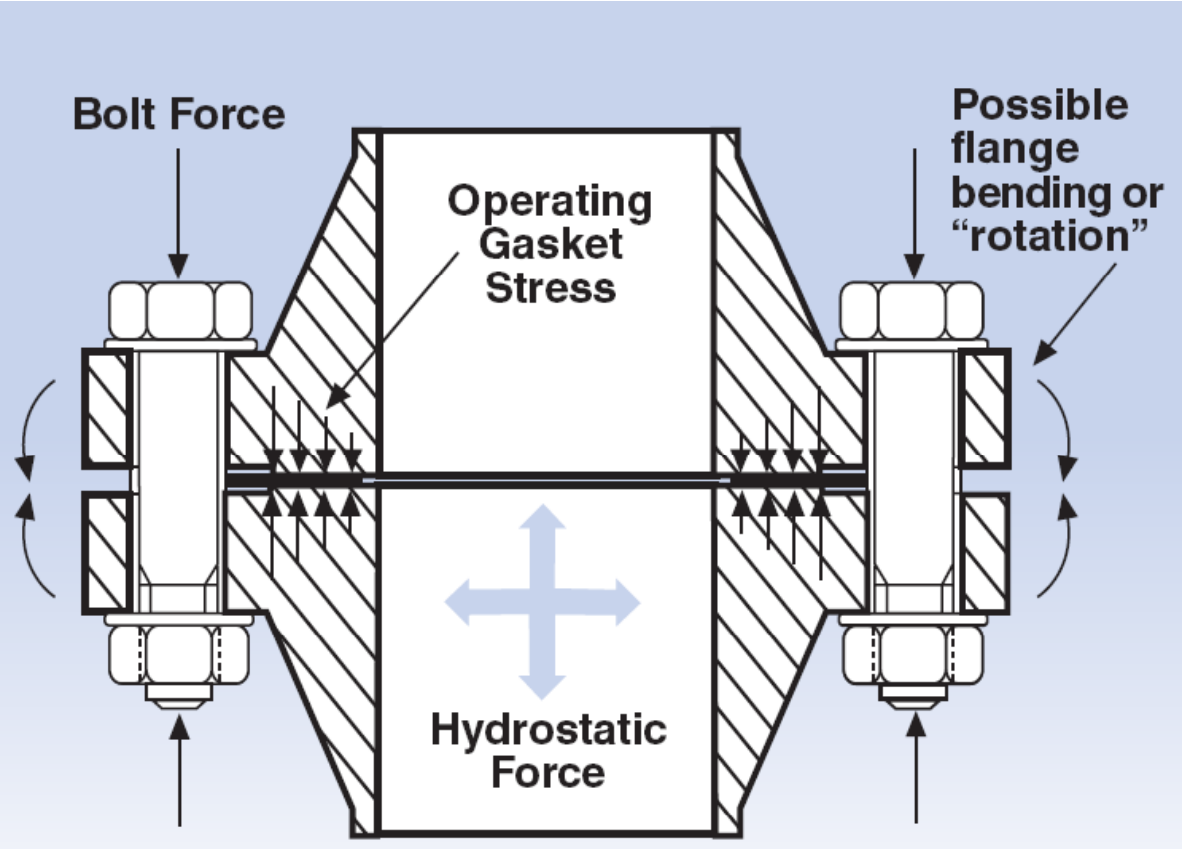
Materiál

Tlako-teplotná trieda

Tabelle G.4.1-8 — PN 100

PN	Werkstoff-nummer	tR (mm)	RT	100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C	450 °C	460 °C	470 °C	480 °C	490 °C	500 °C	510 °C	520 °C	530 °C	540 °C	550 °C	560 °C	570 °C	580 °C	590 °C	600 °C
100	1.0352	<=50	100,0	92,8	88,0	83,3	76,1	69,0	64,2	59,5	32,8															
	1.0352	50<tR<=150	100,0	85,7	83,3	78,5	72,8	64,2	61,9	57,1	32,8															
	1.0426	<=50	100,0	100,0	100,0	100,0	96,1	88,0	80,9	73,8	40,4															
	1.0426	50<tR<=150	100,0	100,0	94,2	86,6	87,6	80,9	73,8	64,2	40,4															
	1.5415	<=60	100,0	100,0	100,0	100,0	97,6	85,7	80,9	76,1	73,8	67,9	62,0	56,0	50,1	44,2	35,2	28,0	22,3							
	1.5415	60<tR<=90	100,0	100,0	100,0	100,0	92,8	80,9	76,1	71,4	69,0	64,0	58,1	52,2	46,3	44,2	35,2	28,0	22,3							
	1.5415	90<tR<=150	100,0	100,0	100,0	95,2	88,0	76,1	73,8	69,0	66,6	62,1	57,7	53,2	48,7	44,2	35,2	28,0	22,3							
	1.7335	<=60	100,0	100,0	100,0	100,0	100,0	99,5	95,2	90,4	85,7	81,6	77,5	73,4	69,3	65,2	55,2	44,7	37,1	29,0	23,3	19,0	15,7			
	1.7335	60<tR<=90	100,0	100,0	100,0	100,0	100,0	92,8	85,7	80,9	76,1	74,0	71,8	69,6	67,4	65,2	55,2	44,7	37,1	29,0	23,3	19,0	15,7			
	1.7335	90<tR<=150	100,0	100,0	100,0	100,0	95,2	88,0	83,3	78,5	73,8	72,0	70,3	68,6	66,9	65,2	55,2	44,7	37,1	29,0	23,3	19,0	15,7			
	1.7383	150	100,0	100,0	100,0	100,0	100,0	100,0	97,6	92,8	88,0	83,3	78,5	73,8	69,0	64,2	56,1	49,0	42,8	37,1	32,3	27,6	24,2	20,9	18,0	16,1
	1.7366	150	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	84,8	69,3	53,8	45,7	38,5	33,3	28,0	23,8	20,4	17,6			
	1.0487	35<tR<=70	100,0	100,0	100,0	93,8	86,1	74,7	65,2	56,1																
	1.0487	70<tR<=100	100,0	100,0	94,2	86,6	79,5	65,2	56,1	46,6																
	1.0487	100<tR<=150	100,0	97,6	88,5	79,5	70,0	56,1	46,6	37,1																
	1.0565	50<tR<=100	100,0	100,0	100,0	100,0	100,0	98,0	90,4	79,5																
	1.0565	100<tR<=150	100,0	100,0	100,0	100,0	100,0	93,3	84,2	70,0																
	1.4922	150	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	91,8	81,5	71,2	60,9	52,8	45,2	38,5	32,8	28,0
	1.4903	130	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	91,8	79,0	71,4	63,8	57,1	50,4	44,7

Potrubný systém. Tesnenie, /Gasket /

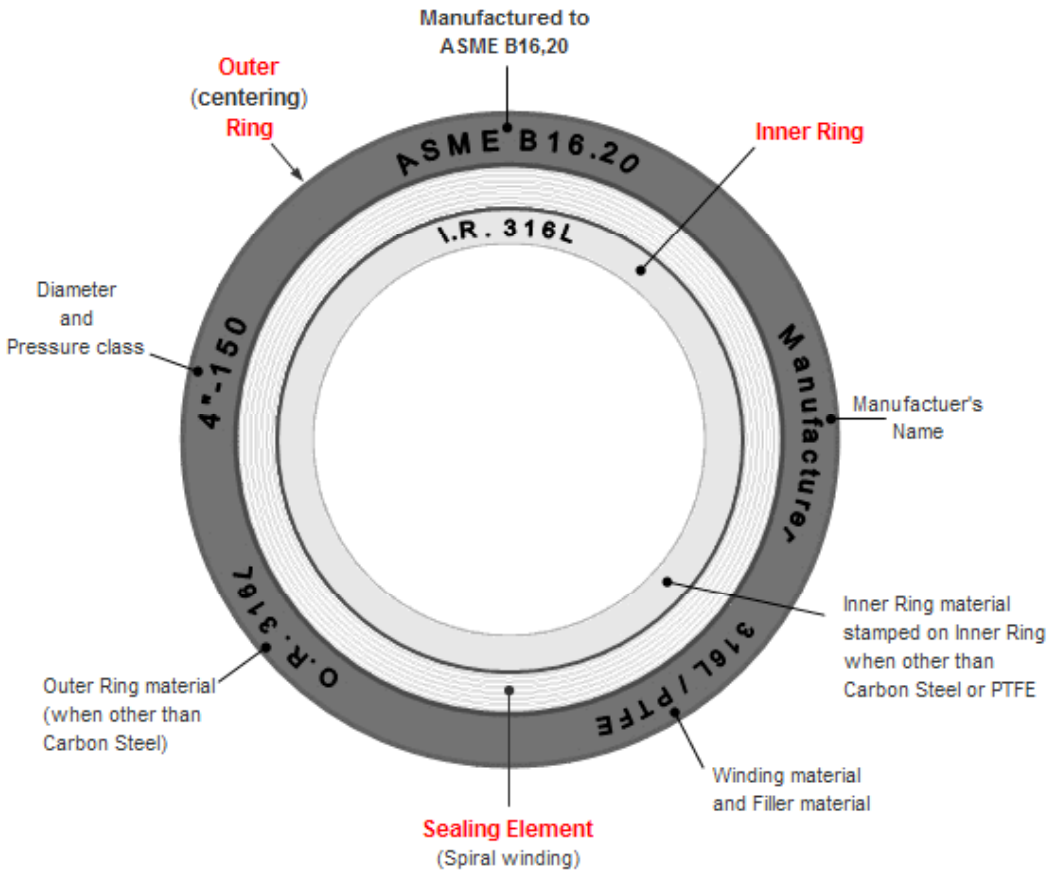


Tesnenie je komponent zabezpečujúci tesnosť dvoch plôch, pomocou uskladnenej energiou medzi nimi.

Materiály pre tesnenia rozdeľujeme:

Nekovové /Non-metallic types/
Semi kovové /Semi-metallic types/
Kovové /Metallic types/

Potrubný systém. Tesnenie, /Gasket /



Čo treba vedieť ?

Chemická odolnosť

Parametre tesnenia ?
(Dovolené zaťaženie)

Leakage rate (leak rate)?

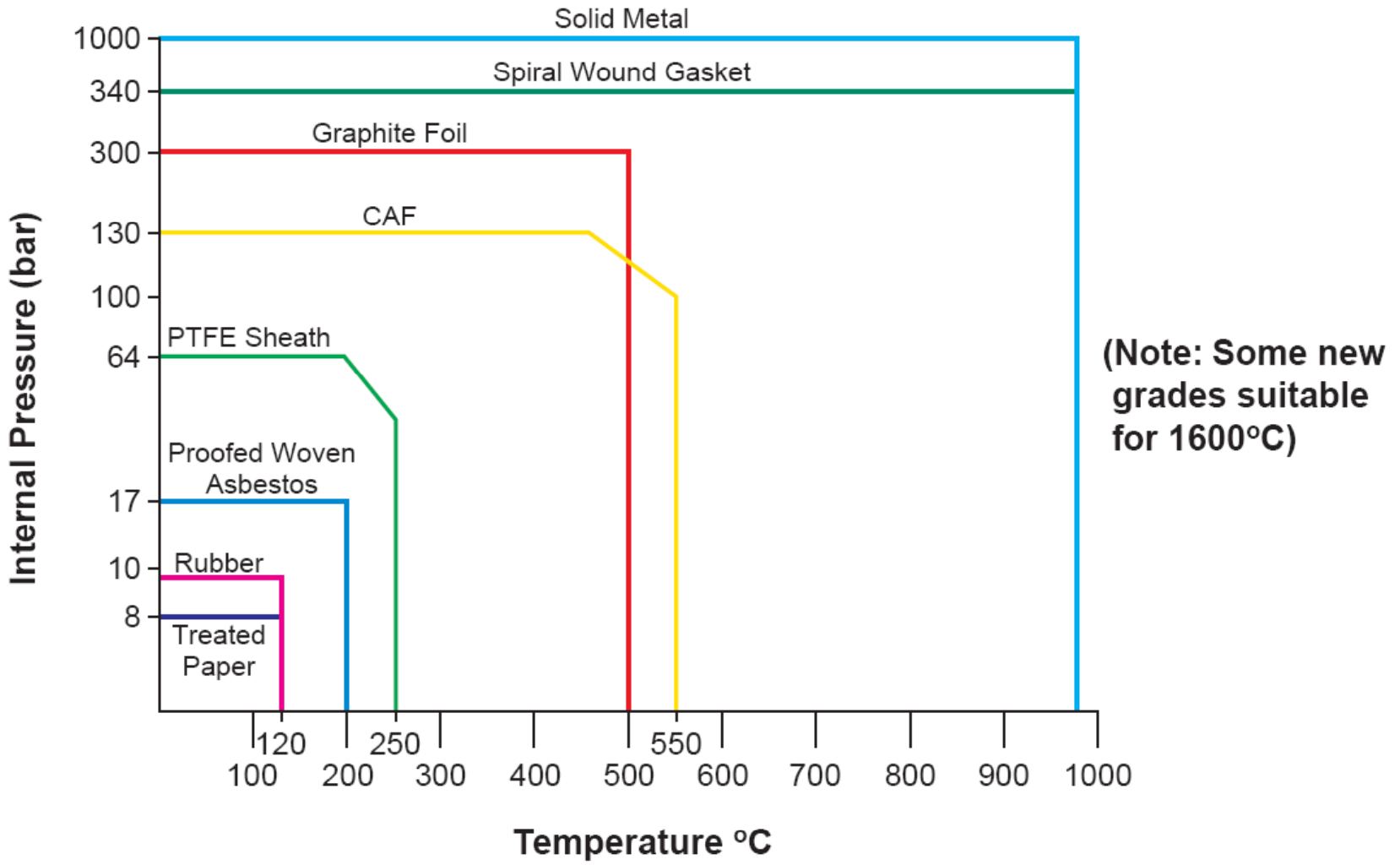
Rozmerová norma (EN, DIN, ASME, v náväznosti na použitú prírubu.)

Potrubný systém. Tesnenie, /Gasket /, B16.21

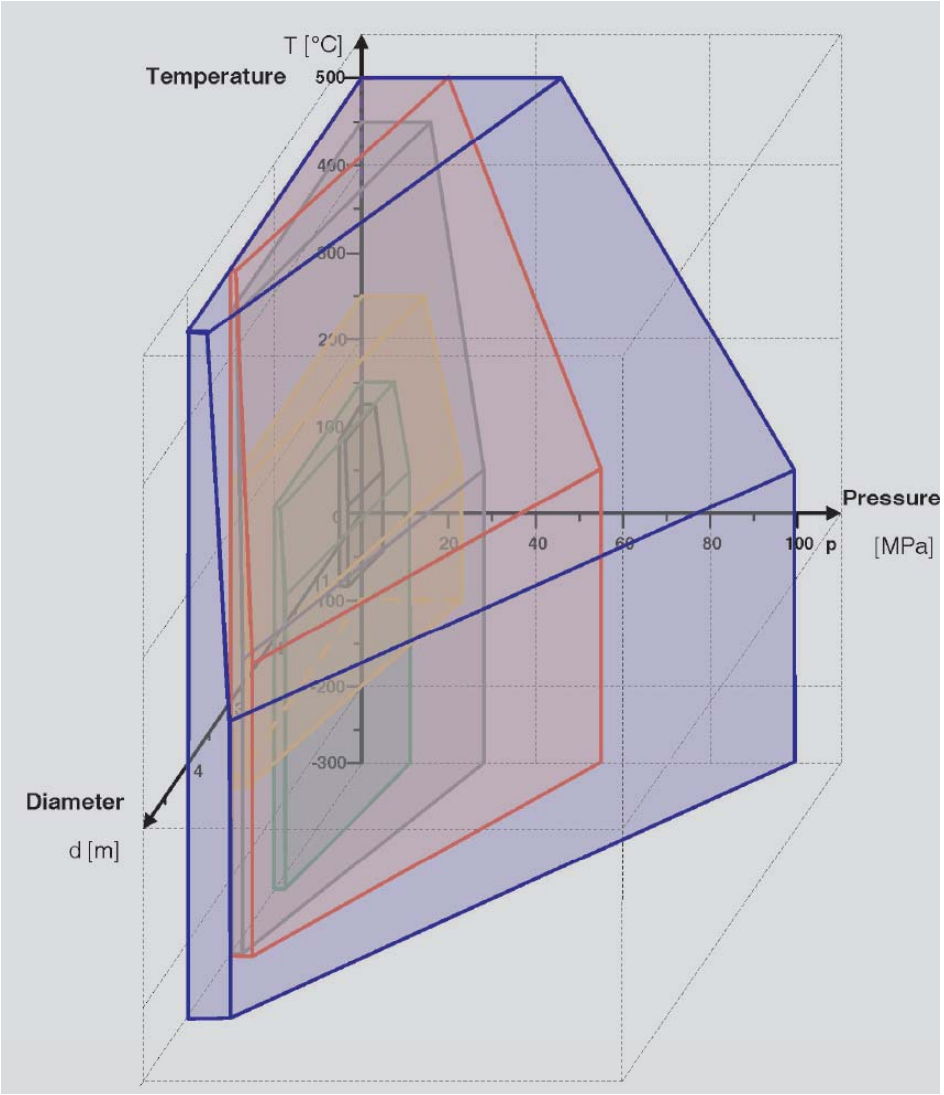
	ELASTOMERIC SEALING MATERIALS			
MATERIAL CODE **CHEMICAL NATURE** **TRADENAME**	**CR** **Polychloroprene Rubber** **NEOPRENE**	**AE/AU** **Polyurethane Rubber** **ADIPRENE**	**NBR** **Nitrile Rubber** **BUNA-N**	**ECO/CO** **Epichloro-hydrin** **HYDRIN**
OIL Aliphatic Hydrocarbons	2	2	1	1
Aromatic Hydrocarbons	3	3	2	1
Crude Oil (< 120°C)	2	2	1	1
Crude Oil (> 120°C)	4	4	4	4
SOUR CRUDE OIL	3	3	2	3
SOUR NATURAL GAS	3	3	2	3
OIL BASED MUD	2	2	1	
WATER BASED MUD	2	1	1	
WATER	2	1	2	
STEAM	3	3	3	
INHIBITORS Amines	3	2	2	
COMPLETION FLUIDS CaCl/CaBr	1	1	1	
ZnBr	1	1	4	
K2CO3	1	2	2	
BRINE Seawater	2	4	1	
CONTROL FLUIDS Mineral Oils	2	1	1	
Glycol Based	1	2	1	
ALCOHOLS Methanol	1	4	1	
ACIDS HCl (dilute)	3	2	3	
HCl (concentrated)	4	4	4	
HF (< 65% cold)	1	5	3	
Acetic Acid (Hot)	4	4	4	
SURFACTANTS	2	4	1	
CHLORINATED SOLVENTS	4	4	4	

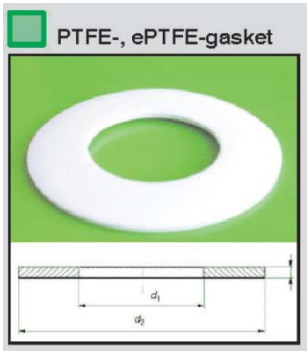
Code	*Rating*	*Significance*
1	Good	Satisfactory performance in relatively high level of chemical.
2	Fair	Satisfactory only if low temperature and/ or low level of chemical.
3	Poor	Performance depends on required life and level of chemical.
4	Bad	No tolerance to chemical - DO NOT USE.
5	Unknown	No data available.

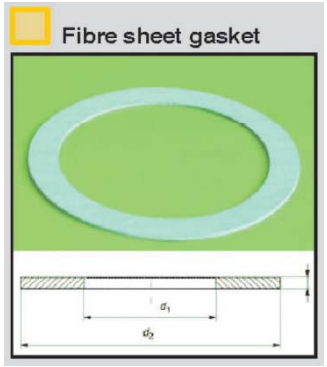
Potrubný systém. Tesnenie, /Gasket /

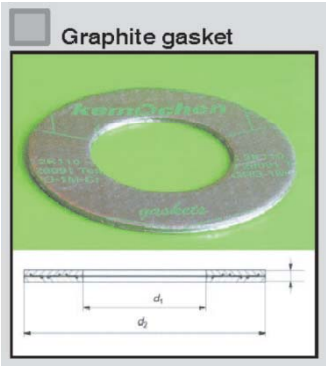


Potrubný systém. Tesnenie, /Gasket /









Potrubný systém. Tesnenie, /Gasket /, B16.21

Class

Table 4 Gasket Dimensions for ASME B16.5 Class 150, Pipe Flanges and Flanged Fittings

			Full Face Gasket			
NPS	Gasket I.D.	Flat Ring O.D.	O.D.	Number of Holes	Hole Diameter	Bolt Circle Diameter
1/2	21	48	89	4	5/8	60.3
3/4	27	57	98	4	5/8	69.9
1	33	67	108	4	5/8	79.4
1 1/4	42	76	117	4	5/8	88.9
1 1/2	48	86	127	4	5/8	98.4
2	60	105	152	4	3/4	120.7
2 1/2	73	124	178	4	3/4	139.7
3	89	137	191	4	3/4	152.4
3 1/2	102	162	216	8	3/4	177.8
4	114	175	229	8	3/4	190.5
5	141	197	254	8	7/8	215.9
6	168	222	279	8	7/8	241.3

Nominal Pipe Diameter

Potrubný systém. Tesnenie, /Gasket /

Type	Profile	Cross-section	Material(s)	R_z* [µm]	R_a* [µinch]	k_0** [mm]	$k_0 \cdot K_D$** [N/mm]	K_t** [mm]	σ_V [N/mm²]	$\sigma_{\vartheta(RT)}$ [N/mm²]	E_G*** E_D	y**** [psi]	m [-]	Note
Soft material flat gaskets	A1		Fibre sheets 2 mm	100	800	--	$25 \cdot b_D$	$1,1 \cdot b_D$	25	80	500	3.000	2,50	
			Fibre sheets 1,5 mm			--	$30 \cdot b_D$	$1,2 \cdot b_D$	30	90	500	4.000	2,75	
			Fibre sheets 1,0 mm			--	$35 \cdot b_D$	$1,3 \cdot b_D$	35	100	500	6.500	3,00	
			PTFE 2 mm	100	800	--	$25 \cdot b_D$	$1,1 \cdot b_D$	25	60	600	3.500	2,50	
			Rubber 2 mm			--	$2 \cdot b_D$	$0,5 \cdot b_D$	2	15	200	300	1,00	
			Graphite with plain metal sheets	100	800	--	$10 \cdot b_D$	$1,1 \cdot b_D$	10	120	1	1.600	2,00	
			Graphite with tanged sheet metal (RS) 2 mm	100	800	--	$30 \cdot b_D$	$1,4 \cdot b_D$	30	130	1	4.500	3,00	
			Graphite with tanged sheet metal(RSP) 2 mm	100	800	--	$30 \cdot b_D$	$1,4 \cdot b_D$	30	130	-	4.500	3,00	
			Graphite with tanged sheet metal (RHD) 2 mm				$30 \cdot b_D$	$1,4 \cdot b_D$	30	130	-	4.500	3,00	
	F1		Fibre sheets 2 mm, with inner eyelet	100	800	--	$30 \cdot b_D$	$1,3 \cdot b_D$	30	80	-	4.000	2,75	
			Graphite with metal sheets and inner eyelet	100	800	--	$15 \cdot b_D$	$1,2 \cdot b_D$	15	120	1	2.200	2,25	
			Graphite with tanged sheet metal (RS) 2 mm and inner eyelet, 2 mm	100	800	--	$35 \cdot b_D$	$1,5 \cdot b_D$	35	130	8000	5.000	3,25	
			Graphite with tanged sheet metal (RSP) 2 mm and inner eyelet, 2 mm	100	800	--	$35 \cdot b_D$	$1,5 \cdot b_D$	35	130	8000	5.000	3,25	
			Graphite with tanged sheet metal (RHD) and inner eyelet, 2 mm	100	800	--	$35 \cdot b_D$	$1,5 \cdot b_D$	35	130	8000	5.000	3,25	
Ring joint gaskets	A11		Iron or carbon steel	3,2	25	2,0	--	6,0	265	525	-	18.000	5,50	
	A12													
	A13		Monel / steel 4 – 6% Cr	1,6	10				300	660	-	21.800	6,0	
	A14		Stainless steel	1,6	10				335	750	-	26.000	6,5	

Potrubný systém. Skrutkový spoj /Bolt /

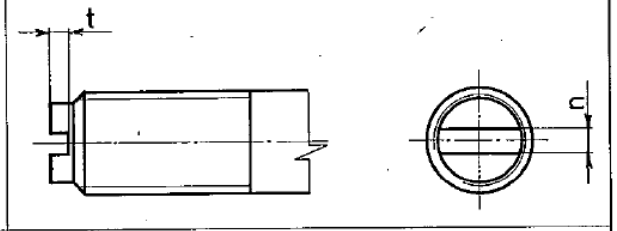
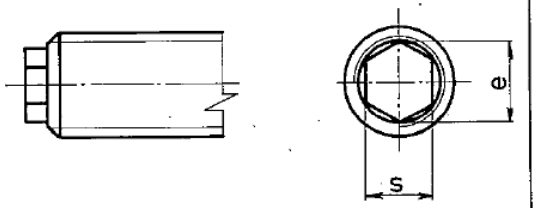
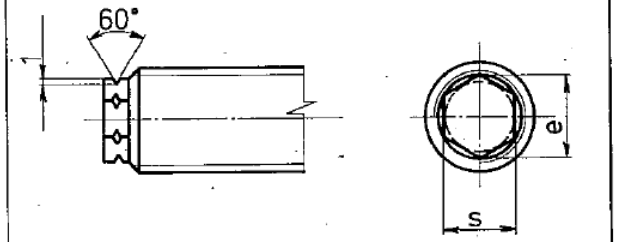
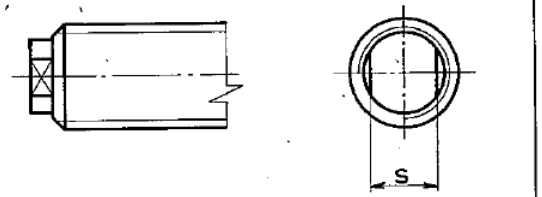
Sub-clause number	Mechanical and physical property		Property class										
			3.6	4.6	4.8	5.6	5.8	6.8	8.8[1] $d \le$ 16mm[3]	8.8[1] $d >$ 16mm[3]	9.8[2]	10.9	12.9
5.1 und 5.2	Tensile strength Rm in N/mm² [4], [5]	nominal value	300	400		500		600	800	800	900	1000	1200
		min.	330	400	420	500	520	600	800	830	900	1040	1220
5.3	Vickers hardness HV F ≥ 98 N	min.	95	120	130	155	160	190	250	255	290	320	385
		max.	220[6]					250	320	335	360	380	435
5.4	Brinell hardness HB F = 30 D^2	min.	90	114	124	147	152	181	238	242	276	304	366
		max.	209[6]					238	304	318	342	361	414
5.5	Rockwell hardness HR	min. HRB	52	67	71	79	82	89	—	—	—	—	—
		min. HRC	—	—	—	—	—	—	22	23	28	32	39
		max. HRB	95[6]					99,5	—	—	—	—	—
		max. HRC	—					—	32	34	37	39	44
5.6	Surface hardness HV 0,3	max.	—						[7]				
5.7	lower yield stress R_{eL}[8] in N/mm²	nominal value	180	240	320	300	400	480	—	—	—	—	—
		min.	190	240	340	300	420	480	—	—	—	—	—
5.8	Stress at 0,2% non-proportional elongation $R_{p0,2}$[9] in N/mm²	nominal value	—					—	640	640	720	900	1080
		min.	—					—	640	660	720	940	1100
5.9	Stress under proofing load S_p	S_p / R_{eL} or $S_p / R_{p0,2}$	0,94	0,94	0,91	0,93	0,9	0,92	0,91	0,91	0,9	0,88	0,88
		N/mm²	180	225	310	280	380	440	580	600	650	830	970
5.10	Breaking torque, M_B Nm min.		—						see ISO 898-7				
5.11	Percent elongation after fracture A in %	min.	25	22	—	20	—	—	12	12	10	9	8
5.12	Reduction area after fracture Z	% min.	—						52		48	48	44
5.13	Strength under wedge loading[5]		The values for full size bolts and screws (not studs) shall not be smaller than the minimum values for tensile strength shown in 5.2										
5.14	Impact strength, KU in J	J min.	—			25	—		30	30	25	20	15
5.15	Head soudness		no fracture										
5.16	Minimum height of non-decarburized thread zone, E		—						$^1/_2 H_1$			$^2/_3 H_1$	$^3/_4 H_1$
	Maximum depth of complete decarburization, G	mm	—						0,015				
5.17	Hardness after retempering		—						Reduction of hardness 20 HV max.				
5.18	Surface integrity		In accordance with ISO 6157-1 or ISO 6157-3 as appropriate										

Skrutkový spoj

Výber vhodného materiálu Mechanické vlastnosti

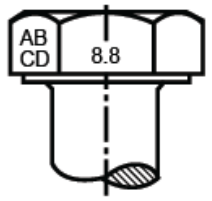
-Vysoké teploty
-Nízke teploty
-Korózne prostredie

Potrubný systém. Skrutkový spoj /Bolt /

Materiál	Doplňková číslice za číslem normy	Tvar konce šroubu
12 050.6 nebo 12 056.6	13 1520.1	
15 320.5	13 1520.2	
15 320.5 [1])	13 1520.3	
17 248.4	13 1520.4	

Skrutkový spoj

Identifikácia



Examples of marking on hexagon screws

Potrubný systém. Skrutkový spoj /Bolt /

Range of application for materials in relation to temperature

Rulings: Standards: 1 = DIN 267-13(93); 2 = DIN 1654-4; 3 = DIN 8975-6; 4 / 5 (DIN 17240/DIN 17280) / DIN EN 10269, 6 = (DIN 17440)/DIN EN 20272, 12 = DIN EN 1515, 13 = DIN EN 3506-1+2
Regulations: 7 = TRD 106; 8 = AD2000-W2; 9 = AD2000-W7; 10 = AD2000-W10; 11 = SEW 680, 14 = VGB R 505 M

Standards Regulations:	Material designation	Bolt	Nut	Duty stamp Bolt / nut	Min. yield strength in N/mm²	Certification allocation Bolt / nut pr EN 10204 (2000)
1, 4, 5, 14	NiCr 20TiAl (Inconnel alloy 80A)	2.4952	2.4952	SB	600	3.2 / 3.1
1, 8, 10, 14, VdTÜV WB433/3 1, 8, 7, VdTÜV WB113/2	X 5 NiCrTi 26 15 X 8 CrNiMoBNb 16 16 wk solution-annealed, hot-salt-hardened, age-hardened	1.4980 1.4986 wk	1.4980 1.4986 wk	SD S	600 490	3.2 / 3.1 3.2 / 3.1
1, 4, 5, 14 1, 4, 5, 7, 9, 14 1, 4, 5	X 19 CrMoVNbN 11 1 X 22 CrMoV 12 1 X 22 CrMoV 12 1 refined	1.4913 1.4923 1.4923 v	1.4923 1.4923 1.4923	VW / V V VH	750 (780) 600 700	3.2 / 3.1 3.2 / 3.1 3.2 / 3.1
1, 4, 5, 7, 9, 12, 14	21 CrMoV 5 7 (previously 21 CrMoV 511 + 24 CrMoV 55)	1.7709	1.7709 / 1.7218 (1.7258)	GA / GA, KG, (G) (J+H)	550	3.2 / 3.1
1, 4, 5, 12, 14	40 CrMoV 4 7 opposite to DIN 17240 the maximum workable temperature is changed depending on the stronght rupture, 3.1/A attestation only with single expert opinion possible. O/M at 500 °C, grain size, Al- content	1 7711	1 7709	GB / GA	700	3.2 / 3.1
5, 12, 14 5, 9, 12	42 CrMo 5-6 42 CrMo 4 maximum temperature according pr EN 1515 is 450°C	1.7233 1.7225	1.7225 1.7225	7233 / GC GC	700 730	3.2 / 3.1
1, 4, 7, 9 5, 12, 14 Austenitic stainless steels are used to TRD 106 to 400 °C. Resistance to intergranular corrosion is required, the application should be limited to 300 °C.	(24 CrMo 5) 25 CrMo 4	(1.7258) 1.7218	(1.7258 / 1.1181 / 1.5511) 1.7218 / A2-60 / A2-70	(G) / (G,YK,YB) KG	440 440	(3.2 / 3.1) 3.2 / 3.1
5, 12 1, 4, 5, 7, 9, 12, 14 1, 4, 7, 9 2, 5, 9, 14, VdTÜV WB 490	C45E (previously Ck 45) C35E (previously Ck 35) C 35 N (previously also C 45 N) 35 B 2	1.1191 1.1181< 1.5511	1.1191 1.0501 1.0501 1.5511 / 1.1181 / 1.0501	ZK YK Y (Z) YB	340 300 300	3.1 / 3.1* 3.1 / 3.1* 3.1 / 3.1* 3.1 / 3.1*
1, 9, DIN EN ISO 898-1 and 2	without attestation of hot yield strength only usable up to 50 °C * for nuts at pressure < 40 bar only a manufacture stamp is required			8, 8 / 8	640	3.2 / 3.1*
1, 9, DIN EN ISO 898-1 and 2 EN 20898-1	** for bolts 5,6 a attestion may not applicable, if they are					
3						
1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 1, 5, 9, 10, 12	X 6 CrNiMoTi 17 12 2 X 6 CrNiMoTi 17 12 2 X 5 CrNiMo 17 12 2 X 5 CrNiMo 17 12 2 25 CrMo 4 (previously 26 CrMo 4)	1.4571 1.4571 1.4401 1.4401 1.7218				
12	42 CrMo 4	1.7225				
1, 5, 9, 10	X 12 Ni 5 (12 Ni 19)	1.5680				
1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 1, 5, 6, 8, 10, 13 8, 10, VdTÜV WB 277/2	X 5 CrNiMoTi 17 12 2 X 5 CrNiMoTi 17 12 2 X 5 CrNiMo 17 12 2 X 5 CrNiMo 17 12 2 X 5 CrNiTi 18 10 X 5 CrNiTi 18 10 X 5 CrNiS 18 8 X 5 CrNiS 18 8 X 5 CrNi 18 10 X 5 CrNi 18 10 X 5 CrMn NiN 18 9 wk	1.4571 1.4571 1.4401 1.4401 1.4541 1.4541 1.4305 1.4305 1.4303 1.4303 1.6909				
3, 11 3, 11	out-dated materials: X 10 CrNiTi 18 10 X 12 CrNi 18 9	1.6903 1.6900				
8, 10, VdTÜV WB 435/3	X 5 NiCrTi 26 15	1.4980				

Descriptions in brackets are out-dated designations and standards

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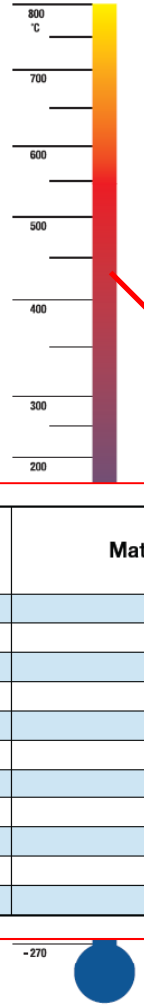
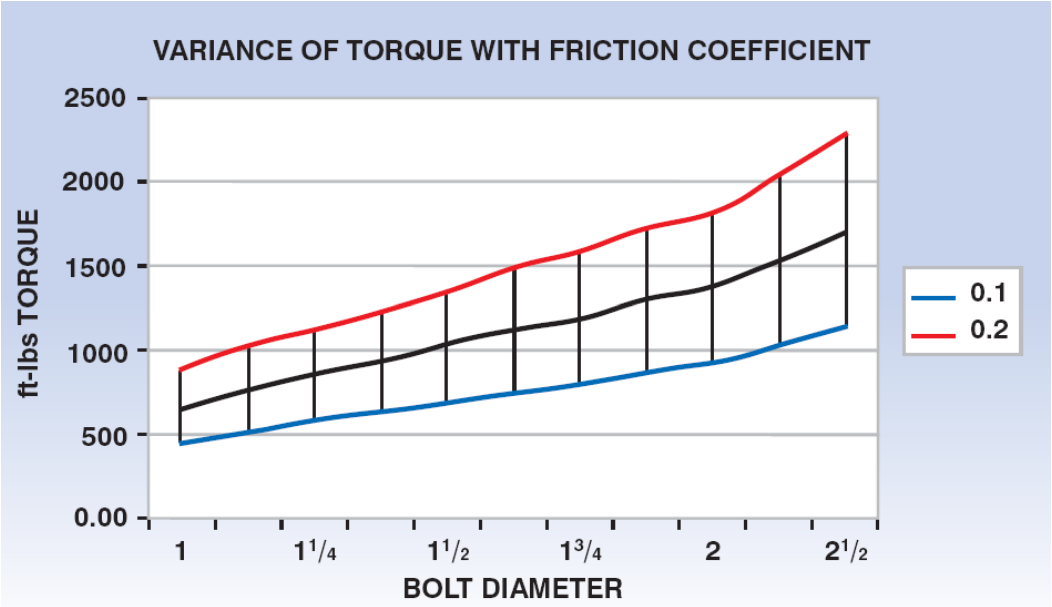


DIN 269-13. Fasteners - Technical specifications - Part 13: Parts for bolted connections with specific mechanical properties for use at temperatures ranging from -200 °C to +700 °C

Material abbreviation	Material number	Marking	Utilisation temperatur limits
C 35 N oder C 35 V	1.0501	Y	+350 °C
Ck 35	1.1181	YK	+350 °C
35 B 2	1.5511	YB	+350 °C
24 CrMo 5	1.7258	G	+400 °C
21 CrMoV 5 7	1.7709	GA	+540 °C
40 CrMoV 4 7	1.7711	GB	+500 °C
X 22 CrMoV 12 1	1.4923	V, VH	+580 °C
X 19 CrMoVNbN 11 1	1.4913	VW	+580 °C
X 8 CrNiMoBNb 16 16	1.4986	S	+650 °C
X 5 NiCrTi 26 15	1.4980	SD	+650 °C
NiCr20 TiAl	2.4952	SB	+700 °C

Potrubný systém. Skrutkový spoj /Bolt /



Súčiniteľ trenia v závite.

V rozsahu 0,1 - 0,5

Zväčšenie súčiniteľa trenia o 0,05 zvýši krútiaci moment o 30 %.

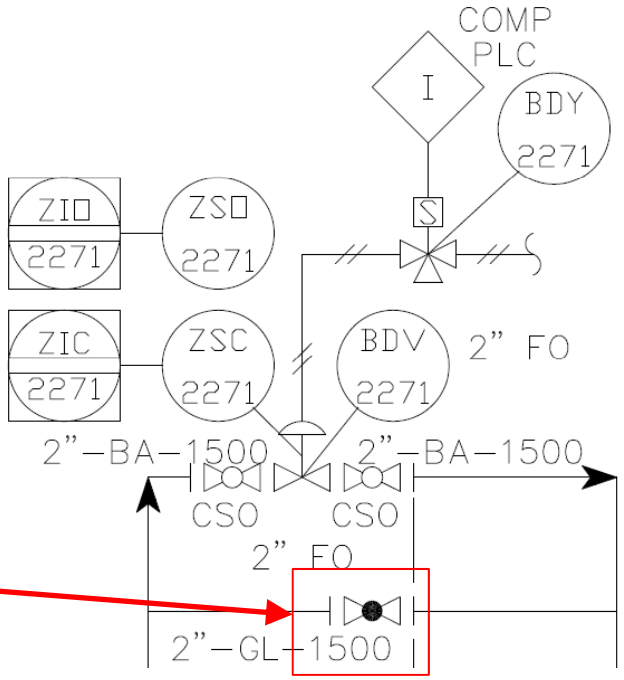
Tightening torques for bolts in current use with friction factor 0.12 and at 80% of yield point

Material		Ck35	24CrMo5	21CrMoV57	40CrMoV47	X22CrMoV121	For Conversion	5.6	8.8
Material number		1.1181	1.7258	1.7709	1.7711	1.4923	purpose		
Duty stamp		YK	G	GA	GB	V	with yield	5.6	8.8
Minimum yield point N/mm²		280	440	550	700	600	1.000	300	640
Temperature max. °C		350	400	550	500	580		300	300
Bolts/ Stud bolts	M12 SW19	40	60	75	95	80	135	40	85
	M16 SW24	90	145	180	230	195	323	95	205
	M20 SW30	180	275	345	440	380	626	190	410
	M24 SW36	300	475	595	755	650	1082	325	720
	M27 SW41	450	700	870	1100	950	1583	470	1000
	M30 SW46	610	950	1200	1500	1300	2161	650	1430

Potrubný systém. Armatúry

Čo ovplyvňuje správny výber armatúr ?

-funkcia
-materiálové prevedenie
-T/p
-bezpečnosť
-životnosť
-pripojenie
-prevádzkovanie
-hmotnosť
-údržba
-cena



Pre jednu pozíciu viacero alternatív
Kompromis, nie cenový

Potrubný systém. Armatúry

Table 5: Loss coefficients ζ for various types of valves and fittings (referred to the velocity of flow in the line connection nominal diameter DN)

	Type of valve / fitting		De-sign	Loss coefficient ζ for DN = 15	20	25	32	40	50	65	80	100	125	150	200	250	300	400	500	600	800	1000	Comment
Shut-off valves	Slide disc valves (d_E = DN)	min	1	0.1	←																	0.1	For d_E < DN cf. footnote 1)
		max		0.65	0.6	0.55	0.5	0.5	0.45	0.4	0.35	0.3	←									0.3	
	Round-body gate valves (d_E = DN)	min	2						0.25	0.24	0.23	0.22	0.21	0.19	0.18	0.17	0.16	0.15	0.13	0.12	0.11	0.11	
		max							0.32	0.31	0.30	0.28	0.26	0.25	0.23	0.22	0.20	0.19	0.18	0.16	0.15	0.14	
	Ball and plug valves (d_E = DN)	min	3	0.10	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02					For d_E < DN ζ = 0.4 to 1.1
		max		0.15	←												→	0.15					
	Butterfly valves PN 2.5 10	min	4					0.90	0.59	0.38	0.26	0.20	0.14	0.12	0.09	0.06	←					0.06	
		max						1.20	1.00	0.80	0.70	0.62	0.56	0.50	0.42	0.40	0.37	0.33	0.33	0.33	0.30	0.28	
	PN 16 25	min							2.04	1.80	1.55	1.30	1.08	0.84	0.75	0.56	0.48	0.40	←			0.40	
		max							2.50*	2.30*	2.10*	1.90*	1.70*	1.50*	1.30	1.10	0.90	0.83	0.76	0.71	0.67*	0.63*	* Also for PN 40
	Globe valves, forged	min	5			6.0	←	→	6.0														
		max				6.8	←	→	6.8														
	Globe valves, cast	min	6	3.0	←												3.0						ζ = 2 to 3 can be achieved for optimized valve
		max		6.0	←												6.0						
	Compact valves	min	7	0.3	0.4	0.6	0.6	1.0	1.1	←				→	1.1								
		max		0.3	0.9	1.9	←	→	1.9	2.2	2.2	2.3	2.5	2.5									
	Angle valves	min	8	2.0	←												→	2.0					
		max		3.1	←	→	3.1	3.4	3.8	4.1	4.4	4.7	5.0	5.3	5.7	6.0	6.3	6.6					
	Y-valves	min	9	1.5	←												1.5						
		max		2.6	←												2.6						
	Straight-through valves	min	10	0.6	←													0.6					
		max		1.6	←													1.6					
	Diaphragm valves	min	11	0.8	←									0.8									
		max		2.7	←									2.7									
Non-return valves	Non-return valves, straight seat	min	12	3.0	←										3.0								
		max		6.0	←										6.0								
	Non-return valves, axial	min	13	3.2	←				3.2	3.7	5.0	7.3	4.3	←			4.3						Axially expanded as from DN 125
		max		3.4	3.4	3.5	3.6	3.8	4.2	5.0	6.4	8.2	4.6	←			4.6						
	Non-return valves, slanted seat	min	14	2.5	2.4	2.2	2.1	2.0	1.9	1.7	1.6	1.5	←				1.5						
		max		3.0	←												3.0						
	Foot valves	min	15						1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.4	(7.0)	(6.1)	(5.5)	(4.5)	(4.0)	( ) In groups
		max							3.0	←							3.0						
	Swing check valves	min	16	0.5	←		→	0.5	0.4	←							0.4	0.3	←			0.3	Swing check valves without levers and weights 2)
		max		3.0	←																	3.0	
	Hydrostops v = 4 m/s		17						0.9			3.0		3.0	2.5	2.5	1.2	2.2					
	v = 3 m/s								1.8			4.0		4.5	4.0	4.0	1.8	3.4					
	v = 2 m/s								5.0			6.0		8.0	7.5	6.5	6.0	7.0					
	Filters		18					2.8	←								2.8						In clean condition
	Strainers		19					1.0	←								1.0						

1) If the narrowest shut-off diameter d_E is smaller than the line connection nominal diameter DN, the loss coefficient ζ must be increased by $(DN/d_E)^x$ with x = 5 to 6.
2) When the valve is partially open, i.e. low flow velocities, the loss coefficients increase to the "max" values. With increasing flow velocities v (in m/s) the loss coefficients decrease roughly as ζ 3/v.
See Fig. 13 for designs.

Prietokový súčiniteľ - charakteristický prietok danou armatúrou za presne definovaných
podmienok pri menovitom
Kv – m3/hod.
Cv- US gal/min.

Procesné parametre:

Tlaková strata ξ

Pre regulačné armatúry
Prietokový súčiniteľ Kv,
Cv.

$$Kv = \frac{1}{100} \cdot Q \cdot \sqrt{\frac{\rho_1}{\Delta p}} \qquad [m^3.h^{-1}]$$

kde

Q	je objemový prietok	$[m^3.h^{-1}]$
ρ	je objemová hmotnosť	$[kg.m^{-3}]$
Δp	je tlaková strata armatúry	[MPa]

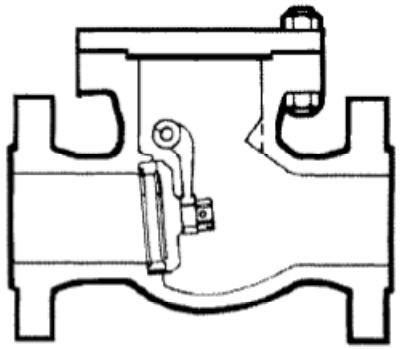
Handwheel rotation	Kv-value (m^3/h)
0.5	1.1
1.0	2.2
1.5	3.2
2.0	4.3
2.5	5.4
3.0	6.45
3.4	7.2

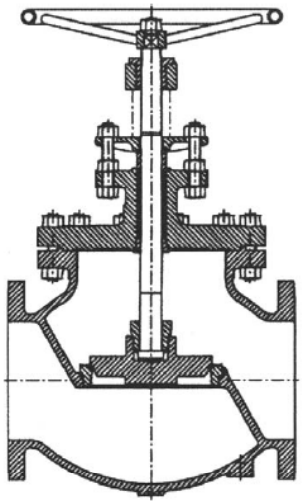
Potrubný systém. Armatúry

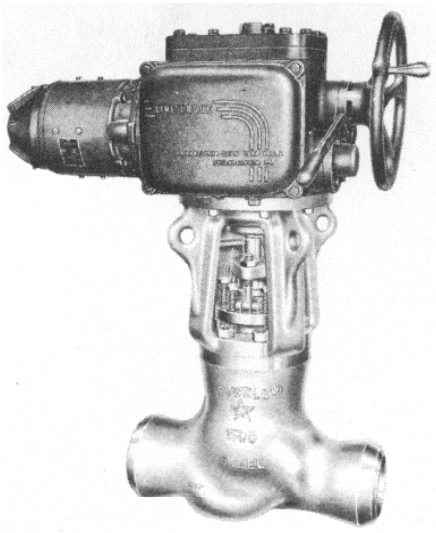
Základné funkcie armatúr

VALVE ACTION	EXPLANATION
ON/OFF	STOPPING OR STARTING FLOW
REGULATING	VARYING THE RATE OF FLOW
CHECKING	PERMITTING FLOW IN ONE DIRECTION ONLY
SWITCHING	SWITCHING FLOW ALONG DIFFERENT ROUTES
DISCHARGING	DISCHARGING FLUID FROM A SYSTEM

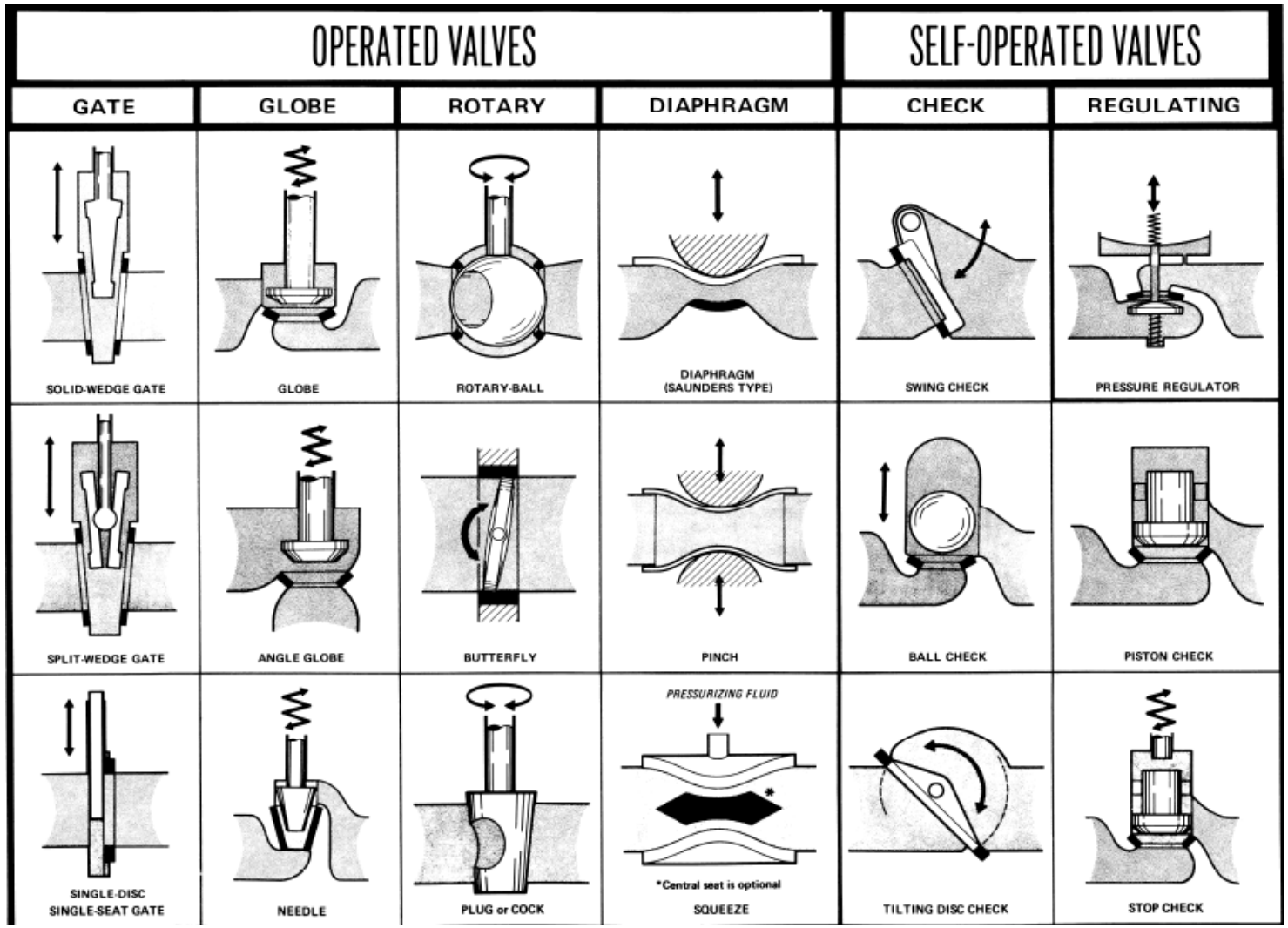
Základné spôsoby ovládania armatúr







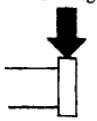
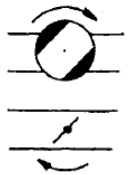
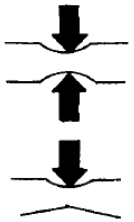
Potrubný systém. Armatúry



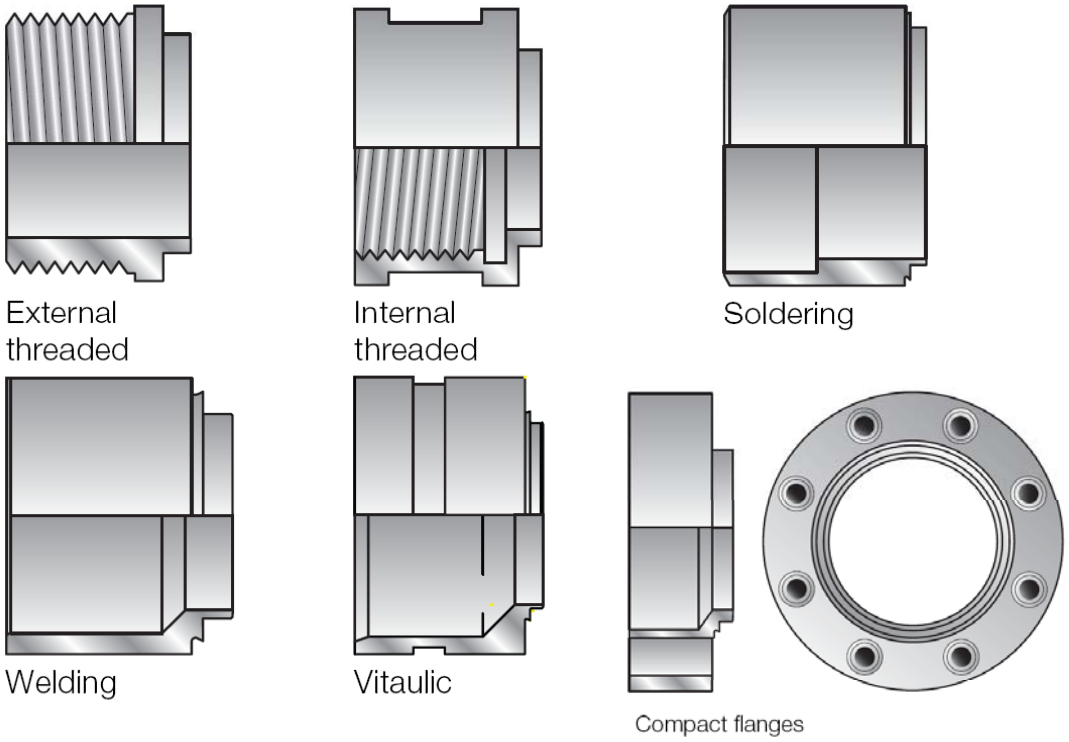
Potrubný systém. Armatúry

Valve Selection Chart

Valve		Mode of Flow Regulation			Fluid				
Group	Type	On-Off	Throttling	Diverting	Free of solids	Solids in Suspension non-abrasive	abrasive	Sticky	Sanitary
Closing down	Globe:								
	–straight pattern	Yes	Yes		Yes				
	–angle pattern	Yes	Yes		Yes	special	special		
	–oblique pattern	Yes	Yes		Yes	special			
	–multiport pattern			Yes	Yes				
	Piston	Yes	Yes		Yes	Yes	special		
Sliding	Parallel gate:								
	–conventional	Yes			Yes				
	–conduit gate	Yes			Yes	Yes	Yes		
	–knife gate	Yes	special		Yes	Yes	Yes		
	Wedge gate:								
	–with bottom cavity	Yes			Yes				
	–without bottom cavity (rubber seated)	Yes	moderate		Yes	Yes			
Rotating	Plug:								
	–non-lubricated	Yes	moderate	Yes	Yes	Yes			Yes
	–lubricated	Yes		Yes	Yes	Yes	Yes		
	–eccentric plug	Yes	moderate		Yes	Yes		Yes	
	–lift plug	Yes		Yes	Yes	Yes		Yes	
	Ball	Yes	moderate	Yes	Yes	Yes			
	Butterfly	Yes	Yes	special	Yes	Yes			Yes
Flexing	Pinch	Yes	Yes	special	Yes	Yes	Yes	Yes	Yes
	Diaphragm:								
	–weir type	Yes	Yes		Yes	Yes		Yes	Yes
	–straight-through	Yes	moderate		Yes	Yes		Yes	Yes

Groups of Valves By Method of Flow Regulation	Valve Types
Closing Down 	Globe Valve Piston Valve
Sliding 	Parallel Gate Valve Wedge Gate Valve
Rotating 	Plug Valve Ball Valve Butterfly Valve
Flexing of Valve Body 	Pinch Valve Diaphragm Valve

Potrubný systém. Armatúry



Pripojenie,
Pripojovací rozmer

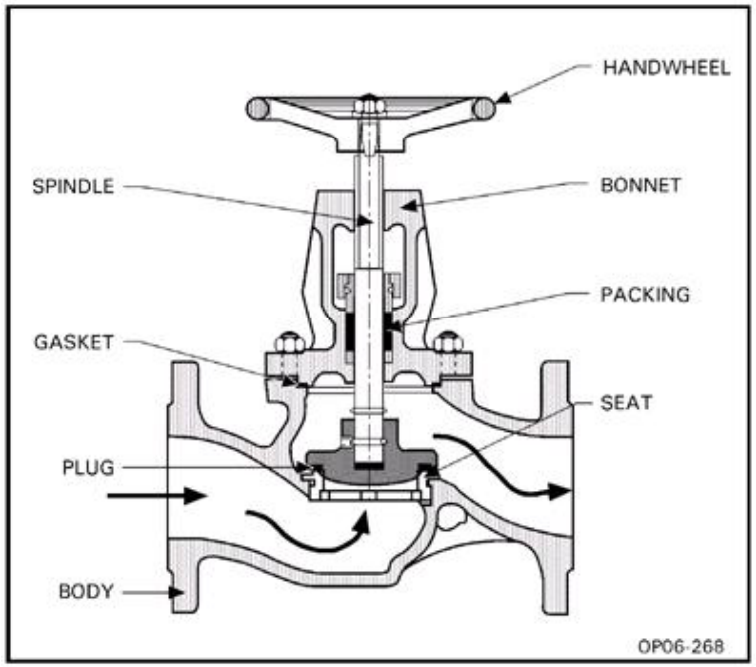
Príruba

Závit

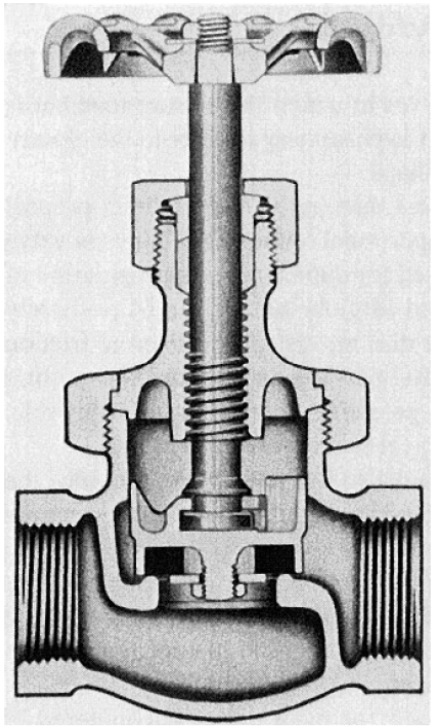
Zvar

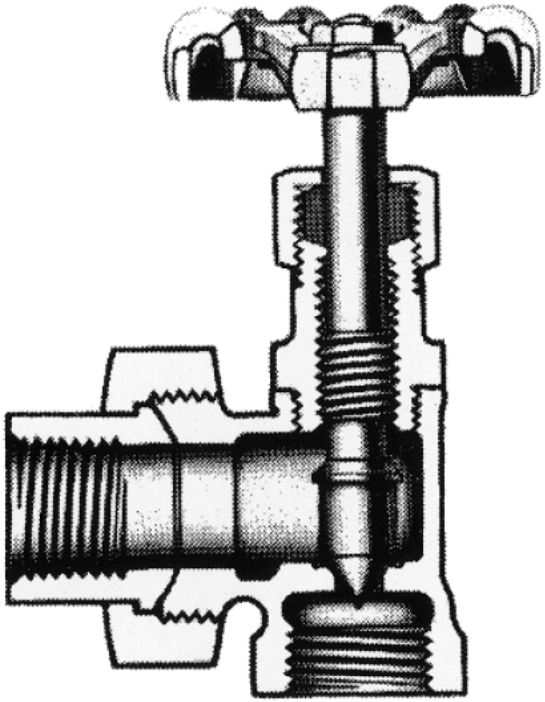
Ostatné pripojenia
(Parker, Swagelock, Clamp, aseptický program …)

Armatúry. Globe Valve /Ventil/



Vzor /Valve Body Pattern/:
-Standard
-Angle
-Oblique „Y“





Funkcia:
-Regulačná
-Uzatváracia
-Časté otváranie a zatváranie

Použitie
(g) a (l) bez častíc
Vákuum

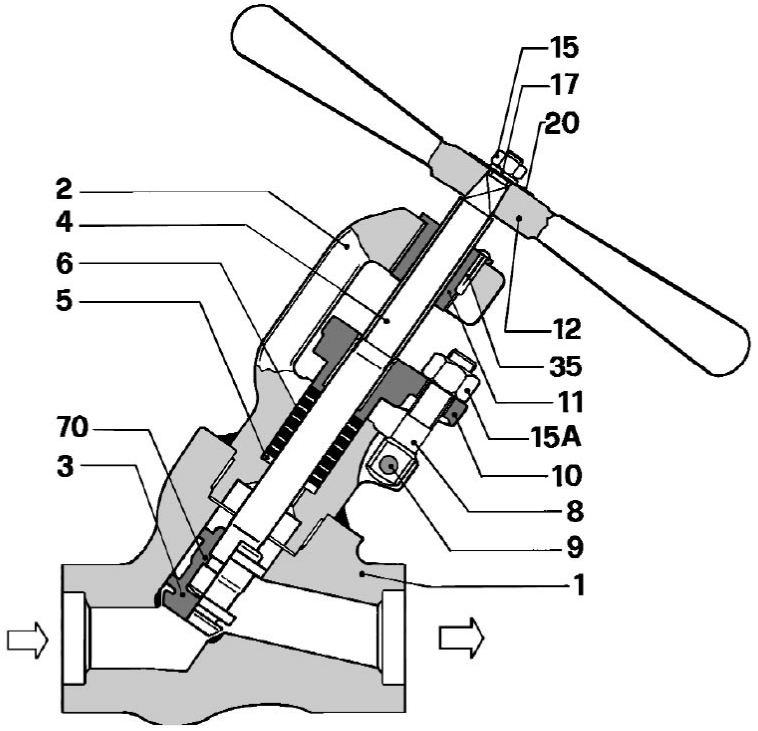
Armatúry. Globe Valve /Ventil/

Item	Part
1	Body
2	Bonnet
2.2	Bonnet
3	Disk
3.2	Disk
3.3	Disk
3.4	Disk
4	Stem
4.4	Stem
5	Bottom Ring
6	Packing
8	Swing Bolt
9	Pin
10	Gland Flange
11	Yoke Bushing
12	Handle
14	Disk Pad
15	Handle Nut
15A	Bolt Nut
17	Washer
18	Disk Cap
20	Name Plate
21	Spring
23	Indicator
24	Spring
35	Grooved Rivet
70	Connecting Ring

MATERIAL SCHEDULES

Here below we list the main characteristic elements of the different Material Schedules (See pag. 2 for complete Material Table):

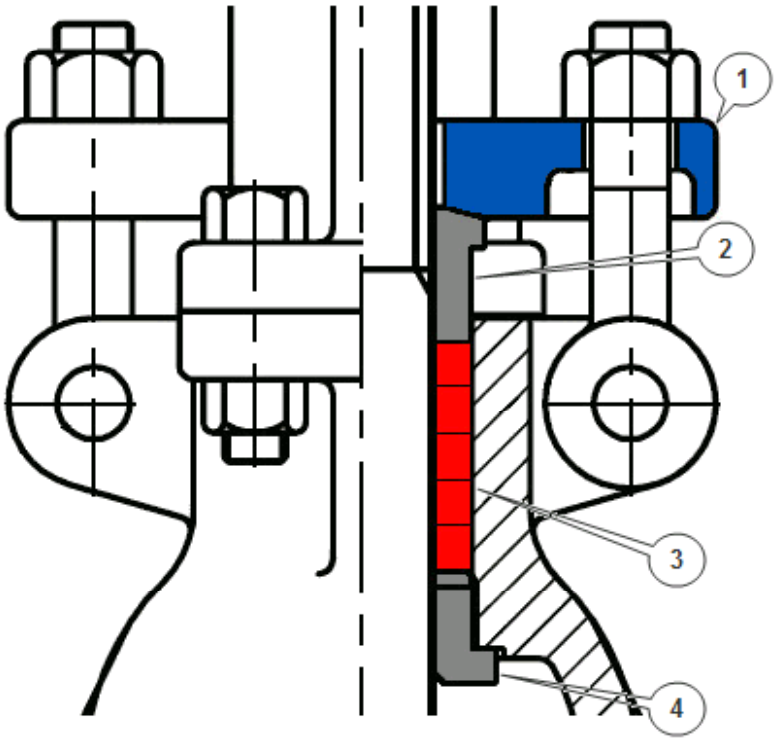
Material Schedule	Body & Bonnet Material	Disc & Seat
71	ASTM A 105	Stellite Gr. 6
11	ASTM A 182 F11	
22	ASTM A 182 F22	
31	ASTM A 182 F316	
91	ASTM A 182 F91	



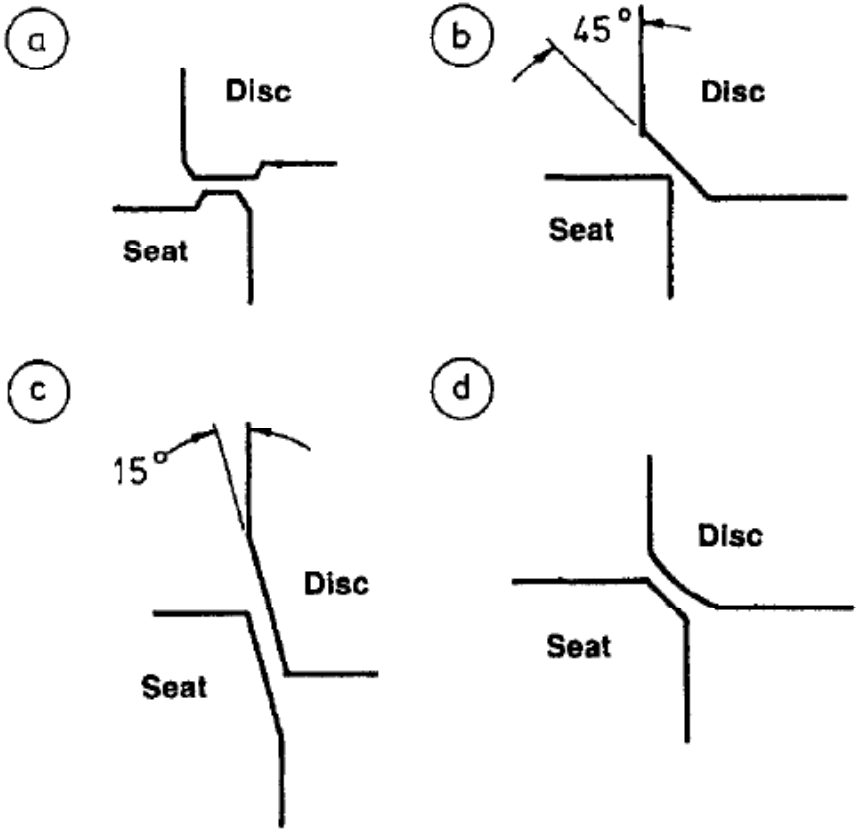
Lepšia prietoková charakteristika (Kv, Cv)

Nižšia tlaková strata.

Armatúry. Globe Valve /Ventil/

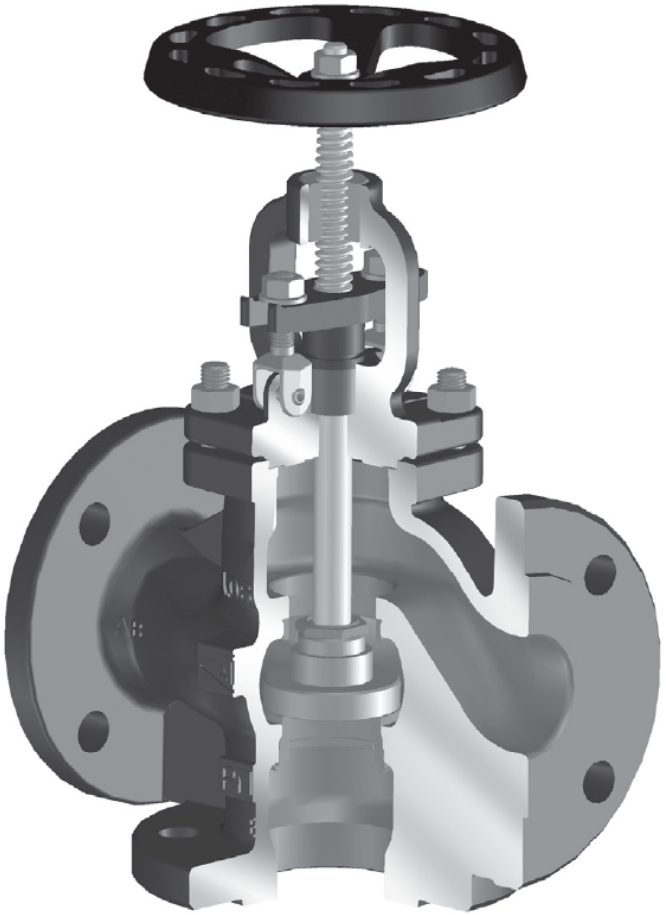


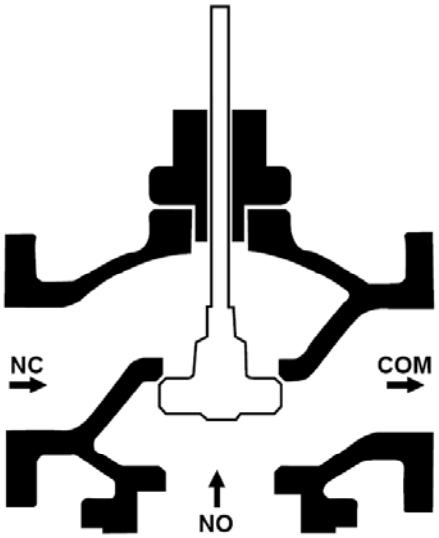
1. Gland follower 2. Gland 3. Packing 4. Back seat



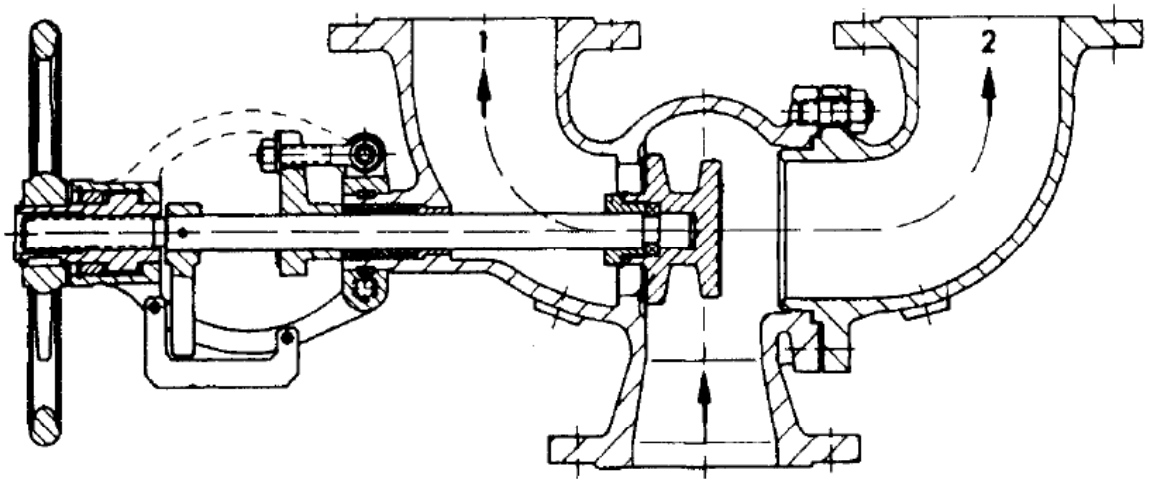
Rôzne riešenia dosadacej plochy (sedlo) a kužeľky

Armatúry. Globe Valve /Ventil/

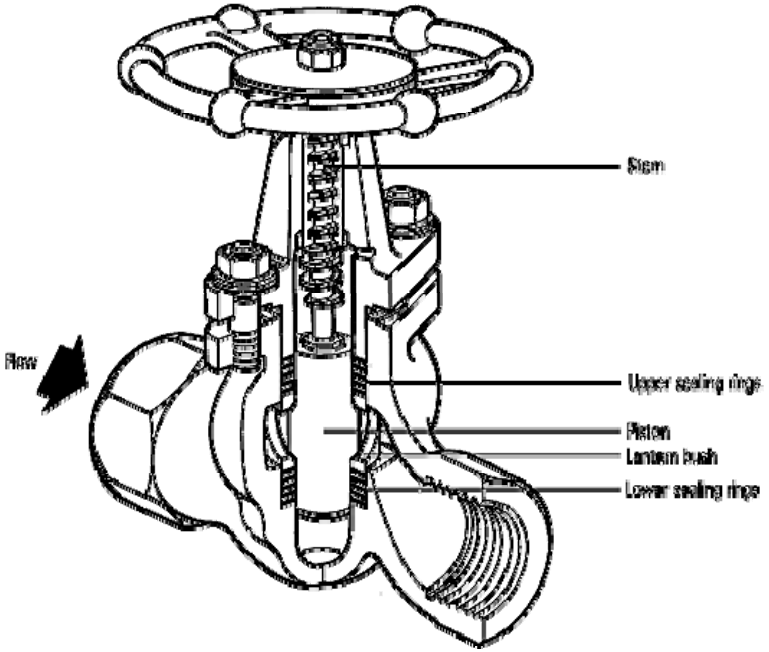


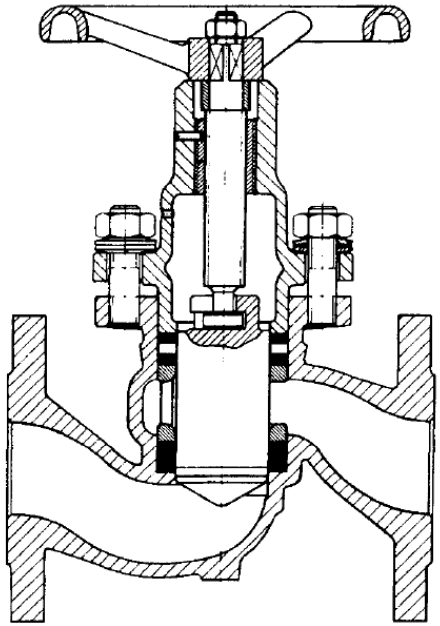


Funkcia:
-3 cestné prevedenie
-zmiešavací ventil



Armatúry. Piston Valve /Piestový Ventil/





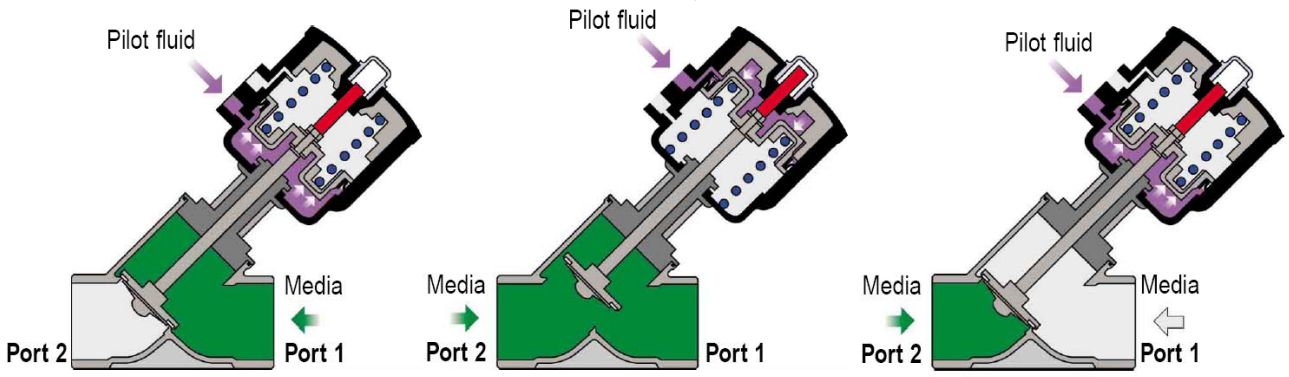
Výhody:
-2té tesnenie (bez vibrácií)
-spoľahlivé
-aj pre nebezpečné médium
-dlhšia životnosť tesnení

Piston valve

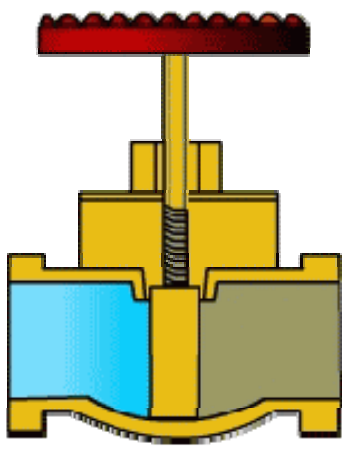
Piston actuated valve

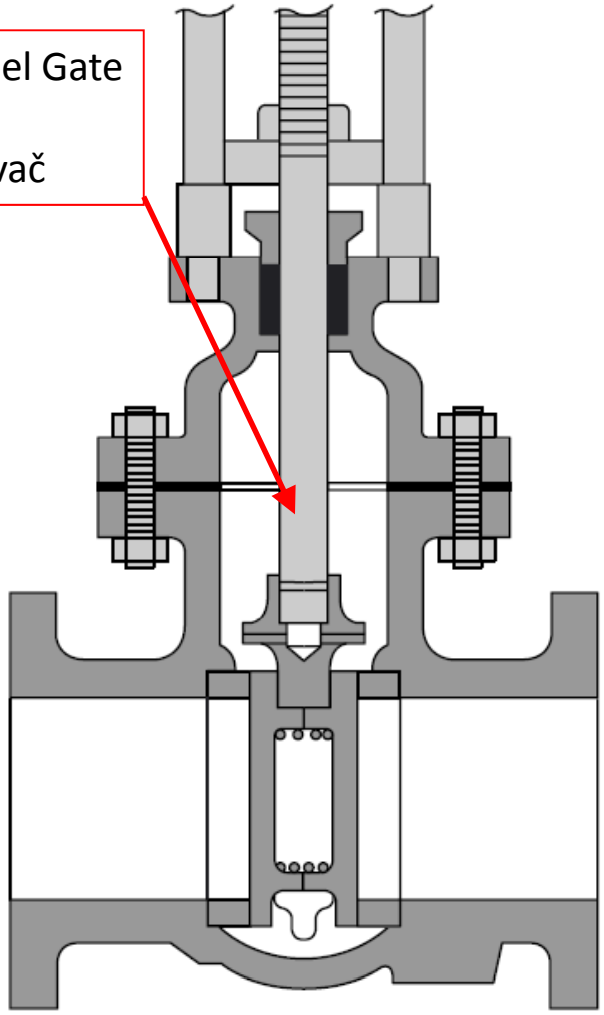
Funkcia:
-Regulačná
-Uzatváracia
-Časté otváranie a zatváranie

Použitie
(g) bez častíc
(l) bez častíc
Vákuum



Armatúry. Parallel Gate Valve /Posúvač/





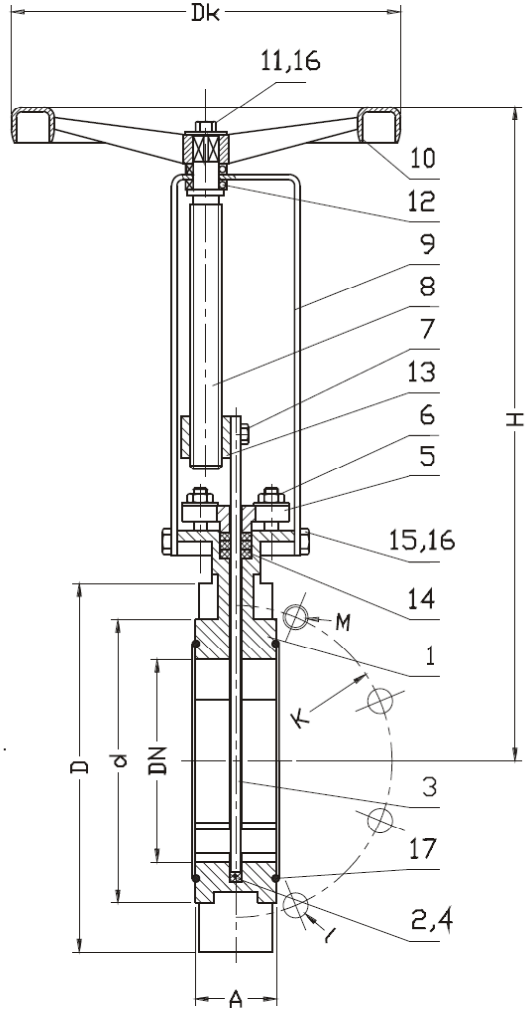
Výhody:
-↓↓↓ tlaková strata pri 100 % otvorení.
- vhodné pre kaly pasty, suspenzie, a ťažko dopravovateľné materiály

Nevýhody:
-nevhodné pre časté otváranie . Poškodenie tesnenia.
-Nevhodné pre regulácia. Efektívna regulácia začína pri 50% zatvorení
- pri ↑↑ rýchlostiach tendencia k vibráciám

Funkcia:
-Uzatváracia
- Regulačná, špeciálna konštrukcia

Použitie
-(g),(l) . Aj supenzie, kaly, pasty
-vákuum

Armatúry. Parallel Gate Valve /Posúvač/



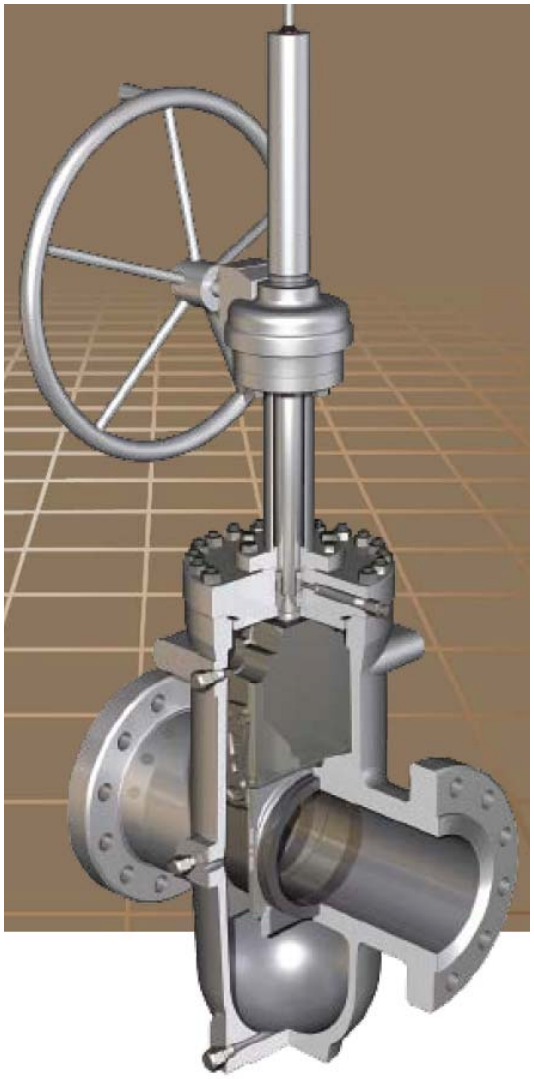
Knife Gate Valve

Zväčša len do nízkych tlakov
PN10 / PN16

Hlavne pre suspenzie, kalové vody atď.

Knife Gate Valve
Nožový posúvač

Armatúry. Conduit Gate Valve /Posúvač/



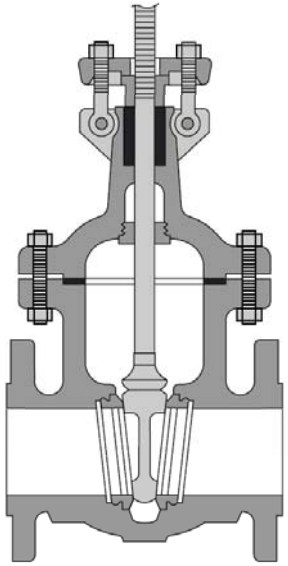
Funkcia:
-Uzatváracia
-Nevhodné pre časté otváranie a zatváranie
Použitie
-(g),(l)

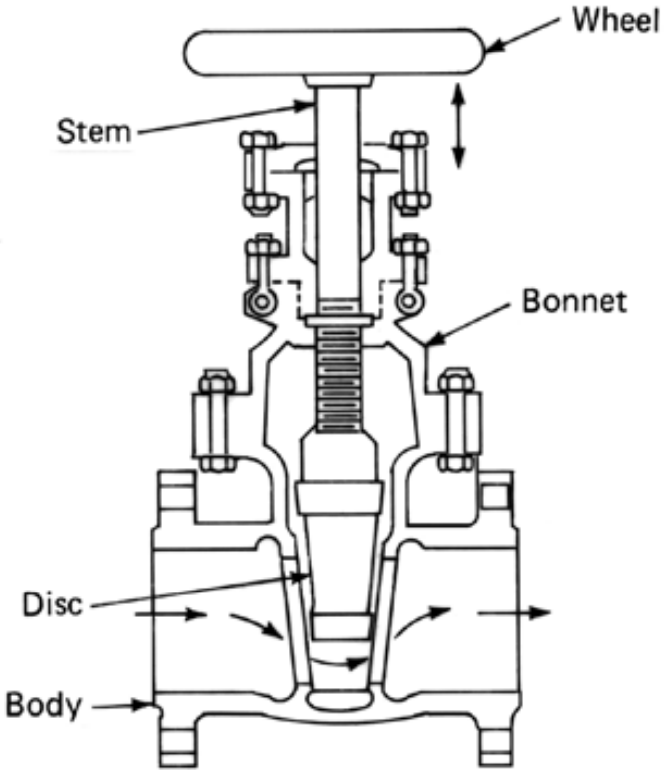
Rovnaký princíp ako paralel, v paralelnej platne je otvor o svetlosti potrubia.

Výhody:
- extrémne náročné aplikácie (do 500 °C)
-↓↓↓ tlaková strata pri 100 % otvorení.
-do vyšších tlakov
-chránené tesnenie.

Nevýhody:
-Nevhodné pre regulácia. Efektívna regulácia začína pri 50% zatvorení
-pomalé otváranie.

Armatúry. Wedge Gate Valve /Klinový Posúvač/





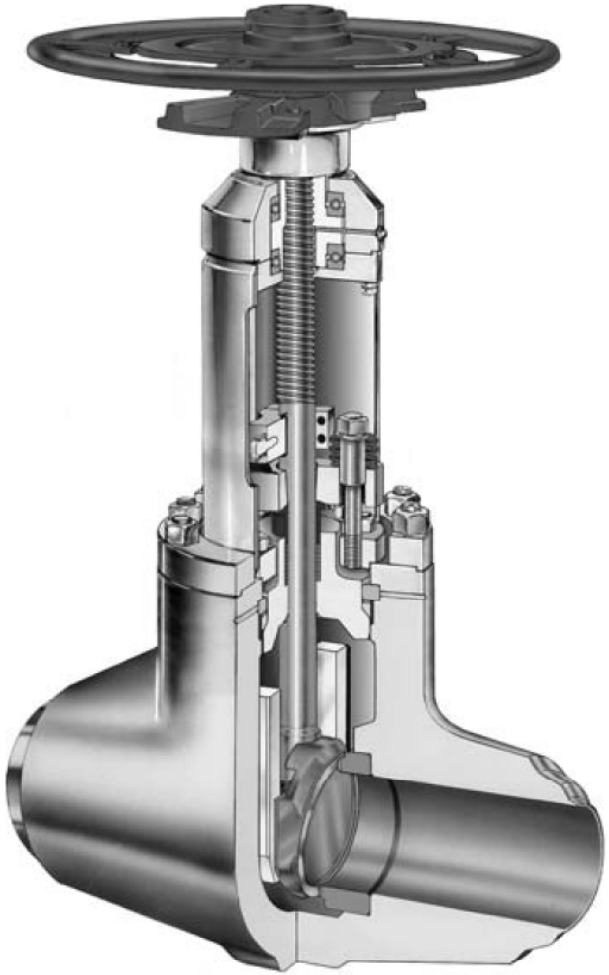
Rovnaký princíp ako paralel namiesto paralelnej platne – klin. Klin je mohutnejší, vyšší prítlak na tesnenie, použitie do vyšších tlakov

Funkcia:
-Uzatváracia
-Nevhodné pre časté otváranie a zatváranie
Použitie
-(g),(l) . Aj suspenzie – použitie pogumovaného klina

Výhody:
-↓↓↓ tlaková strata pri 100 % otvorení.
-do vyšších tlakov
-tvar klina podľa potreby.

Nevýhody:
-nevhodné pre časté otváranie, možnosť poškodenie tesnenia.
-pomalé otváranie.

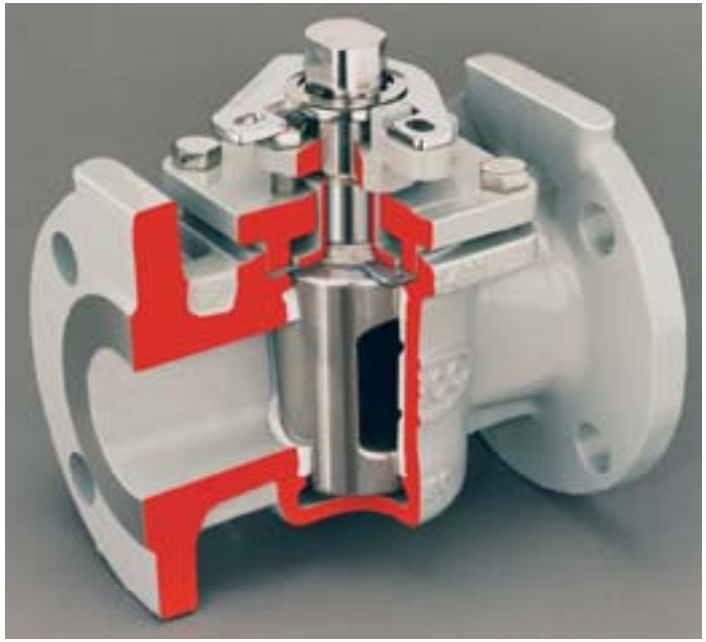
Armatúry. Rising, non-rising Stem / Vreteno/



Rising Stem
/zo stúpajúcim vretenom /

Non- Raising Stem
/s nestúpajúcim vretenom /

Armatúry. Plug Valve /Kužeľový kohút/



Otočná armatúra. Teleso v tvare kužeľa s otvorom.
Tvar: kužeľ, zrezaný kužeľ, valec.

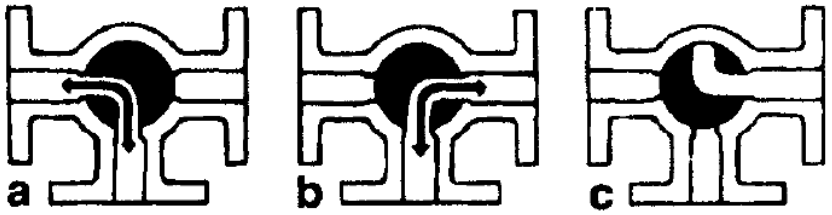
Výhody:
-rýchle otváranie/zatváranie 90°
- vhodný aj pre regulácia.
- o vyšších tlakov
-tvar klina podľa potreby.

Nevýhody:
-zväčša pre ↓↓ teploty/tlaky
- pri 100 % otvorení vyššia tlaková strata

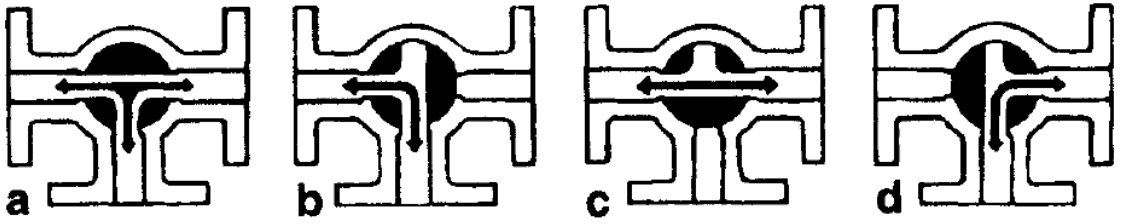
Funkcia:
-Uzatváracia, regulačná, rozdeľovacia
Použitie
-(g),(l), aj suspenzie .

Armatúry. Plug Valve /Kužeľový ventil/

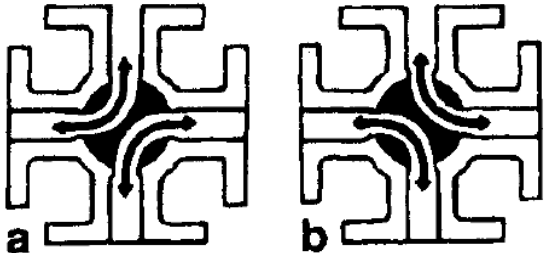
positions of three-way L-ported valves



positions of three-way T-ported valves



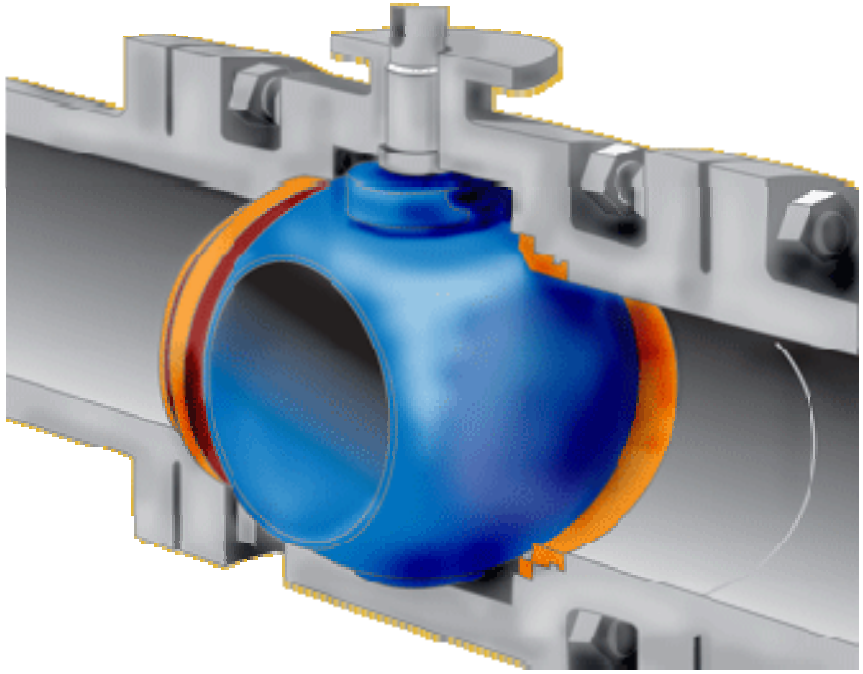
positions of four-way valves



Funkcia:

Rozdeľovacia (Multi-port configuartion)

Armatúry. Ball Valve /Guľový kohút/



Otočná armatúra. Teleso v tvare gule s otvorom.

Výhody:
-rýchle otváranie/zatváranie 90°-
- o vyšších tlakov
- nízka tlaková strata pri 100 % otvorení

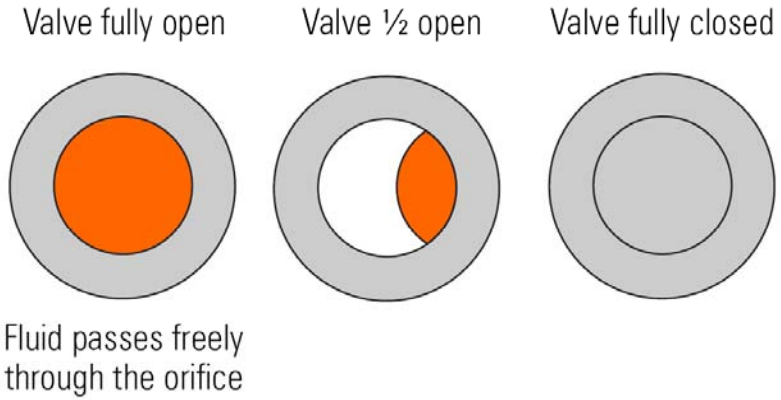
Nevýhody:
-zväčša pre ↓↓ teploty
-nevhodný pre regulácia.

Funkcia:
-Uzatváracia, rozdeľovacia
Použitie
-(g),(l), aj suspenzie .

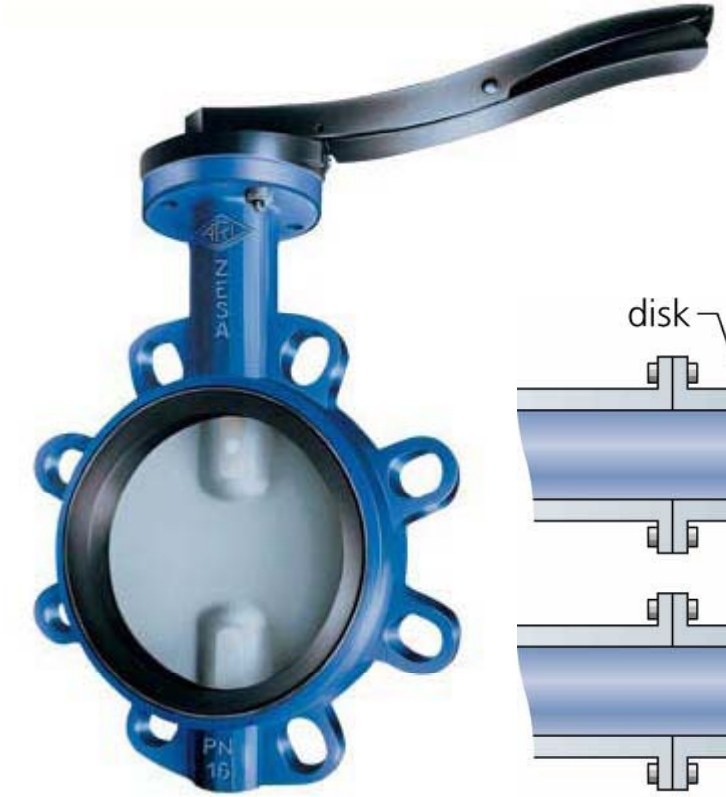
Armatúry. Ball Valve /Guľový kohút/

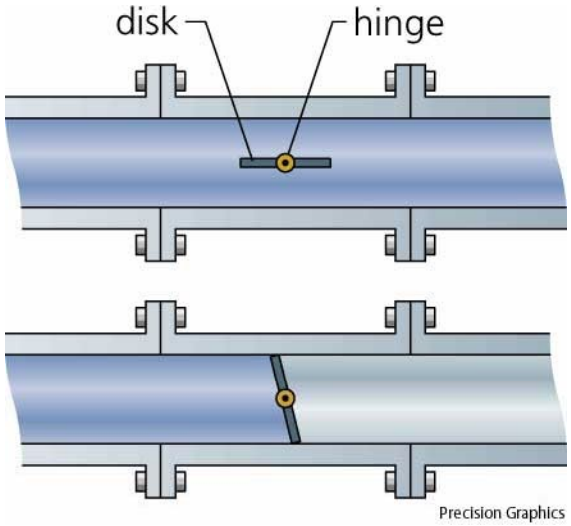
Prevedenie:

1-kus (napr. prírubový/ medziprírubvoný)
2- dielny
3- dielny



Armatúry. Butterfly Valve /Klapka/





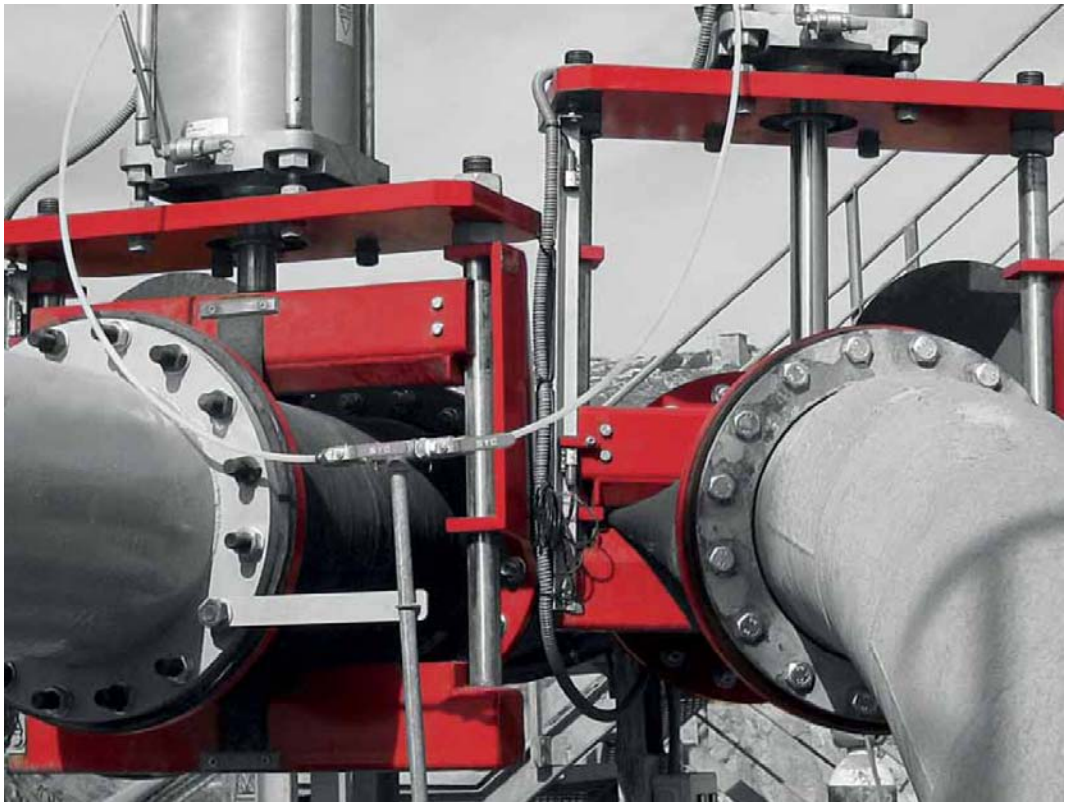
Funkcia:
-Uzatváracia, regulačná
Použitie
-(g),(l), prášky, kaly ....

Otočná armatúra. Otáčanie klapky v priereze potrubia.

Výhody:
-jednoduchá, lacná
-nízka hmotnosť
-otváranie/zatváranie 90°
-nízka tlaková strata pri 100 % otvorení
-implementovaná manžeta
-vhodná aj na reguláciu

Nevýhody:
-zväčša pre ↓↓ teploty/tlaky
- „pigging“, stredová časť

Armatúry. Pinch Valve / Hadicový ventil/



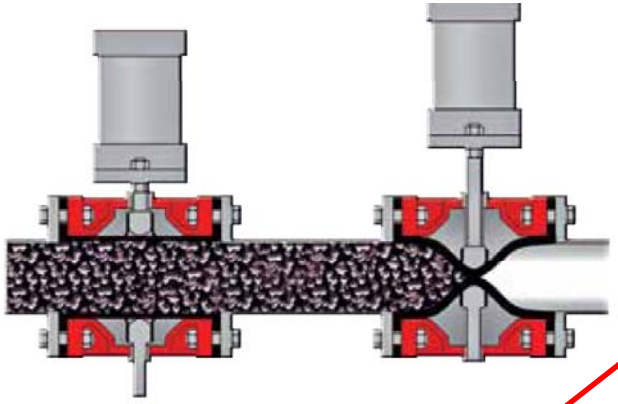
Funkcia:
-Uzatváracia, regulačná
Použitie
- (l) + abrazívne častice, ...

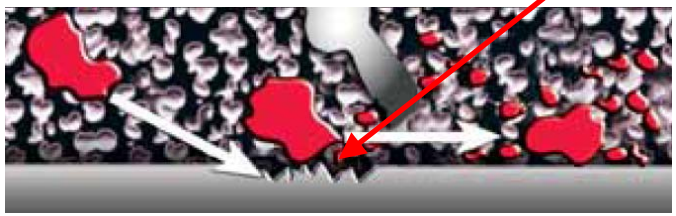
Priamočiary pohyb. Stláčanie ohybného elementu (rúrky).

Výhody:
- pre extrémne abrazívne materiály.
-nízka hmotnosť
- jednoduché
-nízka tlaková strata pri 100 % otvorení
-vhodná aj na reguláciu

Nevýhody:
- teplotné obmedzenia, ↓↓ teploty (do 160 °C)
- nevhodné pre vákuum (špeciálna hadica)
-natlakovanie systému.

Armatúry. Butterfly Valve /Klapka/





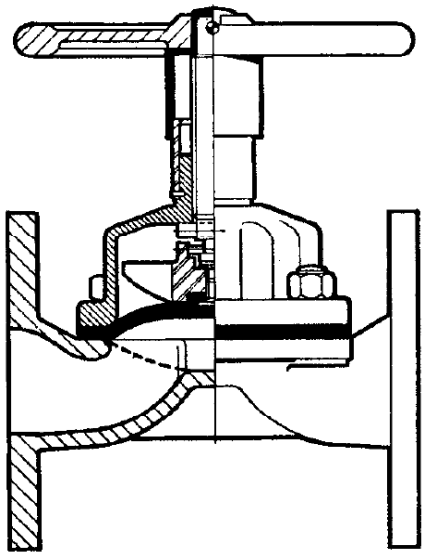
Kovový materiál
Tvrdé častice kontinuálne poškodzujú kontaktné časti armatúry

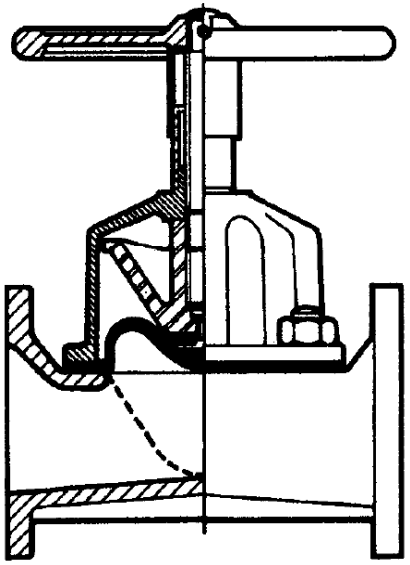
Elastický (pružný) materiál napr. guma
Absorbuje kinetickú energiu tvrdých častice bez poškodenia povrchu

Prevedenie pre nebezpečné média.

Pri prasknutí rúrky tesní vonkajšie teleso

Armatúry. Diaphragm valve /Membránový ventil/





Priamočiary pohyb. Stláčanie ohybného elementu membrány

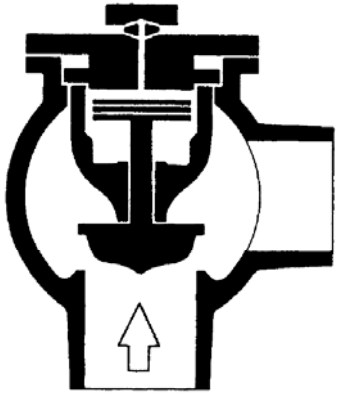
Výhody:
- pre extrémne korozívne a abrazívne materiály.
-nízka hmotnosť
-jednoduché
-vhodná aj na reguláciu

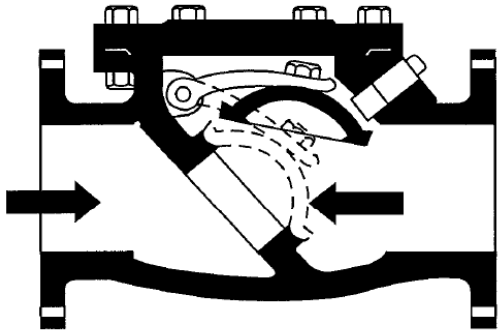
Nevýhody:
- teplotné obmedzenia, ↓↓ teploty (do 160 °C) - membrána
-natlakovanie systému.

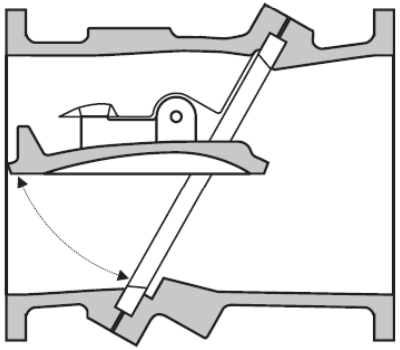
Funkcia:
-Uzatváracia, regulačná
Použitie
- (l),(g) + korozívne médiá.

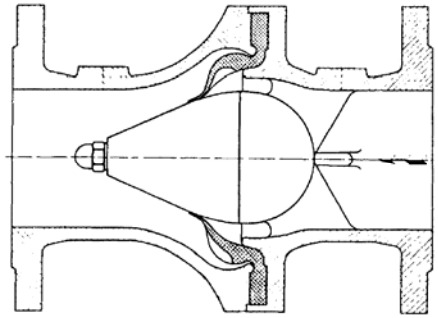
Vnútorná vložka

Armatúry. Check valve / Spätný ventil, spätná klapka /









Základné konštrukčné typy spätných armatúr:

Lift Check Valve

Swing Check Valve

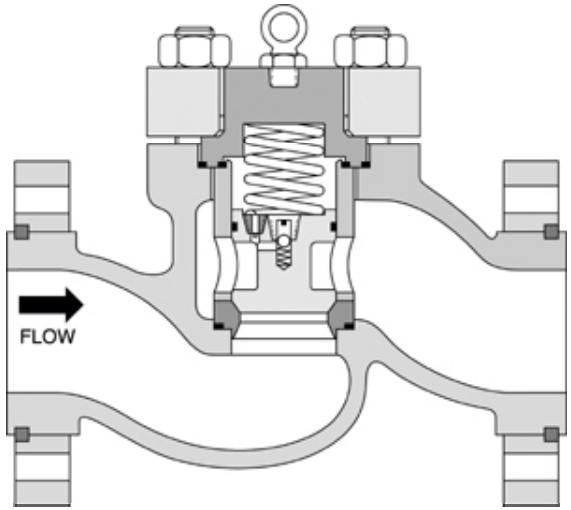
Double disk Swing Check valve (Split Disc Check valve)

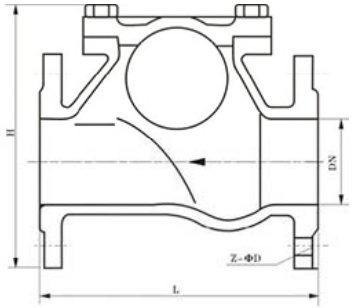
Tiltilng-disk Check Valve

Diaphragm Check Valve

Funkcia:
Zamedzenie spätného toku, automatická armatúra.
Použitie
- (l),(g)

Armatúry. Lift Check Valve / Spätný ventil/





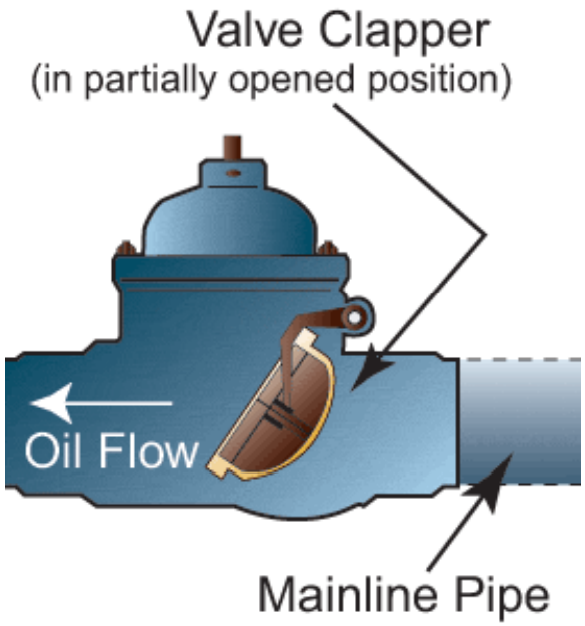
Lift Check Valve
Prúdom média je zdvíhaný uzatvárací prvok, pri spätnom toku je naopak je tlačený na dosadaciu plochu.

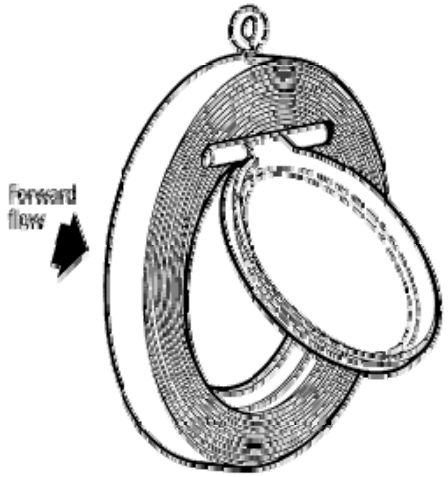
Výhody:
-malá vzdialenosť pohybu uzatváracieho prvku.
- pružina, možnosť nastaviť potrebný tlak na otváranie.

Nevýhody:
- možnosť znečistenia
- len pre čisté média
- dodržať montážnu polohu

Funkcia:
Zamedzenie spätného toku, automatická armatúra.
Použitie
- (l),(g)

Armatúry. Swing Check Valve / Spätná klapka/



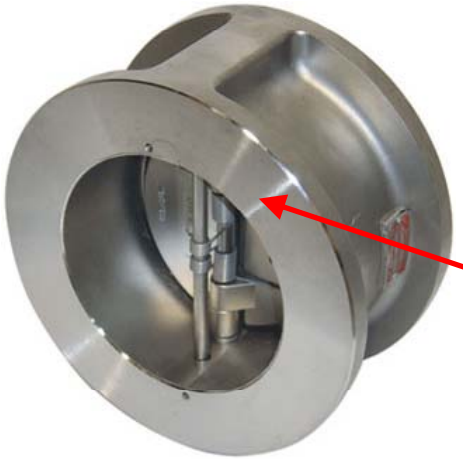


Swing Check Valve
Prúdom média je otáčaný uzatvárací prvok, pri spätnom toku je naopak je tlačený na dosadaciu plochu.

Výhody:
- väčšia vzdialenosť pohybu uzatváracieho prvku.
- malá tendencia k zanášaniu

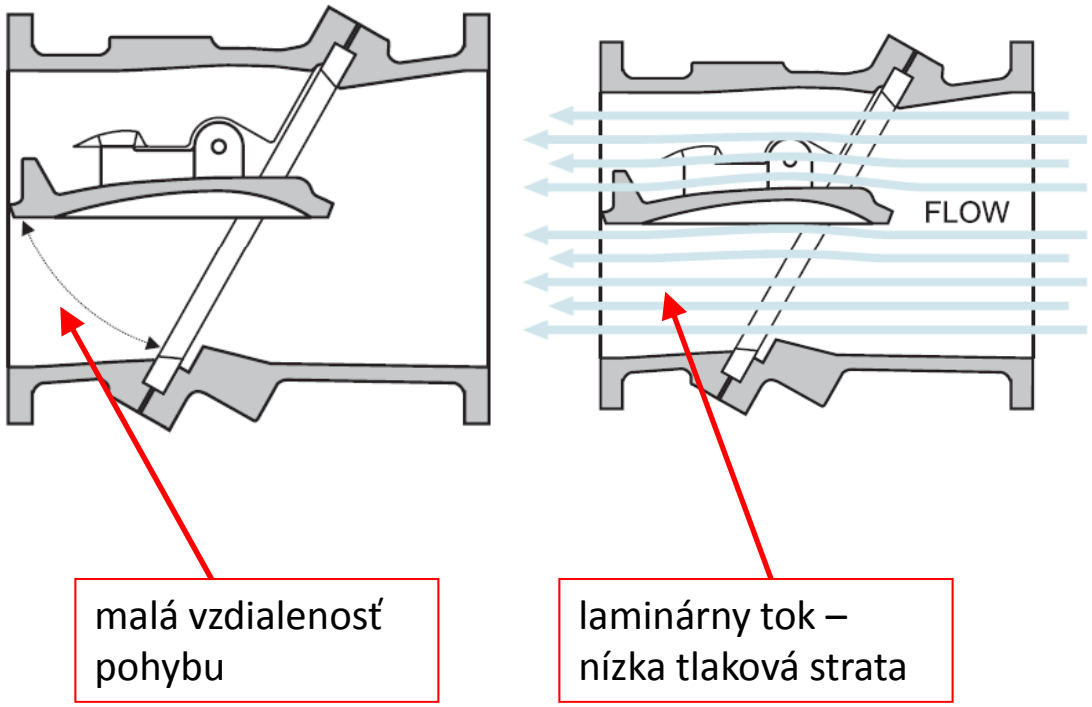
Nevýhody:
-dodržať montážnu polohu

Funkcia:
Zamedzenie spätného toku
Použitie
- (l),(g)



Double disk Swing Check valve

Armatúry. Tiltilng-Disk Check Valve / Spätná klapka/



Funkcia:
Zamedzenie spätného toku
Použitie
- (l),(g)

Tilting- Disk Check Valve
Prúdom média je otáčaný (naklápaný) uzatvárací prvok (disk), okolo pántu umiestneného mimo hlavnú os.

Výhody:
- malá vzdialenosť pohybu uzatváracieho prvku. – rýchly.
-malá tendencia k zanášaniu
-nízka tlaková strata
- použitie kde nestačí bežný swing check valve.

Nevýhody:
-drahý.

Armatúry. Diaphragm Check Valve / Membránový ventil /

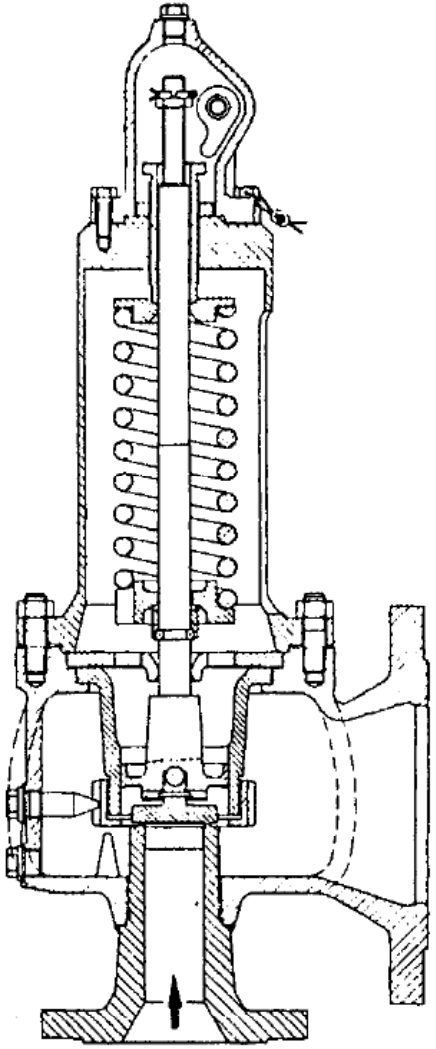
Diaphragm Valve
Prúdom média otvára membránu ,pri spätnom toku je tlačená na pomocnú konštrukciu.

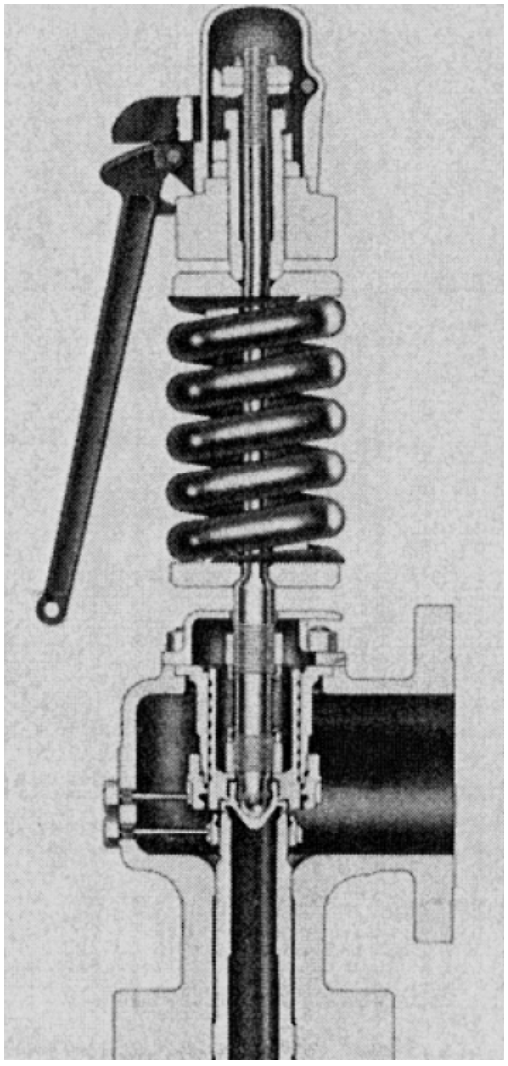
Výhody:
- bez pohyblivých častí
-rýchly
-malá tendencia k zanášaniu
-nízka tlaková strata

Nevýhody:
- nie je veľmi známy

Funkcia:
Zamedzenie spätného toku
Použitie
- (l),(g)

Armatúry. Pressure Relief Valve / Poistný ventil /





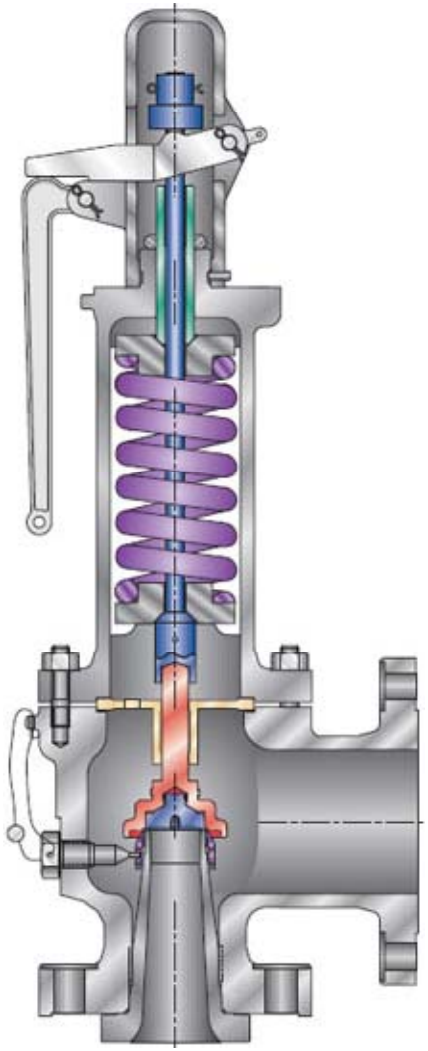
Pressure Relief Valve
Automatická armatúra, pri prekročení dovoleného tlaku sa armatúra otvorí a zníži tlak.

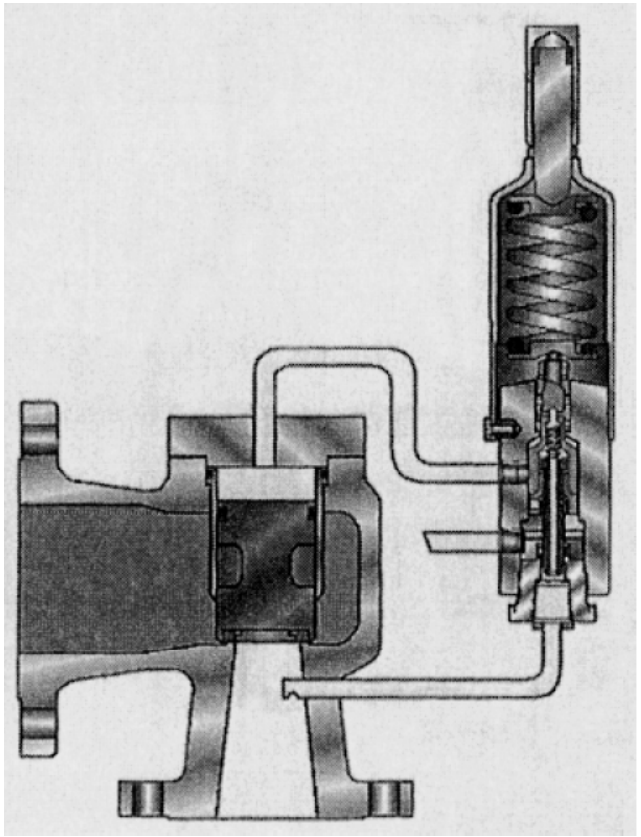
Rozdelenie:
- priamo ovládané PV
-(tlak zväčša otvára cez pružinu, prípadne protiváhu)

- nepriamo ovládané PV (Ventil tkz. “pilot”, ktorá ovláda kužeľeku hlavného ventilu.

Funkcia:
Poistná funkcia
Použitie
(g), (l)

Armatúry. Pressure Relief Valve / Poistný ventil /





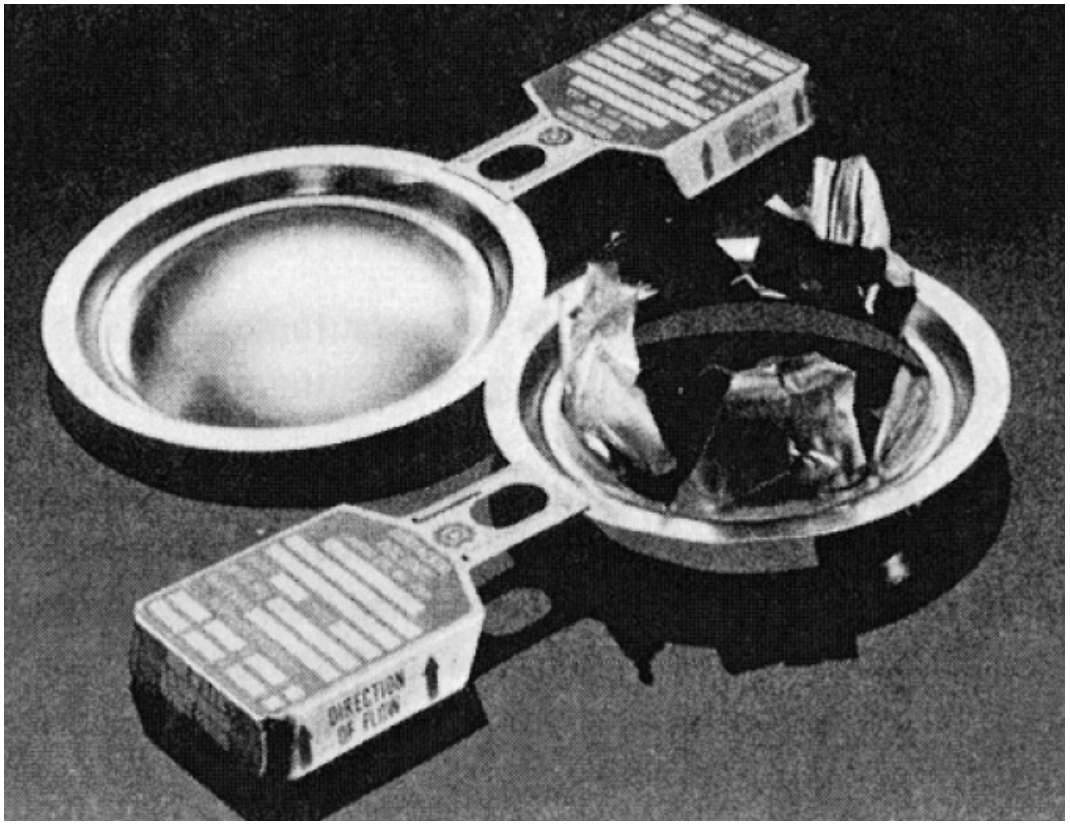
ENG.
Relief Valve – zväčša pre (l)

Safety valve – zväčša pre (g)

Konštrukcie prispôsobené médiu.
-(l)
-(g)

-PV je trvalo uzatvorená armatúra. Niekedy sa počas svojej životnosti otvorí iba pri kalibrácii a prevádzkových testoch

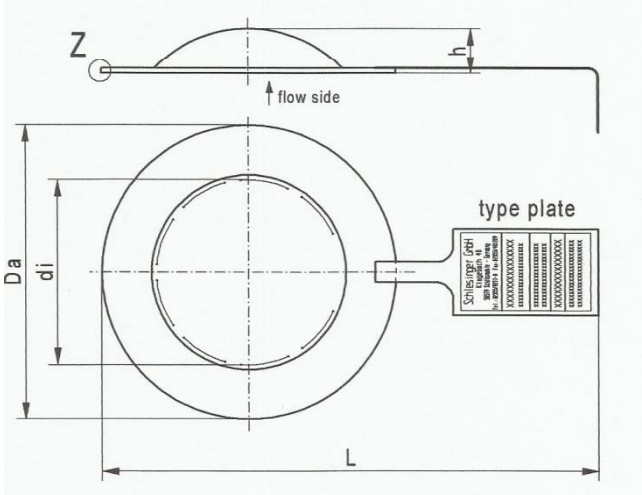
Armatúry. Rapture disk / Prietržné membrány /



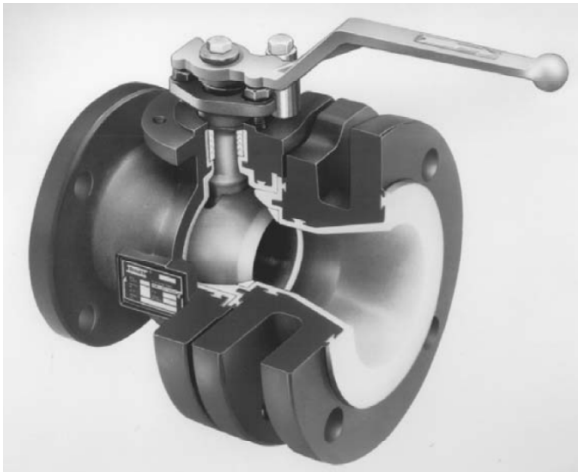
V prípade, že poistný ventil nestačí:

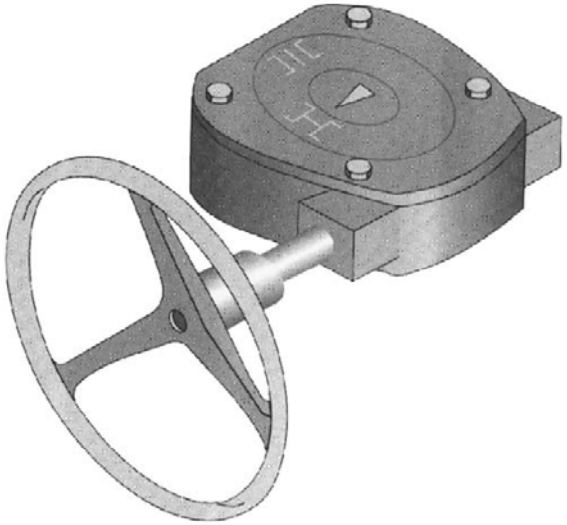
Prietržná membrána
-Obrovská kapacita.
-Extrémne rýchla.
-Aj do vákua
-Pri extrémne nízkych teplotách
-Ako ďalšia úroveň ochrany

-mechanické poškodenie
-nutná výmena.



Armatúry. Pohon / Actuator /



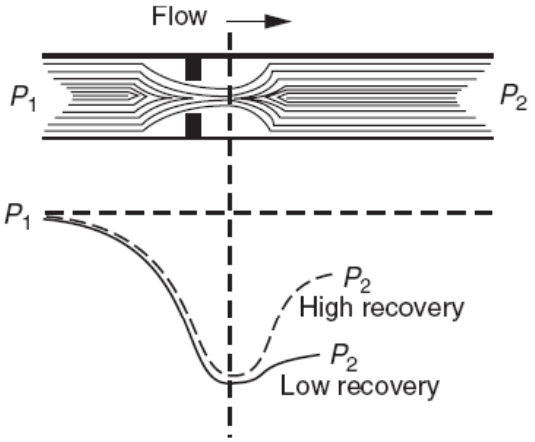


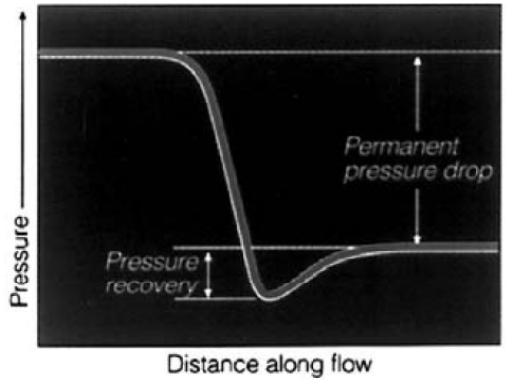
Základné rozdelenie

Manuálny pohon:
Vyžaduje ľudskú silu a mechanický člen spojený s armatúrou (napr. páka, rúčka, koleso)

Ovládaný pohon.
Vyžaduje zdroj energie (napr. Elektrická energia, tlakový vzduch) mechanický člen spojený s armatúrou. Na ovládanie je nutný riadiaci systém .

Armatúry. Najčastejšie problémy

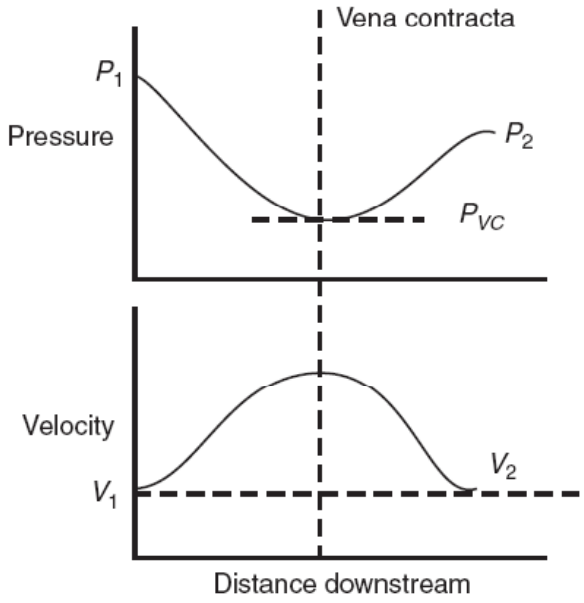


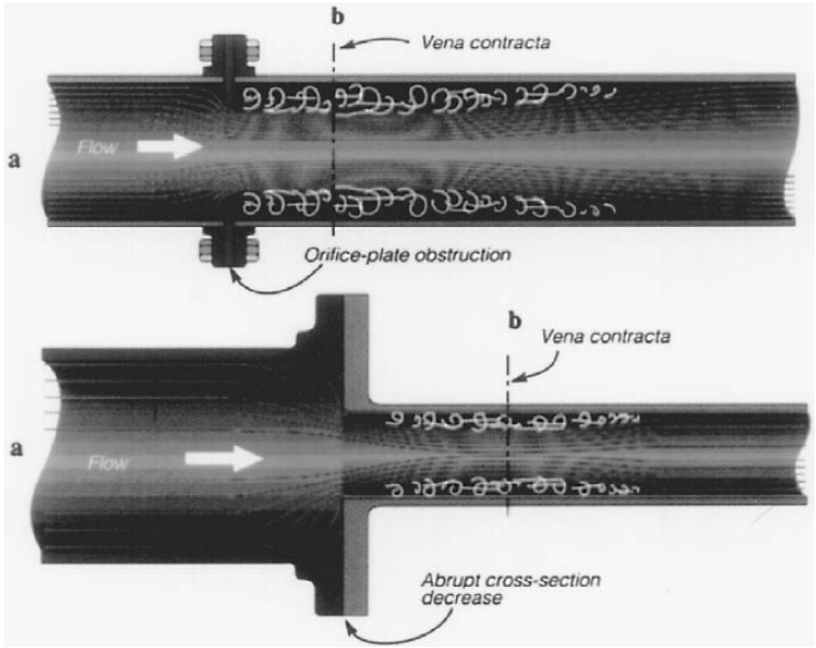


Vysoká tlaková strata

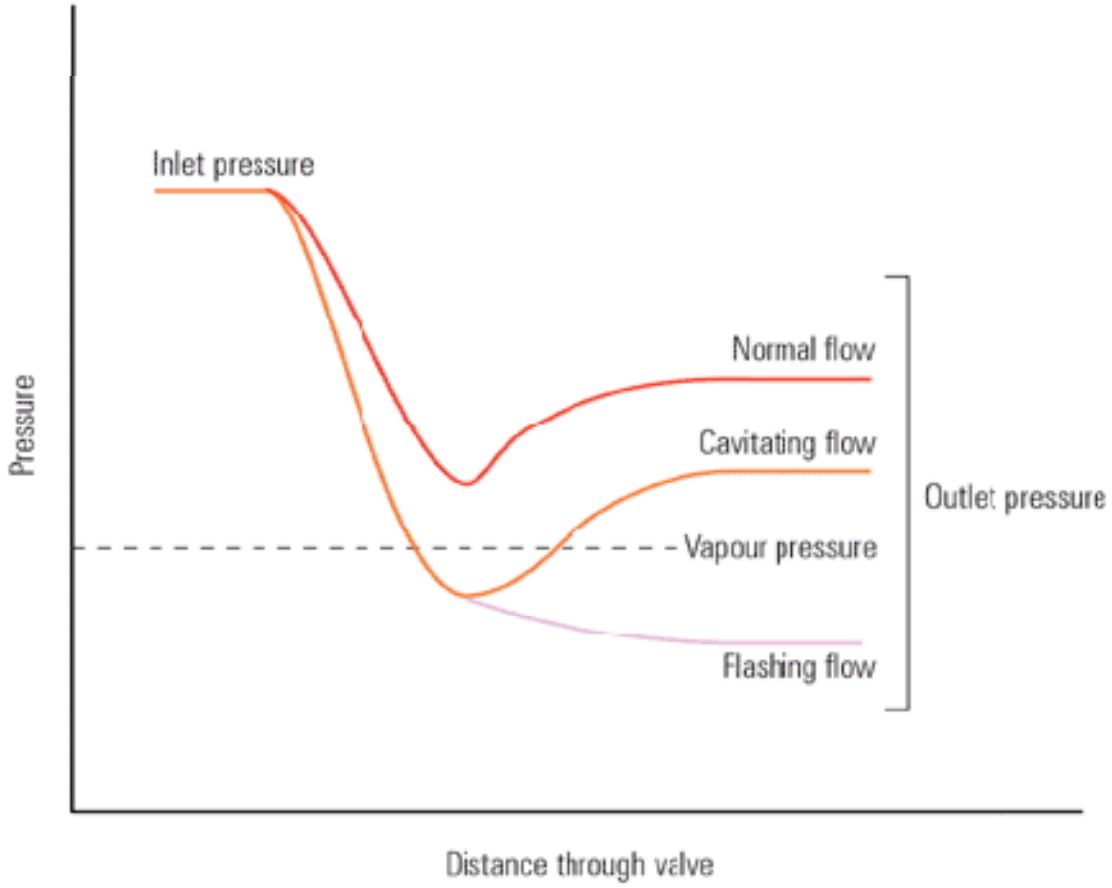
-clona
-ventil

↑↑ náklady na zdroj energie.
(čerpadlo, boiler ...)





Armatúry. Najčastejšie problémy

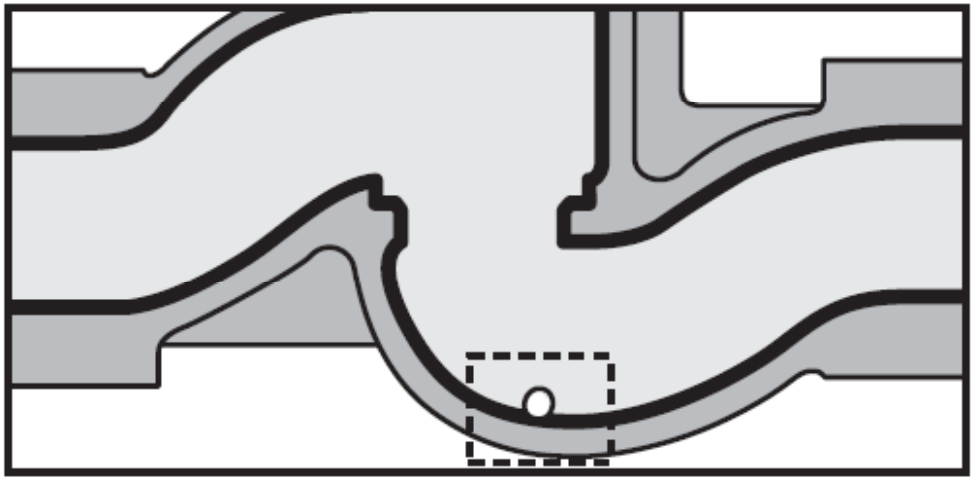


Vysoká tlaková strata
môže spôsobiť:

kavitácia (cavitation)
odparovanie (flashing)
vibrácie
vysoký hluk
práca v kritickom režime (
choked flow)

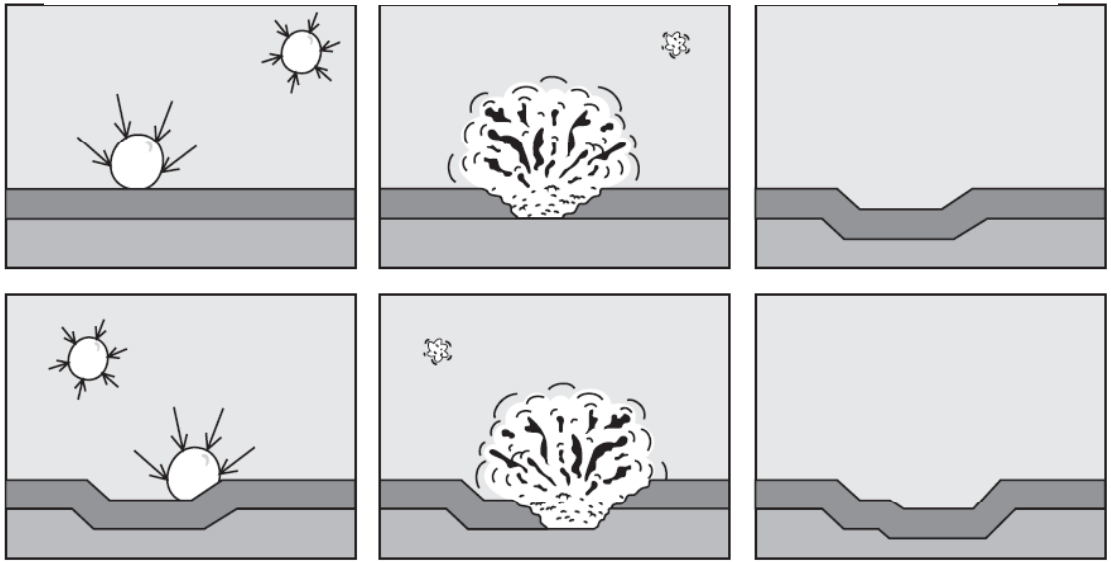
čo spôsobuje
-poškodenie kuželky
-poškodenie tela ventilu
- funkčnosť
-poškodenie ostaných častí
potrubia vplyvom vibrácii
-hluk (problémy obsluhy)
atď.

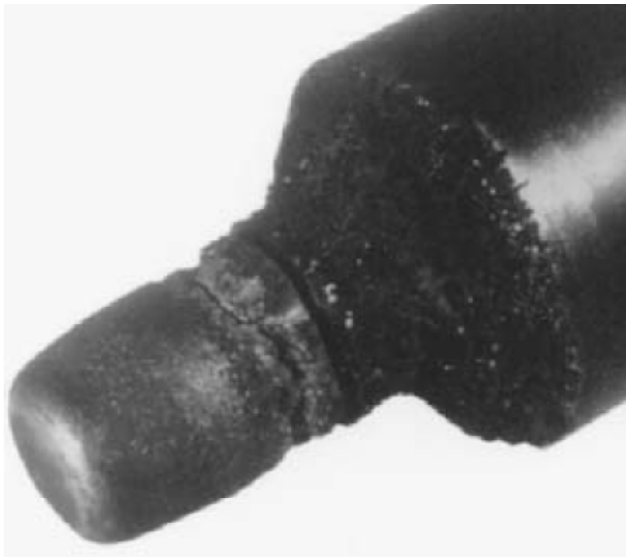
Armatúry. Najčastejšie problémy



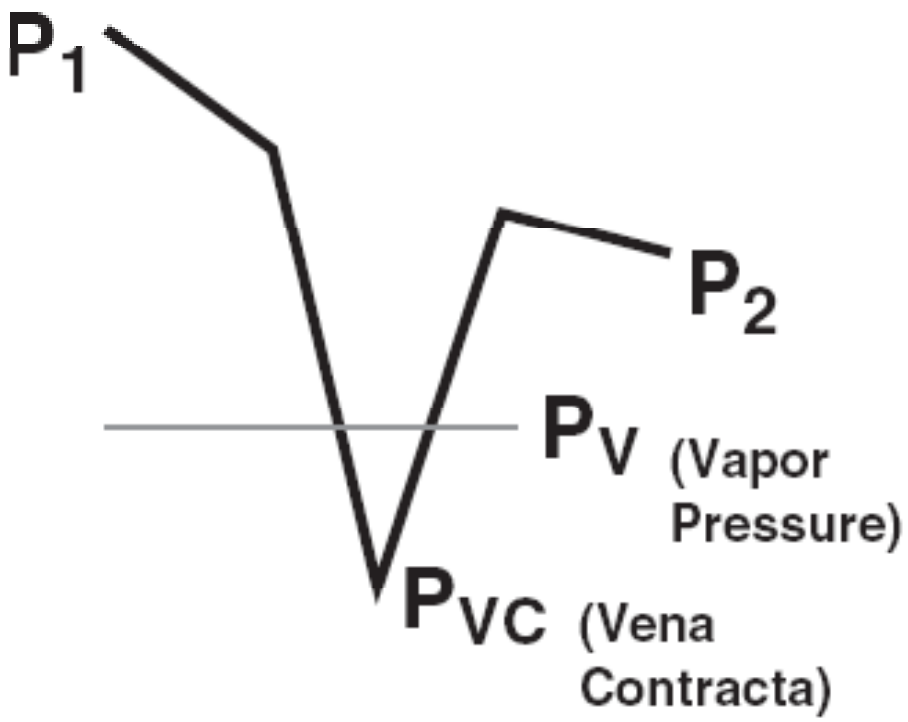
Kavitácia
~1900, lodná skrutka
(high-speed propeler.)

vzniká len v len (l)





Armatúry. Najčastejšie problémy

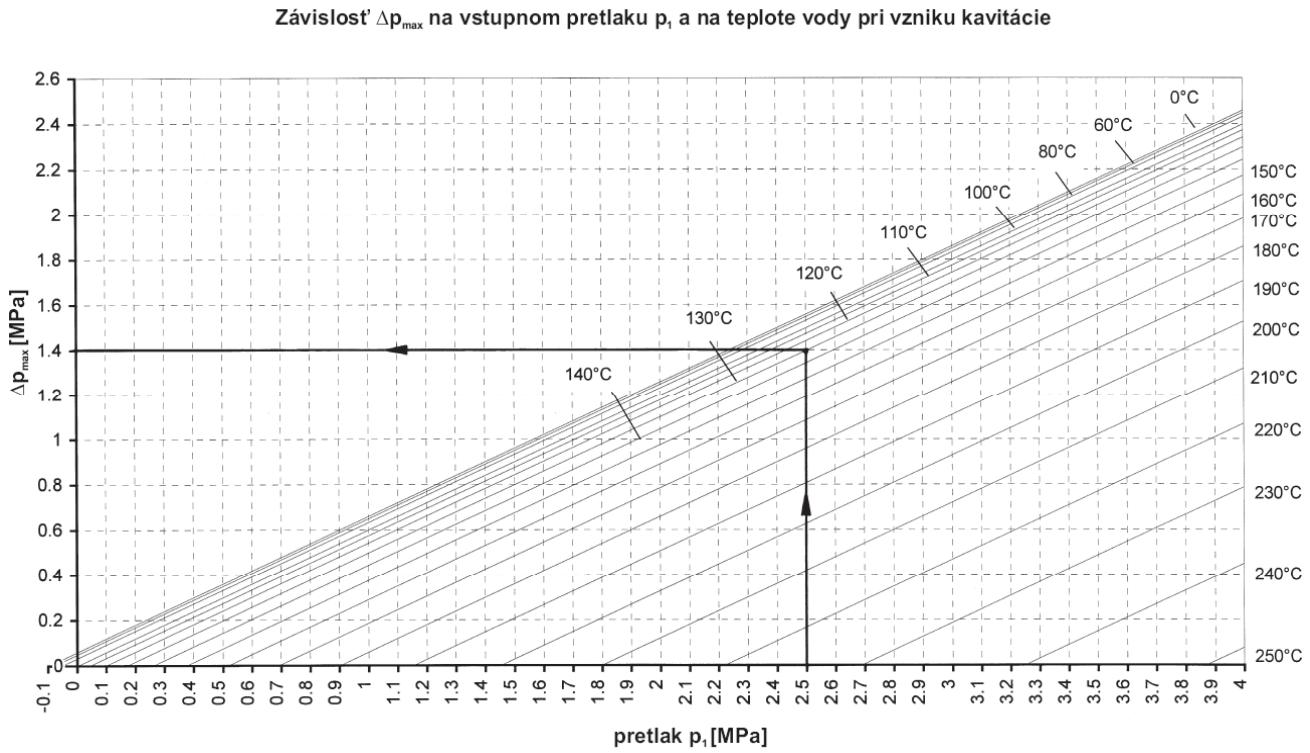


Kavitácia

5. podmienok vzniku kavitácie

1, Kvapalina musí byť na vstupe aj na výstupe.
2, Kvapalina na vstupe nemôže byť v rovnováhe (určite by došlo k jej odpareniu)
3, tlak pár pri danej teplote je pod Vena contracta
4, „recovery“ Naopak tlak za RV musí byť nad rovnovážnym tlak pár .
5, Kvapalina musí obsahovať tkz. nuclei – “host”
„nuclei free“ – proces bez kavitácie.

Armatúry. Najčastejšie problémy



Kavitácia

Eliminácia:

a, zmena parametrov systému.
b, vytvorením tela a kuželky z tvrdeného materiálu (v princípe žiadny materiál neodoláva kavitácii .. 9600 bar)
c, špeciálna konštrukcia kuželky

Armatúry. Najčastejšie problémy

Kavitácia

$$K_C = \frac{P_1 - P_2}{P_1 - P_V} = \frac{\Delta P}{P_1 - P_V}$$

Kavitačný index

where K_C = cavitation index
P_1 = valve inlet pressure
P_2 = valve outlet pressure
P_V = vapor pressure of liquid (at valve inlet and vena contracta)

K

sigma
(používa sa častejšie)

$$\sigma = \frac{P_2 - P_V}{P_1 - P_2}$$

Obe kavitačné indexy musia byť laboratórne namerané.

where σ = cavitation index
P_1 = upstream pressure (measured one pipe diameter upstream from the valve)
P_2 = downstream pressure (measured five pipe diameters downstream from the valve)
P_V = liquid vapor pressure (at flowing temperature)

Armatúry. Najčastejšie problémy

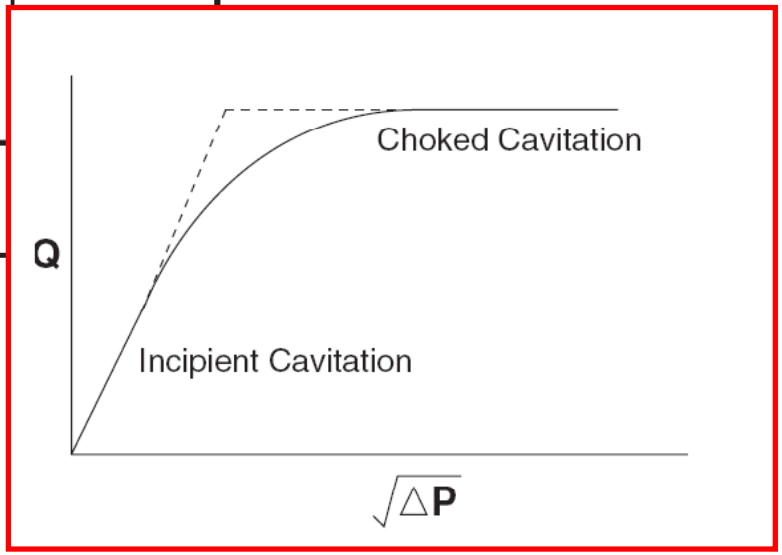
Valve Style	Flow Direction	Trim Size	Incipient σ	Choked σ
Globe	over the plug	full area	0.73	0.38
	over the plug	reduced	0.93	0.56
	under the plug	full/reduced	0.52	0.52
Butterfly	60° open	full	1.40	0.73
	90° open	full	3.16	2.19
Ball	60° open	full	1.40	
	90° open	full	5.20	
Globe with special trim	under the plug	full/reduced	0.30 to 0.001	

Kavitácia

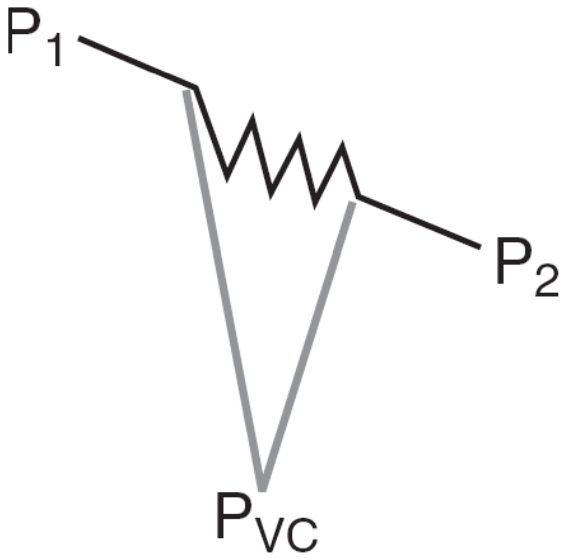
Kavitačný index - sigma

Sigma – používanejšia

Incipient – začiatok kavitácie
Choked – plne rozvinutá kavitácia.
Zaporná sigma – Flashing



Armatúry. Najčastejšie problémy

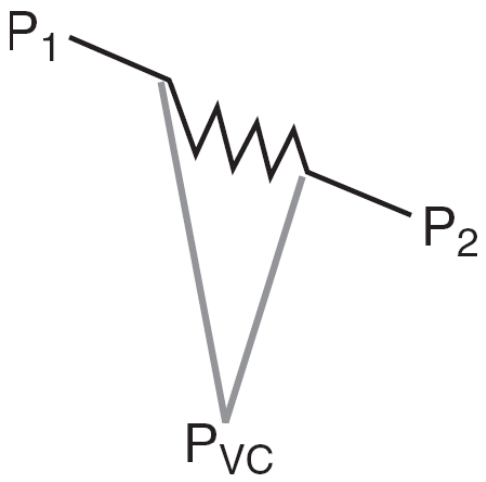


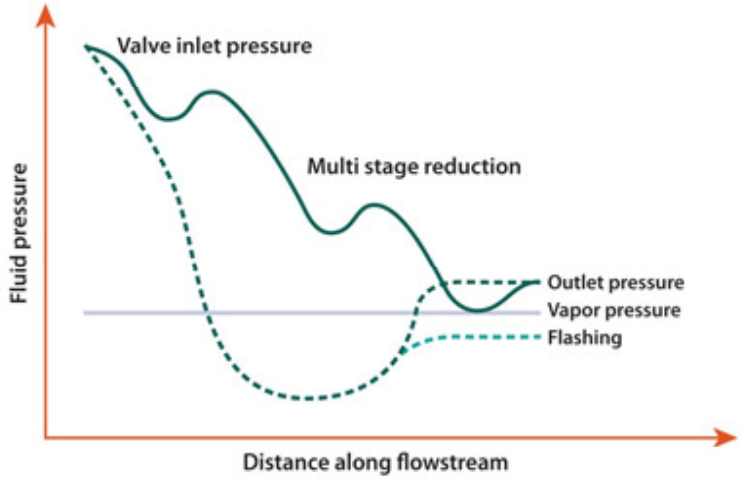
Kavitácia

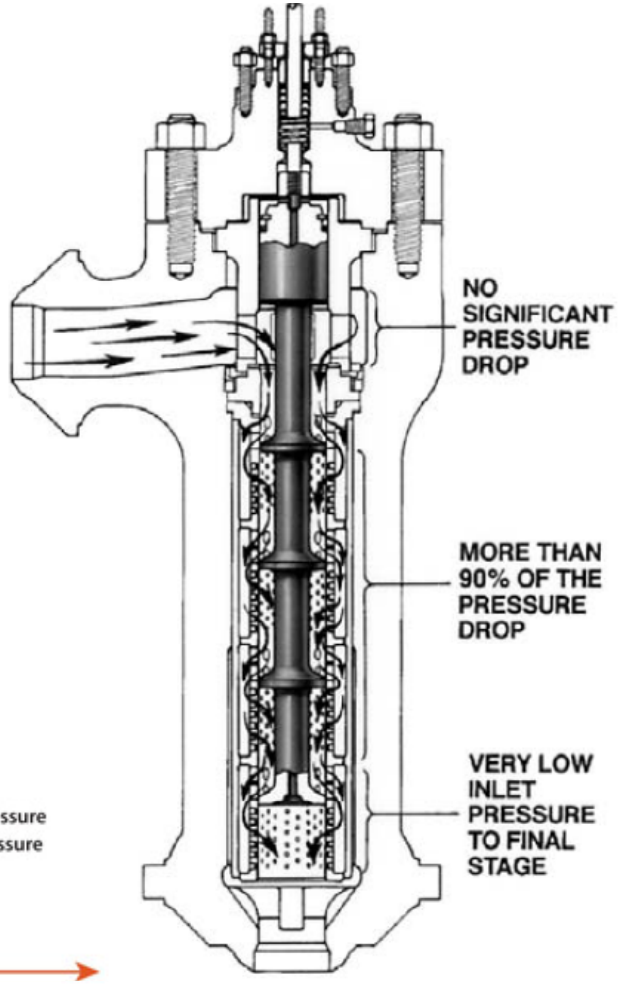
Postupné znižovanie vstupného tlaku ... tak aby sme sa nedostali pod vena contracta.

Zvyšovanie tlakovej straty na na výstupe.
„back-pressure device“
(hlavne guľové a kuželové kohúty)

Armatúry. Najčastejšie problémy





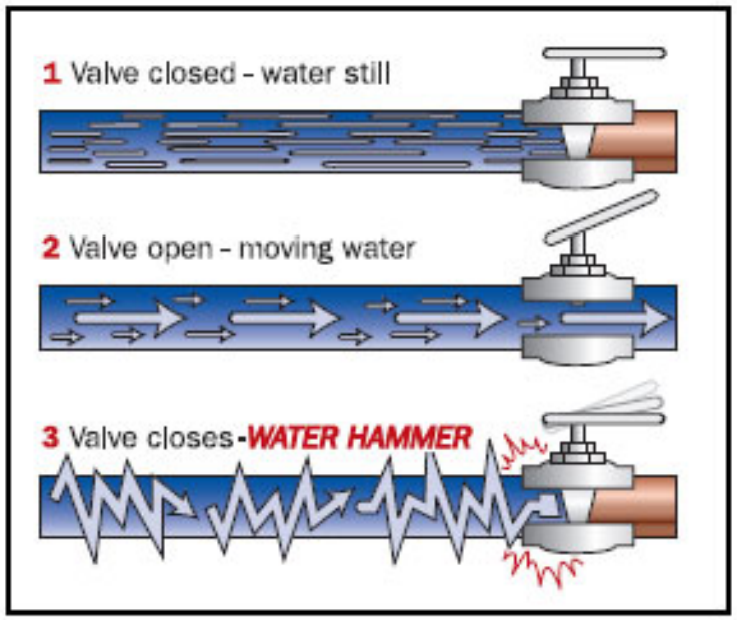


Kavitácia

Postupné znižovanie vstupného tlaku ... tak aby sme sa nedostali pod vena contracta.

Anticavitation trim. – špeciálna konštrukcia

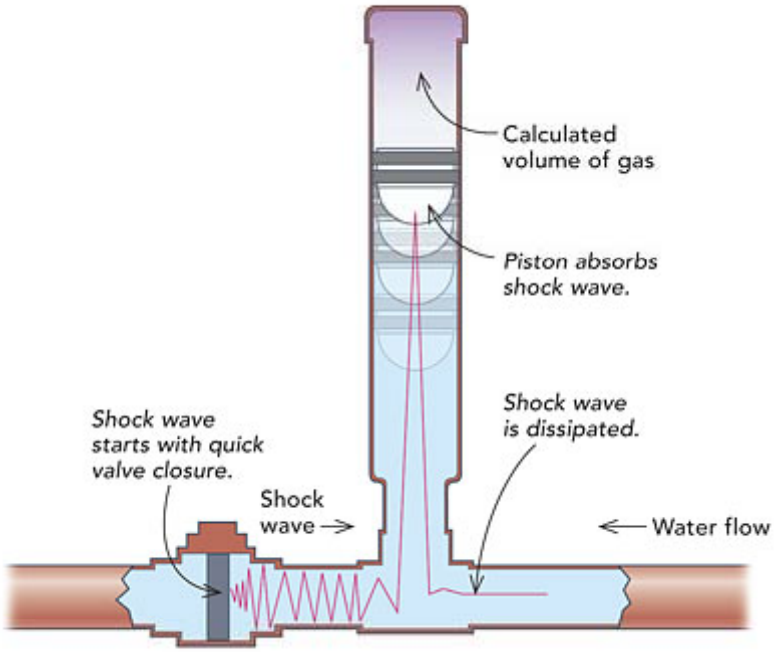
Armatúry. Najčastejšie problémy



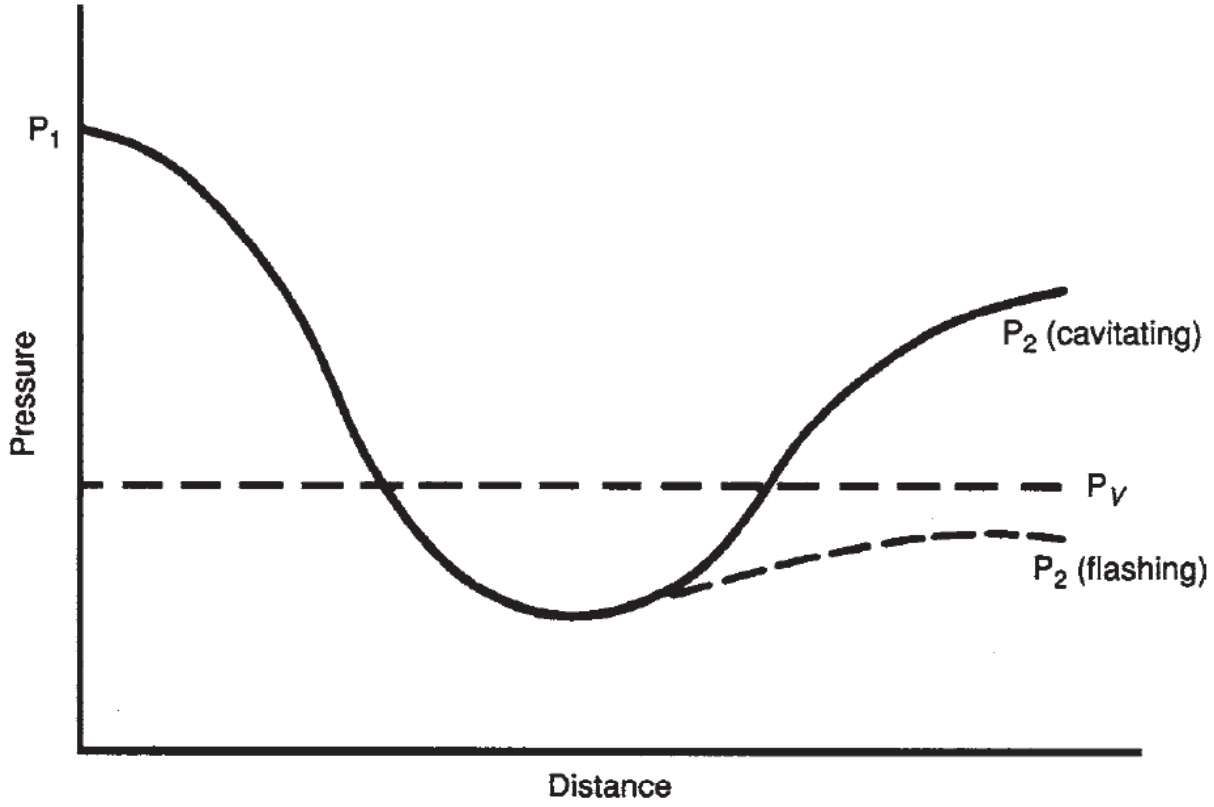
Water Hammer

-Náhle uzatvorenie
-Shock way ...

dummpers



Armatúry. Najčastejšie problémy

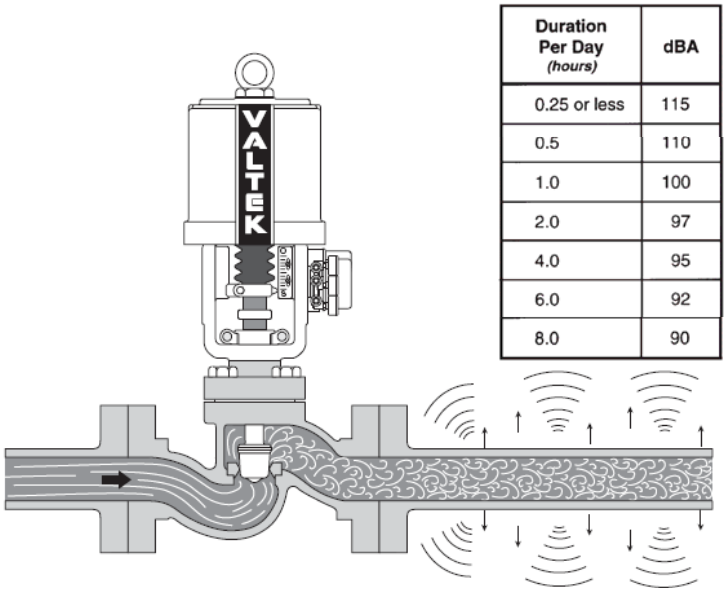


Flashing

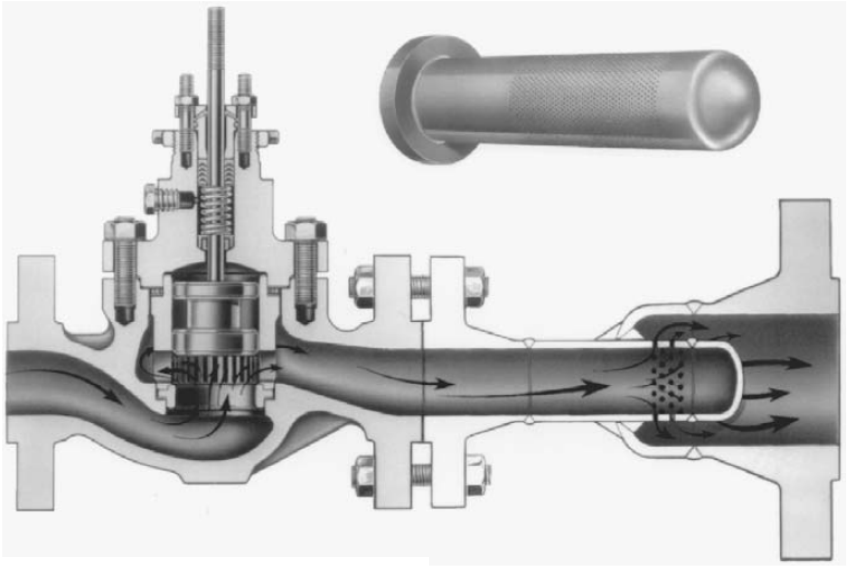
Výstup z ventilu je paro-kvapalná zmes.

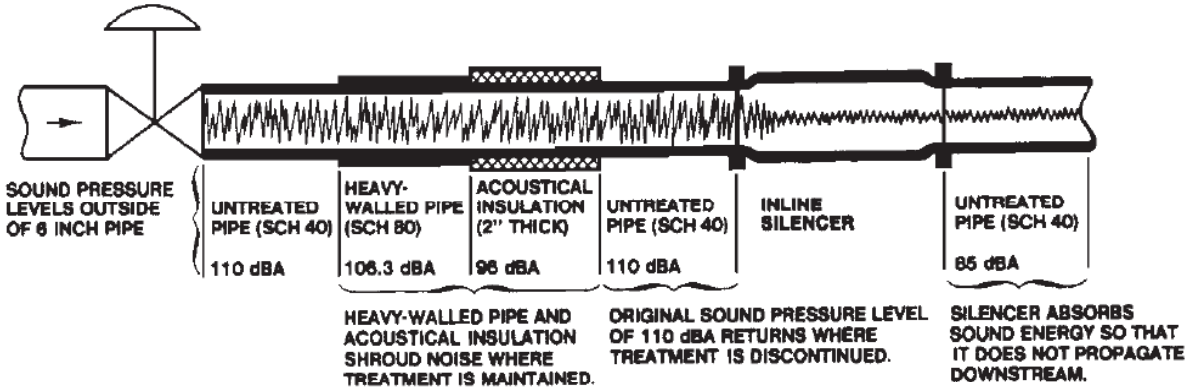
Eliminácia je komplikovaná. Zväčša si vyžaduje kompletne modifikovať systém.

Armatúry. Najčastejšie problémy



Duration Per Day (hours)	dBA
0.25 or less	115
0.5	110
1.0	100
2.0	97
4.0	95
6.0	92
8.0	90





Hluk
komplexný problém...

Predovšetkým funkcoiu
rýchlosti
Techické eliminácie hluku