

T 2559 EN

Type 2357-3 Pressure Build-up Regulator with safety function and integrated excess pressure valve

Self-operated Pressure Regulators for special applications



Application

Pressure regulators for cryogenic gases as well as other liquids, gases and vapors · Operating pressures up to **40 bar** · Set point ranges from **2 to 40 bar** · Temperatures from **-196 to +200 °C** · Oxygen clean according to international standards and guidelines

Industrial gases (such as argon, nitrogen and oxygen) are stored in a liquefied condition at extremely low temperatures and at a constant pressure in thermally insulated tanks. Pipes transport the medium to the consumer. The extreme operating conditions (pressures up to 40 bar and temperatures down to -196 °C) make it necessary to use special valves. The Type 2357-3 Pressure Regulator is especially designed for the conditions in cryogenic service.

Special features

- Low-maintenance proportional regulators requiring no auxiliary energy
- Wide set point range and convenient set point adjustment
- Rugged design and low overall height
- Cleaned and packed for oxygen service

Versions

The pressure regulator consists of a valve body with three ports (marked A, B and C), a spring-loaded operating bellows with set point adjuster and a tubular plug.

– Pressure build-up regulator with safety function

Operating direction from port A to port B (closing): the pressure at port B acts on the operating bellows. When the downstream pressure rises, the pressure build-up plug closes the valve.

Safety function: the tubular plug in the pressure build-up regulator operates like a safety valve and relieves the pressure chamber at port A of pressure when the pressure exceeds the set point by 5 bar. The difference in pressure at the bellows between the inside pressure at port C and outside pressure at port A creates a positioning force. This force opens the plug, opposing the force of the closing spring. As a result, the pressures are equalized and the pressure chamber upstream of port A is relieved of pressure.

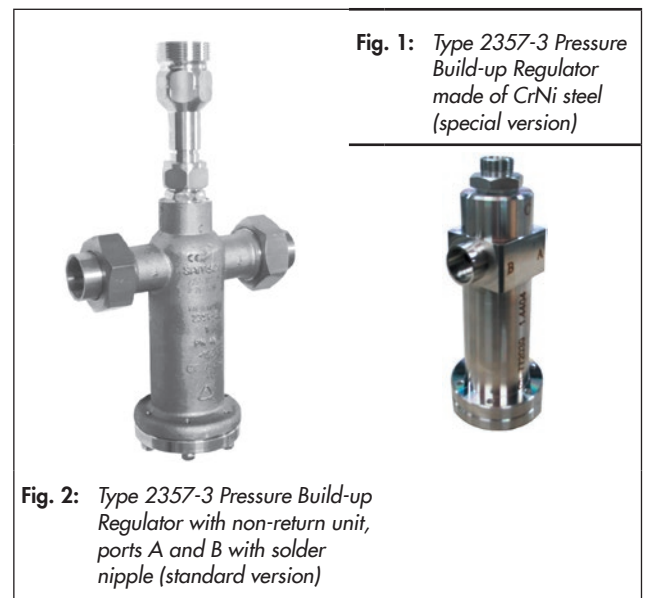


Fig. 1: Type 2357-3 Pressure Build-up Regulator made of CrNi steel (special version)

Fig. 2: Type 2357-3 Pressure Build-up Regulator with non-return unit, ports A and B with solder nipple (standard version)

- **Excess pressure valve · Direction of flow from B to C (opening):** when no pressure is applied, the passage from port B to C is closed. The tubular plug does not open the valve until the pressure becomes 0.5 bar higher than the set point (pressure build-up) to relieve the pressure chamber downstream of port B of pressure.

Port C can be optionally equipped with a non-return unit.

Accessories

- Ports A and B: solder nipple with ball-type bushing (for 28 mm pipe diameter)
- Port C: solder nipple with ball-type bushing (for 18 mm pipe diameter, without non-return unit)
- Non-return unit: solder nipple with ball-type bushing (for 28 mm pipe diameter) to mount on the non-return unit.

Further accessories in Data Sheet ► T 2570.

Special versions

- Version as pressure regulator (also for hydrogen)
- Version for flammable gases (e.g. LNG) on request
- All wetted parts are made of CrNi steel
- Regulator for use with process medium in the liquid phase

Principle of operation

The process medium flows from port A to port B in the Type 2357-3 Pressure Regulator used as a build-up pressure regulator with safety function.

The valve is open when no pressure is applied. The pressure downstream of the valve is transmitted to the operating diaphragm (3). The positioning force produced by this pressure moves the pressure build-up plug (2.1), which is firmly attached to the plug sleeve, depending on the spring force adjustable at the set point adjuster (10). The valve closes as soon as the pressure downstream of the valve has assumed the adjusted set point.

Functioning as a pressure build-up regulator, the regulator also operates as a safety valve for the pressure chamber upstream of port A. When the pressure rises above the set point by approx. 5 bar, the positioning force overcomes the force of the closing spring (16), causing the pressure build-up plug (2.1) to open and the pressure is relieved to ports B and C.

Functioning as an excess pressure valve, the medium flows from port B to C. The tubular plug seals off the operating bellows when there is no pressure drop across port B and C. The pressure at port B acts on the operating bellows (3). The positioning force produced by this pressure opposes the adjustable spring force of the set point spring (8) and opens the tubular plug (2.2) when the pressure rises above the set point by approx. 0.5 bar. The pressures are equalized and the medium escapes through the inside of the tubular plug over port C.

As an excess pressure valve, the regulator can be optionally equipped with a non-return unit (12). It prevents the medium from flowing back to port C and allows maintenance work to be performed on the regulator without having to empty the tank first.

Installation

Port C pointing upward

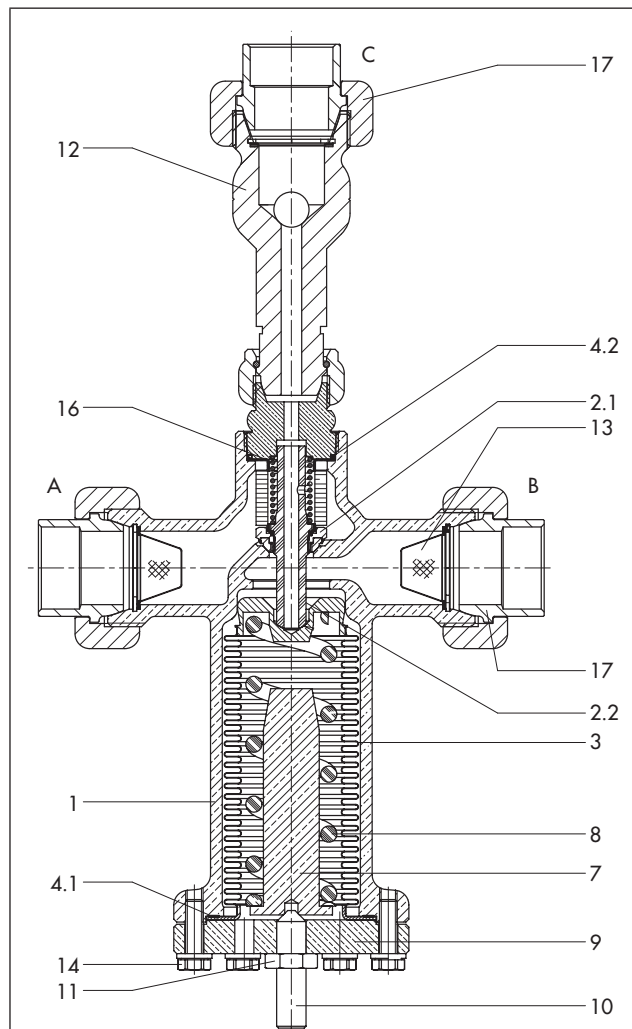
Used as

- **Pressure build-up regulator** with safety function
Direction of flow from port A to port B
- **Excess pressure valve**
Direction of flow from port B to port C

Further information is available in ► EB 2559.

EC type examination

An EC type examination according to the Pressure Equipment Directive 97/23/EC, Module B has been performed on the regulators.



1	Valve body
2.1	Pressure build-up plug
2.2	Tubular plug
3	Operating bellows
4.1	Seal (body cover)
4.2	Seal (top section of body)
7	Spring plate
8	Set point spring
9	Body cover
10	Set point adjuster (hex socket, SW 5)
11	Lock nut (SW 17)
12	Non-return unit (accessories)
13	Filter
14	Body screws
16	Closing spring
17	Solder nipple with ball-type bushing (accessories)

Fig. 3: Type 2357-3 Pressure Build-up Regulator with safety function and integrated excess pressure valve

Serial number

The devices are marked with a serial number on the nameplate. Details on the nameplate are available in ► EB 2559.

Installation example

Pressure regulator functioning as a pressure build-up regulator with safety function

When tapping the liquefied cryogenic gas, the gas pressure in the insulated tank causes the medium to be transferred to the vaporizer (8). The gas pressure drops below the adjusted operating pressure. The Type 2357-3 Pressure Build-up Regulator opens and allows the liquefied gas to flow into the pressure build-up vaporizer (7). The gas pressure increases and reaches the operating pressure again. The pressure build-up regulator closes.

After closing the shut-off valve (6.1), the liquid remaining in the pipeline between shut-off valve and regulator (2) vaporizes, causing the pressure to increase. The plug of the pressure regulator acts as safety valve by opening the valve (upstream pressure at port A) to B and C when the set point is exceeded by approx. 5 bar to equalize the pressures and relieve the pressure chamber. The corresponding applies to the special version.

To discharge small quantities of gas, the Type 2357-2 Excess Pressure Valve (11) can be used with special accessories. The safety valve does not react when just the gas volume must be discharged due to heat leak.

Pressure regulator

The process medium flows from port A to port B in the version as pressure reducing valve (globe valve). The forces at the operating bellows (3) affect the position of the special plug in the same manner as described for the pressure build-up function.

Pressure regulator functioning as an excess pressure valve

The Type 2357-3 Regulator (2) functions as an excess pressure valve when the process medium flows from port B to C. The valve opens when the operating pressure is approx. 0.5 bar higher than the set point adjusted. The process medium is drained over port C into the consumer pipeline back to the plant.

The process medium flows from port B to port C in the version as excess pressure valve (angle valve). The port A of the standard valve made of brass is sealed by an accessory part. A special valve body without port A is used for the stainless steel version. The forces at the operating bellows (3) affect the function in the same manner as described for the pressure relief function.

The version for flammable gases has a leakage line connection instead of the venting bore in the body cover (9).

The version for liquid hydrogen is usually installed at ambient temperature (outside the vacuum-insulated storage tank). As a result, the regulator can be easily operated. The design and material used ensures that the regulator functions even at extreme medium temperatures.

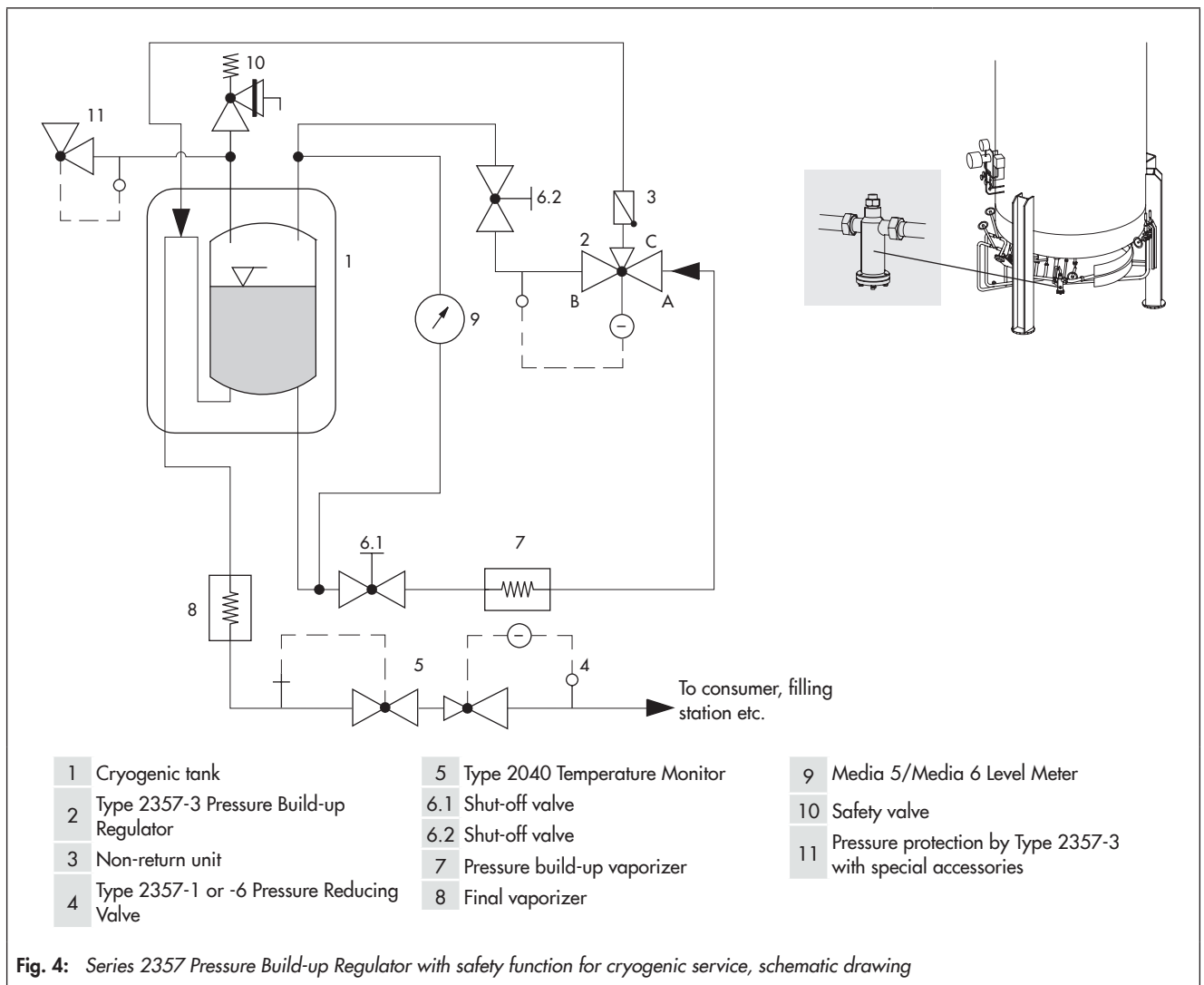


Table 1: Technical data · All pressures in bar (gauge)

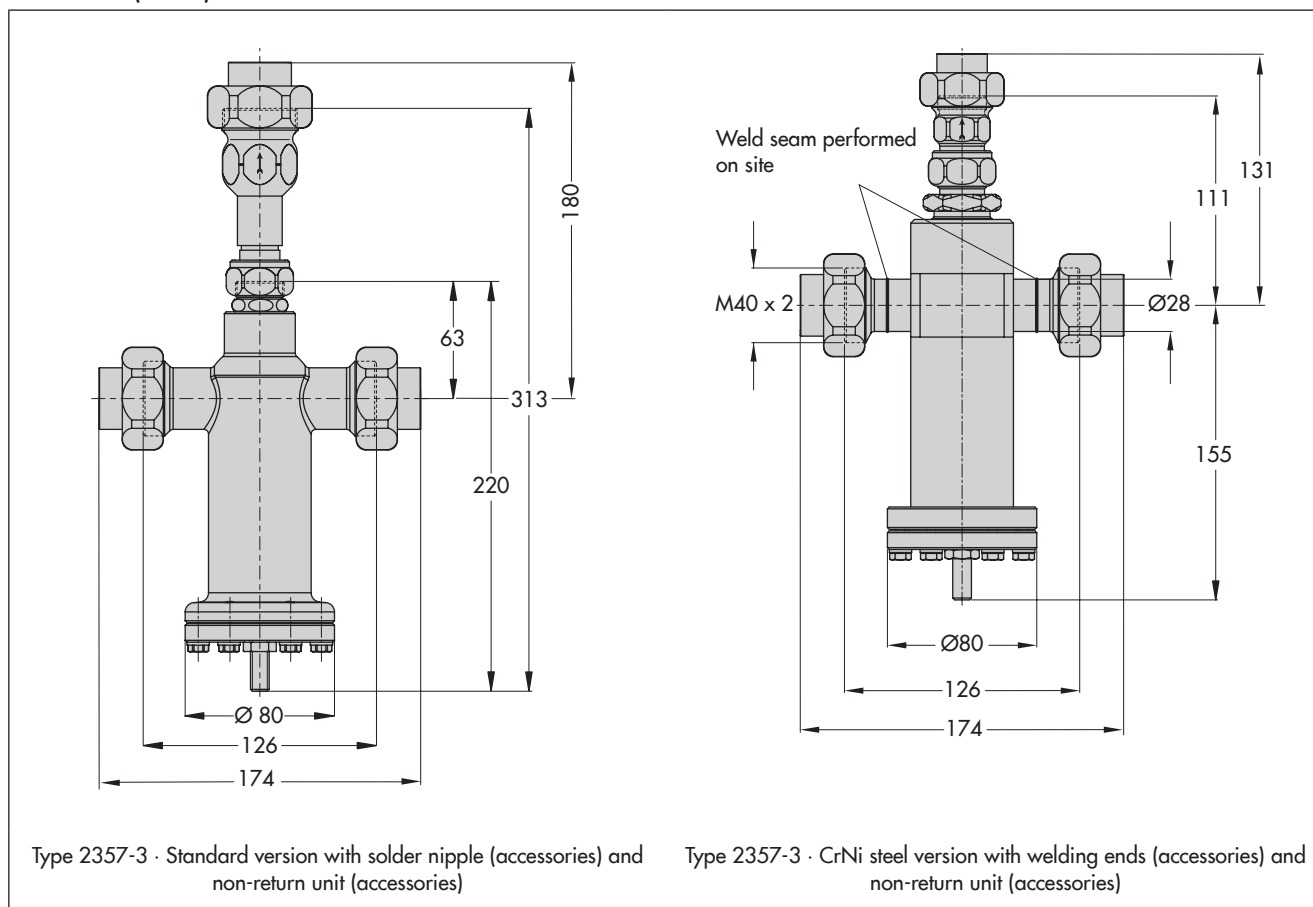
Type	2357-3	2357-3
	– Process medium in the gas phase –	– Special version in the liquid phase –
Pressure rating	PN 40	
K _{VS} coefficient	3.2	
Set point range	2 to 10 bar · 8 to 26 bar · 25 to 40 bar	
Fail-safe action	5 bar above the set point	12 bar above the set point
Pressure relief function	0.5 bar above the set point	
Temperature range	(-254 °C) ¹⁾ -196 to +200 °C	
Weight, approx.	3.5 kg	
Conformity	CE · EAC	

¹⁾ Version for liquid hydrogen

Table 2: Materials · Material numbers according to DIN EN

Type	2357-3		
Body	CC754S-GM (brass)	1.4404	
Tubular plug	1.4301	1.4301	
Plug	1.4301 · PTFE soft seal		
Bellows	1.4571		
Set point springs	Stainless steel 1.4310		
Body gasket	PTFE		
Connections	A, B	M40x2	Welding ends 26.9 x 2
	C	M26x1.5 male thread	
	Non-return unit	M40x2	M26x1.5

Dimensions (in mm)



Flow capacity of the regulator dependent on the liquid column and the adjusted pressure level in the cryogenic tank

The flow capacity is indicated separately in value tables and mass flow diagrams for the media nitrogen (N₂), oxygen (O₂), argon (Ar), carbon dioxide (CO₂) and natural gas (LNG).

The specifications apply to the **Type 2357-3** Pressure Build-up Regulator installed in the gas phase of the pressure build-up control loop; as shown in Fig. 4 (sample application).

The maximum flow capacity [kg/h] of the regulator arises from the adjusted pressure level (set point p_g) and the liquid level [m] of the medium in the tank and can be determined for every state from the graph.

The data in the graph are based on theoretical calculations which do not take factors, such as pressure losses in the pipeline, into account. Therefore, the real flow capacity may deviate from the calculated value.

Table 3: Mass flow of nitrogen (N₂) dependent on the liquid column and adjusted pressure level (set point p_g) in the cryogenic tank

Set point p _g	bar	2	4	6	8	10	12	15	20	25	30	35	40
	psi	29	58	87	116	145	174	217.6	290.1	362.6	435.1	507.6	580.2
	kg/cm ²	2	4.1	6.1	8.2	10.2	12.2	15.3	20.4	25.5	30.6	35.7	40.8
Filling level [m]	Mass flow rate [kg/h]												
1	125	159	188	214	238	260	293	348	408	487	656	736	
3	190	243	287	326	362	398	448	532	625	747	1010	1125	
5	239	305	361	410	456	499	564	670	786	942	1276	1411	
7	280	356	421	479	533	583	659	784	921	1102	1501	1650	
9	315	402	475	541	601	658	744	885	1041	1248	1699	1860	
11	349	443	524	594	660	726	820	976	1148	1381	1880	2049	
14	393	499	588	670	745	818	921	1100	1296	1567	2125	2307	
17	435	551	648	738	820	898	1015	1208	1426	1739	2349	2535	
20	473	597	702	799	891	976	1103	1314	1552	1903	2560	2750	

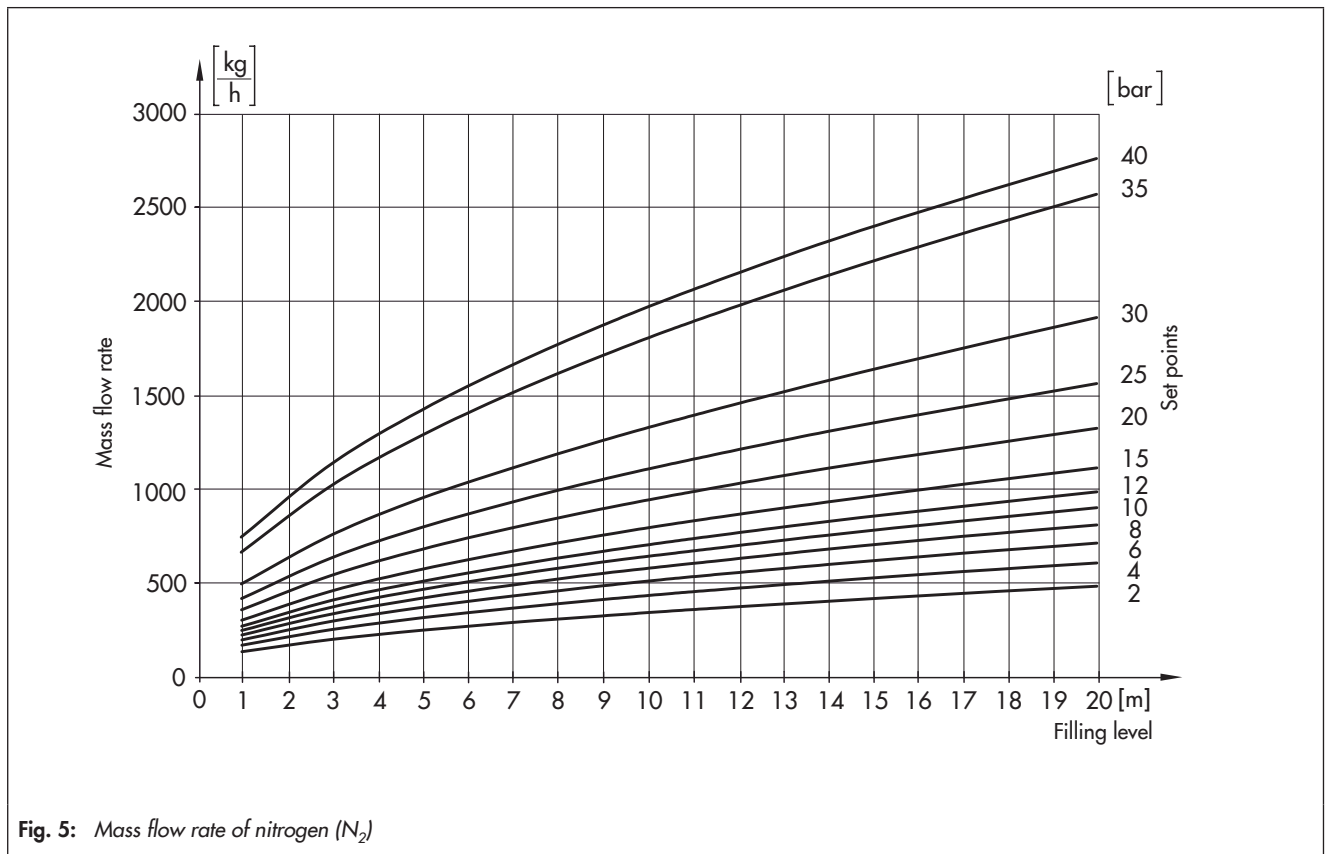


Fig. 5: Mass flow rate of nitrogen (N₂)

Table 4: Mass flow of oxygen (O₂) dependent on the liquid column and adjusted pressure level (set point p_g) in the cryogenic tank

Set point p _g	bar	2	4	6	8	10	12	15	20	25	30	35	40
	psi	29	58	87	116	145	174	217.6	290.1	362.6	435.1	507.6	580.2
	kg/cm ²	2	4.1	6.1	8.2	10.2	12.2	15.3	20.4	25.5	30.6	35.7	40.8

Filling level [m]	Mass flow rate [kg/h]												
1	145	185	217	245	270	295	328	382	433	485	541	603	
3	222	282	331	374	414	451	503	585	663	743	829	921	
5	279	354	416	471	520	567	632	735	833	933	1039	1159	
7	328	415	486	550	607	661	739	857	975	1093	1215	1356	
9	371	467	549	619	685	746	831	967	1101	1233	1371	1533	
11	410	517	604	684	755	823	917	1067	1209	1355	1514	1693	
14	465	583	682	769	850	924	1033	1202	1363	1529	1709	1912	
17	515	643	751	849	937	1020	1135	1321	1504	1686	1885	2105	
20	562	699	815	920	1016	1108	1234	1435	1633	1833	2044	2294	

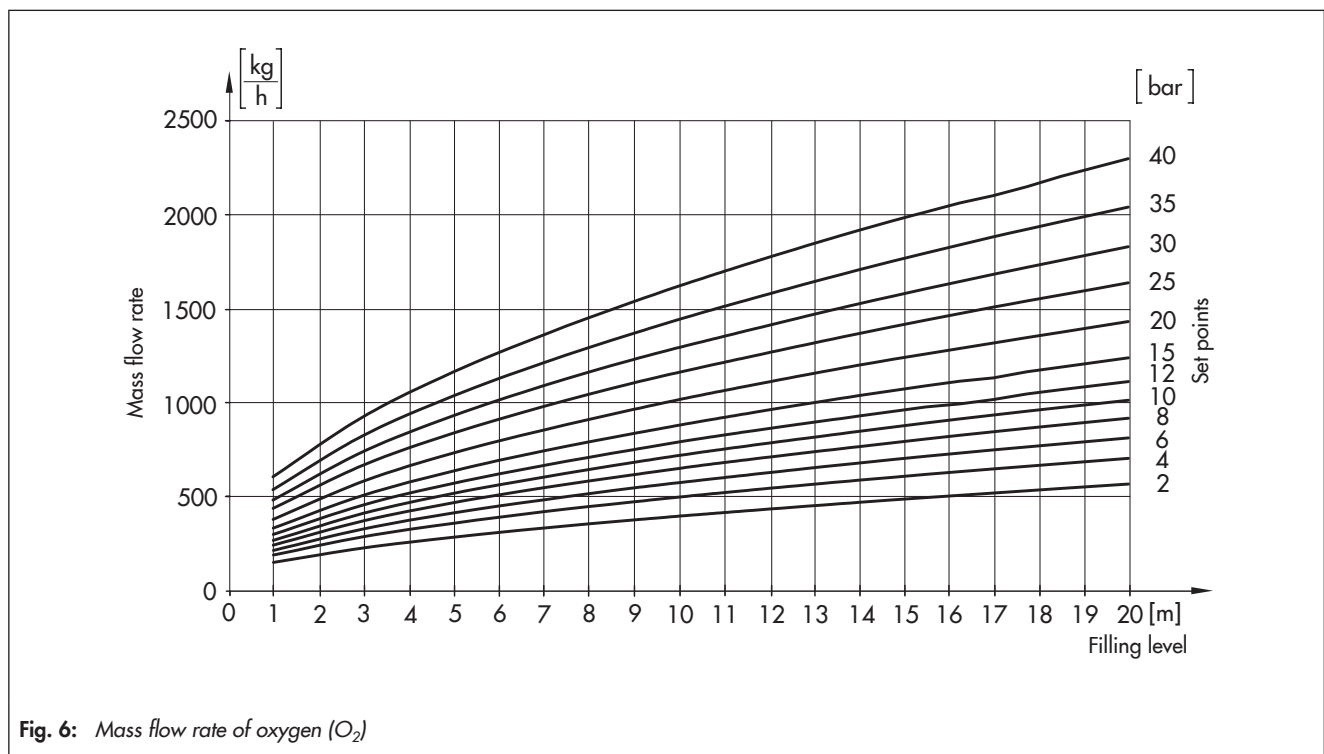


Fig. 6: Mass flow rate of oxygen (O₂)

Table 5: Mass flow of argon (Ar) dependent on the liquid column and adjusted pressure level (set point p_g) in the cryogenic tank

Set point p_g	bar	2	4	6	8	10	12	15	20	25	30	35	40
	psi	29	58	87	116	145	174	217.6	290.1	362.6	435.1	507.6	580.2
	kg/cm ²	2	4.1	6.1	8.2	10.2	12.2	15.3	20.4	25.5	30.6	35.7	40.8

Filling level [m]	Mass flow rate [kg/h]												
	1	183	232	272	308	340	371	413	480	546	613	683	765
3	283	356	418	472	522	568	633	736	836	939	1049	1176	
5	358	450	527	594	657	714	796	927	1051	1179	1320	1478	
7	422	530	618	696	770	837	934	1084	1233	1384	1544	1735	
9	480	599	700	788	869	945	1053	1224	1394	1564	1748	1963	
11	534	664	774	870	959	1046	1163	1353	1536	1724	1931	2173	
14	611	754	876	985	1086	1179	1315	1525	1734	1949	2184	2463	
17	683	838	972	1090	1199	1305	1452	1684	1917	2154	2416	2724	
20	753	919	1061	1190	1308	1419	1580	1836	2082	2346	2628	2977	

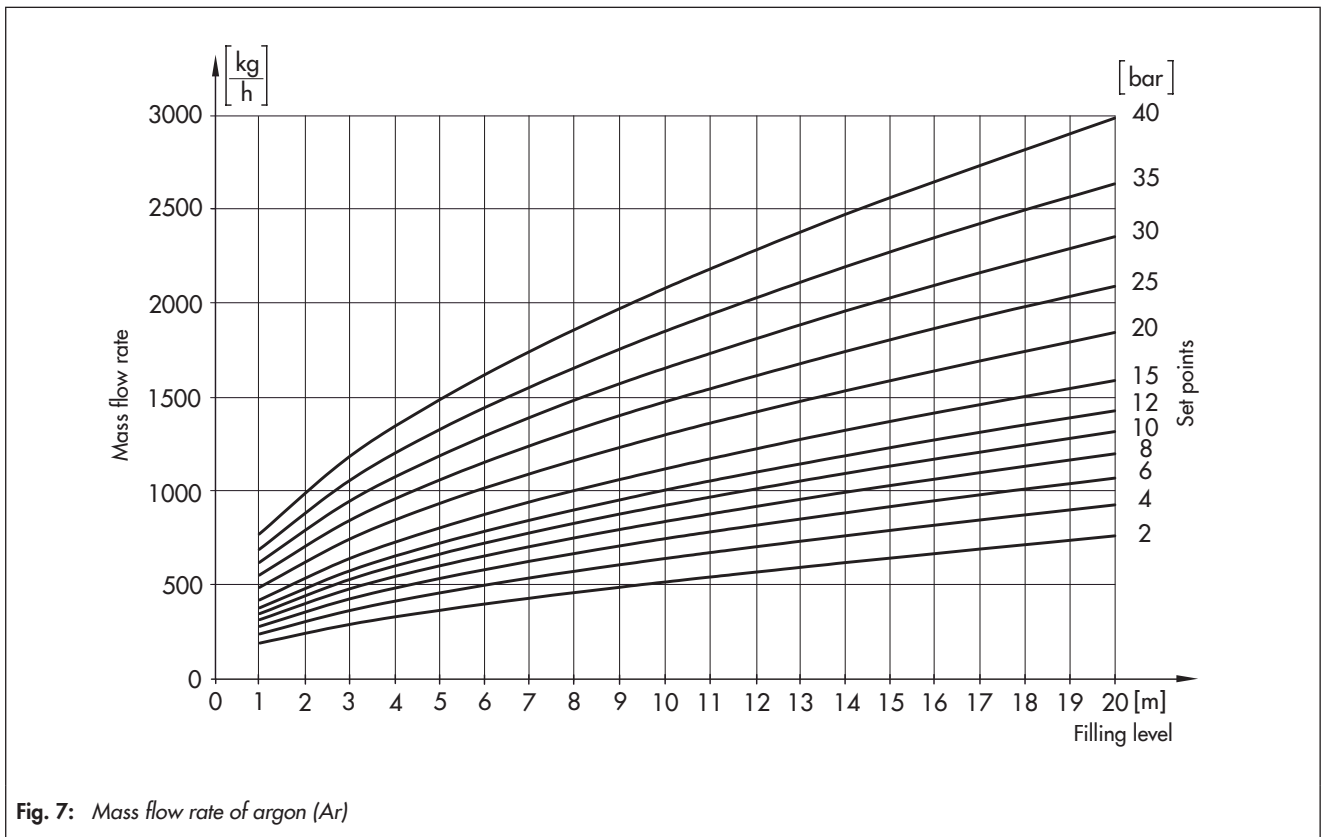


Fig. 7: Mass flow rate of argon (Ar)

Table 6: Mass flow of carbon dioxide (CO₂) dependent on the liquid column and adjusted pressure level (set point pg) in the cryogenic tank

Set point p _g	bar	2	4	6	8	10	12	15	20	25	30	35	40
	psi	29	58	87	116	145	174	217.6	290.1	362.6	435.1	507.6	580.2
	kg/cm ²	2	4.1	6.1	8.2	10.2	12.2	15.3	20.4	25.5	30.6	35.7	40.8

Filling level [m]	Mass flow rate [kg/h]												
1	-	-	180	204	224	244	272	313	352	390	426	463	
3	-	-	276	311	344	374	416	480	540	596	653	709	
5	-	-	345	390	431	469	521	601	676	748	819	890	
7	-	-	404	456	504	547	608	702	790	874	956	1040	
9	-	-	455	514	567	617	685	792	890	985	1078	1171	
11	-	-	501	566	625	679	754	870	979	1083	1187	1290	
14	-	-	564	637	702	764	849	979	1102	1219	1336	1452	
17	-	-	621	700	772	840	932	1076	1210	1342	1468	1595	
20	-	-	674	759	837	910	1012	1167	1313	1452	1593	1731	

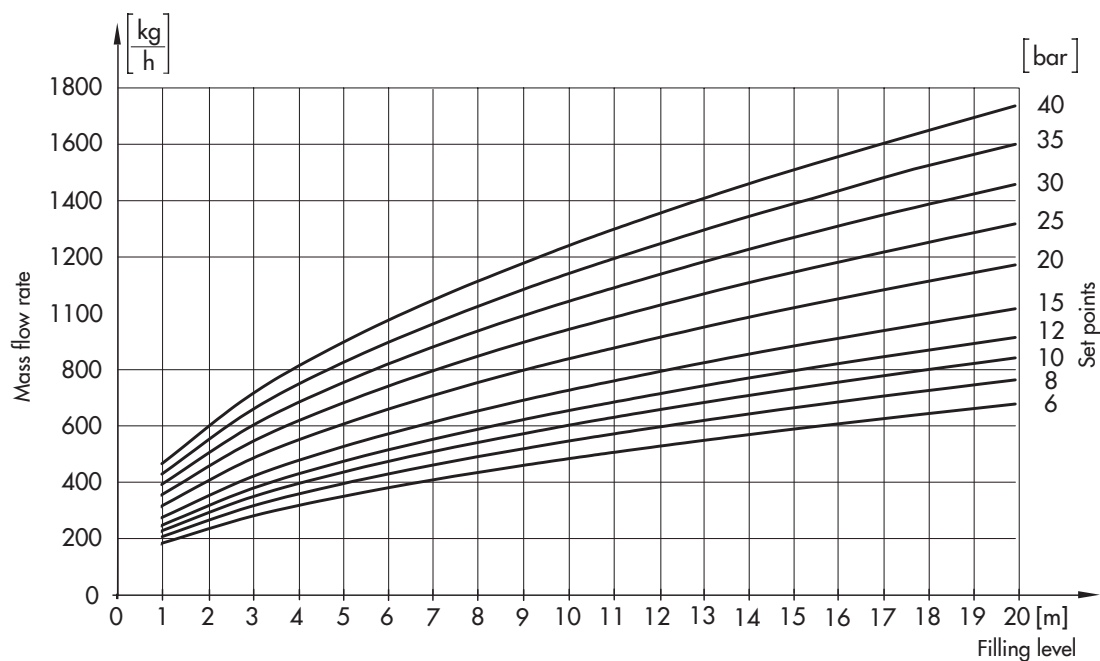


Fig. 8: Mass flow rate of carbon dioxide (CO₂)

Table 7: Mass flow of natural gas (LNG) dependent on the liquid column and adjusted pressure level (set point p_g) in the cryogenic tank

Set point p_g	bar	2	4	6	8	10	12	15	20	25	30	35	40
	psi	29	58	87	116	145	174	217.6	290.1	362.6	435.1	507.6	580.2
	kg/cm ²	2	4.1	6.1	8.2	10.2	12.2	15.3	20.4	25.5	30.6	35.7	40.8

Filling level [m]	Mass flow rate [kg/h]												
1	56	71	84	95	105	114	128	149	170	191	215	244	
3	86	109	128	145	161	175	196	228	260	293	329	373	
5	108	137	161	182	202	220	245	286	326	368	413	469	
7	126	160	188	213	235	257	287	335	381	430	483	549	
9	142	180	212	240	265	289	323	377	430	484	545	618	
11	157	199	230	264	292	318	356	415	473	533	599	682	
14	177	223	262	297	328	358	400	466	531	599	675	767	
17	194	246	289	326	361	393	439	513	585	659	742	845	
20	211	267	313	353	391	426	476	555	633	714	805	917	

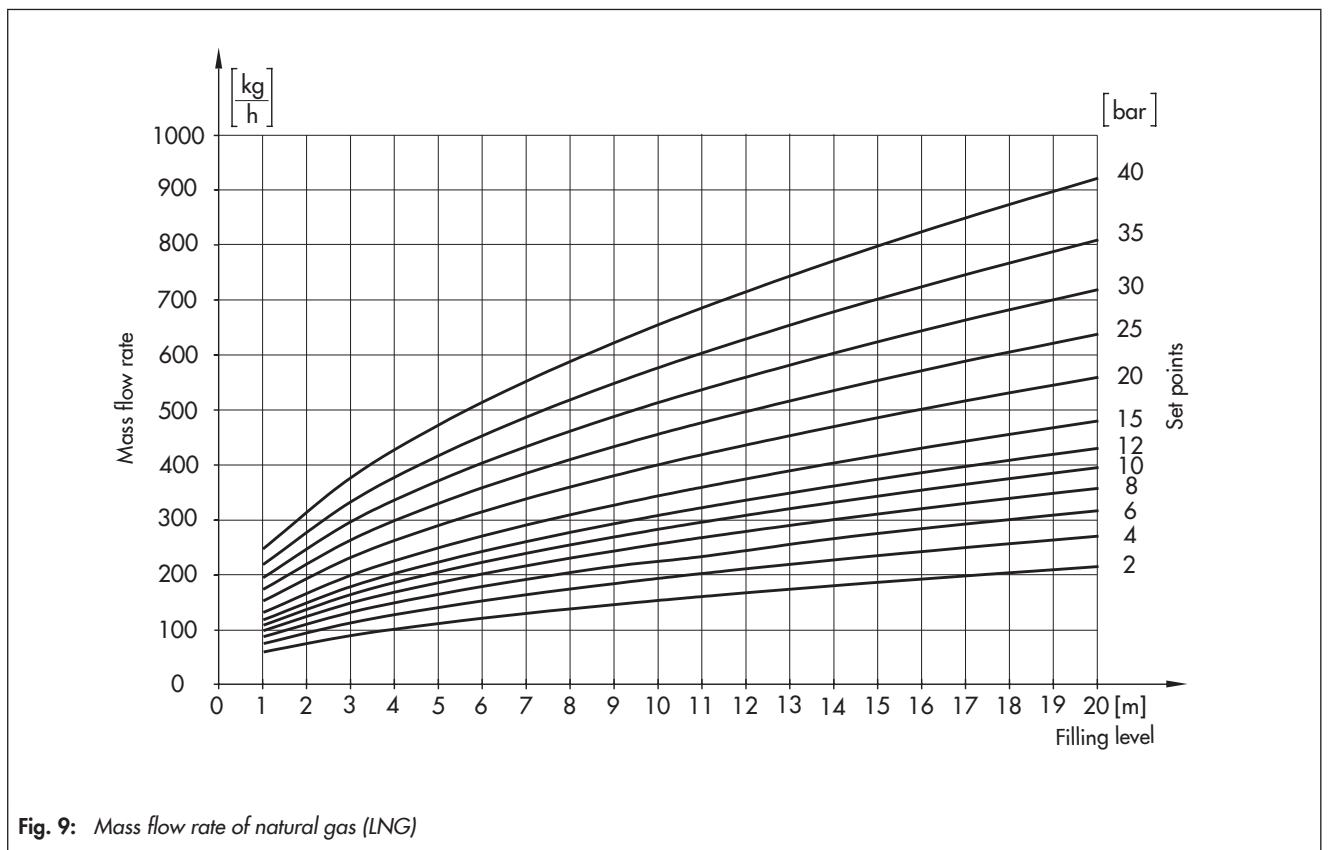


Fig. 9: Mass flow rate of natural gas (LNG)

Table 8: Mass flow of various media dependent on the adjusted pressure level in the cryogenic tank

Pressure in bar	Process medium				
	N ₂	O ₂	AR	CO ₂	LNG
5	87	84	96	68	54
10	119	112	128	90	74
15	147	137	155	110	90
20	174	159	180	128	103
25	199	179	205	146	115
30	218	201	226	158	130
35	243	220	250	172	147
40	270	240	280	190	168

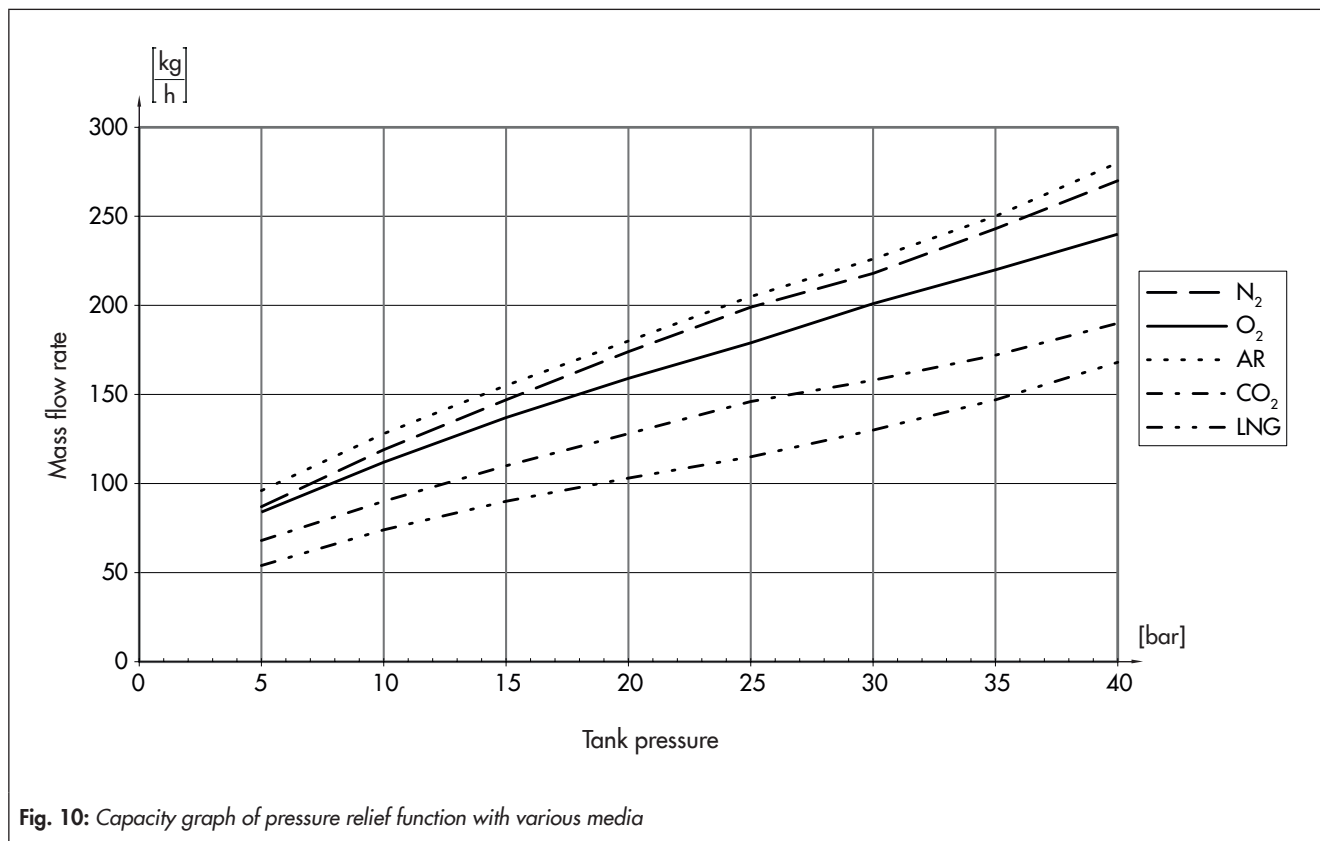


Fig. 10: Capacity graph of pressure relief function with various media

Ordering text

Type 2357-3 Pressure Build-up Regulator

Set point range ... bar

Optionally, accessories ...

Optionally, special version ...