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PILOT-OPERATED PRESSURE REGULATOR RTG 410

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Introduction

RTG 410 regulators are of indirect action type and are used for reducing and regulating the pressure of non-corrosive gases (natural gases, LPG, etc.). The regulators ensure constant maintenance of outlet pressure within the limits of the regulation class, irrespective of the fluctuations of inlet pressure and flow rate. The regulators are designed for industrial use, in natural gas transportation and distribution networks. The regulators can be used in all installations with rapid variations of flow. The excellent performance of the pilot system ensures precise regulation of pressure and rapid reaction of regulator. The body design allows the installation of a control mechanism of SB 75 type at the lower part of the regulator. RTG 410 regulator family comprises the following models: RTG 411, RTG 412 and RTG 413.

Advantages of RTG 410 pressure regulators

RTG 410 regulators of indirect action type offer a series of advantages such as:

- fast response of regulator to variations in flow rate;
- precise, exact and constant operation even if the inlet pressure fluctuates greatly;
- easy regulation of outlet pressure value;
- easy change of the setting range, if desired;
- high flow rate due to the body special design (high flow coefficient);
- excellent reliability due to high quality materials, precise machining and rigorous control;
- reduced overall dimensions compared to similar products;
- wide range of dimensions intended to provide optimal solution to any problem mentioned;
- easy maintenance, without dismantling the regulator from the installation;
- low noise level during operation even at high flow rates;
- optionally, the regulator can be equipped with an incorporated shut-off valve.

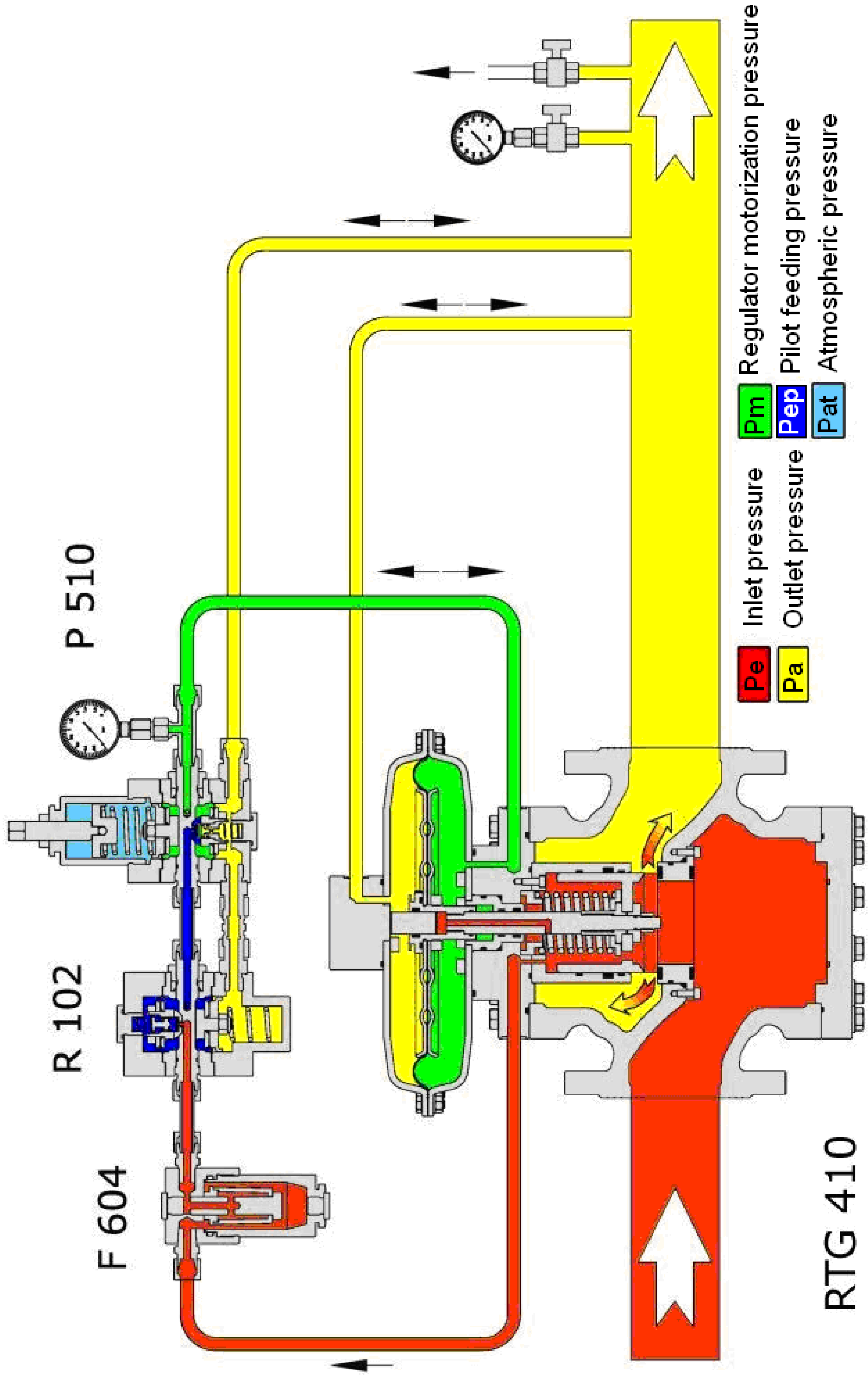

Figure 1 - RTG 410 operating diagram

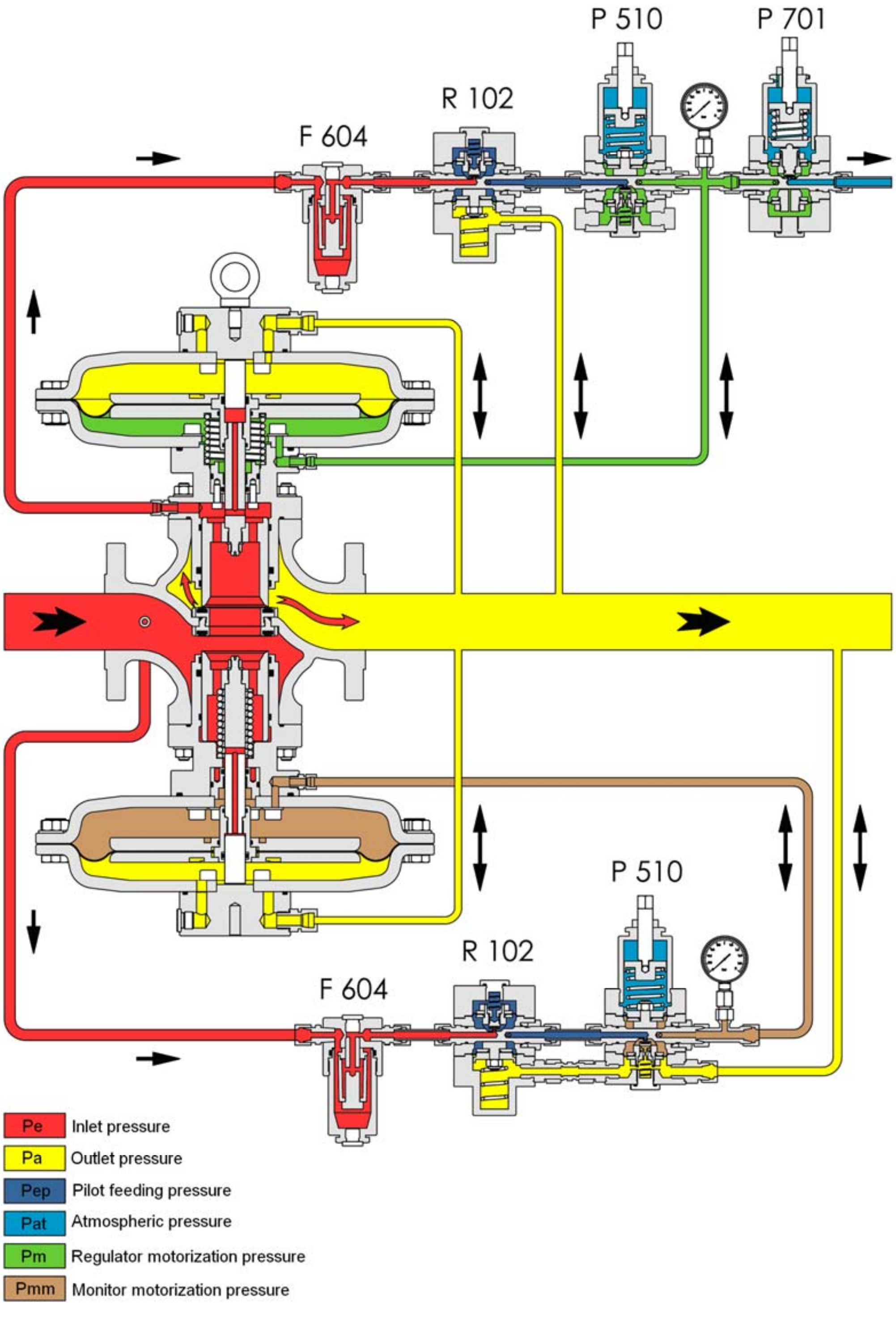

Figure 2 – Monitor operating diagram

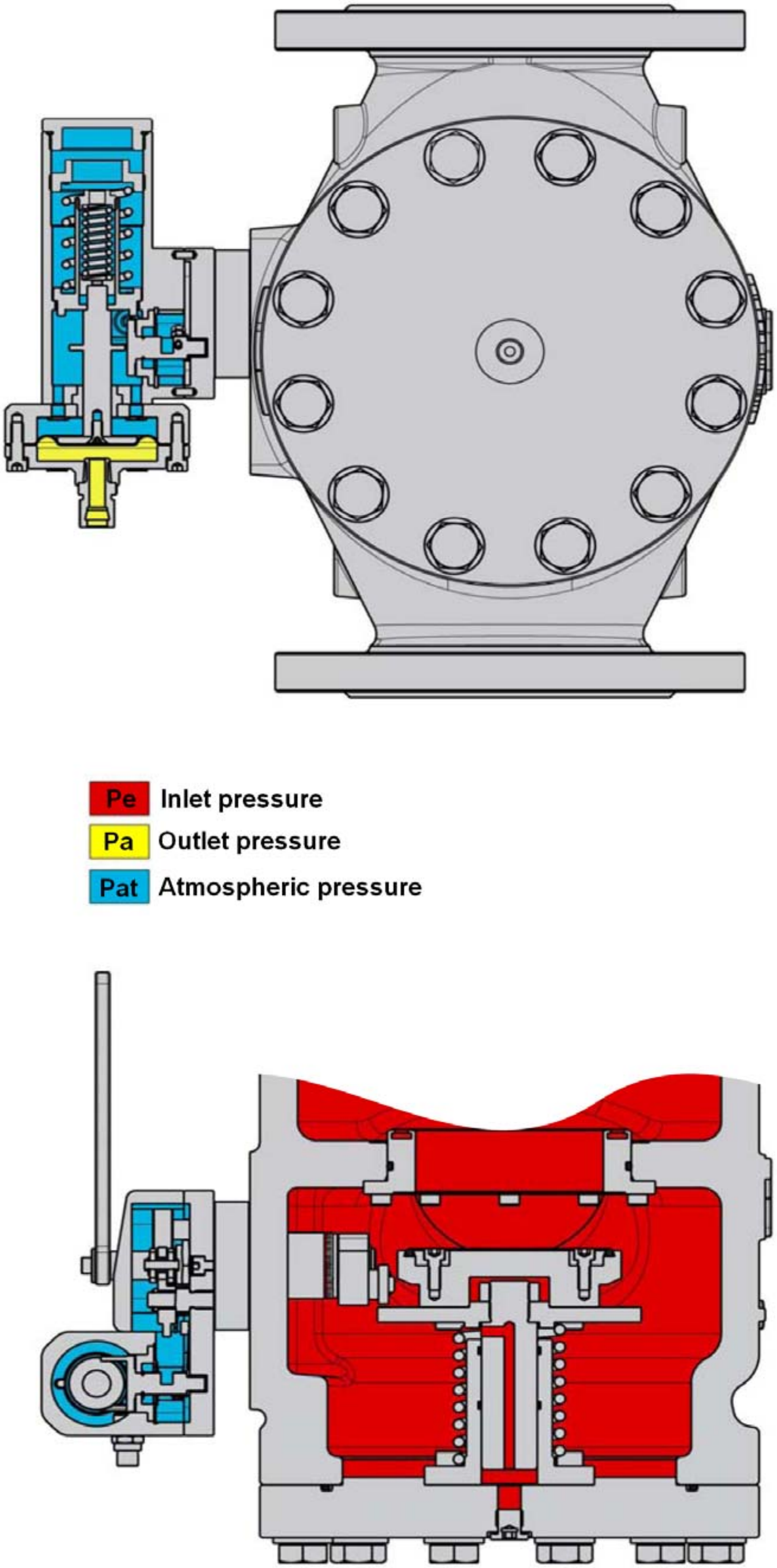

Figure 3 – Operating diagram of SB 750 shut-off valve

Pressure regulator operation

RTG 410 regulators (Figure 1 and Figure 4) comprise the control mechanism – F 604 filter (1), R 106 (2) or R 102 preregulator, P 510 Pilot (3) and the operating equipment – regulator (4), and optionally an incorporated shut-off valve with SB 75 control mechanism (5).

RTG 410 regulators can be equipped optionally with a WE 860 electric gas heater for the pilot system.

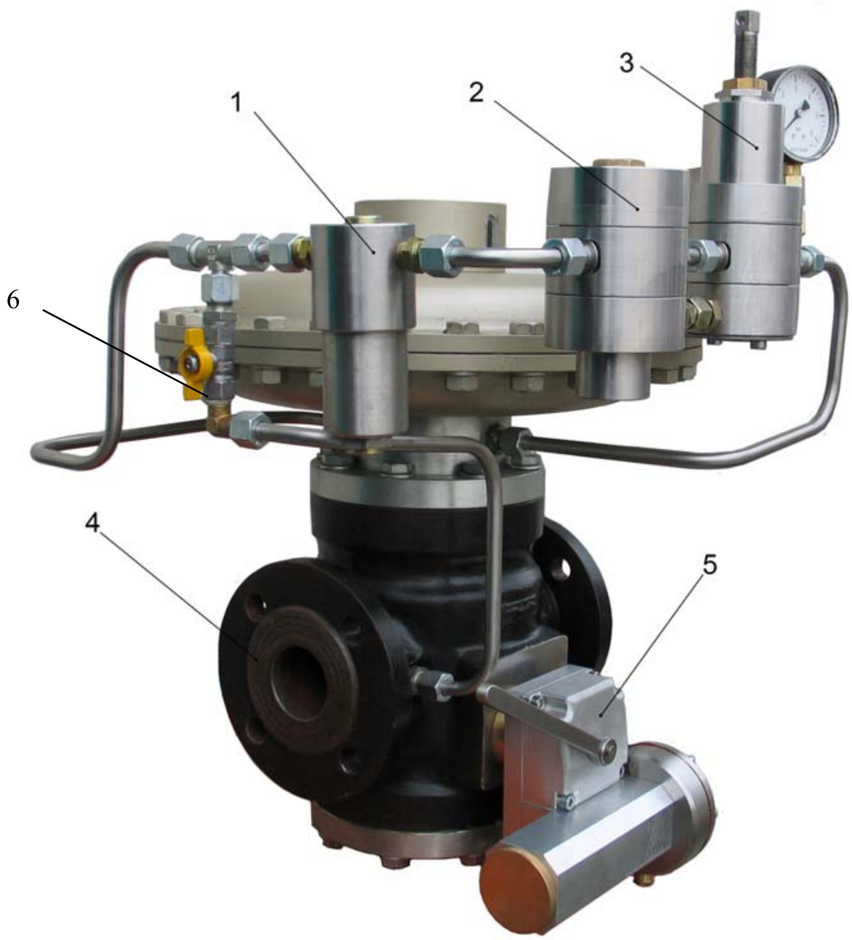

Figure 4 – RTG 410 pressure regulator

(1) F 604 filter; (2) R 102 preregulator; (3) P 510 pilot; (4) Regulator;

(5) SB 75 shut-off device (optionally); (6) By-pass valve

The regulator operation is described on the basis of Figure 1.

RTG 410 (Figure 1) regulators function on the principle of the balance between the forces acting on the operating element. The force delivered by the downstream pressure (Pa) on the diaphragm acts in conjunction with the force generated by the operating mechanism spring and by the weight of the mechanism. The resultant force balances the force exerted by the motorization pressure (Pm) on the diaphragm.

Since the regulator is normally closed, in the absence of pressure in the control equipment circuit, the operating mechanism piston is maintained in closed position by the spring. Fluctuations in the upstream pressure do not modify this position because the piston is completely balanced and exposed to equal pressure acting on surfaces with equal areas. The rod is also balanced.

The gas in the control mechanism is taken from the regulator inlet, then passes through F 604 filter and undergoes an initial pressure reduction in R 102 preregulator. The pilot feeding pressure (Pep) is obtained at the preregulator outlet and depends on the regulator outlet pressure. The pilot feeding pressure is applied at the P 510 pilot inlet, thus generating the motorization pressure (Pm) acting on the lower side of the operating mechanism diaphragm. The value of the outlet pressure (Pa) can be modified by turning the pilot adjustment screw [clockwise to increase (Pm) and, consequently, (Pa) and anticlockwise to decrease them]. If the pressure (Pa) downstream of the regulator decreases because of an increase in the required flow rate, this induces an imbalance in the pilot mobile subassembly, which results in the modification of the motorization pressure (Pm) value and, implicitly, in a different balance position of the adjustment element. An increase of the pressure downstream of the regulator changes the balance position of the pilot mobile subassembly and leads to the decrease of the motorization pressure (Pm) [at a certain value of the downstream pressure (Pa), the pilot moves to closed position]; the (Pm) pressure decreases and the force exerted by the spring causes the adjustment element in the regulator to move to closed position. Continuous operation is ensured by the relief nozzle in the pilot, through which the gas at (Pm) circulates towards the outlet pipe (Pa).

Technical characteristics

Table 1 indicates the technical characteristics of RTG 410 regulators, part of which are also listed on the product specification plate on delivery.

Table 1 – Technical characteristics of RTG 410 regulators

Regulator type	**RTG 411** **RTG 411 SB** **RTG 411 M**	**RTG 412** **RTG 412 SB** **RTG 412 M**	**RTG 413** **RTG 413 SB** **RTG 413 M**
Inlet/ outlet connection diameter	Flange Dn 25÷Dn 400 PN16÷PN20/ANSI Class 150	Flange Dn 25÷Dn 300 PN25÷PN50/ANSI Class 300	Flanşa Dn 25÷Dn 300 PN25÷PN50/ANSI Clasa 300 PN64÷PN110/ANSI Class 600
Inlet pressure [bar]	0.2 ÷ 16/20	0.4 ÷ 40/50	0.5 ÷ 40/50 0.5 ÷ 100
Outlet pressure [bar]	0.2 ÷ 12	0.2 ÷ 49	0.5 ÷ 75
Differential pressure Δp [bar]	0.2	0.4	0.5
Working medium	Natural gases (SR 3317–2003), other non-corrosive gases		
Ambient temperature [^{o}C]	-30 ÷ 80		
Working medium temperature [^{o}C]	-20 ÷ 60		
Intervention accuracy class (AG)	- minimum up to 2.5% - maximum up to 1% (depending on the control pressure)		
Accuracy class (AC)	± 1 ÷ 5%	± 1 ÷ 5%	± 1 ÷ 2.5%
Lock-up pressure class (SG)	2.5 ÷ 10%	1 ÷ 5%	1 ÷ 2.5%

Materials

The external surfaces of the regulator are painted and zinc coated in order to provide anti-corrosion protection.

Table 2 - Materials

Part	**Material**
Body	**ASTM A216 WCB, ASTM A352 LCB**
Seat	**Stainless steel**
Rod	**Stainless steel**
Covers	**Carbon steel**
Internal parts	**Stainless steel, aluminium alloy, brass**
Valve plate	**Rubber (NBR) or polyurethane**
Diaphragms	**Rubber (NBR) with textile insert, Rubber (NBR)**
O-rings	**Rubber (NBR), Viton, HNBR**

Pressure regulator selection

When selecting the pressure regulator, the following data should be considered:

- inlet pressure
- outlet pressure
- maximum flow rate
- working medium
- working medium temperature
- ambient temperature

According to SR EN 334+A1:2009, the flow coefficient Cg is taken into consideration when selecting the regulator size. The maximum flow rate is established assuming that the regulator is totally open.

The following formulas are used to determine the maximum flow rate:

a) in subcritical conditions, when $\frac{P_a}{P_e} \geq 0.5$

$$Q = \frac{13.57}{\sqrt{d \cdot (t_e + 273)}} \cdot C_g \sqrt{(P_e - P_a) \cdot P_a}$$

Or:

$$Q = K_g \cdot \sqrt{(P_e - P_a) \cdot P_a}$$

b) in critical conditions, when $\frac{P_a}{P_e} < 0.5$

$$Q = \frac{6.78}{\sqrt{d \cdot (t_e + 273)}} . C_g \cdot P_e$$

Or:

$$Q = \frac{K_g}{2} \cdot P_e$$

Symbols:

Q – flow rate [Nm^3/h]

P_e – absolute inlet pressure [bar]

P_a – absolute outlet pressure [bar]

C_g – air flow coefficient [m^3/h x bar], according to Table 3

K_g – natural gas flow coefficient [Nm^3/h]

d – relative density (for air d = 1)

t_e – natural gas temperature at regulator inlet

Relative densities for other working fluids are listed in Table 4.

For natural gas, the formulae based on K_g coefficient can be directly used (the formulae already contain the correction for natural gas at t = 15ºC).

Table 3 - RTG 410 regulator flow coefficient

DN	Cg	Cg	Cg	KG	KG	KG
Nominal diameter	RTG 410	RTG 410 + SB 750	RTG 410 + AM 814	RTG 410	RTG 410 + SB 750	RTG 410 + AM 814
25	567	510	306	585	527	316
40	1475	1328	801	1523	1370	827
50	2233	2010	1224	2305	2075	1263
80	4633	4170	2548	4783	4304	2630
100	8070	7263	4664	8331	7498	4815
150	16787	15108	9485	17329	15596	9791
200	26465	23819	14767	27320	24588	15245
250	38810	34929	21734	40064	36057	22436
300	65157	58641	36488	67262	60536	37667

Table 4 – Gas relative density

Gas	Relative density (d)
Air	1.0
Propane	1.53
Butane	2.0
Nitrogen	0.97
Oxygen	1.14
Carbon dioxide	1.52

Gas velocity is also considered when selecting the pressure regulator and sizing the pipes.

For regulators, the recommended gas velocity in the outlet flange is less than 150 m/s. The erosion phenomenon accelerates and the noise level increases significantly at greater velocity.

The pipes are sized for gas velocities lower than 20 m/s.

Gas velocity in the outlet flange or in pipes is calculated using the formula:

$$V = 345.92 \times \frac{Q \times (1 - 0.002 \cdot P_a)}{D_i^2 \times (1 + P_a)}$$

where:

- V – gas velocity [m/s]
- Q – flow rate [Sm^3/h]
- D_i – inside diameter [mm] (for regulators RTG 410 D_i = Dn)
- P_a – outlet pressure [barg]

Safety devices and optional accesories

Pilot equipment

The pilot equipment mounted on the regulators included in RTG 410 family comprises:

- *micro-filter* F 604 series
- *gas electric heater* WE 860 series (optionally)
- *preregulator* R 100 (R 102 or R 106) series
- *pilot* P 510 (P 510, P 510 A, P 510 HP, P 511) series

The type of pilot mounted in the regulator depends on the required outlet pressure value (Pa).

Thus:

P 510 A	Wh = 0.015 ÷ 1 bar
P 510	Wh = 0.20 ÷ 12 bar
P 510 HP	Wh = 4 ÷ 30 bar
P 511	Wh = 10 ÷ 75 bar

Table 5 – Adjustment springs for P 510 pilots

Pilot	Code	Setting range[bar]
P 510 A	1450224	0.02 ÷ 0.10
	1450226	0.02 ÷ 0.40
	1450227	0.1 ÷ 1
P 510	1450228	0.2 ÷ 0.6
	1450229	0.5 ÷ 2
	1450230	1 ÷ 3.5
	1450231	2 ÷ 7
	1450232	4 ÷12
P 510 HP	1450284	3 ÷ 8
	1450285	6 ÷ 14
	1450286	10 ÷ 26
	1450287	20 ÷ 32
P 511	1450234	10 ÷ 25
	1450235	20 ÷ 40
	1450236	30 ÷ 75

Monitor

The monitor (Figure 2) is an emergency regulator which comes into operation in the regulating process when the pressure downstream of the regulator increases up to the monitor set pressure.

There are two assembling solutions: with incorporated monitor or in-line monitor.

Incorporated monitor

In this case, the emergency regulator (monitor) is directly assembled on the body of the main regulator. Both regulators use the same body, except that:

- they are governed by two different pilots, separately assembled;
- they operate on different surfaces of the same seat.

The monitor can be mounted on RTG 410 regulator already installed without major modifications.

In-line monitor

The monitor is installed in line upstream of the operating regulator and is identic with the main regulator. The control pressure of the monitor is collected downstream of the working regulator and the pressure acting on the pilot equipment on the working regulator is collected upstream of the monitor.

SB 750 shut-off valve operation

The valve (Figure 3 and 5) working position is normally open. When the regulated pressure (Pa) is within the set range, the shut-off valve is open. The load of the Pa pressure on the diaphragm (1) of the servomotor (Figure 5) maintains the rod (2) in balance position. Thus, the cam (7) movement under the action of the spring is obstructed by the fork (5) whose radial movement is induced by the rod (2). When the Pa pressure exceeds the maximum allowable value, the force of the spring (4) is overcome, which causes the rod (2) to move. The fork (5) releases the cam (7) which moves under the action of the spring (6) and releases the valve plate holder (9). When the Pa pressure decreases below the minimum allowable value, the force of the spring (3) moves the rod (2) which rotates the fork (5) and releases the cam (7) which in its turn moves under the action of the spring (6) and releases the piston. The movement of the valve plate holder (9) under the action of the spring (8) closes the valve. Sealing is ensured by O-rings and seat valve plate.

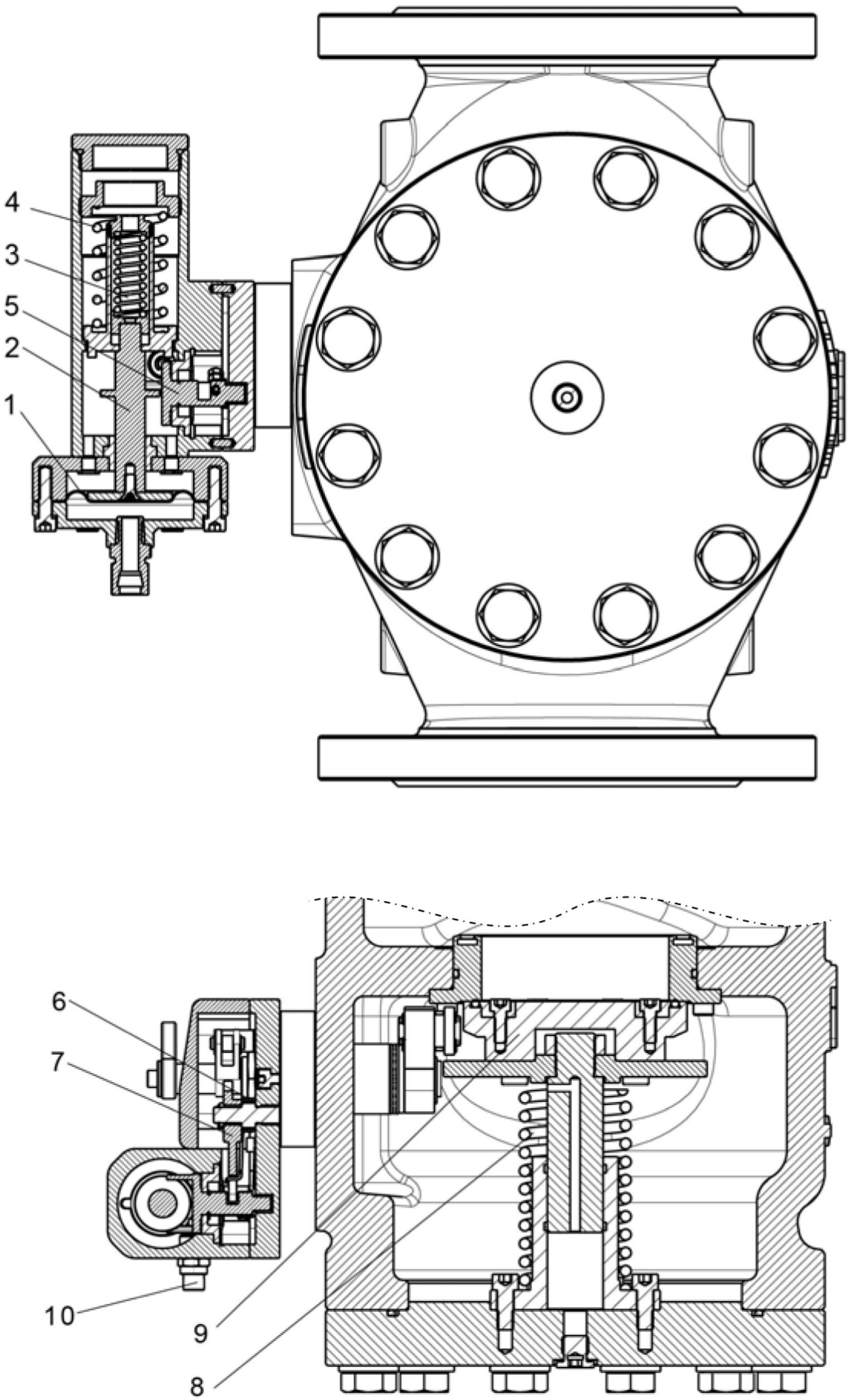

Figure 5 - SB 750 shut-off valve

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Table 6 – Adjustment springs for SB 75 control mechanism

Servomotor type	Minimum spring		Maximum spring	
	Code	Adjustment range [bar]	Code	Adjustment range [bar]
SM 15	1450353	2.4 ÷ 4.8	1450367	21.3 ÷ 42.7
	1450354	4.1 ÷ 8.3	1450368	41.9 ÷ 83.8
	1450355	8.0 ÷ 15.6		
	1450358	9.0 ÷ 18.2		
	1450359	17.8 ÷ 35.7		
	1450360	34.9 ÷ 62.1		
SM 20	1450353	1.3 ÷ 2.7	1450367	12.0 ÷ 24.0
	1450354	2.3 ÷ 4.6	1450368	23.5 ÷ 47.2
	1450355	4.5 ÷ 8.7		
	1450358	5.1 ÷ 10.2		
	1450359	10.0 ÷ 20.1		
	1450360	19.6 ÷ 34.9		
SM 25	1450354	1.4 ÷ 3.0	1450368	15.1 ÷ 30.2
	1450355	2.9 ÷ 5.6		
	1450359	6.4 ÷ 12.8		
	1450360	12.5 ÷ 22.4		
SM 37	1450352	0.2 ÷ 0.5	1450366	2.04 ÷ 4.1
	1450353	0.4 ÷ 0.9	1450367	3.9 ÷ 7.8
	1450354	0.7 ÷ 1.5	1450368	7.6 ÷ 15.4
	1450355	1.4 ÷ 2.9		
	1450358	1.6 ÷ 3.3		
	1450359	3.2 ÷ 6.5		
	1450360	6.4 ÷ 12.4		
SM 50	1450351	0.06 ÷ 0.14	1450364	0.27 ÷ 0.55
	1450352	0.12 ÷ 0.25	1450365	0.53 ÷ 1.07
	1450353	0.21 ÷ 0.44	1450366	1.0 ÷ 2.0
	1450354	0.37 ÷ 0.75	1450367	1.9 ÷ 3.8
	1450355	0.72 ÷ 1.40	1450368	3.7 ÷ 7.6
	1450356	0.21 ÷ 0.43		
	1450357	0.42 ÷ 0.85		
	1450358	0.81 ÷ 1.63		
	1450359	1.60 ÷ 3.20		
	1450360	3.13 ÷ 5.60		
SM 70	1450351	0.03 ÷ 0.08	1450361	0.02 ÷ 0.04
	1450352	0.06 ÷ 0.1	1450362	0.03 ÷ 0.08
	1450353	0.1 ÷ 0.2	1450363	0.06 ÷ 0.14
	1450354	0.1 ÷ 0.4	1450364	0.13 ÷ 0.28
	1450355	0.3 ÷ 0.7	1450365	0.27 ÷ 0.55
	1450356	0.1 ÷ 0.2	1450366	0.51 ÷ 1.02
	1450357	0.2 ÷ 0.5	1450367	0.98 ÷ 1.95
	1450358	0.4 ÷ 0.8	1450368	1.92 ÷ 3.85
	1450359	0.8 ÷ 1.7		
	1450360	1.6 ÷ 2.9		

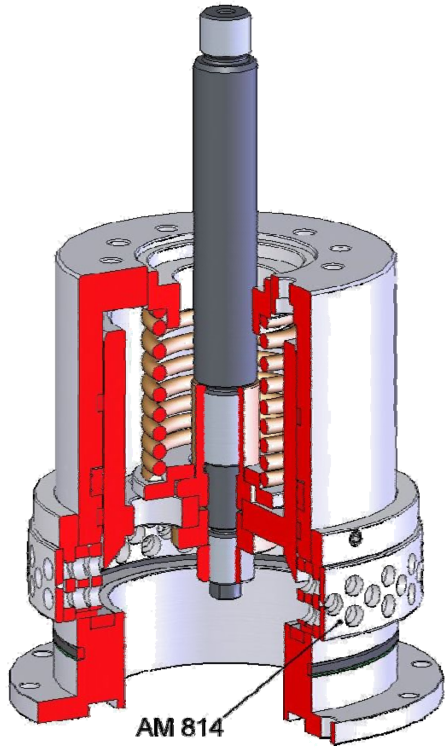
Incorporated silencer

Optionally, RTG 410 pressure regulator can be equipped with an AM 814 internal silencer.

The internal silencer is selected depending on the specific operating conditions. It ensures noise level reduction of up to 20 dB.

The installation of an internal silencer leads to a decrease in the flow coefficient (Cg) to a value ranged 20 ÷ 30%.

Figure 6 – AM 814 silencer ➪



WE 860 electric heater

WE 860 gas heaters are mounted in the circuit of the pilot equipment which controls indirect acting pressure regulators. WE 860 heaters ensure that gas temperature is high enough before expansion, thus preventing the forming of hydrates and the frost resulted from the phenomena specific to the gas pressure reduction process.

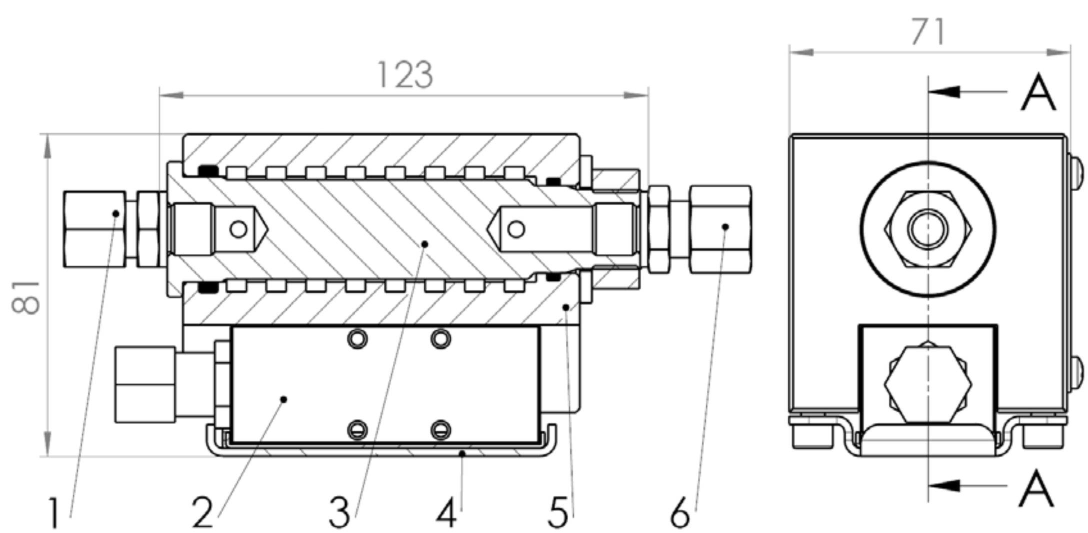


Figure 7 - Component elements and overall dimensions of WE 860

(1) Connection; (2) Heating element; (3) Central body; (4) Cover; (5) Shell; (6) Connection

Assembly diagram of RTG 410 regulator family

In order to ensure proper operation of the regulator, it is recommended to observe the diagram in Figure 8.

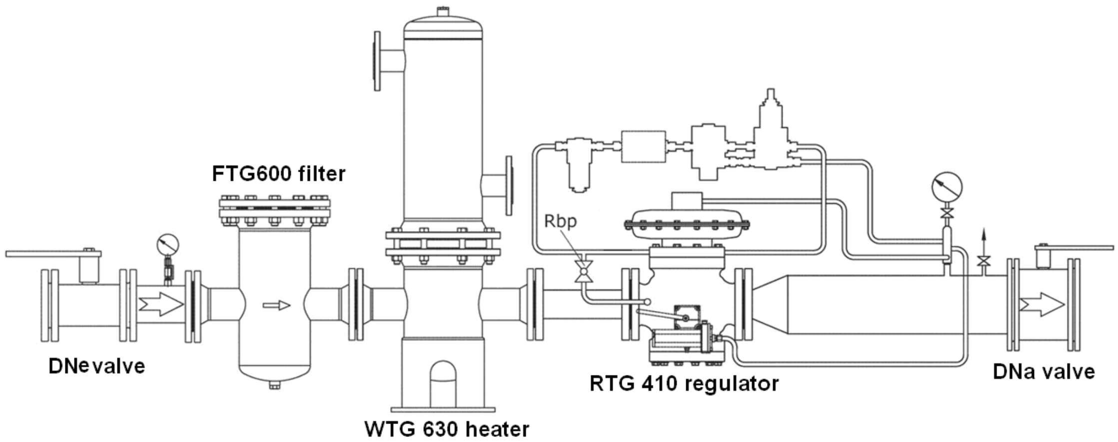


Figure 8 – RTG 410 assembly example

The FTG 600 and WTG 630 heaters are recommended.

The control pressure for the regulator and the shut-off valve must be taken off downstream of the regulator, according to the diagrams in Figures 10 and 11.

The impulse line connections layout must be as per Figure 9.

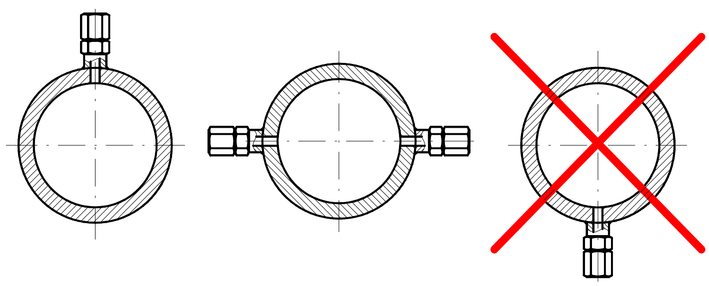


Figure 9 – Impulse line connections layout

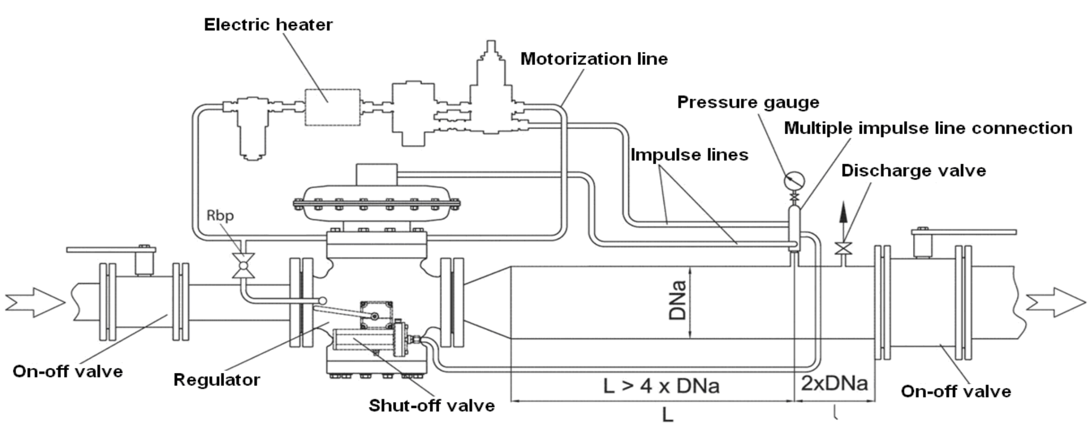


Figure 10 – Multiple impulse line connections layout in a horizontal installation

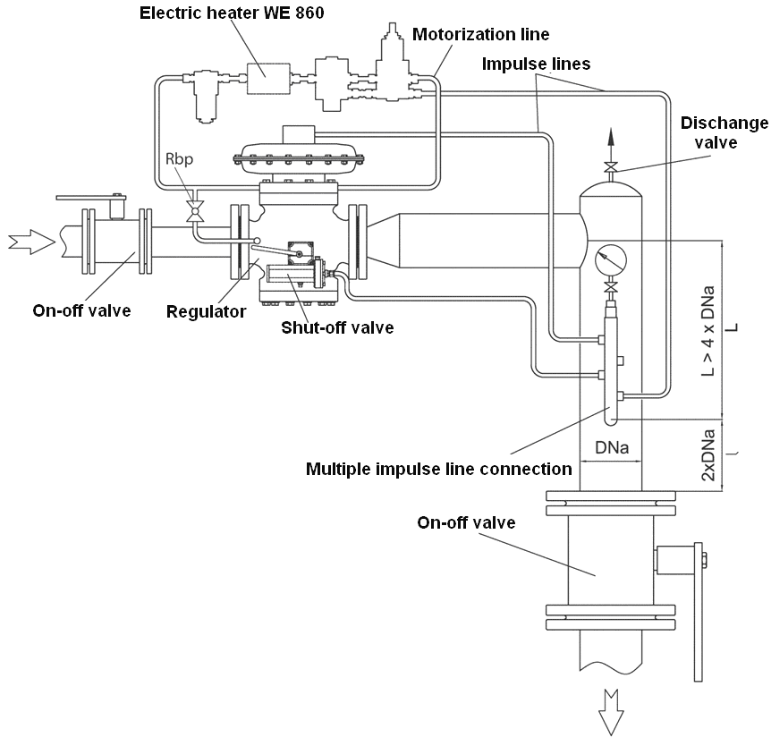


Figure 11 – Multiple impulse line connections layout in a vertical installation

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Overall dimensions

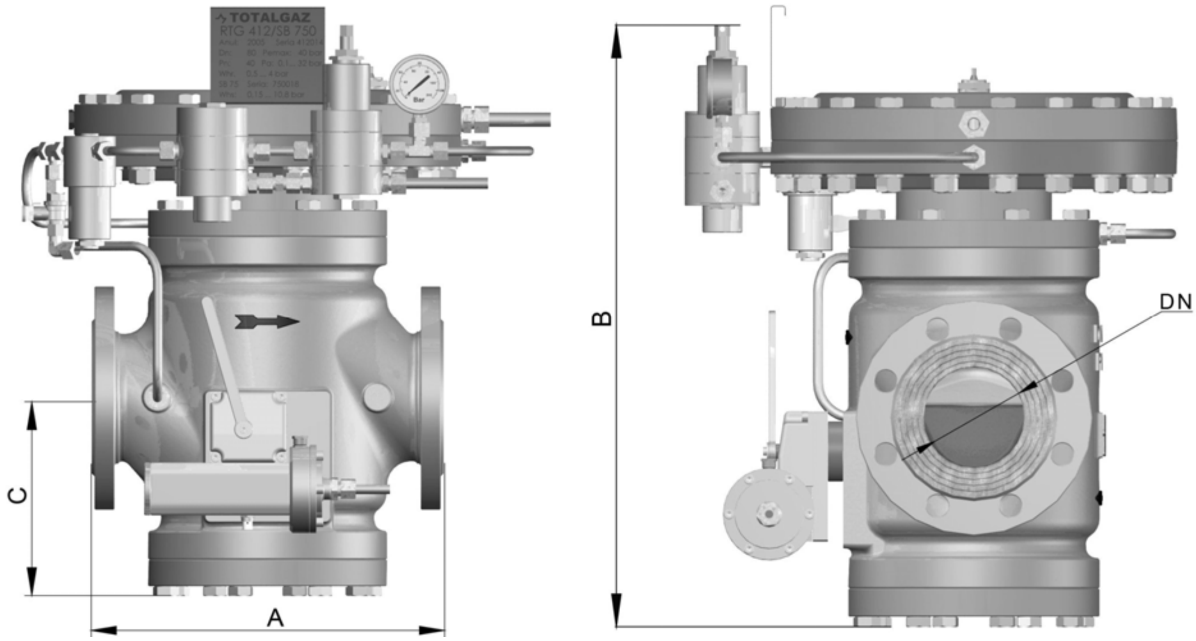


Figure 12 – Overall dimensions

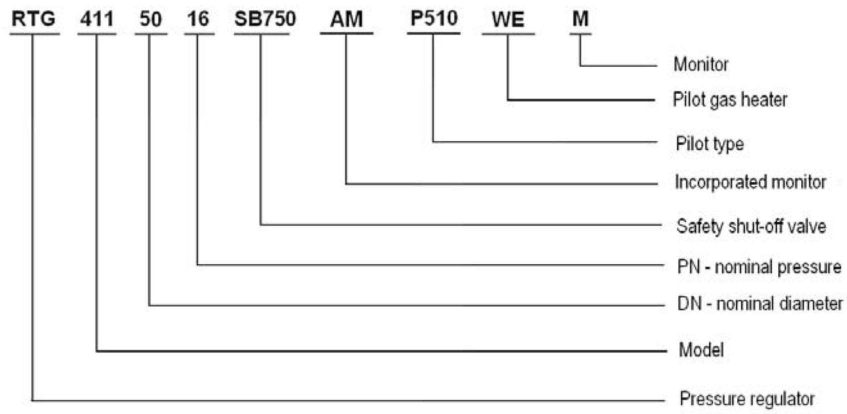
Table 7 – RTG 410 regulator overall dimensions

Nominal diameter Dn	RTG 411 *(Pn 16; Clasa 150)*			RTG 412 *(Pn 25; Pn 40 Clasa 300)*			RTG 413 *(Pn 64; Pn 100 Clasa 600)*		
	A [mm]	B [mm]	C [mm]	A [mm]	B [mm]	C [mm]	A [mm]	B [mm]	C [mm]
25	184	435	125	197	442	127	210	454	134
40	222	470	140	235	475	142	246	495	150
50	254	495	155	267	560	145	286	530	170
80	298	545	200	317	552	204	336	570	212
100	352	620	210	368	625	215	394	650	225
150	451	750	230	473	758	235	508	772	250
200	543	870	275	568	880	281	609	900	298
250	673	930	350	708	937	362	752	985	382
300	737	1020	382	770	1028	396	804	1050	405
400	1016	1476	495	-	-	-	-	-	-

Ordering code

The pressure regulator is identified by specifying the constructive variant, the nominal dimensions of the inlet – outlet connections and the maximum working pressure.

Example:



For example, the RTG 411 – 50 – 16 – SB 750 – AM – P 510 –WE – M notation designates a regulator of 411 type with DN 50, maximum working pressure of 16 bar, provided with an incorporated SB 750 shut-off valve, incorporated silencer, P 510 pilot, gas heater for the pilot system and monitor.

Additional requirements, if any, must be specified when placing the order.

The manufacturer reserves the right to make modifications without any prior notification.

CT No. 215 / 2009 / 01

TOTALGAZ INDUSTRIE
Nr. R.C.: J-22-3277/1994
CUI: RO6658553

IBAN: RO28BRDE240SV13842272400
B.R.D. G.S.G. Iaşi

Şos. Păcurari, nr. 128,
Iaşi, cod 700545, România
Tel. : 0040-232-216.391(2)
Fax : 0040-232-215.983
E-mail: office@totalgaz.ro
Web: www.totalgaz.ro

Certified Management System