Calculation header

Identifier		**Airlitec Sarl - 11/29197**		
Tag No.		**36-FE-082**		

Operating data

Medium		**Hydrogen**		
Operating pressure	p1	**21,5**		kp/cm²(g)
Operating temperature	t1	**42,0**		°C
Gas		**Gas, dry (Standard conditions)**		
☒ Automatic phase detection		☒ Enhanced substance calculation		

Properties at operating point

State		**Gaseous**		
Vapour pressure (t1)	pv1	**12,376**		kp/cm²(g)
Vapour temperature (p1)	tv1	**-239,96**		°C
Real gas factor (t1, p1)	Z1	**1,0124**		-
Operating density (t1, p1)	ρ	**1,6791**		kg/m³
Isentropic exponent (t1, p1)	κ	**1,4236**		-
◉ Dynamic viscosity (t1,p1)	η1	**8,1692**	E -3	cP
○ Kinematic viscosity (t1,p1)	ν1	**4,8651**		mm²/s

Physical constants

Standard conditions		**0°C, 1013 mbar**		
○ Density (standard conditions, dry gas)	ρn	**0,089883**		kg/m³
◉ Molecular weight	M	**2,0159**		kg/kmol
Critical pressure	pc	**13,15**		bar(a)
Critical temperature	tc	**-239,96**		°C

Pipeline

Material number		**1.0436**		
Material short name		**A 106 (B)**		
Condition		**new, seamless, cold drawn**		
Pipe diameter		**Circular**		
◉ Pipe class		**ANSI**		
Size class	DN	**2"**		
Pressure class	PN	**STD**		
○ Pipe outside diameter	Do	**60,325**		mm
Pipe wall thickness	tp	**3,9116**		mm
○ Pipe inside diameter (20°C)	Di	**52,502**		mm
Linear coefficient of thermal expansion	αlin	**11,47**	E -6	1/K
Pipe roughness	k	**0,02**		mm

Flow element - operating values

Device type		**ISO 5167-device**		
Calculation standard		**EN ISO 5167:2003**		
Primary device		**Flange orifice**		
Calculation reference		**Sizing: C and ε with 2/3 qm**		
Calculated value		**d**		
Throttle orifice (20°C)	d	**37,128**		mm
Pressure difference	Δp	**0,1**		kp/cm²
◉ Mass flow rate	qm	**500,0**		kg/h
○ Volume flow rate (standard conditions)	qn	**5.562,8**		m³/h

Flow element - material

Material number	Device **1.4401**

Material short name	Device	**316 1.4401**		
Linear coefficient of thermal expansion	αlin,D	**16,0**	**E -6**	1/K
Edge radius (20°C)	rk	**0,011138**		mm

Values table

☒ Flow value table

Increment for value table n **10,0** %

No.	Δp [%]	Δp [kp/cm²]	qm [kg/h]	qn [m³/h]	up [m/s]	Meets stand...
1	10,0	0,01	158,2	1.760,0	12,08	☒
2	20,0	0,02	223,7	2.489,0	17,08	☒
3	30,0	0,03	273,9	3.048,0	20,92	☒
4	40,0	0,04	316,2	3.518,0	24,15	☒
5	50,0	0,05	353,5	3.933,0	27,0	☒
6	60,0	0,06	387,2	4.308,0	29,57	☒
7	70,0	0,07	418,2	4.652,0	31,94	☒
8	80,0	0,08	447,0	4.973,0	34,14	☒
9	90,0	0,09	474,0	5.274,0	36,2	☒
10	100,0	0,1	499,6	5.558,0	38,16	☒

More calculated values

Values marked (*) depend on the calculation reference qm or 2/3 qm

☒ Discharge coefficient (*)	C	**0,61209**	-
Residual pressure loss	Δω	**0,049998**	kp/cm²
Power loss	PΔω	**0,40601**	kW
Mechanical stream power	PΔp	**0,81296**	kW
Flow velocity in pipeline	up	**38,188**	m/s
Flow velocity in flow element	uf	**76,346**	m/s
Reynolds number (*)	ReD	**274.800,0**	-
Pipe inside diameter (t1)	Di,t1	**52,515**	mm
Throttle orifice (t1)	d,t1	**37,141**	mm
Diameter ratio	β	**0,70724**	-
Relative pipe roughness	kr	**3,8084**	-
Correction factor for pipe roughness	br	**1,0**	-
Correction factor for edge radius	bk	**1,0**	-
Expansion factor (*)	ε	**0,99934**	-
Pressure ratio (*)	τ	**0,99803**	-

Confirmation:

The calculation is according to EN ISO 5167:2003.

Calculation header

Identifier		**Airlitec Sarl - 11/29197**		
Tag No.		**001-FE-031**		

Operating data

Medium		**athmospheric Residue**		
Operating pressure	p1	**5,0**		kp/cm²(g)
Operating temperature	t1	**130,0**		°C
State		**Liquid**		

Properties at operating point

Vapour pressure (t1)	pv1	**1,7229**		kp/cm²(g)
Operating density (t1, p1)	ρ	**935,0**		kg/m³
Dynamic viscosity (t1,p1)	η1	**14,0**		cP

Physical constants

Critical pressure	pc	**220,64**		bar(a)
Critical temperature	tc	**373,95**		°C

Pipeline

Material number		**1.0436**		
Material short name		**A 106 (B)**		
Condition		**new, seamless, cold drawn**		
Pipe diameter		**Circular**		
◉ Pipe class		**ANSI**		
Size class	DN	**6"**		
Pressure class	PN	**STD**		
○ Pipe outside diameter	Do	**168,28**		mm
Pipe wall thickness	tp	**7,112**		mm
○ Pipe inside diameter (20°C)	Di	**154,05**		mm
Linear coefficient of thermal expansion	αlin	**12,111**	**E -6**	1/K
Pipe roughness	k	**0,02**		mm

Flow element - operating values

Device type		**ISO 5167-device**		
Calculation standard		**EN ISO 5167:2003**		
Primary device		**Flange orifice**		
Calculation reference		**Sizing: C and ε with 2/3 qm**		
Calculated value		**d**		
Throttle orifice (20°C)	d	**103,28**		mm
Pressure difference	Δp	**0,1**		kp/cm²
○ Mass flow rate	qm	**88.825,0**		kg/h
◉ Volume flow rate (operating conditions)	qv	**95,0**		m³/h

Flow element - material

Material number	Device	**1.4401**		
Material short name	Device	**316 1.4401**		
Linear coefficient of thermal expansion	αlin,D	**16,15**	**E -6**	1/K
Edge radius (20°C)	rk	**0,030983**		mm

Values table

☒ Flow value table				
Increment for value table	n	**10,0**		%

Differential pressure flow element: Airlitec Sarl - 11/29197 09.06.2011 17:02:19

No.	Δp [%]	Δp [kp/cm²]	qm [kg/h]	qv [m³/h]	up [m/s]	Meets stand...
1	10,0	0,01	28.090,0	30,04	0,4465	☐
2	20,0	0,02	39.720,0	42,49	0,6315	☐
3	30,0	0,03	48.650,0	52,03	0,7734	☐
4	40,0	0,04	56.180,0	60,08	0,893	☐
5	50,0	0,05	62.810,0	67,18	0,9985	☐
6	60,0	0,06	68.800,0	73,59	1,094	☐
7	70,0	0,07	74.320,0	79,48	1,181	☒
8	80,0	0,08	79.450,0	84,97	1,263	☒
9	90,0	0,09	84.270,0	90,12	1,34	☒
10	100,0	0,1	88.820,0	95,0	1,412	☒

More calculated values

Values marked (*) depend on the calculation reference qm or 2/3 qm

☒ Discharge coefficient (*)	C	**0,61209**	-
Residual pressure loss	Δω	**0,054486**	kp/cm²
Power loss	PΔω	**0,141**	kW
Mechanical stream power	PΔp	**0,25879**	kW
Flow velocity in pipeline	up	**1,412**	m/s
Flow velocity in flow element	uf	**3,1389**	m/s
Reynolds number (*)	ReD	**9.698,0**	-
Pipe inside diameter (t1)	Di,t1	**154,26**	mm
Throttle orifice (t1)	d,t1	**103,46**	mm
Diameter ratio	β	**0,67071**	-
Relative pipe roughness	kr	**1,2965**	-
Correction factor for pipe roughness	br	**1,0**	-
Correction factor for edge radius	bk	**1,0**	-

Calculation header

Identifier		**Airlitec Sarl - 11/29197**		
Tag No.		**011-FE-031**		

Operating data

Medium		**athmospheric Residue**		
Operating pressure	p1	**5,0**		kp/cm²(g)
Operating temperature	t1	**130,0**		°C
State		**Liquid**		

Properties at operating point

Vapour pressure (t1)	pv1	**1,7229**		kp/cm²(g)
Operating density (t1, p1)	ρ	**935,0**		kg/m³
Dynamic viscosity (t1,p1)	η1	**14,0**		cP

Physical constants

Critical pressure	pc	**220,64**		bar(a)
Critical temperature	tc	**373,95**		°C

Pipeline

Material number		**1.0436**		
Material short name		**A 106 (B)**		
Condition		**new, seamless, cold drawn**		
Pipe diameter		**Circular**		
◉ Pipe class		**ANSI**		
Size class	DN	**6"**		
Pressure class	PN	**STD**		
○ Pipe outside diameter	Do	**168,28**		mm
Pipe wall thickness	tp	**7,112**		mm
○ Pipe inside diameter (20°C)	Di	**154,05**		mm
Linear coefficient of thermal expansion	αlin	**12,111**	**E -6**	1/K
Pipe roughness	k	**0,02**		mm

Flow element - operating values

Device type		**ISO 5167-device**		
Calculation standard		**EN ISO 5167:2003**		
Primary device		**Flange orifice**		
Calculation reference		**Sizing: C and ε with 2/3 qm**		
Calculated value		**d**		
Throttle orifice (20°C)	d	**96,222**		mm
Pressure difference	Δp	**0,1**		kp/cm²
○ Mass flow rate	qm	**74.800,0**		kg/h
◉ Volume flow rate (operating conditions)	qv	**80,0**		m³/h

Flow element - material

Material number	Device	**1.4401**		
Material short name	Device	**316 1.4401**		
Linear coefficient of thermal expansion	αlin,D	**16,15**	**E -6**	1/K
Edge radius (20°C)	rk	**0,028867**		mm

Values table

☒ Flow value table				
Increment for value table	n	**10,0**		%

No.	Δp [%]	Δp [kp/cm²]	qm [kg/h]	qv [m³/h]	up [m/s]	Meets stand...
1	10,0	0,01	23.650,0	25,3	0,376	☐
2	20,0	0,02	33.450,0	35,78	0,5318	☐
3	30,0	0,03	40.970,0	43,82	0,6513	☐
4	40,0	0,04	47.310,0	50,6	0,752	☐
5	50,0	0,05	52.890,0	56,57	0,8408	☐
6	60,0	0,06	57.940,0	61,97	0,9211	☐
7	70,0	0,07	62.580,0	66,93	0,9949	☒
8	80,0	0,08	66.900,0	71,55	1,064	☒
9	90,0	0,09	70.960,0	75,89	1,128	☒
10	100,0	0,1	74.800,0	80,0	1,189	☒

More calculated values

Values marked (*) depend on the calculation reference qm or 2/3 qm

☒ Discharge coefficient (*)	C	**0,61209**	-
Residual pressure loss	Δω	**0,059835**	kp/cm²
Power loss	PΔω	**0,1304**	kW
Mechanical stream power	PΔp	**0,21793**	kW
Flow velocity in pipeline	up	**1,1891**	m/s
Flow velocity in flow element	uf	**3,0452**	m/s
Reynolds number (*)	ReD	**8.166,7**	-
Pipe inside diameter (t1)	Di,t1	**154,26**	mm
Throttle orifice (t1)	d,t1	**96,393**	mm
Diameter ratio	β	**0,62489**	-
Relative pipe roughness	kr	**1,2965**	-
Correction factor for pipe roughness	br	**1,0**	-
Correction factor for edge radius	bk	**1,0**	-

Calculation header

Identifier		**Airlitec Sarl - 11/29197**		
Tag No.		**911-FE-031**		

Operating data

Medium		**athmospheric Residue**		
Operating pressure	p1	**7,0**		kp/cm²(g)
Operating temperature	t1	**130,0**		°C
State		**Liquid**		

Properties at operating point

Vapour pressure (t1)	pv1	**1,7229**		kp/cm²(g)
Operating density (t1, p1)	ρ	**935,0**		kg/m³
Dynamic viscosity (t1,p1)	η1	**14,0**		cP

Physical constants

Critical pressure	pc	**220,64**		bar(a)
Critical temperature	tc	**373,95**		°C

Pipeline

Material number		**1.0436**		
Material short name		**A 106 (B)**		
Condition		**new, seamless, cold drawn**		
Pipe diameter		**Circular**		
◉ Pipe class		**ANSI**		
Size class	DN	**8"**		
Pressure class	PN	**STD**		
○ Pipe outside diameter	Do	**219,08**		mm
Pipe wall thickness	tp	**8,1788**		mm
○ Pipe inside diameter (20°C)	Di	**202,72**		mm
Linear coefficient of thermal expansion	αlin	**12,111**	**E -6**	1/K
Pipe roughness	k	**0,02**		mm

Flow element - operating values

Device type		**ISO 5167-device**		
Calculation standard		**EN ISO 5167:2003**		
Primary device		**Flange orifice**		
Calculation reference		**Sizing: C and ε with 2/3 qm**		
Calculated value		**d**		
Throttle orifice (20°C)	d	**149,55**		mm
Pressure difference	Δp	**0,2**		kp/cm²
○ Mass flow rate	qm	**280.500,0**		kg/h
◉ Volume flow rate (operating conditions)	qv	**300,0**		m³/h

Flow element - material

Material number	Device	**1.4401**		
Material short name	Device	**316 1.4401**		
Linear coefficient of thermal expansion	αlin,D	**16,15**	**E -6**	1/K
Edge radius (20°C)	rk	**0,044864**		mm

Values table

☒ Flow value table				
Increment for value table	n	**10,0**		%

No.	Δp [%]	Δp [kp/cm²]	qm [kg/h]	qv [m³/h]	up [m/s]	Meets stand...
1	10,0	0,02	88.700,0	94,87	0,8143	☐
2	20,0	0,04	125.400,0	134,2	1,152	☐
3	30,0	0,06	153.600,0	164,3	1,41	☒
4	40,0	0,08	177.400,0	189,7	1,629	☒
5	50,0	0,1	198.300,0	212,1	1,821	☒
6	60,0	0,12	217.300,0	232,4	1,995	☒
7	70,0	0,14	234.700,0	251,0	2,154	☒
8	80,0	0,16	250.900,0	268,3	2,303	☒
9	90,0	0,18	266.100,0	284,6	2,443	☒
10	100,0	0,2	280.500,0	300,0	2,575	☒

More calculated values

Values marked (*) depend on the calculation reference qm or 2/3 qm

☒ Discharge coefficient (*)	C	**0,61209**	-
Residual pressure loss	Δω	**0,092091**	kp/cm²
Power loss	PΔω	**0,75258**	kW
Mechanical stream power	PΔp	**1,6344**	kW
Flow velocity in pipeline	up	**2,5751**	m/s
Flow velocity in flow element	uf	**4,7275**	m/s
Reynolds number (*)	ReD	**23.273,0**	-
Pipe inside diameter (t1)	Di,t1	**202,99**	mm
Throttle orifice (t1)	d,t1	**149,81**	mm
Diameter ratio	β	**0,73804**	-
Relative pipe roughness	kr	**0,98528**	-
Correction factor for pipe roughness	br	**1,0**	-
Correction factor for edge radius	bk	**1,0**	-

Confirmation:

The calculation is according to EN ISO 5167:2003.