

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE15035 (design point)
 Serial No.:
 Pipe Data: ID= 696,800/7,100 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Air

Pipe Internal Dimensions: 696,800 mm
 Flowing Temperature: 23,100 °C
 Flowing Pressure: 5,620 bar A
 Density: 1,293 kg/Nm³
 Viscosity: 0,0183 cPs
 K-Factor: 0,6496 without unit

Base Temperature	273,15 Kelvin
Base Pressure	101,30 kPa

Op. Density: 6,614

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin	
Flow Rate	120.000,00	96.000,00	24.000,00	Nm ³ /h
Reynolds No.	4.302.618	3.442.094	860.524	without unit
Permanent press. loss	0,870	0,560	0,030	mbar
Expansionsfactor	0,999	0,999	1,000	without unit
Velocity:	17,09	13,67	3,42	m/sec.
Differential Pressure	22,400	14,330	0,890	mbar

Itabar-Type: IBF-25-ID696,8/7,1mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A62-E06
 Material Sensor: 316SS
 Note: mounting stud with flange DN40 PN16

Max. DeltaP	32,30 mbar	Max. Flow Rate	144.206,31 Nm ³ /h
Natural Freq.:	21,39 hz	Operat. Freq.:	0,49 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füllingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE15035 (case 1)
 Serial No.:
 Pipe Data: ID= 696,800/7,100 mm - vertikal
 Date: 03.02.2005
 Person in charge TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Air

Pipe Internal Dimensions: 696,800 mm
 Flowing Temperature: 23,100 °C
 Flowing Pressure: 5,360 bar A
 Density: 1,293 kg/Nm3
 Viscosity: 0,0183 cPs
 K-Factor: 0,6496 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,30 kPa

Op. Density: 6,308

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin
Flow Rate	120.000,00	71.574,00	24.000,00 Nm3/h
Reynolds No.	4.302.618	2.566.297	880.524 without unit
Permanent press. loss	0,920	0,330	0,040 mbar
Expansionsfactor	0,999	1,000	1,000 without unit
Velocity:	17,92	10,69	3,58 m/sec.
Differential Pressure	23,490	8,350	0,940 mbar

Itabar-Type: IBF-25-ID696,8/7,1mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A62-E06
 Material Sensor 316SS
 Note: mounting stud with flange DN40 PN16

Max. DeltaP 32,30 mbar Max. Flow Rate 140.830,53 Nm3/h
 Natural Freq.: 21,39 hz Operat. Freq.: 0,48 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE15035 (case 2)
 Serial No.:
 Pipe Data: ID= 696,800/7,100 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Air

Pipe Internal Dimensions: 696,800 mm
 Flowing Temperature: 23,100 °C
 Flowing Pressure: 5,620 bar A
 Density: 1,293 kg/Nm³
 Viscosity: 0,0183 cPs
 K-Factor: 0,6496 without unit

Base Temperature	273,15 Kelvin
Base Pressure	101,30 kPa

Op. Density: 6,614

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin
Flow Rate	120.000,00	95.378,00	24.000,00 Nm ³ /h
Reynolds No.	4.302.618	3.419.793	860.524 without unit
Permanent press. loss	0,870	0,550	0,030 mbar
Expansionsfactor	0,999	0,999	1,000 without unit
Velocity:	17,09	13,58	3,42 m/sec.
Differential Pressure	22,400	14,140	0,890 mbar

Itabar-Type: IBF-25-ID696,8/7,1mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A62-E06
 Material Sensor 316SS
 Note: mounting stud with flange DN40 PN16

Max. DeltaP 32,30 mbar Max. Flow Rate 144.205,31 Nm³/h
 Natural Freq.: 21,39 hz Operat. Freq.: 0,49 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE15035 (case 3)
 Serial No.:
 Pipe Data: ID= 696,800/7,100 mm - vertikal
 Date: 03.02.2005
 Person in charge TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Air

Pipe Internal Dimensions: 696,800 mm
 Flowing Temperature: 23,100 °C
 Flowing Pressure: 5,510 bar A
 Density: 1,293 kg/Nm³
 Viscosity: 0,0183 cPs
 K-Factor: 0,6496 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,30 kPa

Op. Density: 6,485

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin
Flow Rate	120.000,00	95.911,00	24.000,00 Nm ³ /h
Reynolds No.	4.302.618	3.438.903	860.524 without unit
Permanent press. loss	0,890	0,570	0,040 mbar
Expansionfactor	0,999	0,999	1,000 without unit
Velocity:	17,43	13,93	3,49 m/sec.
Differential Pressure	22,850	14,590	0,910 mbar

Itabar-Type: IBF-25-ID696,8/7,1mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A63-E08

Material Sensor 316SS

Note: mounting stud with flange DN40 PN16

Max. DeltaP: 32,30 mbar Max. Flow Rate: 142.787,25 Nm³/h
 Natural Freq.: 21,39 hz Operat. Freq.: 0,49 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füllingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE15041 (design point)
 Serial No.:
 Pipe Data: ID= 495,400/6,300 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Nitrogen

Pipe Internal Dimensions: 495,400 mm
 Flowing Temperature: 20,000 °C
 Flowing Pressure: 1,170 bar A
 Density: 1,251 kg/Nm³
 Viscosity: 0,0174 cPs
 K-Factor: 0,6437 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,30 kPa

Op. Density: 1,346

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin
Flow Rate	22.000,00	18.000,00	4.400,00 Nm ³ /h
Reynolds No.	1.128.531	923.343	225.706 without unit
Permanent press. loss	0,840	0,560	0,030 mbar
Expansionsfactor	0,998	0,998	1,000 without unit
Velocity:	29,45	24,10	5,89 m/sec.
Differential Pressure	13,830	9,250	0,550 mbar

Itabar-Type: IBF-25-ID495,4/6,3mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A62-E06
 Material Sensor 316SS
 Note: mounting stud with flange DN40 PN16

Max. DeltaP: 60,10 mbar Max. Flow Rate: 45.955,98 Nm³/h
 Natural Freq.: 40,13 hz Operat. Freq.: 0,69 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingsweg 34
 Zip Code/City: 47806 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE15041 (case 1)
 Serial No.:
 Pipe Data: ID= 495,400/6,300 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Nitrogen

Pipe Internal Dimensions: 495,400 mm
 Flowing Temperature: 23,100 °C
 Flowing Pressure: 1,250 bar A
 Density: 1,251 kg/Nm3
 Viscosity: 0,0176 cPs
 K-Factor: 0,6437 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,33 kPa

Op. Density: 1,422

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin	
Flow Rate	22.000,00	18.000,00	4.400,00	Nm3/h
Reynolds No.	1.115.706	912.851	223.141	without unit
Permanent press. loss	0,800	0,530	0,030	mbar
Expansionsfactor	0,998	0,999	1,000	without unit
Velocity	27,88	22,81	5,58	m/sec.
Differential Pressure	13,080	8,750	0,520	mbar

Itabar-Type: IBF-25-ID495,4/6,3mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A62-E06
 Material Sensor: 316SS
 Note: mounting stud with flange DN40 PN16

Max. DeltaP: 60,10 mbar Max. Flow Rate: 47.251,48 Nm3/h
 Natural Freq.: 40,13 hz Operat. Freq.: 0,69 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE15041 (case 2)
 Serial No.:
 Pipe Data: ID= 495,400/6,300 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Nitrogen

Pipe Internal Dimensions: 495,400 mm
 Flowing Temperature: 19,900 °C
 Flowing Pressure: 1,170 bar A
 Density: 1,251 kg/Nm3
 Viscosity: 0,0174 cPs
 K-Factor: 0,6437 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,33 kPa

Op. Density: 1,346

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin	
Flow Rate	22.000,00	18.000,00	4.400,00	Nm3/h
Reynolds No.	1.128.531	923.343	225.706	without unit
Permanent press. loss	0,840	0,560	0,030	mbar
Expansionsfactor	0,998	0,998	1,000	without unit
Velocity:	29,45	24,10	5,89	m/sec.
Differential Pressure	13,830	9,250	0,550	mbar

Itabar-Type: IBF-25-ID495,4/6,3mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A62-E06
 Material Sensor 316SS
 Note: mounting stud with flange DN40 PN16

Max. DeltaP: 60,10 mbar
 Natural Freq.: 40,13 hz
 Max. Flow Rate: 45.963,82 Nm3/h
 Operat. Freq.: 0,69 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingeweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No.: 052/31607
 P. Order Number:
 Tag No.: FE15041 (case 3)
 Serial No.:
 Pipe Data: ID= 495,400/6,300 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Nitrogen

Pipe Internal Dimensions: 495,400 mm
 Flowing Temperature: 21,800 °C
 Flowing Pressure: 1,170 bar A
 Density: 1,251 kg/Nm³
 Viscosity: 0,0175 cPs
 K-Factor: 0,6437 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,33 kPa

Op. Density: 1,337

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin	
Flow Rate	22.000,00	18.000,00	4.400,00	Nm ³ /h
Reynolds No.	1.122.082	918.067	224.416	without unit
Permanent press. loss	0,850	0,570	0,030	mbar
Expansionsfactor	0,998	0,998	1,000	without unit
Velocity:	29,65	24,26	5,93	m/sec.
Differential Pressure	13,920	9,310	0,550	mbar

Itabar-Type: IBF-25-ID495,4/6,3mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A 67E06
 Material Sensor 316SS
 Note: mounting stud with flange DN40 PN16

Max. DeltaP: 60,10 mbar Max. Flow Rate: 45.815,56 Nm³/h
 Natural Freq.: 40,13 hz Operat. Freq.: 0,69 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE16073 (design point)
 Serial No.:
 Pipe Data: ID= 255,400/8,800 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Air

Pipe Internal Dimensions: 255,400 mm
 Flowing Temperature: 25,000 °C
 Flowing Pressure: 57,000 bar A
 Density: 1,293 kg/Nm3
 Viscosity: 0,0184 cPs
 K-Factor: 0,6155 without unit

Base Temperature	273,15 Kelvin
Base Pressure	101,30 kPa

Op. Density: 66,655

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin	
Flow Rate	65.000,00	52.000,00	13.000,00	Nm3/h
Reynolds No.	6.323.906	5.059.125	1.264.781	without unit
Permanent press. loss	4,380	2,800	0,180	mbar
Expansionsfactor	1,000	1,000	1,000	without unit
Velocity:	6,84	5,47	1,37	m/sec.
Differential Pressure	40,190	25,720	1,810	mbar

Itabar-Type: IBF-25-ID255,4/8,8mm-S-SM-1-1-B03-R-M-C3-0-KI-VL-T0-0-A03-A62-E06
 Material Sensor 316SS
 Note: mounting stud with flange DN40 PN63

Max. DeltaP 187,30 mbar Max. Flow Rate 140.322,02 Nm3/h
 Natural Freq.: 114,65 hz Operat. Freq.: 1,24 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE16073 (case 1)
 Serial No.:
 Pipe Data: ID= 255,400/8,800 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Air

Pipe Internal Dimensions: 255,400 mm
 Flowing Temperature: 25,100 °C
 Flowing Pressure: 55,000 bar A
 Density: 1,293 kg/Nm3
 Viscosity: 0,0184 cPs
 K-Factor: 0,6155 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,30 kPa

Op. Density: 64,294

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin	
Flow Rate	65.000,00	35.163,00	13.000,00	Nm3/h
Reynolds No.	6.323.906	3.421.039	1.264.781	without unit
Permanent press. loss	4,540	1,330	0,180	mbar
Expansionsfactor	1,000	1,000	1,000	without unit
Velocity:	7,09	3,83	1,42	m/sec.
Differential Pressure	41,660	12,180	1,570	mbar

Itabar-Type: IBF-25-ID255,4/8,8mm-S-SM-1-1-B03-R-M-C3-0-KI-VL-T0-0-A03-A4Z-E06
 Material Sensor: 316SS
 Note: mounting stud with flange DN40 PN63

Max. DeltaP: 187,30 mbar Max. Flow Rate: 137.815,19 Nm3/h
 Natural Freq.: 114,65 Hz Operat. Freq.: 1,24 Hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füllingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE16073 (case 2)
 Serial No.:
 Pipe Data: ID= 255,400/8,800 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Air

Pipe Internal Dimensions: 255,400 mm
 Flowing Temperature: 25,100 °C
 Flowing Pressure: 57,000 bar A
 Density: 1,293 kg/Nm³
 Viscosity: 0,0184 cPs
 K-Factor: 0,6155 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,30 kPa

Op. Density: 66,632

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin	
Flow Rate	65,000,00	43,910,00	13,000,00	Nm ³ /h
Reynolds No.	6,323,906	4,272,042	1,264,781	without unit
Permanent press. loss	4,380	2,000	0,180	mbar
Expansionsfactor	1,000	1,000	1,000	without unit
Velocity:	6,84	4,62	1,37	m/sec.
Differential Pressure	40,200	18,340	1,610	mbar

Itabar-Type: IBF-25-ID255,4/8,8mm-S-SM-1-1-B03-R-M-C3-0-KI-VL-T0-0-A03-A62-E06
 Material Sensor 316SS
 Note: mounting stud with flange DN40 PN63

Max. DeltaP: 187,30 mbar Max. Flow Rate: 140,298,48 Nm³/h
 Natural Freq.: 114,65 Hz Operat. Freq.: 1,24 Hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE16073 (case 3)
 Serial No.:
 Pipe Data: ID= 255,400/8,800 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Air

Pipe Internal Dimensions: 255,400 mm
 Flowing Temperature: 25,100 °C
 Flowing Pressure: 57,000 bar A
 Density: 1,293 kg/Nm³
 Viscosity: 0,0184 cPs
 K-Factor: 0,6155 without unit

Base Temperature	273,15 Kelvin
Base Pressure	101,30 kPa

Op. Density: 66,632

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin	
Flow Rate	65.000,00	59.074,00	13.000,00	Nm ³ /h
Reynolds No.	6.323.906	5.747.361	1.264.781	without unit
Permanent press. loss	4,380	3,620	0,180	mbar
Expansionsfactor	1,000	1,000	1,000	without unit
Velocity:	6,84	6,22	1,37	m/sec.
Differential Pressure	40,200	33,200	1,610	mbar

Itabar-Type: IBF-25-ID255,4/8,8mm-S-SM-1-1-B03-R-M-C3-0-KI-VL-T0-0-A03-A6Z-E06
 Material Sensor 316SS
 Note: mounting stud with flange DN40 PN63


Max. DeltaP: 187,30 mbar Max. Flow Rate: 140.298,48 Nm³/h
 Natural Freq.: 114,65 hz Operat. Freq.: 1,24 hz

Your specialist for measuring level and flow


Calculation header

Identifier **FE20001**
 Tag No. **HP-GAN EX COLDBOX**








Operating data

Medium  **Nitrogen**
 Operating pressure (absolute) **p1** **21,0** **bar(a)**
 Operating temperature **t1** **20,0** **°C**
 Gas **Gas, dry**

Properties at operating point

State  **Gaseous**
 Operating density (t1, p1) **p** **24,233** **kg/m³**
 Isentropic exponent (t1, p1) **k** **1,4334** **-**

Pipeline

Material number  **1.0254 St 37.0**
 Material group  **Steel I**
 Condition  **-**
 Pipe diameter  **Circular**
 Pipe class  **DIN**
 Size class  **DN 100**
 Pressure class  **PN 40**
 Linear coefficient of thermal expansion **αlin** **12,6** **E -6** **1/K**
 Pipe roughness **k** **0,03** **mm**

Flow element - operating values

Calculation standard **EN ISO 5167:2003**
 Primary device **Corner orifice**
 Calculation reference **Sizing: C and ε with 2/3 qm**
 Calculated value **d**
 Throttle orifice (20 °C) **d** **60,47** **mm**
 Pressure difference **Δp** **150,0** **mbar(a)**
 Mass flow rate **qm** **5.626,9** **kg/h**
 Volume flow rate (standard conditi...) **qn** **4.500,0** **m³/h**

Flow element - material

Material number **Device** **1.4571 X 6 Cr Ni Mo Ti 17 12**
 Material group **Device** **Steel V**
 Linear coefficient of thermal expansion **αlin,D** **17,0** **E -6** **1/K**
 Edge radius (20 °C) **rk** **0,018141** **mm**

More calculated values

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

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

Differential pressure flow element: FE20001

18.08.2005 14:57:52

No.	Δp	Δp	qm	qn	up	Meets stand...
1	10,0	15,0	1.784,0	1.426,0	2,269	☒
2	20,0	30,0	2.520,0	2.015,0	3,206	☒
3	30,0	45,0	3.084,0	2.466,0	3,924	☒
4	40,0	60,0	3.559,0	2.847,0	4,529	☒
5	50,0	75,0	3.978,0	3.181,0	5,061	☒
6	60,0	90,0	4.356,0	3.484,0	5,542	☒
7	70,0	105,0	4.703,0	3.761,0	5,985	☒
8	80,0	120,0	5.027,0	4.020,0	6,396	☒
9	90,0	135,0	5.330,0	4.263,0	6,782	☒
10	100,0	150,0	5.617,0	4.492,0	7,147	☒
<input type="checkbox"/> Flow coefficient (*)			C	0,60551	-	
Residual pressure loss			$\Delta\omega$	100,09	mbar(a)	
Power loss			$P\Delta\omega$	0,64712	kW	
Stream power			$P\Delta p$	0,97095	kW	
Flow velocity in pipeline			up	7,1595	m/s	
Flow velocity in flow element			uf	22,458	m/s	
Reynolds number (*)			Re	692.190,0	-	
Pipe inside diameter (t1)			Di,t1	107,1	mm	
Throttle orifice (t1)			d,t1	60,47	mm	
Diameter ratio			β	0,56461	-	
Relative pipe roughness			kr	2,8011	-	
Correction factor for pipe roughness			br	1,0	-	
Correction factor for edge radius			bk	1,0	-	
Expansion factor (*)			ε	0,99914	-	
Pressure ratio (*)			τ	0,99683	-	

Required inlet and outlet sections

☐ Specify as factors

Presentation

0.5% additional uncertainty - upstream

One or two 90° bends, S>30D		963,9	mm
Two 90° bends, 30D>S>5D, same plane		1.071,0	mm
Two 90° bends, 5D>S, same plane		1.071,0	mm
Two 90° bends, 30D>S>5D, vertical planes		1.927,8	mm
Two 90° bends, 5D>S, vertical planes		3.641,4	mm
Single 90° tee		963,9	mm
One or two 45° bends, S>22D		1.927,8	mm
Reducer		535,5	mm
Diffusor		963,9	mm
Gate valve, completely open		642,6	mm
Abrupt diameter reduction		1.606,5	mm
Thermometer pocket, $\phi < 0,03 Di$		321,3	mm
Thermometer pocket, $\phi > 0,03 Di$		1.071,0	mm
Required outlet section		642,6	mm




Uncertainties

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



Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e, ρ 1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of expansion factor (*)	e, ε	7,7517	E -3 %
Unc. of flow coefficient	e,C	0,5	%

Differential pressure flow element: FE20001

18.08.2005 14:57:52

Unc. of corrected flow coefficient	e,Cb 	1,0	%
Unc. of mass flow rate	e,qm 	2,7281	%
Additional uncertainty	e,ad 	0,5	%

Legend

-  Calculated value
 Lookup value

Calculation header

Identifier

FE20003

Tag No.

HP-GAN TO CUSTOMER

Operating data

Medium



Nitrogen

Operating pressure (absolute)

p1

21,0

bar(a)

Operating temperature

t1

20,0

°C

Gas

Gas, dry

Properties at operating point

State



Gaseous

Operating density (t1, p1)

ρ

24,233

kg/m³

Isentropic exponent (t1, p1)

κ

1,4334

-

Pipeline

Material number



1.0254 St 37.0

Material group



Steel I

Condition



-

Pipe diameter



Circular

● Pipe class



DIN

Size class

DN

DN 100

Pressure class

PN

PN 40

Linear coefficient of thermal expansion

αlin

12,6

E -6 1/K

Pipe roughness

k

0,03

mm

Flow element - operating values

Calculation standard

EN ISO 5167:2003

Primary device

Corner orifice

Calculation reference

Sizing: C and ε with 2/3 qm

Calculated value

d

Throttle orifice (20 °C)

d

60,47

mm

Pressure difference

Δp

150,0

mbar(a)

○ Mass flow rate

qm

5.626,9

kg/h

● Volume flow rate (standard conditi...

qn

4.500,0

m³/h

Flow element - material

Material number

Device

1.4571 X 6 Cr Ni Mo Ti 17 12

Material group

Device

Steel V

Linear coefficient of thermal expansion

αlin,D

17,0

E -6 1/K

Edge radius (20 °C)

rk

0,018141

mm

More calculated values

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

☑ Flow value table

Increment for value table

n

10,0

%

Differential pressure flow element: FE20003

No.	Δp	Δp	qm	qn	up	Meets stand...
1	10,0	15,0	1.784,0	1.426,0	2,269	☒
2	20,0	30,0	2.520,0	2.015,0	3,206	☒
3	30,0	45,0	3.084,0	2.466,0	3,924	☒
4	40,0	60,0	3.559,0	2.847,0	4,529	☒
5	50,0	75,0	3.978,0	3.181,0	5,061	☒
6	60,0	90,0	4.356,0	3.484,0	5,542	☒
7	70,0	105,0	4.703,0	3.761,0	5,985	☒
8	80,0	120,0	5.027,0	4.020,0	6,396	☒
9	90,0	135,0	5.330,0	4.263,0	6,782	☒
10	100,0	150,0	5.617,0	4.492,0	7,147	☒
<input type="checkbox"/> Flow coefficient (*)			C	0,60551	-	
Residual pressure loss			$\Delta\omega$	100,09	mbar(a)	
Power loss			$P\Delta\omega$	0,64712	kW	
Stream power			$P\Delta p$	0,97095	kW	
Flow velocity in pipeline			up	7,1595	m/s	
Flow velocity in flow element			uf	22,458	m/s	
Reynolds number (*)			Re	692.190,0	-	
Pipe inside diameter (t1)			Di,t1	107,1	mm	
Throttle orifice (t1)			d,t1	60,47	mm	
Diameter ratio			β	0,56461	-	
Relative pipe roughness			kr	2,8011	-	
Correction factor for pipe roughness			br	1,0	-	
Correction factor for edge radius			bk	1,0	-	
Expansion factor (*)			ϵ	0,99914	-	
Pressure ratio (*)			τ	0,99683	-	

Required inlet and outlet sections☐ Specify as factors

Presentation

0.5% additional uncertainty - upstream

One or two 90° bends, $S > 30D$		963,9	mm
Two 90° bends, $30D > S > 5D$, same plane		1.071,0	mm
Two 90° bends, $5D > S$, same plane		1.071,0	mm
Two 90° bends, $30D > S > 5D$, vertical planes		1.927,8	mm
Two 90° bends, $5D > S$, vertical planes		3.641,4	mm
Single 90° tee		963,9	mm
One or two 45° bends, $S > 22D$		1.927,8	mm
Reducer		535,5	mm
Diffusor		963,9	mm
Gate valve, completely open		642,6	mm
Abrupt diameter reduction		1.606,5	mm
Thermometer pocket, $\phi < 0,03 Di$		321,3	mm
Thermometer pocket, $\phi > 0,03 Di$		1.071,0	mm
Required outlet section		642,6	mm




Uncertainties

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



Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e, ρ_1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of expansion factor (*)	e, ϵ	7,7517	E -3 %
Unc. of flow coefficient	e,C	0,5	%

Differential pressure flow element: FE20003

18.08.2005 14:59:08

Unc. of corrected flow coefficient	e,Cb 	1,0	%
Unc. of mass flow rate	e,qm 	2,7281	%
Additional uncertainty	e,ad 	0,5	%

Legend

-  Calculated value
 Lookup value

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE20005 (design point)
 Serial No.:
 Pipe Data: ID= 597,400/6,300 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Nitrogen

Pipe Internal Dimensions: 597,400 mm
 Flowing Temperature: 20,000 °C
 Flowing Pressure: 1,150 bar A
 Density: 1,251 kg/Nm³
 Viscosity: 0,0174 cPs
 K-Factor: 0,6460 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,30 kPa

Op. Density: 1,323

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin
Flow Rate	35.000,00	28.000,00	7.000,00 Nm ³ /h
Reynolds No.	1.488,845	1.191,076	287,769 without unit
Permanent press. loss	0,790	0,500	0,030 mbar
Expansion factor	0,997	0,998	1,000 without unit
Velocity	32,78	26,23	6,56 m/sec
Differential Pressure	16,750	10,700	0,670 mbar

Itabar-Type: IBF-25-ID597,4/6,3mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A6Z-ED6
 Material Sensor: 316SS
 Note: mounting stud with flange DN40 PN16

Max. DeltaP: 42,90 mbar Max. Flow Rate: 56.178,08 Nm³/h
 Natural Freq.: 28,62 hz Operat. Freq.: 0,57 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

**WINFLOW 2.75 (I) Diff. Pressure Calculation
ITABAR - Flow - Sensor**

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füllingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE20005 (case 1)
 Serial No.:
 Pipe Date: ID= 597,400/6,300 mm - vertikal
 Date: 03.02.2005
 Person in charge TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Nitrogen

Pipe Internal Dimensions: 597,400 mm
 Flowing Temperature: 19,900 °C
 Flowing Pressure: 1,150 bar A
 Density: 1,251 kg/Nm3
 Viscosity: 0,0174 cPs
 K-Factor: 0,6460 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,30 kPa

Op: Density: 1,323

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin
Flow Rate	36.000,00	29.750,00	7.000,00 Nm3/h
Reynolds.No.	1.488.845	1.265.518	297.769 without unit
Permanent press. loss	0,790	0,570	0,030 mbar
Expansionsfactor	0,997	0,998	1,000 without unit
Velocity:	32,78	27,87	6,56 m/sec.
Differential Pressure	16,740	12,080	0,670 mbar

Itabar-Type: IBF-25-ID597,4/6,3mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-Q-A03-A62-E06
 Material Sensor 316SS
 Note: mounting stud with flange DN40 PN16

Max. DeltaP: 42,90 mbar Max. Flow Rate: 56.187,67 Nm3/h
 Natural Freq.: 28,82 hz Operat. Freq.: 0,57 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingsweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31807
 P. Order Number:
 Tag No.: FE20005 (case 2)
 Serial No.:
 Pipe Data: ID= 597,400/6,300 mm - vertikal
 Date: 03.02.2005
 Person in charge: TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Nitrogen

Pipe Internal Dimensions: 597,400 mm
 Flowing Temperature: 21,700 °C
 Flowing Pressure: 1,160 bar A
 Density: 1,251 kg/Nm³
 Viscosity: 0,0175 cPs
 K-Factor: 0,6460 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,30 kPa

Op. Density: 1,327

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin	
Flow Rate	35.000,00	29.750,00	7.000,00	Nm ³ /h
Reynolds No.	1.480.337	1.258.287	296.067	without unit
Permanent press. loss	0,790	0,570	0,030	mbar
Expansionsfactor	0,997	0,998	1,000	without unit
Velocity:	32,69	27,78	6,64	m/sec.
Differential Pressure	18,700	12,040	0,660	mbar

Itabar-Type: IBF-25-ID597,4/6,3mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A12-E06
 Material Sensor: 316SS
 Note: mounting stud with flange DN40 PN16

Max. DeltaP: 42,90 mbar Max. Flow Rate: 66.258,64 Nm³/h
 Natural Freq.: 28,62 hz Operat. Freq.: 0,57 hz

Your specialist for measuring level and flow

INTRA-AUTOMATION GmbH

D-41515 Grevenbroich * Otto-Hahn-Str. 20 * Tel: +49 2181-68761 * Fax: +49 2181-64492

WINFLOW 2.75 (I) Diff. Pressure Calculation ITABAR - Flow - Sensor

Company: Air Liquide AGS GmbH
 Name(capital letters): Herr Möller
 Street: Füttingweg 34
 Zip Code/City: 47805 Krefeld
 Offer-/Com. No: 052/31607
 P. Order Number:
 Tag No.: FE20005 (case 3)
 Serial No.:
 Pipe Data: ID= 597,400/6,300 mm - vertikal
 Date: 03.02.2005
 Person in charge TK

Calculation: Volume Rate of Flow Gas(Standard Cond.)
 Fluid: Nitrogen

Pipe Internal Dimensions: 597,400 mm
 Flowing Temperature: 23,000 °C
 Flowing Pressure: 1,150 bar A
 Density: 1,251 kg/Nm3
 Viscosity: 0,0175 cPs
 K-Factor: 0,6460 without unit

Base Temperature: 273,15 Kelvin
 Base Pressure: 101,30 kPa

Op. Density: 1,309

Comp. factor at operating cond.: 1,0000
 Comp. factor at norm cond.: 1,0000
 Ratio of Specific Heat: 1,40

	QMax	QNorm	QMin	
Flow Rate	35.000,00	29.750,00	7.000,00	Nm3/h
Reynolds No.	1.480.337	1.258.287	296.067	without unit
Permanent press. loss	0,800	0,570	0,030	mbar
Expansionsfactor	0,997	0,998	1,000	without unit
Velocity:	33,14	28,16	6,63	m/sec.
Differential Pressure	16,920	12,200	0,670	mbar

Itabar-Type: IBF-25-ID597,4/6,3mm-S-SM-1-1-B01-R-M-C10-KI-VL-T0-0-A03-A62-E06
 Material Sensor 316SS
 Note: mounting stud with flange DN40 PN16


Max. DeltaP: 42,90 mbar Max. Flow Rate: 55.892,88 Nm3/h
 Natural Freq.: 28,62.hz Operat. Freq.: 0,57.hz

Your specialist for measuring level and flow


Calculation header

Identifier **FE20011**
 Tag No. **HP-GOX EX COLDBOX**






Operating data

Medium  **Oxygen**
 Operating pressure (absolute) **p1** **28,0** **bar(a)**
 Operating temperature **t1** **20,0** **°C**
 Gas **Gas, dry**

Properties at operating point

State  **Gaseous**
 Operating density (t1, p1) **p** **37,451** **kg/m³**
 Isentropic exponent (t1, p1) **κ** **1,4267** **-**

Pipeline

Material number  **1.4571 X 6 Cr Ni Mo Ti 17 12**
 Material group  **Steel V**
 Condition  **-**
 Pipe diameter  **Circular**
☒ Pipe class  **DIN**
 Size class **DN** **250**
 Pressure class **PN** **40**
 Linear coefficient of thermal expansion **αlin** **17,0** **E -6 1/K**
 Pipe roughness **k** **0,03** **mm**

Flow element - operating values

Calculation standard **EN ISO 5167:2003**
 Primary device **Corner orifice**
 Calculation reference **Sizing: C and ε with 2/3 qm**
 Calculated value **d**
 Throttle orifice (20 °C) **d** **142,83** **mm**
 Pressure difference **Δp** **250,0** **mbar(a)**
☐ Mass flow rate **qm** **50.017,0** **kg/h**
☒ Volume flow rate (standard conditi... **qn** **35.000,0** **m³/h**

Flow element - material

Material number **Device** **1.4571 X 6 Cr Ni Mo Ti 17 12**
 Material group **Device** **Steel V**
 Linear coefficient of thermal expansion **αlin,D** **17,0** **E -6 1/K**
 Edge radius (20 °C) **rk** **0,042848** **mm**

More calculated values

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

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

Differential pressure flow element: FE20011

18.08.2005 15:05:53

No.	Δp	Δp	qm	qn	up	Meets stand...
1	10,0	25,0	15.850,0	11.090,0	2,234	<input checked="" type="checkbox"/>
2	20,0	50,0	22.390,0	15.670,0	3,157	<input checked="" type="checkbox"/>
3	30,0	75,0	27.410,0	19.180,0	3,865	<input checked="" type="checkbox"/>
4	40,0	100,0	31.640,0	22.140,0	4,461	<input checked="" type="checkbox"/>
5	50,0	125,0	35.360,0	24.740,0	4,986	<input checked="" type="checkbox"/>
6	60,0	150,0	38.720,0	27.100,0	5,46	<input checked="" type="checkbox"/>
7	70,0	175,0	41.810,0	29.260,0	5,895	<input checked="" type="checkbox"/>
8	80,0	200,0	44.680,0	31.270,0	6,3	<input checked="" type="checkbox"/>
9	90,0	225,0	47.380,0	33.150,0	6,68	<input checked="" type="checkbox"/>
10	100,0	250,0	49.930,0	34.940,0	7,04	<input checked="" type="checkbox"/>
<input type="checkbox"/> Flow coefficient (*)			C	0,60425	-	
Residual pressure loss			$\Delta\omega$	170,27	mbar(a)	
Power loss			$P\Delta\omega$	6,336	kW	
Stream power			$P\Delta p$	9,3161	kW	
Flow velocity in pipeline			up	7,0523	m/s	
Flow velocity in flow element			uf	23,155	m/s	
Reynolds number (*)			Re	2,1991	E 6 -	
Pipe inside diameter (t1)			Di,t1	258,8	mm	
Throttle orifice (t1)			d,t1	142,83	mm	
Diameter ratio			β	0,55188	-	
Relative pipe roughness			kr	1,1592	-	
Correction factor for pipe roughness			br	1,0	-	
Correction factor for edge radius			bk	1,0	-	
Expansion factor (*)			ε	0,99893	-	
Pressure ratio (*)			τ	0,99603	-	

Required inlet and outlet sections

☐ Specify as factors

Presentation

0.5% additional uncertainty - upstream




One or two 90° bends, $S > 30D$		2.329,2	mm
Two 90° bends, $30D > S > 5D$, same plane		2.588,0	mm
Two 90° bends, $5D > S$, same plane		2.588,0	mm
Two 90° bends, $30D > S > 5D$, vertical planes		4.658,4	mm
Two 90° bends, $5D > S$, vertical planes		8.799,2	mm
Single 90° tee		2.329,2	mm
One or two 45° bends, $S > 22D$		4.658,4	mm
Reducer		1.294,0	mm
Diffusor		2.329,2	mm
Gate valve, completely open		1.552,8	mm
Abrupt diameter reduction		3.882,0	mm
Thermometer pocket, $\phi < 0,03 Di$		776,4	mm
Thermometer pocket, $\phi > 0,03 Di$		2.588,0	mm
Required outlet section		1.552,8	mm

Uncertainties



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

Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e,p1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of expansion factor (*)	e, ε	9,7349	E -3 %
Unc. of flow coefficient	e,C	0,5	%

Differential pressure flow element: FE20011

Unc. of corrected flow coefficient	e,Cb 	1,0	%
Unc. of mass flow rate	e,qm 	2,7277	%
Additional uncertainty	e,ad 	0,5	%

Legend

-  Calculated value
 Lookup value

Calculation headerIdentifier
Tag No.**FE20013**
HP-GOX TO CUSTOMER**Operating data**Medium
Operating pressure (absolute)
Operating temperature
Gasp1
t1**Oxygen**
28,0
20,0
bar(a)
°C
Gas, dry**Properties at operating point**State
Operating density (t1, p1)
Isentropic exponent (t1, p1)
ρ
κ**Gaseous**
37,451
1,4267
kg/m³
-**Pipeline**Material number
Material group
Condition
Pipe diameter
● Pipe class
Size class
Pressure class
Linear coefficient of thermal expansion
Pipe roughness

DN
PN
αlin
k**1.4571 X 6 Cr Ni Mo Ti 17 12**
Steel V
-
Circular
DIN
DN 250
PN 40
17,0
0,03
E -6
1/K
mm**Flow element - operating values**Calculation standard
Primary device
Calculation reference
Calculated value
Throttle orifice (20 °C)
Pressure difference
○ Mass flow rate
● Volume flow rate (standard conditi...d
Δp
qm
qn**EN ISO 5167:2003**
Corner orifice
Sizing: C and ε with 2/3 qm
d
142,83
250,0
50.017,0
35.000,0
mm
mbar(a)
kg/h
m³/h**Flow element - material**Material number
Material group
Linear coefficient of thermal expansion
Edge radius (20 °C)Device
Device
αlin,D
rk**1.4571 X 6 Cr Ni Mo Ti 17 12**
Steel V
17,0
0,042848
E -6
1/K
mm**More calculated values**

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

☒ Flow value table

Increment for value table

n

10,0**%**

Differential pressure flow element: FE20013

18.08.2005 15:15:12

No.	Δp	Δp	qm	qn	up	Meets stand...
1	10,0	25,0	15.850,0	11.090,0	2,234	☒
2	20,0	50,0	22.390,0	15.670,0	3,157	☒
3	30,0	75,0	27.410,0	19.180,0	3,865	☒
4	40,0	100,0	31.640,0	22.140,0	4,461	☒
5	50,0	125,0	35.360,0	24.740,0	4,986	☒
6	60,0	150,0	38.720,0	27.100,0	5,46	☒
7	70,0	175,0	41.810,0	29.260,0	5,895	☒
8	80,0	200,0	44.680,0	31.270,0	6,3	☒
9	90,0	225,0	47.380,0	33.150,0	6,68	☒
10	100,0	250,0	49.930,0	34.940,0	7,04	☒
<input type="checkbox"/> Flow coefficient (*)			C	0,60425	-	
Residual pressure loss			$\Delta\omega$	170,27	mbar(a)	
Power loss			P $\Delta\omega$	6,336	kW	
Stream power			P Δp	9,3161	kW	
Flow velocity in pipeline			up	7,0523	m/s	
Flow velocity in flow element			uf	23,155	m/s	
Reynolds number (*)			Re	2,1991	E 6 -	
Pipe inside diameter (t1)			Di,t1	258,8	mm	
Throttle orifice (t1)			d,t1	142,83	mm	
Diameter ratio			β	0,55188	-	
Relative pipe roughness			kr	1,1592	-	
Correction factor for pipe roughness			br	1,0	-	
Correction factor for edge radius			bk	1,0	-	
Expansion factor (*)			ε	0,99893	-	
Pressure ratio (*)			τ	0,99603	-	

Required inlet and outlet sections

☐ Specify as factors

Presentation

0.5% additional uncertainty - upstream

One or two 90° bends, S>30D	2.329,2	mm
Two 90° bends, 30D>S>5D, same plane	2.588,0	mm
Two 90° bends, 5D>S, same plane	2.588,0	mm
Two 90° bends, 30D>S>5D, vertical planes	4.658,4	mm
Two 90° bends, 5D>S, vertical planes	8.799,2	mm
Single 90° tee	2.329,2	mm
One or two 45° bends, S>22D	4.658,4	mm
Reducer	1.294,0	mm
Diffusor	2.329,2	mm
Gate valve, completely open	1.552,8	mm
Abrupt diameter reduction	3.882,0	mm
Thermometer pocket, $\phi < 0,03$ Di	776,4	mm
Thermometer pocket, $\phi > 0,03$ Di	2.588,0	mm
Required outlet section	1.552,8	mm




Uncertainties

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



Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e, ρ 1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of expansion factor (*)	e, ε	9,7349	E -3 %
Unc. of flow coefficient	e,C	0,5	%

Differential pressure flow element: FE20013

18.08.2005 15:15:12

Unc. of corrected flow coefficient	e,Cb 	1,0	%
Unc. of mass flow rate	e,qm 	2,7277	%
Additional uncertainty	e,ad 	0,5	%

Legend

-  Calculated value
 Lookup value

Calculation headerIdentifier
Tag No.**FE22013**
LIN TO LP-COLUMN**Operating data**Medium
Operating pressure (absolute)
Operating temperaturep1
t1**Nitrogen****4,7**
-191,6**bar(a)**
°C**Properties at operating point**State
Boiling pressure (t1)
Operating density (t1, p1)pv1
p**Liquid****1,6167**
787,6**bar(a)**
kg/m³**Pipeline**Material number
Material group
Condition
Pipe diameter
● Pipe outside diameter
Pipe wall thickness
Linear coefficient of thermal expansion
Pipe roughnessDo
s
αlin
k**Aluminium**
Aluminium
smooth, without deposit
Circular**168,3**
7,1
19,647
0,02**mm**
mm
E -6 1/K
mm**Flow element - operating values**Calculation standard
Primary device
Calculation reference
Calculated value
Throttle orifice (20 °C)
Pressure difference
● Mass flow rate
○ Volume flow rated
Δp
qm
qv**EN ISO 5167:2003**
Corner orifice
Sizing: C and ε with 2/3 qm
Δp**75,152**
125,0
43.764,0
55,567**mm**
mbar(a)
kg/h
m³/h**Flow element - material**Material number
Material group
Linear coefficient of thermal expansion
Edge radius (20 °C)Device
Device
αlin,D
rk**1.4571 X 6 Cr Ni Mo Ti 17 12**
Steel V**16,196**
0,022546**E -6 1/K**
mm**More calculated values**

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

☒ Flow value table

Increment for value table

n

10,0**%**

Differential pressure flow element: FE22013

18.08.2005 15:15:45

No.	Δp	Δp	qm	qv	up	Meets stand...
1	10,0	12,5	13.860,0	17,6	0,2643	<input checked="" type="checkbox"/>
2	20,0	25,0	19.580,0	24,87	0,3735	<input checked="" type="checkbox"/>
3	30,0	37,5	23.980,0	30,44	0,4572	<input checked="" type="checkbox"/>
4	40,0	50,0	27.680,0	35,15	0,5278	<input checked="" type="checkbox"/>
5	50,0	62,5	30.940,0	39,29	0,59	<input checked="" type="checkbox"/>
6	60,0	75,0	33.890,0	43,03	0,6463	<input checked="" type="checkbox"/>
7	70,0	87,5	36.600,0	46,48	0,698	<input checked="" type="checkbox"/>
8	80,0	100,0	39.130,0	49,68	0,7461	<input checked="" type="checkbox"/>
9	90,0	112,5	41.500,0	52,69	0,7913	<input checked="" type="checkbox"/>
10	100,0	125,0	43.740,0	55,54	0,834	<input checked="" type="checkbox"/>
<input type="checkbox"/> Flow coefficient (*)			C	0,60398	-	
Residual pressure loss			$\Delta\omega$	93,051	mbar(a)	
Power loss			$P\Delta\omega$	0,14363	kW	
Stream power			$P\Delta p$	0,19294	kW	
Flow velocity in pipeline			up	0,83452	m/s	
Flow velocity in flow element			uf	3,5036	m/s	
Reynolds number (*)			Re	535.320,0	-	
Pipe inside diameter (t1)			Di,t1	153,46	mm	
Throttle orifice (t1)			d,t1	74,895	mm	
Diameter ratio			β	0,48804	-	
Relative pipe roughness			kr	1,3033	-	
Correction factor for pipe roughness			br	1,0	-	
Correction factor for edge radius			bk	1,0	-	

Required inlet and outlet sections

☐ Specify as factors

Presentation

0.5% additional uncertainty - upstream



One or two 90° bends, $S > 30D$		460,38	mm
Two 90° bends, $30D > S > 5D$, vertical planes		2.762,3	mm
Two 90° bends, $5D > S$, vertical planes		3.836,5	mm
Single 90° tee		460,38	mm
One or two 45° bends, $S > 22D$		1.381,1	mm
Diffusor		1.227,7	mm
Gate valve, completely open		920,76	mm
Abrupt diameter reduction		2.301,9	mm
Thermometer pocket, $\varphi < 0,03 Di$		460,38	mm
Thermometer pocket, $\varphi > 0,03 Di$		1.534,6	mm
Required outlet section		920,76	mm

Uncertainties

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

Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e,p1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of flow coefficient	e,C	0,5	%
Unc. of corrected flow coefficient	e,Cb	1,0	%
Unc. of mass flow rate	e,qm	2,7266	%
Additional uncertainty	e,ad	0,5	%

Legend

-  Calculated value
-  Lookup value

Calculation headerIdentifier
Tag No.**FE22043**
GOX FROM LP COLUMN**Operating data**Medium
Operating pressure (absolute)
Operating temperature
On boiling point curve
Gas

	Oxygen		
p1	1,38	bar(a)	
t1	93,25	K	
	Gas/vapor		
	Gas, dry		

Properties at operating pointState
Operating density (t1, p1)
Isentropic exponent (t1, p1)

	Saturated		
ρ	5,9338	kg/m³	
κ	1,3896	-	

PipelineMaterial number
Material group
Condition
Pipe diameter
● Pipe outside diameter
Pipe wall thickness
Linear coefficient of thermal expansion
Pipe roughness

	Aluminium		
	Aluminium		
	smooth, without deposit		
	Circular		
Do	168,3	mm	
s	7,1	mm	
α_{lin}	19,852	E -6 1/K	
k	0,02	mm	

Flow element - operating valuesCalculation standard
Primary device
Calculation reference
Calculated value
Diffusor angle of venturi tube
Throttle orifice (20 °C)
Pressure difference
○ Mass flow rate
● Volume flow rate (standard conditi...

	EN ISO 5167:2003		
	Venturi nozzle		
	Recalculation: C and ϵ with qm		
	d		
ϕ	7,5	-	
d	31,461	mm	
Δp	60,0	mbar(a)	
qm	714,53	kg/h	
qn	500,0	m³/h	

Flow element - materialMaterial number
Material group
Linear coefficient of thermal expansion

Device	1.4571 X 6 Cr Ni Mo Ti 17 12		
Device	Steel V		
$\alpha_{lin,D}$	16,24	E -6 1/K	

More calculated values

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

☒ Flow value table

Increment for value table

n	5,0	%
---	-----	---

Differential pressure flow element: FE22043

No.	Δp	Δp	qm	qn	up	Meets stand...
1	5,0	3,0	163,5	114,4	0,4136	<input type="checkbox"/>
2	10,0	6,0	230,9	161,6	0,5842	<input type="checkbox"/>
3	15,0	9,0	282,5	197,7	0,7147	<input type="checkbox"/>
4	20,0	12,0	325,8	228,0	0,8243	<input type="checkbox"/>
5	25,0	15,0	363,8	254,6	0,9205	<input type="checkbox"/>
6	30,0	18,0	398,1	278,6	1,007	<input type="checkbox"/>
7	35,0	21,0	429,4	300,5	1,087	<input type="checkbox"/>
8	40,0	24,0	458,5	320,9	1,16	<input type="checkbox"/>
9	45,0	27,0	485,8	339,9	1,229	<input type="checkbox"/>
10	50,0	30,0	511,4	357,9	1,294	<input type="checkbox"/>
11	55,0	33,0	535,8	374,9	1,355	<input type="checkbox"/>
12	60,0	36,0	558,9	391,1	1,414	<input type="checkbox"/>
13	65,0	39,0	581,0	406,6	1,47	<input type="checkbox"/>
14	70,0	42,0	602,2	421,4	1,524	<input type="checkbox"/>
15	75,0	45,0	622,6	435,7	1,575	<input type="checkbox"/>
16	80,0	48,0	642,2	449,4	1,625	<input type="checkbox"/>
17	85,0	51,0	661,2	462,7	1,673	<input type="checkbox"/>
18	90,0	54,0	679,5	475,5	1,719	<input type="checkbox"/>
19	95,0	57,0	697,3	487,9	1,764	<input type="checkbox"/>
20	100,0	60,0	714,5	500,0	1,808	<input type="checkbox"/>

<input type="checkbox"/> Flow coefficient (*)	C	0,98565	-
Residual pressure loss - lower limit	$\Delta\omega, \min$	7,8148	mbar(a)
Residual pressure loss - upper limit	$\Delta\omega, \max$	15,705	mbar(a)
Power loss	$P\Delta\omega$	0,039504	kW
Stream power	$P\Delta p$	0,20519	kW
Flow velocity in pipeline	up	1,8078	m/s
Flow velocity in flow element	uf	43,308	m/s
Reynolds number (*)	Re	240.980,0	-
Pipe inside diameter (t1)	Di,t1	153,49	mm
Throttle orifice (t1)	d,t1	31,359	mm
Diameter ratio	β	0,20431	-
Relative pipe roughness	kr	1,303	-
Correction factor for pipe roughness	br	1,0	-
Expansion factor (*)	ϵ	0,9762	-
Pressure ratio (*)	τ	0,95652	-

Required inlet and outlet sections

<input type="checkbox"/> Specify as factors			
Presentation		0.5% additional uncertainty - upstream	
Single 90° bend or tee	<input type="checkbox"/>	920,93	mm
Several 90° bends, same plane	<input type="checkbox"/>	1.074,4	mm
Several 90° bends, different planes	<input type="checkbox"/>	2.609,3	mm
Diffusor	<input type="checkbox"/>	1.227,9	mm
Globe valve, completely open	<input type="checkbox"/>	1.381,4	mm
Gate valve, completely open	<input type="checkbox"/>	920,93	mm
Abrupt diameter reduction	<input type="checkbox"/>	2.302,3	mm
Thermometer pocket, $\phi < 0,03 Di$	<input type="checkbox"/>	460,47	mm
Thermometer pocket, $\phi > 0,03 Di$	<input type="checkbox"/>	1.534,9	mm
Required outlet section	<input type="checkbox"/>	613,95	mm








Uncertainties

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


Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%

Differential pressure flow element: FE22043




18.08.2005 15:16:34

Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e, ρ_1	5,0	%
Unc. of correction factor br	e,br 	0,0	%
Unc. of correction factor bk	e,bk 	0,0	%
Unc. of expansion factor (*)	e, ϵ 	0,17393	%
Unc. of flow coefficient	e,C 	1,2026	%
Unc. of corrected flow coefficient	e,Cb 	1,7026	%
Unc. of mass flow rate	e,qm 	3,0592	%
Additional uncertainty	e,ad 	0,5	%

Warning:

 Device not according to standard. d (31,46 mm) < 50 mm (Venturi nozzle)

Legend

-  Calculated value
-  Lookup value
-  Warning

Calculation header

Identifier

FE24101

Tag No.

HP-AIR TO EXPANDER TURBINE 1

Operating data

Medium



Air (dry)

Operating pressure (absolute)

p1

56,65

bar(a)

Operating temperature

t1

182,0

K

Gas

Gas, dry

Properties at operating point

State



Gaseous

Operating density (t1, p1)

ρ

132,86

kg/m³

Isentropic exponent (t1, p1)

κ

1,5969

-

Pipeline

Material number



Aluminium

Material group



Aluminium

Condition



smooth, without deposit

Pipe diameter

Circular

☒ Pipe outside diameter

Do

114,3

mm

Pipe wall thickness

s

6,0

mm

Linear coefficient of thermal expansion

αlin

21,405

E -6

1/K

Pipe roughness

k

0,02

mm

Flow element - operating values

Calculation standard

EN ISO 5167:2003

Primary device

Corner orifice

Calculation reference

Sizing: C and ε with 2/3 qm

Calculated value

d

Throttle orifice (20 °C)

d

76,668

mm

Pressure difference

Δp

100,0

mbar(a)

☐ Mass flow rate

qm

19.394,0

kg/h

☒ Volume flow rate (standard conditi...

qn

15.000,0

m³/h

Flow element - material

Material number

Device

1.4571 X 6 Cr Ni Mo Ti 17 12

Material group

Device

Steel V

Linear coefficient of thermal expansion

αlin,D

16,578

E -6

1/K

Edge radius (20 °C)

rk

0,023

mm

More calculated values

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

☒ Flow value table

Increment for value table

n

10,0

%

Differential pressure flow element: FE24101

18.08.2005 15:20:48

No.	Δp	Δp	qm	qn	up	Meets stand...
1	10,0	10,0	6.149,0	4.756,0	1,572	☒
2	20,0	20,0	8.685,0	6.717,0	2,22	☒
3	30,0	30,0	10.630,0	8.221,0	2,717	☒
4	40,0	40,0	12.270,0	9.488,0	3,136	☒
5	50,0	50,0	13.710,0	10.600,0	3,504	☒
6	60,0	60,0	15.020,0	11.610,0	3,838	☒
7	70,0	70,0	16.210,0	12.540,0	4,144	☒
8	80,0	80,0	17.330,0	13.400,0	4,429	☒
9	90,0	90,0	18.380,0	14.210,0	4,697	☒
10	100,0	100,0	19.370,0	14.980,0	4,95	☒

<input type="checkbox"/> Flow coefficient (*)	C	0,59435	-
Residual pressure loss	$\Delta\omega$	45,489	mbar(a)
Power loss	$P\Delta\omega$	0,18453	kW
Stream power	$P\Delta p$	0,40586	kW
Flow velocity in pipeline	up	4,957	m/s
Flow velocity in flow element	uf	8,816	m/s
Reynolds number (*)	Re	2,9957	E 6 -
Pipe inside diameter (t1)	Di,t1	102,06	mm
Throttle orifice (t1)	d,t1	76,527	mm
Diameter ratio	β	0,74985	-
Relative pipe roughness	kr	1,9597	-
Correction factor for pipe roughness	br	1,0	-
Correction factor for edge radius	bk	1,0	-
Expansion factor (*)	ε	0,99974	-
Pressure ratio (*)	τ	0,99922	-

Required inlet and outlet sections

☐ Specify as factors

Presentation

0.5% additional uncertainty - upstream

One or two 90° bends, S>30D		2.041,1	mm
Two 90° bends, 30D>S>5D, same plane		1.837,0	mm
Two 90° bends, 5D>S, same plane		2.041,1	mm
Two 90° bends, 30D>S>5D, vertical planes		2.041,1	mm
Two 90° bends, 5D>S, vertical planes		1.837,0	mm
Single 90° tee		1.837,0	mm
One or two 45° bends, S>22D		1.837,0	mm
Reducer		612,34	mm
Diffusor		1.428,8	mm
Gate valve, completely open		918,51	mm
Abrupt diameter reduction		1.530,8	mm
Thermometer pocket, $\varphi < 0,03 Di$		306,17	mm
Thermometer pocket, $\varphi > 0,03 Di$		1.020,6	mm
Required outlet section		714,4	mm




Uncertainties

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



Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e,p1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of expansion factor (*)	e, ε	1,7196	E -3 %
Unc. of flow coefficient	e,C	0,74975	%

Differential pressure flow element: FE24101

18.08.2005 15:20:48

Unc. of corrected flow coefficient	e,Cb 	1,2497	%
Unc. of mass flow rate	e,qm 	2,8549	%
Additional uncertainty	e,ad 	0,5	%

Legend

-  Calculated value
 Lookup value

Calculation header

Identifier

FE24201

Tag No.

HP-AIR TO EXPANDER TURBINE 2

Operating data

Medium



Air (dry)

Operating pressure (absolute)

p1

56,65

bar(a)

Operating temperature

t1

182,0

K

Gas

Gas, dry

Properties at operating point

State



Gaseous

Operating density (t1, p1)

ρ

132,86

kg/m³

Isentropic exponent (t1, p1)

κ

1,5969

-

Pipeline

Material number



Aluminium

Material group



Aluminium

Condition



smooth, without deposit

Pipe diameter

Circular

☉ Pipe outside diameter

Do

114,3

mm

Pipe wall thickness

s

6,0

mm

Linear coefficient of thermal expansion

αlin

21,405

E -6

1/K

Pipe roughness

k

0,02

mm

Flow element - operating values

Calculation standard

EN ISO 5167:2003

Primary device

Corner orifice

Calculation reference

Sizing: C and ε with 2/3 qm

Calculated value

d

Throttle orifice (20 °C)

d

76,668

mm

Pressure difference

Δp

100,0

mbar(a)

○ Mass flow rate

qm

19.394,0

kg/h

☉ Volume flow rate (standard conditi...

qn

15.000,0

m³/h

Flow element - material

Material number

Device

1.4571 X 6 Cr Ni Mo Ti 17 12

Material group

Device

Steel V

Linear coefficient of thermal expansion

αlin,D

16,578

E -6

1/K

Edge radius (20 °C)

rk

0,023

mm

More calculated values

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

☒ Flow value table

Increment for value table

n

10,0

%

Differential pressure flow element: FE24201

18.08.2005 15:22:18

No.	Δp	Δp	qm	qn	up	Meets stand...
1	10,0	10,0	6.149,0	4.756,0	1,572	☒
2	20,0	20,0	8.685,0	6.717,0	2,22	☒
3	30,0	30,0	10.630,0	8.221,0	2,717	☒
4	40,0	40,0	12.270,0	9.488,0	3,136	☒
5	50,0	50,0	13.710,0	10.600,0	3,504	☒
6	60,0	60,0	15.020,0	11.610,0	3,838	☒
7	70,0	70,0	16.210,0	12.540,0	4,144	☒
8	80,0	80,0	17.330,0	13.400,0	4,429	☒
9	90,0	90,0	18.380,0	14.210,0	4,697	☒
10	100,0	100,0	19.370,0	14.980,0	4,95	☒

<input type="checkbox"/> Flow coefficient (*)	C	0,59435	-
Residual pressure loss	$\Delta\omega$	45,489	mbar(a)
Power loss	$P\Delta\omega$	0,18453	kW
Stream power	$P\Delta p$	0,40586	kW
Flow velocity in pipeline	up	4,957	m/s
Flow velocity in flow element	uf	8,816	m/s
Reynolds number (*)	Re	2,9957	E 6 -
Pipe inside diameter (t1)	Di,t1	102,06	mm
Throttle orifice (t1)	d,t1	76,527	mm
Diameter ratio	β	0,74985	-
Relative pipe roughness	kr	1,9597	-
Correction factor for pipe roughness	br	1,0	-
Correction factor for edge radius	bk	1,0	-
Expansion factor (*)	ε	0,99974	-
Pressure ratio (*)	τ	0,99922	-

Required inlet and outlet sections

☐ Specify as factors

Presentation

0.5% additional uncertainty - upstream

One or two 90° bends, S>30D		2.041,1	mm
Two 90° bends, 30D>S>5D, same plane		1.837,0	mm
Two 90° bends, 5D>S, same plane		2.041,1	mm
Two 90° bends, 30D>S>5D, vertical planes		2.041,1	mm
Two 90° bends, 5D>S, vertical planes		1.837,0	mm
Single 90° tee		1.837,0	mm
One or two 45° bends, S>22D		1.837,0	mm
Reducer		612,34	mm
Diffusor		1.428,8	mm
Gate valve, completely open		918,51	mm
Abrupt diameter reduction		1.530,8	mm
Thermometer pocket, $\phi < 0,03$ Di		306,17	mm
Thermometer pocket, $\phi > 0,03$ Di		1.020,6	mm
Required outlet section		714,4	mm




Uncertainties

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



Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e, ρ 1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of expansion factor (*)	e, ε	1,7196	E -3 %
Unc. of flow coefficient	e,C	0,74975	%

Differential pressure flow element: FE24201

18.08.2005 15:22:18

Unc. of corrected flow coefficient	e,Cb 	1,2497	%
Unc. of mass flow rate	e,qm 	2,8549	%
Additional uncertainty	e,ad 	0,5	%

Legend

-  Calculated value
 Lookup value

Calculation header

Identifier

FE40011 Blende

Tag No.

SIDEARMGAS FROM LP COLUMN

Operating data

Medium



Oxygen

Operating pressure (absolute)

p1

1,35

bar(a)

Operating temperature

t1

93,025

K

On boiling point curve

Gas/vapor

Gas

Gas, dry

Properties at operating point

State



Saturated

Operating density (t1, p1)

ρ

5,815

kg/m³

Isentropic exponent (t1, p1)

κ

1,3895

-

Pipeline

Material number



Aluminium

Material group



Aluminium

Condition



smooth, without deposit

Pipe diameter

Circular

☒ Pipe outside diameter

Do

508,0

mm

Pipe wall thickness

s

6,0

mm

Linear coefficient of thermal expansion

αlin

19,848

E -6

1/K

Pipe roughness

k

0,02

mm

Flow element - operating values

Calculation standard

EN ISO 5167:2003

Primary device

Venturi nozzle

Calculation reference

Sizing: C and ε with 2/3 qm

Calculated value

d

Diffusor angle of venturi tube

φ

7,5

-

Throttle orifice (20°C)

d

257,74

mm

Pressure difference

Δp

45,0

mbar(a)

☐ Mass flow rate

qm

42.872,0

kg/h

☒ Volume flow rate (standard conditi...)

qn

30.000,0

m³/h

Flow element - material

Material number

Device

1.4571 X 6 Cr Ni Mo Ti 17 12

Material group

Device

Steel V

Linear coefficient of thermal expansion

αlin,D

16,24

E -6

1/K

More calculated values

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

☒ Flow value table

Increment for value table

n

10,0

%

Differential pressure flow element: FE40011 Blende

18.08.2005 15:23:18

No.	Δp	Δp	qm	qn	up	Meets stand...
1	10,0	4,5	13.650,0	9.553,0	3,402	<input checked="" type="checkbox"/>
2	20,0	9,0	19.270,0	13.480,0	4,801	<input type="checkbox"/>
3	30,0	13,5	23.550,0	16.480,0	5,869	<input type="checkbox"/>
4	40,0	18,0	27.140,0	18.990,0	6,763	<input type="checkbox"/>
5	50,0	22,5	30.280,0	21.190,0	7,546	<input type="checkbox"/>
6	60,0	27,0	33.100,0	23.160,0	8,25	<input type="checkbox"/>
7	70,0	31,5	35.680,0	24.970,0	8,893	<input type="checkbox"/>
8	80,0	36,0	38.070,0	26.640,0	9,487	<input type="checkbox"/>
9	90,0	40,5	40.300,0	28.200,0	10,04	<input type="checkbox"/>
10	100,0	45,0	42.390,0	29.660,0	10,56	<input type="checkbox"/>

<input type="checkbox"/> Flow coefficient (*)	C	0,97546	-
Residual pressure loss - lower limit	$\Delta\omega, \min$	3,4	mbar(a)
Residual pressure loss - upper limit	$\Delta\omega, \max$	6,4861	mbar(a)
Power loss	$P\Delta\omega$	1,0142	kW
Stream power	$P\Delta p$	9,3729	kW
Flow velocity in pipeline	up	10,684	m/s
Flow velocity in flow element	uf	39,508	m/s
Reynolds number (*)	Re	3,0036	E 6 -
Pipe inside diameter (t1)	Di,t1	494,03	mm
Throttle orifice (t1)	d,t1	256,91	mm
Diameter ratio	β	0,52002	-
Relative pipe roughness	kr	0,40483	-
Correction factor for pipe roughness	br	1,0	-
Expansion factor (*)	ε	0,99114	-
Pressure ratio (*)	τ	0,98519	-

Required inlet and outlet sections




<input type="checkbox"/> Specify as factors		
Presentation		0.5% additional uncertainty - upstream
Single 90° bend or tee		3.952,2 mm
Several 90° bends, same plane		5.434,3 mm
Several 90° bends, different planes		10.869,0 mm
Reducer		2.470,1 mm
Diffusor		4.940,3 mm
Globe valve, completely open		5.928,4 mm
Gate valve, completely open		3.458,2 mm
Abrupt diameter reduction		7.410,4 mm
Thermometer pocket, $\varphi < 0,03 Di$		1.482,1 mm
Thermometer pocket, $\varphi > 0,03 Di$		4.940,3 mm
Required outlet section		2.964,2 mm

Uncertainties

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

Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e, ρ_1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of expansion factor (*)	e, ε	0,067182	%
Unc. of flow coefficient	e,C	1,3097	%
Unc. of corrected flow coefficient	e,Cb	1,8097	%
Unc. of mass flow rate	e,qm	3,1171	%
Additional uncertainty	e,ad	0,5	%

Legend

-  Calculated value
-  Lookup value
-  Warning

Calculation headerIdentifier
Tag No.**FE40011 Düse**
SIDEARMGAS FROM LP COLUMN**Operating data**Medium
Operating pressure (absolute)
Operating temperature
On boiling point curve
Gasp1
t1**Oxygen**
1,35
93,025
bar(a)
K
Gas/vapor
Gas, dry**Properties at operating point**State
Operating density (t1, p1)
Isentropic exponent (t1, p1)
ρ
κ **Saturated**
5,815
1,3895
kg/m³
-**Pipeline**Material number
Material group
Condition
Pipe diameter
● Pipe outside diameter
Pipe wall thickness
Linear coefficient of thermal expansion
Pipe roughness

Do
s
αlin
k **Aluminium**
Aluminium
smooth, without deposit
Circular
508,0
6,0
19,848
0,02
mm
mm
E -6 1/K
mm**Flow element - operating values**Calculation standard
Primary device
Calculation reference
Calculated value
Diffusor angle of venturi tube
Throttle orifice (20°C)
Pressure difference
○ Mass flow rate
● Volume flow rate (standard conditi...φ
d
Δp
qm
qn**EN ISO 5167:2003**
Venturi nozzle
Sizing: C and ε with 2/3 qm
d
7,5
257,93
45,0
42.872,0
30.000,0
-
mm
mbar(a)
kg/h
m³/h**Flow element - material**Material number
Material group
Linear coefficient of thermal expansionDevice
Device
αlin,D **Aluminium**
Aluminium
19,848
E -6 1/K**More calculated values**

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

☒ Flow value table

Increment for value table

n
10,0
%

Differential pressure flow element: FE40011 Düse

18.08.2005 15:24:05

No.	Δp	Δp	qm	qn	up	Meets stand...
1	10,0	4,5	13.650,0	9.553,0	3,402	<input checked="" type="checkbox"/>
2	20,0	9,0	19.270,0	13.480,0	4,801	<input type="checkbox"/>
3	30,0	13,5	23.550,0	16.480,0	5,869	<input type="checkbox"/>
4	40,0	18,0	27.140,0	18.990,0	6,763	<input type="checkbox"/>
5	50,0	22,5	30.280,0	21.190,0	7,546	<input type="checkbox"/>
6	60,0	27,0	33.100,0	23.160,0	8,25	<input type="checkbox"/>
7	70,0	31,5	35.680,0	24.970,0	8,893	<input type="checkbox"/>
8	80,0	36,0	38.070,0	26.640,0	9,487	<input type="checkbox"/>
9	90,0	40,5	40.300,0	28.200,0	10,04	<input type="checkbox"/>
10	100,0	45,0	42.390,0	29.660,0	10,56	<input type="checkbox"/>

<input type="checkbox"/> Flow coefficient (*)	C	0,97546	-
Residual pressure loss - lower limit	$\Delta\omega, \min$	3,4	mbar(a)
Residual pressure loss - upper limit	$\Delta\omega, \max$	6,4861	mbar(a)
Power loss	$P\Delta\omega$	1,0142	kW
Stream power	$P\Delta p$	9,3729	kW
Flow velocity in pipeline	up	10,684	m/s
Flow velocity in flow element	uf	39,508	m/s
Reynolds number (*)	Re	3,0036	E 6 -
Pipe inside diameter (t1)	Di,t1	494,03	mm
Throttle orifice (t1)	d,t1	256,91	mm
Diameter ratio	β	0,52002	-
Relative pipe roughness	kr	0,40483	-
Correction factor for pipe roughness	br	1,0	-
Expansion factor (*)	ε	0,99114	-
Pressure ratio (*)	τ	0,98519	-

Required inlet and outlet sections




<input type="checkbox"/> Specify as factors		
Presentation		0.5% additional uncertainty - upstream
Single 90° bend or tee		3.952,2 mm
Several 90° bends, same plane		5.434,3 mm
Several 90° bends, different planes		10.869,0 mm
Reducer		2.470,1 mm
Diffuser		4.940,3 mm
Globe valve, completely open		5.928,4 mm
Gate valve, completely open		3.458,2 mm
Abrupt diameter reduction		7.410,4 mm
Thermometer pocket, $\varphi < 0,03 Di$		1.482,1 mm
Thermometer pocket, $\varphi > 0,03 Di$		4.940,3 mm
Required outlet section		2.964,2 mm

Uncertainties

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

Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e, ρ_1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of expansion factor (*)	e, ε	0,067182	%
Unc. of flow coefficient	e,C	1,3097	%
Unc. of corrected flow coefficient	e,Cb	1,8097	%
Unc. of mass flow rate	e,qm	3,1171	%
Additional uncertainty	e,ad	0,5	%

Legend

-  Calculated value
-  Lookup value
-  Warning

Calculation header

Identifier

FE40011 Venturi

Tag No.

SIDEARMGAS FROM LP COLUMN

Operating data

Medium



Oxygen

Operating pressure (absolute)

p1

1,35

bar(a)

Operating temperature

t1

93,025

K

On boiling point curve

Gas/vapor

Gas

Gas, dry

Properties at operating point

State



Saturated

Operating density (t1, p1)

 ρ

5,815

kg/m³

Isentropic exponent (t1, p1)

 κ

1,3895

-

Pipeline

Material number



Aluminium

Material group



Aluminium

Condition



smooth, without deposit

Pipe diameter

Circular

☒ Pipe outside diameter

Do

406,0

mm

Pipe wall thickness

s

7,0

mm

Linear coefficient of thermal expansion

 α_{lin}

19,848

E -6

1/K

Pipe roughness

 k

0,02

mm

Flow element - operating values

Calculation standard

EN ISO 5167:2003

Primary device

Venturi tube, welded

Calculation reference

Sizing: C and ε with 2/3 qm

Calculated value

d

Diffusor angle of venturi tube

 φ

7,5

-

Throttle orifice (20°C)

 d

244,77

mm

Pressure difference

 Δp

50,0

mbar(a)

☐ Mass flow rate

qm

42.872,0

kg/h

☒ Volume flow rate (standard conditi...

qn

30.000,0

m³/h

Flow element - material

Material number

Device

Aluminium

Material group

Device

Aluminium

Linear coefficient of thermal expansion

 $\alpha_{lin,D}$

19,848

E -6

1/K

More calculated values

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

☒ Flow value table

Increment for value table

n

10,0

%

Differential pressure flow element: FE40011 Venturi

18.08.2005 15:25:18

No.	Δp	Δp	qm	qn	up	Meets stand...
1	10,0	5,0	13.670,0	9.569,0	5,456	<input checked="" type="checkbox"/>
2	20,0	10,0	19.290,0	13.500,0	7,696	<input type="checkbox"/>
3	30,0	15,0	23.570,0	16.490,0	9,403	<input type="checkbox"/>
4	40,0	20,0	27.140,0	18.990,0	10,83	<input type="checkbox"/>
5	50,0	25,0	30.270,0	21.180,0	12,08	<input type="checkbox"/>
6	60,0	30,0	33.080,0	23.150,0	13,2	<input type="checkbox"/>
7	70,0	35,0	35.640,0	24.940,0	14,22	<input type="checkbox"/>
8	80,0	40,0	38.000,0	26.590,0	15,16	<input type="checkbox"/>
9	90,0	45,0	40.210,0	28.140,0	16,04	<input type="checkbox"/>
10	100,0	50,0	42.270,0	29.580,0	16,87	<input type="checkbox"/>
<input type="checkbox"/> Flow coefficient (*)			C	0,985	-	
Residual pressure loss - lower limit			$\Delta\omega, \min$	3,0153	mbar(a)	
Residual pressure loss - upper limit			$\Delta\omega, \max$	6,119	mbar(a)	
Power loss			$P\Delta\omega$	0,93692	kW	
Stream power			$P\Delta p$	10,434	kW	
Flow velocity in pipeline			up	17,105	m/s	
Flow velocity in flow element			uf	45,557	m/s	
Reynolds number (*)			Re	3,8005	E 6 -	
Pipe inside diameter (t1)			Di,t1	390,44	mm	
Throttle orifice (t1)			d,t1	243,8	mm	
Diameter ratio			β	0,62442	-	
Relative pipe roughness			kr	0,51224	-	
Correction factor for pipe roughness			br	1,0	-	
Expansion factor (*)			ε	0,98899	-	
Pressure ratio (*)			τ	0,98354	-	

Required inlet and outlet sections

☐ Specify as factors

Presentation

0.5% additional uncertainty - upstream




Single 90° bend or tee		1.171,3	mm
Several 90° bends, same plane		1.171,3	mm
Several 90° bends, different planes		1.171,3	mm
Reducer		976,11	mm
Diffusor		976,11	mm
Gate valve, completely open		976,11	mm
Required outlet section		979,09	mm

Uncertainties

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

Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e, ρ_1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of expansion factor (*)	e, ε	0,10389	%
Unc. of flow coefficient	e,C	2,0	%
Unc. of corrected flow coefficient	e,Cb	2,5	%
Unc. of mass flow rate	e,qm	3,5663	%
Additional uncertainty	e,ad	0,5	%

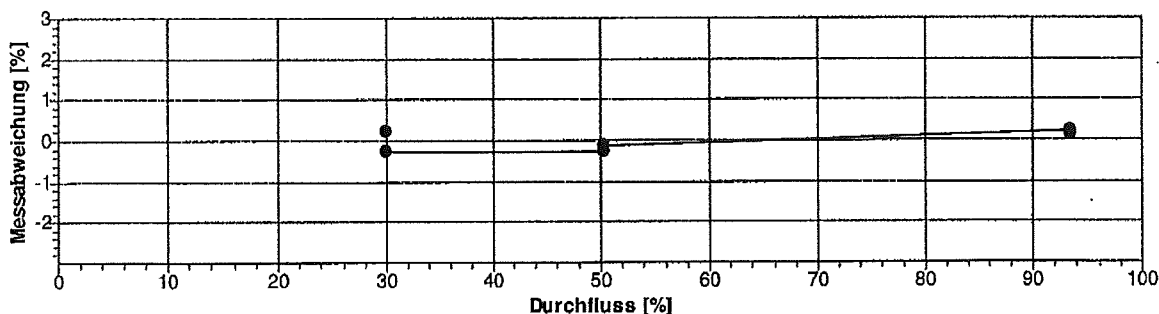
Legend

-  Calculated value
-  Lookup value
-  Warning

MESSPROTOKOLL

Messgeräte Typ:		S/N: kd		Zulassung: 5.731/99.03	
Qmin : t/h	Eichzahl :	Alpha High	Alpha Low		
Qmax : 8,5t/h	Softwareversion : 2.23	Multipoint : Nein			
Kl. Abgabemenge : kg	Softwaredatum :				
Drosselstelle			Differenzdruckaufnehmer		
Typ : SWM 15-17,5-2110-14-0	Typ : 1151 DP5 S2A				
S/N : 02.05.7009	S/N : KD				
Nennweite : 38,1mm	Messbereich : 430mbar				
Offnung : 17,5mm	Nullpunkt : 0mbar				
M : 0,224	Nullpunkt : mA				
Temperaturfühler		Druckaufnehmer		Kapazitätssensor	
Typ	Typ	Typ		Typ	
S/N	S/N	S/N		S/N	
	Messbereich			Dielektrizität	
Drucker			Datenerfassung		
Typ			Typ		
S/N			S/N		
Zulassung			Softwareversion		
Fahrzeugdaten		Fahrzeughalter		Fahrzeugbetreiber	
KFZ-Kennzeichen					
Modul-Nr.					
Tankwagen ID-Nr.					
Tankherstell Nr. FFHerstellNrDat					

LfdNr	Durchfluss		Normal	Prüfling	Messabweichung	
	[%]	[t/h]			[kg]	[%]
1	93,40	7,94	200	200,4	0,40	0,20
2	93,40	7,94	200	200,3	0,30	0,15
3	50,20	4,27	200	199,5	-0,50	-0,25
4	50,20	4,27	200	199,7	-0,30	-0,15
5	30,10	2,56	200	200,4	0,40	0,20
6	30,10	2,56	200	199,5	-0,50	-0,25



Prüfmittel : CO2 Prüfstand	Auftragsnummer : 409427
Prüfort : Solingen	
Prüfdatum : 11.03.05	
Geprüft bis Ende :	Prüfer : SSC
	Unterschrift _____

MESSSTRECKE TYP SWM15-17,5-2110-14-0 S/N 02057009

Auftragsnummer: 409427

Medium LOX
a*m [-] 0,224
D [m] 0,0381 m
dpmax [Pa] 38300
Dichte ~~LOX~~ [kg/m³] 1137
M max. [kg/h] 8580

Berechnungstabelle für die SPS:

Durchfluss		I
[%]	[kg/h] \dot{m}	mA
0	0	4,000
5	429	4,800
10	858	5,600
15	1287	6,400
20	1716	7,200
25	2145	8,000
30	2574	8,800
35	3003	9,600
40	3432	10,400
45	3861	11,200
50	4290	12,000
55	4719	12,800
60	5148	13,600
65	5577	14,400
70	6006	15,200
75	6435	16,000
80	6864	16,800
85	7293	17,600
90	7722	18,400
95	8151	19,200
100	8580	20,000

Der DP-Transmitter muß intern auf „radizierend“ eingestellt werden.

$$\dot{m} = 3600 \cdot \alpha \cdot m \cdot \frac{D^2 \cdot \pi}{4} \cdot \sqrt{2 \cdot \rho \cdot \Delta p}$$

MESSSTRECKE TYP SWM15-17,5-2110-14-0 S/N 02057009

Auftragsnummer: 409427

Medium		LOX
a*m	[-]	0,224
D	[m]	0,0381 m
dpmax	[Pa]	38300
Dichte LIN	[kg/m ³]	1137
M max.	[kg/h]	8580

Berechnungstabelle für die SPS:


Durchfluss		I
[%]	[kg/h]	mA
0	0	4,000
5	429	4,800
10	858	5,600
15	1287	6,400
20	1716	7,200
25	2145	8,000
30	2574	8,800
35	3003	9,600
40	3432	10,400
45	3861	11,200
50	4290	12,000
55	4719	12,800
60	5148	13,600
65	5577	14,400
70	6006	15,200
75	6435	16,000
80	6864	16,800
85	7293	17,600
90	7722	18,400
95	8151	19,200
100	8580	20,000

Der DP-Transmitter muß intern auf „radizierend“ eingestellt werden.


Calculation header

Identifier **FE70041**
 Tag No. **MP-GAN TO CUSTOMER**








Operating data

Medium  **Nitrogen**
 Operating pressure (absolute) **p1** **7,3** **bar(a)**
 Operating temperature **t1** **26,0** **°C**
 Gas **Gas, dry**

Properties at operating point

State  **Gaseous**
 Operating density (t1, p1) **ρ** **8,2322** **kg/m³**
 Isentropic exponent (t1, p1) **κ** **1,4105** **-**

Pipeline

Material number  **1.0254 St 37.0**
 Material group  **Steel I**
 Condition  **-**
 Pipe diameter  **Circular**
 Pipe class  **DIN**
 Size class  **DN 350**
 Pressure class  **PN 25**
 Linear coefficient of thermal expansion **αlin** **12,626** **E -6** **1/K**
 Pipe roughness **k** **0,03** **mm**

Flow element - operating values

Calculation standard **EN ISO 5167:2003**
 Primary device **Corner orifice**
 Calculation reference **Sizing: C and ε with 2/3 qm**
 Calculated value **d**
 Throttle orifice (20°C) **d** **217,14** **mm**
 Pressure difference **Δp** **150,0** **mbar(a)**
 Mass flow rate **qm** **43.765,0** **kg/h**
 Volume flow rate (standard conditi...) **qn** **35.000,0** **m³/h**

Flow element - material

Material number **Device** **1.4571 X 6 Cr Ni Mo Ti 17 12**
 Material group **Device** **Steel V**
 Linear coefficient of thermal expansion **αlin,D** **17,023** **E -6** **1/K**
 Edge radius (20°C) **rk** **0,065142** **mm**

More calculated values

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

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

Differential pressure flow element: FE70041

18.08.2005 15:25:53

No.	Δp	Δp	qm	qn	up	Meets stand...
1	10,0	15,0	13.890,0	11.110,0	5,175	☒
2	20,0	30,0	19.620,0	15.690,0	7,307	☒
3	30,0	45,0	24.000,0	19.200,0	8,94	☒
4	40,0	60,0	27.690,0	22.140,0	10,31	☒
5	50,0	75,0	30.930,0	24.740,0	11,52	☒
6	60,0	90,0	33.860,0	27.080,0	12,61	☒
7	70,0	105,0	36.540,0	29.220,0	13,61	☒
8	80,0	120,0	39.040,0	31.220,0	14,54	☒
9	90,0	135,0	41.380,0	33.090,0	15,41	☒
10	100,0	150,0	43.580,0	34.850,0	16,23	☒
<input type="checkbox"/> Flow coefficient (*)			C	0,60438	-	
Residual pressure loss			$\Delta\omega$	87,839	mbar(a)	
Power loss			$P\Delta\omega$	13,05	kW	
Stream power			$P\Delta p$	22,382	kW	
Flow velocity in pipeline			up	16,301	m/s	
Flow velocity in flow element			uf	39,87	m/s	
Reynolds number (*)			Re	1,6919	E 6 -	
Pipe inside diameter (t1)			Di,t1	339,63	mm	
Throttle orifice (t1)			d,t1	217,16	mm	
Diameter ratio			β	0,63942	-	
Relative pipe roughness			kr	0,88333	-	
Correction factor for pipe roughness			br	1,0	-	
Correction factor for edge radius			bk	1,0	-	
Expansion factor (*)			ε	0,99728	-	
Pressure ratio (*)			τ	0,99087	-	

Required inlet and outlet sections

☐ Specify as factors

Presentation

0.5% additional uncertainty - upstream

One or two 90° bends, S>30D		4.415,1	mm
Two 90° bends, 30D>S>5D, same plane		6.113,3	mm
Two 90° bends, 5D>S, same plane		6.113,3	mm
Two 90° bends, 30D>S>5D, vertical planes		6.113,3	mm
Two 90° bends, 5D>S, vertical planes		8.490,6	mm
Single 90° tee		6.113,3	mm
One or two 45° bends, S>22D		6.113,3	mm
Reducer		1.698,1	mm
Diffuser		3.735,9	mm
Gate valve, completely open		2.377,4	mm
Abrupt diameter reduction		5.094,4	mm
Thermometer pocket, $\phi < 0,03 Di$		1.018,9	mm
Thermometer pocket, $\phi > 0,03 Di$		3.396,3	mm
Required outlet section		2.377,4	mm




Uncertainties

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



Unc. of operating temperature	e,t1	1,0	%
Unc. of absolute pressure	e,p1	0,6	%
Unc. of pipe diameter	e,Di	0,4	%
Unc. of throttle orifice	e,d	0,07	%
Unc. of pressure difference	e, Δp	0,8	%
Unc. of operating density	e,p1	5,0	%
Unc. of correction factor br	e,br	0,0	%
Unc. of correction factor bk	e,bk	0,0	%
Unc. of expansion factor (*)	e, ε	0,022662	%
Unc. of flow coefficient	e,C	0,5657	%

Differential pressure flow element: FE70041

18.08.2005 15:25:53

Unc. of corrected flow coefficient	e,Cb 	1,0657	%
Unc. of mass flow rate	e,qm 	2,7569	%
Additional uncertainty	e,ad 	0,5	%

Legend

-  Calculated value
 Lookup value