Integral Orifice Assembly

Measuring line for small flow measurements

Characteristics

The Integral Orifice Assembly can be mounted directly to the differential pressure transmitter (see fig. 1).

Application

The Integral Orifice Assembly is a segment of a line to measure small flows. It is suitable for liquids and gases.

The integrated orifice is the differential pressure sensor and is mounted inside of the assembly. While medium passes through the orifice there will happened a drop of pressure. This is a proportion for the flow. The differential pressure transmitter transforms the loss of pressure to an uniformed signal, normally a current output (f.e. 4 to 20 mA)

The equation for the volume flow q_v is:

$$q_v = c * \sqrt{\Delta p} .$$

Description of orifice calculation

The Integral Orifice Assembly can be ordered with 6 different sizes of orifice. To get the differential pressure and the size of the orifice, the volume or mass flow under operation condition has to be converted to equivalent volume flow for water or air. Now it is possible to choose the size of orifice and for a first approach the span of the differential pressure while using the Nomogram for liquids or gases. The exact find out of the differential pressure has to be calculated numerical in accordance to the formulas of the attached data sheets.

After changing the orifice size it is necessary to calculate again.

fig. 1 integral orifice assembly with transmitter

Technical Informations

Integral Orifice Assembly

mediums: liquids, gases

range of measuring
- liquids: 0.396 up to 1109.52 GPH; 1,500 up to 4200 l/h
- gases: 1.766 up to 4238 cu ft/h; 0,050 up to 120 m³/h

innerside diameter of integrated orifice

size	d_i[inch]	d_i[mm]
1	0.0278	0.705
2	0.0394	1.000
3	0.0630	1.600
4	0.1260	3.200
5	0.2047	5.200
6	0.3425	8.700

nominal pressure: ANSI 600 # (PN 100)

temperature of medium: -40 up to +248 °F; -40 up to +120°C

process connection: ½“ NPT- F

materials

integral orifice assembly: mat. 316TI (1.4571)
other materials on request

weight: appr. 4.41 lbs (2 kg)

Otto-Hahn-Straße 20
D-41515 Grevenbroich
Postbox 10 03 27
D-41487 Grevenbroich

Phone +49 (0)2181 68671
Telex 8517226 INTA D
Telefax +49 (0)2181 64492
E-Mail: Intra-Automation@T-Online.de

A. Flow measuring of liquids

Data sheet for calculation and an example to find out the differential pressure span and size of orifice.

Operation condition of the liquid:				
Medium	______			*example:* *medium: frigene*
Q_F or q_{mF}	______	[dm³/h] / [kg/h]	max. volume flow / max. mass flow	Q_F = 1000 dm³/h
ρ_F	______	[kg/dm³]	density	ρ_F = 1,329 kg/dm³
ν or η	______	[mm²/s=cSt] / [mPas=cP]	kinematic viscosity / dynamic viscosity	η = 0,23 cP; $\nu = \eta / \rho_F$ =0,23/1,329 = 0,165 cSt
p	______	[bar]	max. stat. operation press.	p = 8 bar
t_F	______	[°C]	max. operation temp.	t_F = 20 °C

(1) Converting to Q_w, maximal equivalent volume flow of water

$Q_w = Q_F * (\rho_F)^{½}$ [dm³/h] *or* $Q_w = q_{mF} * (1/\rho_F)^{½}$ [dm³/h]

Q_w = ( )^{½} *or* Q_w = (1/)^{½}

Q_W= ______ dm³/h

*Q_w = 1000 * (1,329)^{½}*

Q_w = 1152,8 dm³/h

(2) From Nomogram for liquids size of orifice, k and Δp can be find out. Choose the size of orifice with the biggest differential pressure.

size of orifice ______

Δp ≈ ______ mbar **diff. pressure, first approach**

k = ______ **correction factor, depending on size of orifice**

size of orifice: 5

Δp ≈ 1300 mbar

k = 10,363

(3) Numerical calculation of the max. differential pressure Δp

Δp [mmWC] = $(Q_w / k)^2 * 0,0981$ = (/)² * 0,0981

Δp = ______ **max. differential pressure**

*Δp = (1152,8/10,363)²*0,0981*

Δp = 1213,96 mbar

(4) The accuracy of flow measuring is influenced by the viscosity of the medium:

$\frac{Q_F}{\nu_F}$ = ______ = > see table below

The accuracy of measuring: <± %

accuracy \ size of orifice	1	2	3	4	5	6
< ± 2%	5,3	13	21	70	90	280
< ± 3%	3,8	10	17	60	80	225
< ± 5%	2,5	7,3	12	46	60	175

1000 / 0,165 = 6060,6

> 90

result:
accuracy < ± 2%

Otto-Hahn-Straße 20
D-41515 Grevenbroich
Postbox 10 03 27
D-41487 Grevenbroich

Phone +49 (0)2181 68671
Telex 8517226 INTA D
Telefax +49 (0)2181 64492
E-Mail: Intra-Automation@T-Online.de

Integral Orifice Assembly

Measuring line for small flow measurements

B. Flow measuring of gases

Data sheet for calculation and an example to find out the differential pressure span and size of orifice.

Operation conditions of the gas:

Medium ______________

Q_{nG} *or*	______	[Nm³/h]	max. stand. volume flow *(at 0°C; 1,013 bar)*
q_{mG}	______	[kg/h]	max. mass flow
ρ_{nG}	______	[kg/Nm³]	standard density
ν_G *or*	______	[mm²/s=cSt]	kinematic viscosity
η_G	______	[mPas=cP]	dynamic viscosity
p_{absG}	______	[bar]	absolute pressure
T_G	______	[°K]	absolute temperature

(1) Calculation of Q_{nL}, maximal equivalent volume flow of air (standard cond.)

$Q_{nL} = Q_{nG}*[(\rho_{nG}*1{,}013*T_G)/(1*p_{absG}+273)]^{½}$ or $Q_{nL} = (q_{mG} / 1{,}293)*[(\rho_{nG}*1{,}013*T_G)/(1*p_{absG}+273)]^{½}$

$Q_{nL} =$ *[(*1,013*)/(1* +273)]^{½} or $Q_{nL} =$ (/ 1,293)*[(*1,013*)/(1* +273)]^{½}

$Q_{nL} =$ ______ Nm³/h

(2) From Nomogram for gases size of orifice, k and Δp can be find out. Choose the size of orifice with the biggest differential pressure.

size of orifice ______

Δp ≈ ______ mbar **diff. pressure, first approach**

k = ______ **correction factor, depending on size of orifice**

(3) Numerical calculation of the max. differential pressure Δp.
Converting to Q_w max. volume flow of water

Q_w [dm³/h]] = Q_{nL} [m³/h] * 36,012 = * 36,012 = dm³/h

Δp = (Q_w / k)² * 0,0981 = (/)² * 0,0981

Δp = ______ **max. differential pressure**

(4) The accuracy of flow measuring is influenced by the viscosity of the medium:

$$\frac{\mathbf{Q_{nG} * (T_G / p_{absG}) * (1{,}013 / 273) * 1000}}{\mathbf{\nu_G}} = \frac{\mathbf{* (\quad / \quad) * (1{,}013 / 273)*1000}}{}$$

= > see table below

The accuracy of measuring: <± % ***The expansion factor of gas is not taken into consideration while calculating***

accuracy \ size of orifice	1	2	3	4	5	6
< ± 2%	5,3	13	21	70	90	280
< ± 3%	3,8	10	17	60	80	225
< ± 5%	2,5	7,3	12	46	60	175

example:

medium: nitrogen

Q_{nG} = 5,0 Nm³/h

ρ_{nG}= 1,2505 kg/Nm³
η_G = 0,01752 cP
ν = η_G / ρ_{nG} =0,01752/1,2505
= 0,165 cSt
p_{gG}=4bar_g → p_{absG}=1,013+4=5,013
t_G =15°C → T_G=273+15=288

Q_{nL} =5[$^{(1,2505*1,013*288)}/_{(1*5,033*273)}$]^{*½}*

Q_{nL} = 2,6 Nm³/h

size of orifice: 3

Δp ≈ 950 mbar

k = 0,9560

*Q_w = 2,6 * 36,012 = 93,63*

*Δp = (93,63,8/0,9560)²*0,0981*

Δp = 940,99 mbar

[5,0(288/5,033)*(1,013/273)*100]/0,014*

=77329,5 > 21

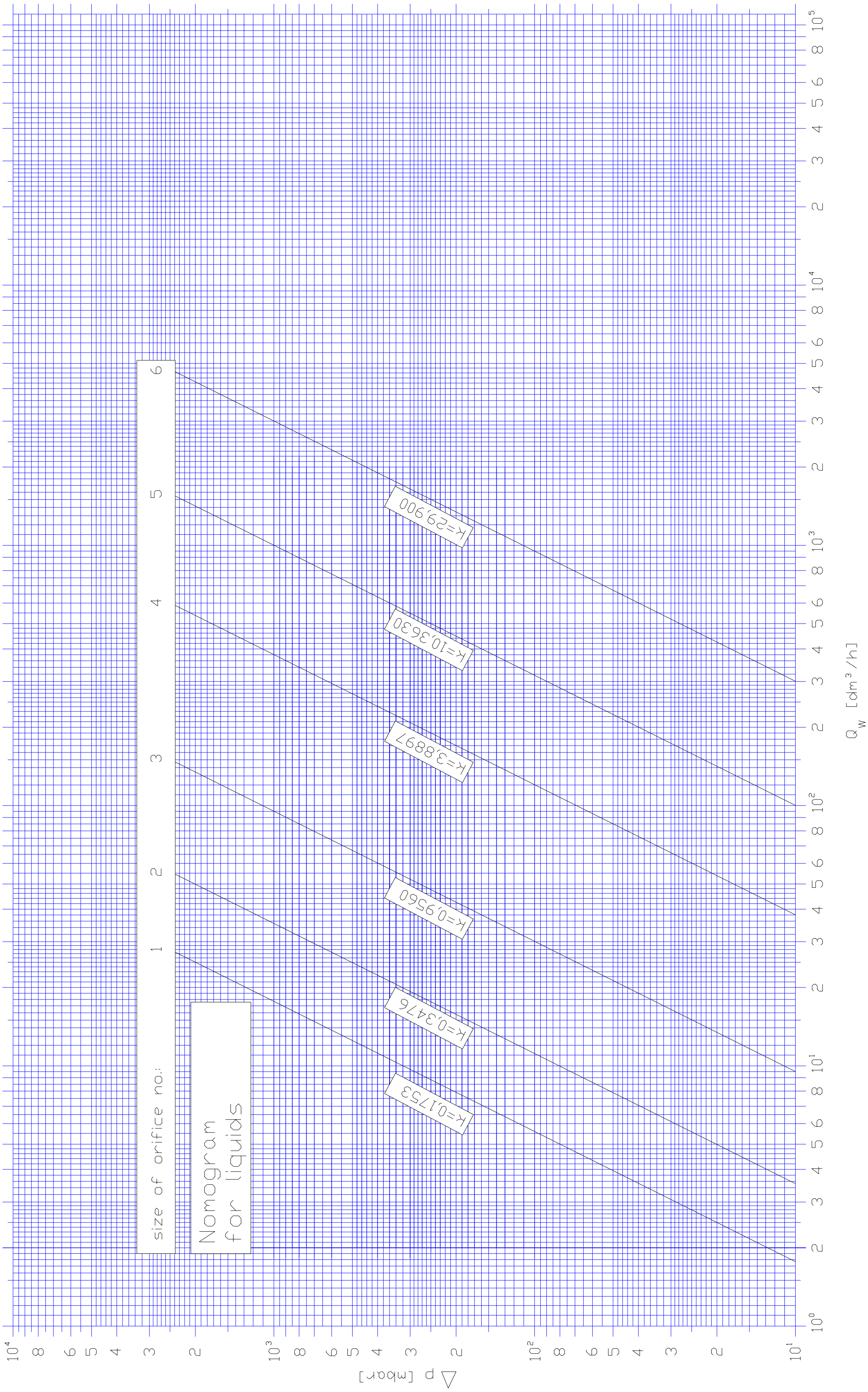
result:
accuracy < ± 2%

Otto-Hahn-Straße 20
D-41515 Grevenbroich
Postbox 10 03 27
D-41487 Grevenbroich

Phone +49 (0)2181 68671
Telex 8517226 INTA D
Telefax +49 (0)2181 64492
E-Mail: Intra-Automation@T-Online.de

Integral Orifice Assembly

Measuring line for small flow measurements

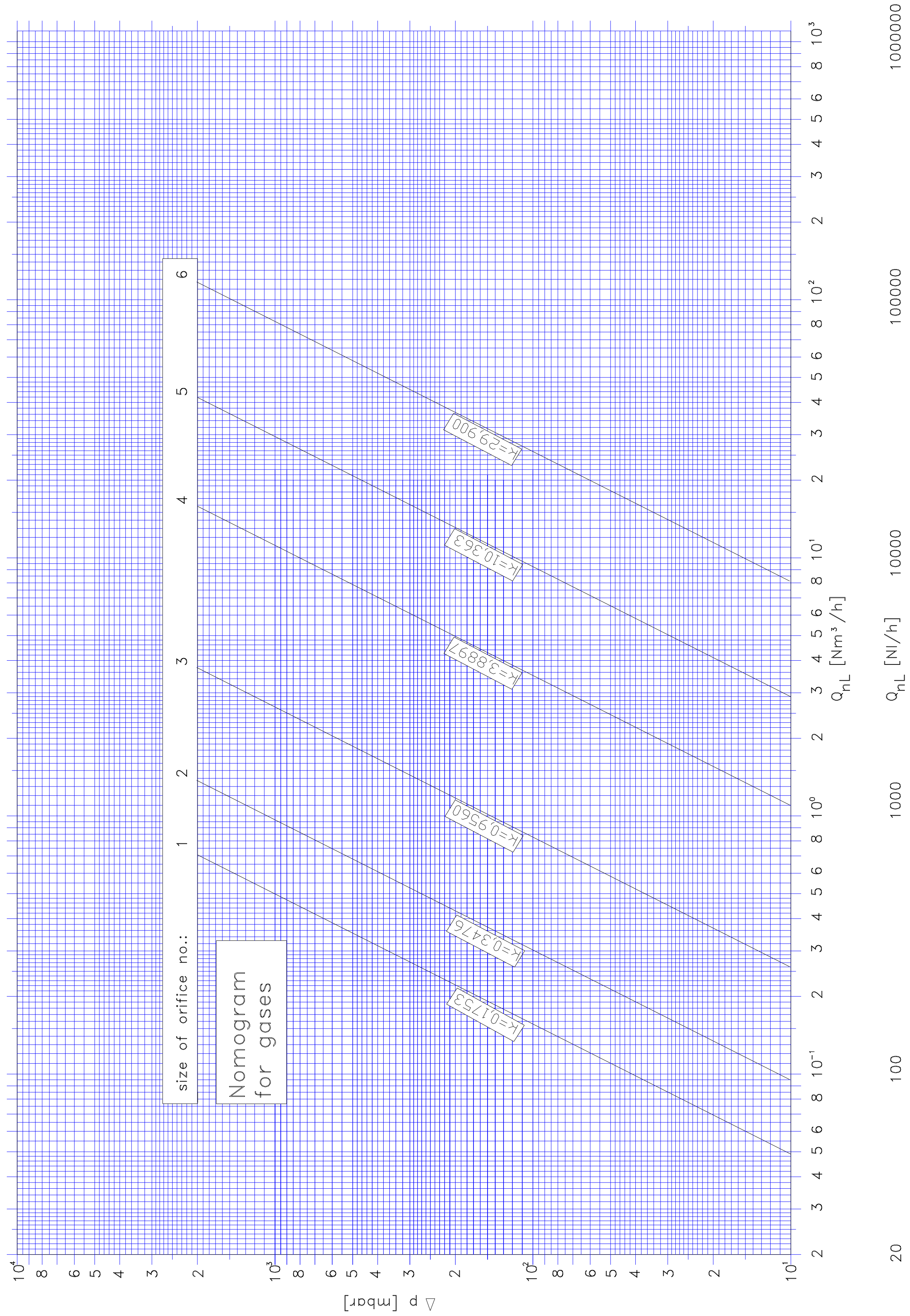


Otto-Hahn-Straße 20
D-41515 Grevenbroich
Postbox 10 03 27
D-41487 Grevenbroich

Phone +49 (0)2181 68761
Telex 8517226 INTA D
Telefax +49 (0)2181 64492
E-Mail: Intra-Automation@T-Online.de

Integral Orifice Assembly

Measuring line for small flow measurements



Otto-Hahn-Straße 20
D-41515 Grevenbroich
Postbox 10 03 27
D-41487 Grevenbroich

Phone +49 (0)2181 68761
Telex 8517226 INTA D
Telefax +49 (0)2181 64492
E-Mail: Intra-Automation@T-Online.de

Integral Orifice Assembly

Measuring line for small flow measurements

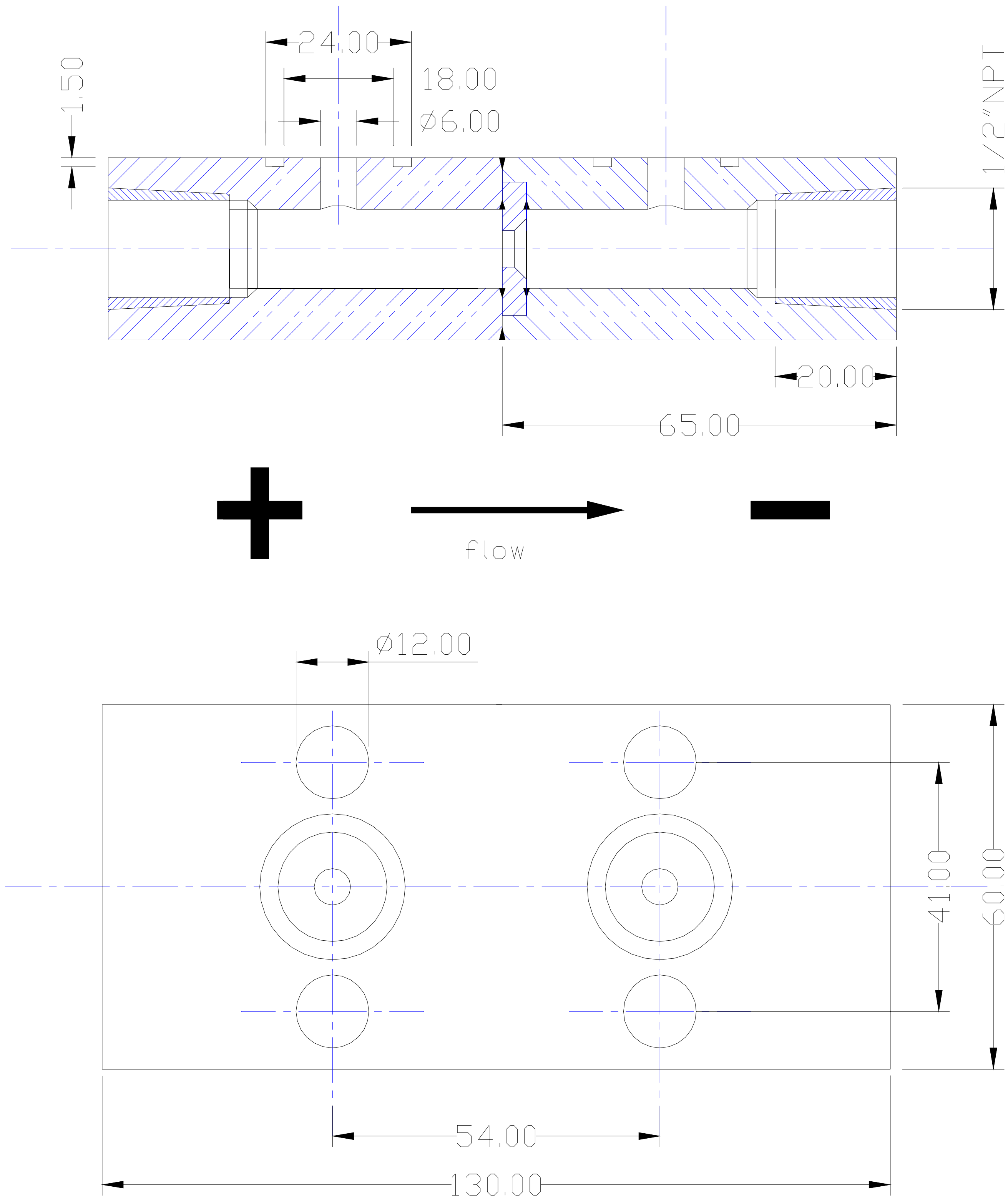


fig. 2 drawing of the Intergral Orifice Assembly

Otto-Hahn-Straße 20
D-41515 Grevenbroich
Postbox 10 03 27
D-41487 Grevenbroich

Phone +49 (0)2181 68761
Telex 8517226 INTA D
Telefax +49 (0)2181 64492
E-Mail: Intra-Automation@T-Online.de