

DIFFERENTIAL PRESSURE CALCULATIONS AND RESONANCE FREQUENCY CHECK

FLOW TO DP

LIQUIDS (Volumetric)

$$DP = \left[\frac{QA \times \sqrt{D}}{K \times A \times 4.6285} \right]^2 \text{ mbar}$$

GASES (Volumetric)

$$DP = \left[\frac{S \times (Tf + 273)}{Pf} \right] \left[\frac{QB}{K \times A \times 66.839} \right]^2 \text{ mbar}$$

LIQUIDS / GASES / STEAM (Mass)

$$DP = \left[\frac{QC}{K \times A \times \sqrt{D} \times 4.6285} \right]^2 \text{ mbar}$$

SYMBOLS & UNITS

- QA** = Flow (m³/hr)
- QB** = Flow (Nm³/hr) at 0°C, 1 atms (1.013 bar)
- QC** = Flow (kg/hr)
- S** = Specific Gravity (Air = 1)
- D** = Density at actual conditions (kg/m³)
Base Density of water at 4°C = 999.972 kg/m³
Density of water at 15.55°C = 999.074 kg/m³
Base Density of Air at 0°C
1 ATMOS (1.013 bar) = 1.292 kg/m³
- A** = Pipe internal X-Section Area (cm²)
- Tf** = Actual Temperature (°C)
- Pf** = Actual Pressure (bar Absolute)
- K** = Torflow Co-efficient (see table)

TORFLOW CO-EFFICIENT K

PIPE SIZE (Internal diameter)	MODEL NUMBER					
	301	601	401	402	511	512
(mms)	311		411	412	811	812
50		0.6483				
75		0.7027				
100		0.7497	0.6174			
150		0.7671	0.6505			
200			0.6647			
250			0.6794	0.6876		
300			0.6941	0.7024		
350			0.7160	0.7303		
400			0.7380	0.7564		
450			0.7402	0.7699		
600			0.7468	0.7815		
900			0.7473	0.7847		
1200			0.7475	0.7849		
1500			0.7476	0.7850		
1800		and above	0.7476	0.7850		
FOR SIZES NOT SHOWN ABOVE, DETERMINE K BY EXTRAPOLATION						
For Models 121, 122, 123 (all sizes) K = 1						

IT IS IMPORTANT THAT THE ANSWERS FROM THESE EQUATIONS ARE VERIFIED WITH THE FACTORY OR TORBAR ACCREDITED SUPPLIER BEFORE USE WITH YOUR SYSTEM

DP TO FLOW

LIQUIDS (Volumetric)

$$\text{Flow(Q)} = \sqrt{DP} \times \left[\frac{KxAx4.6285}{\sqrt{D}} \right] \text{ m}^3/\text{hr}$$

GASES (Volumetric)

$$\text{Flow(Q)} = \sqrt{DP} \times \left[\frac{KxAx\sqrt{(Tf+273)}}{\sqrt{Sx4.0323x\sqrt{Pf}}} \right] \text{ Am}^3/\text{hr}$$

(Actual conditions)
or

$$\text{Flow(Q)} = \sqrt{DP} \times \left[\frac{KxAx66.839x\sqrt{Pf}}{\sqrt{Sx\sqrt{(Tf+273)}}} \right] \text{ Nm}^3/\text{hr}$$

(Normal conditions)

LIQUIDS / GASES / STEAM (Mass)

$$\text{Flow(Q)} = \sqrt{DP} \times (KxAx\sqrt{Dx4.6285}) \text{ kg/hr}$$

SYMBOLS & UNITS

- DP** Differential Pressure (mbar)
- S** Specific Gravity (Air = 1)
- D** Density at Actual Conditions (kg/m³)
Base Density of Water at 4°C 999.972 kg/m³
Density of Water at 15.55°C 999.074 kg/m³
Density of Air at 0°C 1.292 kg/m³
- A** Pipe Internal x-section Area (cm²)
- Tf** Actual Temperature (°C)
- Pf** Actual Pressure (Bar A) (Absolute)
- K** TORFLOW Co-efficient (see Table)

Normal Conditions 0°C, 1 Atmosphere (1.013 bar)

STATEMENT OF ACCURACY: The calculated differential pressure will lie within an uncertainty band of +/- 1% with 95% confidence if the TORFLOW is installed strictly in accordance with the published Installation Instructions. For applications which do not conform to those instructions, it is recommended that an on site calibration is performed in order to achieve the optimum accuracy.

RESONANCE FREQUENCY CHECK

This check is not necessary for LIQUID FLOWS, because the maximum allowable DP is reached before resonance occurs (see table opposite) or Models 121, 122, and 123. For Gas and Vapour flows a Resonance Frequency Check MUST be made. Equations have been derived for the various TORFLOW models to determine LOW and HIGH critical velocities (VL and VH) which define the narrow resonance band of velocities which should be outside the continuous operating flow range of the TORFLOW. The table below lists those equations to calculate the VL and VH. If the calculation shows VL to VH to be within the continuous operating flow range, then an alternative, suitable model of TORFLOW should be selected to give acceptable values of VL and VH. Always check that the maximum flow DP is less than the 'Maximum Allowable DP' as shown in the opposite table.

TORFLOW MODEL	CRITICAL VELOCITIES		UNSUPPORTED LENGTH L (METRES) (see below)
	VL (M/SEC)	VH (M/SEC)	
301	0.472 ÷ L ²	0.728 ÷ L ²	ID + WALL + 0.05
311	0.472 ÷ L ²	0.728 ÷ L ²	ID + WALL + SO
L601	0.472 ÷ L ²	0.728 ÷ L ²	ID + WALL + 0.02
401	1.843 ÷ L ²	2.840 ÷ L ²	ID + WALL + 0.08
402	8.08 ÷ L ²	12.44 ÷ L ²	ID + 2 x WALL + 0.115
411	1.843 ÷ L ²	2.840 ÷ L ²	ID + WALL + SO
412	8.08 ÷ L ²	12.44 ÷ L ²	ID + 2 x WALL + SO + 0.05
L701	1.843 ÷ L ²	2.840 ÷ L ²	ID + WALL + 0.05
L702	8.08 ÷ L ²	12.44 ÷ L ²	ID + 2 x WALL + 0.10
H701	1.843 ÷ L ²	2.840 ÷ L ²	ID + WALL + 0.05
H702	8.08 ÷ L ²	12.44 ÷ L ²	ID + 2 x WALL + 0.10
H711	1.843 ÷ L ²	2.840 ÷ L ²	ID + WALL + SO + VV + 0.05
H712	8.08 ÷ L ²	12.44 ÷ L ²	ID + 2 x WALL + SO + VV + 0.10
511	10.88 ÷ L ²	16.766 ÷ L ²	ID + WALL + SO
512	47.65 ÷ L ²	73.43 ÷ L ²	ID + 2 x WALL + SO + 0.08
H811	10.88 ÷ L ²	16.766 ÷ L ²	ID + WALL + SO + VV + 0.05
H812	47.65 ÷ L ²	73.43 ÷ L ²	ID + 2 x WALL + SO + VV + 0.13

- L** = UNSUPPORTED LENGTH (METRES)
- ID** = PIPE INTERNAL DIAMETER (METRES)
- WALL** = PIPE WALL THICKNESS (METRES)
- SO** = OVERALL LENGTH OF FLANGED PIPE FITTING (METRES) (See page 9)
- VV** = OVERALL LENGTH OF ISOLATION VALVE (METRES) (See page 9)

THE ABOVE EQUATIONS ARE DERIVED FROM TORFLOW RESONANCE FREQUENCY DATA AND CALCULATIONS. FULL DETAILS ARE AVAILABLE ON REQUEST.

MAXIMUM ALLOWABLE DP

Depending on the model and size of TORFLOW there is a maximum figure of Differential Pressure above which the TORFLOW should NOT be used due to the imposition of excessive mechanical stresses. Check the table below to ensure that the application is suitable. If the calculated DP exceeds the maximum shown below, then select an other appropriate model to suit the application. For Bi-Directional configurations (accessory code BW), use 50% of the figures in this table.

FOR LIQUID FLOW APPLICATIONS WHERE THERE IS A POSSIBILITY OF PROCESS PULSATATIONS OR INTERMITTENT EXCESSIVE FLOW VELOCITY, THEN THE END-SUPPORT MODELS SHOULD ALWAYS BE SELECTED FOR PIPE SIZES OVER 250mm DIAMETER (400 AND 700 SERIES) AND 600mm (500 AND 800 SERIES).

PIPE SIZE (Internal Dia.)	TORFLOW BASE MODEL NUMBER *								
	301	311	401	411	402	412	511	512	
	601		701	711	702	712	811	812	
	611								
(ins)	(mms)	Maximum allowable DP in mbar							
2	50	6250							
3	75	2790							
4	100	1565	5100						
6	150	695	2285						
8	200		1285						
10	250		820	3250		3400			
12	300		570	2250	2350				
14	350		415	1680	1725				
16	400		320	1285	1335				
18	450		250	1015	1055	4225			
24	600		140	570	590	2375			
36	900		50	250	265	1055			
48	1200		30	140	145	590			
60	1500		20	90	90	380			
72	1800		10	60	65	265			

Above 1800 mm - consult factory

FOR SIZES NOT SHOWN ABOVE DETERMINE MAXIMUM ALLOWABLE DP BY EXTRAPOLATION

* For models 121, 122, 123 (all sizes) Maximum DP value is 2500 mbar.

THE ABOVE FIGURES ARE THEORETICALLY DERIVED AND INCLUDE A X10 SAFETY FACTOR OVER AND ABOVE BASIC STANDARDS AND SPECIFICATION. FULL THEORETICAL DATA IS AVAILABLE ON REQUEST.