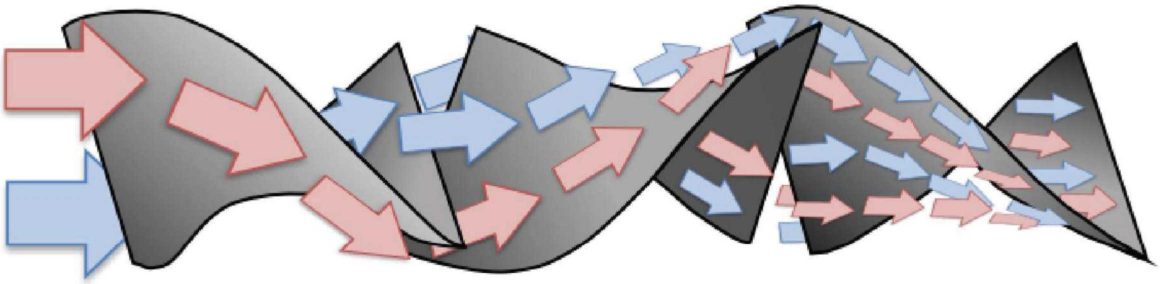
Static Mixer

A static mixer is a device, usually metal or plastic fixed to a pipe or tube. As the fluid flows through this section, it is continuously divided, reoriented, sheared and stretched by the helical right-and left-hand elements producing new interfacial element that are subsequently recombined. Through the action of the static mixer, fluid at the center of the flow field can be directed towards the walls while material at the walls is sent to the center. This produces a distributive mixing of the fluid components in a radial direction. It can produce a homogeneous blend of dispersion in laminar, transitional or turbulent flow within a very short pipe length. It is widely used in the process industry for a large variety of mixing applications.

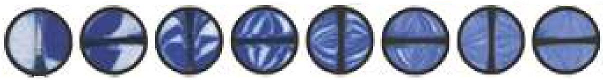
Mixing Principle

A "static mixer" often called an inline mixer, is a device used frequently in water treatment to create an injection point for chemicals like chlorine and soda ash into a water line. Its purpose is to create turbulence that enhances the rapid mixing of the injected chemical into the water stream. Use of the static mixer can reduce the necessary size of storage tanks following the injection point.



The picture above is a cutaway made to expose the inner workings of the mixer. It's a simple device. The service flow of the water is from left to right in the picture. The chemical is injected through the threaded pipe extension on the left of the mixer body. As water passes through the mixer, it is churned by the metal baffles seen in the picture and the chemical is mixed with the water.

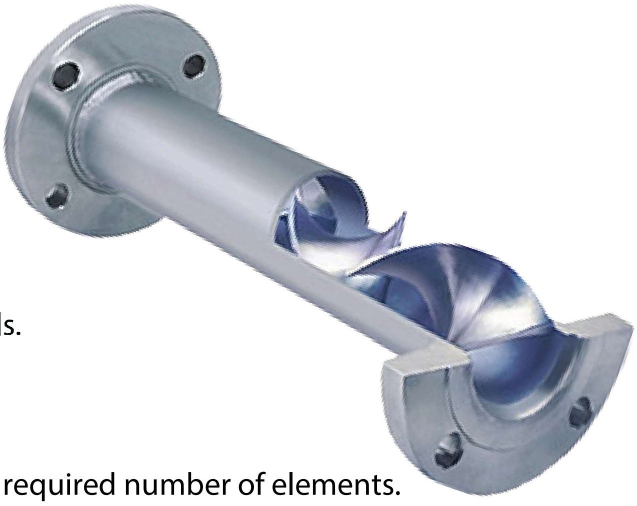
Flow is divided equally passing each element and number of divisions increases in a geometrical progression as the number of elements increase.

Number of Elements (n)	1	2	3	4	5	6	7	8
Flow Division								
Number of Partitions (N)	2	4	8	16	32	64	128	256

The partition number N = 2, (where n is the number of elements.)

Features and Benefits

- No moving parts and no contamination
- Low capital cost and maintenance
- Easy to install as standard
- Long service life and low power requirements
- No need for tanks in most cases
- Minimal space requirement
- Improved performance of the injected chemicals.



The Minimum Number of Elements

Reynolds number should be determined to specify the required number of elements.
The Reynolds number can be calculated namely ;

$$Re = \frac{D_P \rho_L V_S}{\mu}$$

Where:

D_P = Pipe diameter (m)
ρ_L = Mass density of water (kg/m³)
V_s = Water Velocity (m/s)
μ = Viscosity (kg/m-sec)

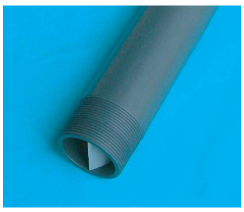
Flow Regime	Reynold's Number (Re)	No. Of Elements
Laminar	<1	24
	1-10	18
	11-50	14
	51-100	12
	101-500	10
Transitional	501-1,000	8
	1,001-2,000	6
Turbulent	2,001-50,000	4
	50,001+	2

Material of Construction

- stainless steel 304 & 316L
- PP, PVC and PE
- Carbon steel

End Connection


Plain


Threaded Pipes


Flanged


Union

Pressure Drop Number of Element

Calculate Pressure Drop, ΔP

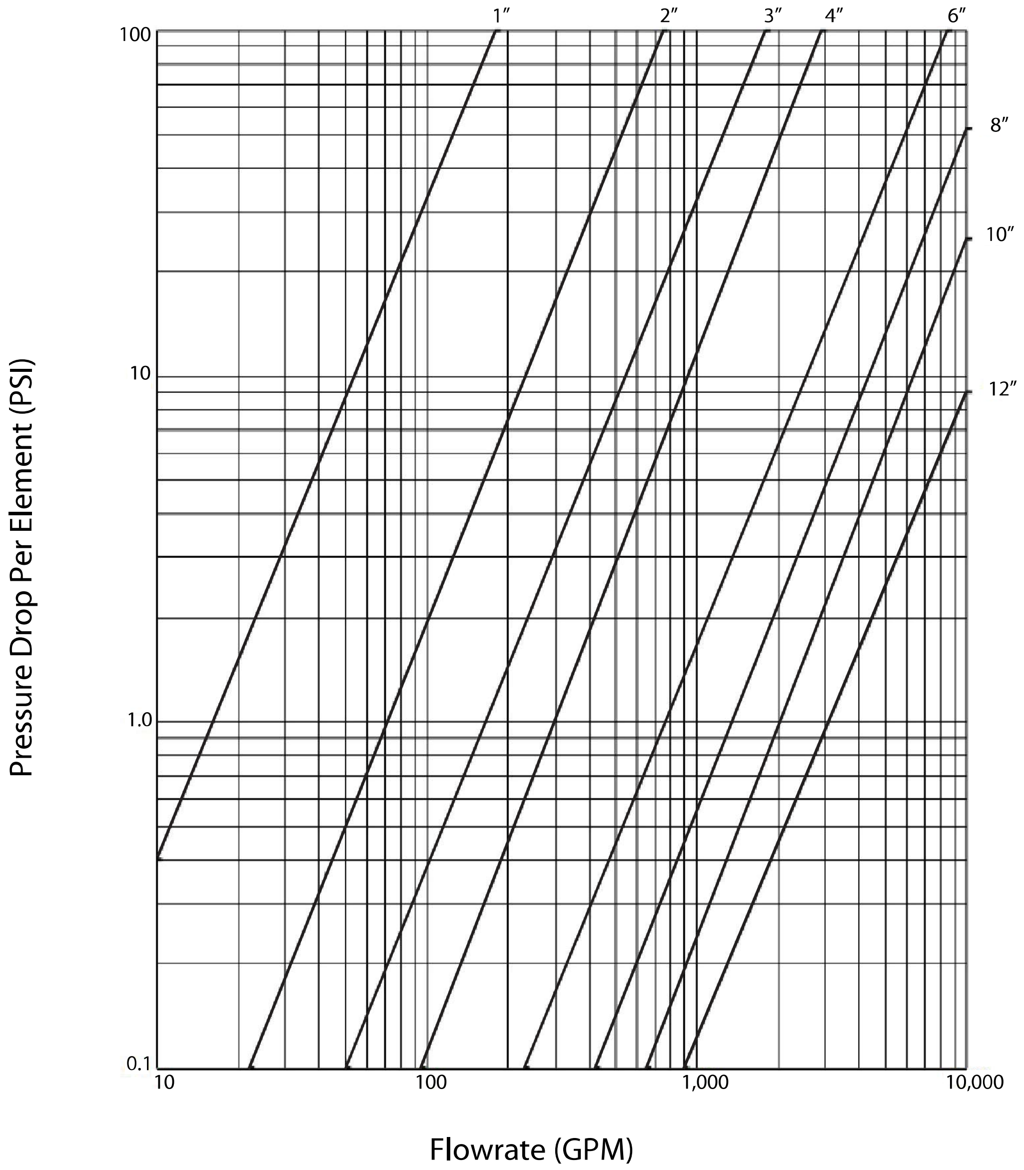
Where :
ΔP = Pressure Drop (kg/cm²) or (bar)
f SM = Friction Lambda static mixer (from table)

$$\Delta P = 3.061 \times 10^{-6} \times f_{NSM} \rho (\overline{u})^2 E$$

f SM<0.1; **f SM** = $\frac{16}{Re.NO} \times 6$

ρ = Liquid density (g/cm³)
$\overline{u}$ = Liquid velocity (cm/s)
E = Element

PRESSURE DROP PER ELEMENT VERSUS FLOWRATE
For 1" through 12" Diameter Static Mixers



Mixer Velocity

Calculate Speed, V

$$V = \frac{Q}{A}$$

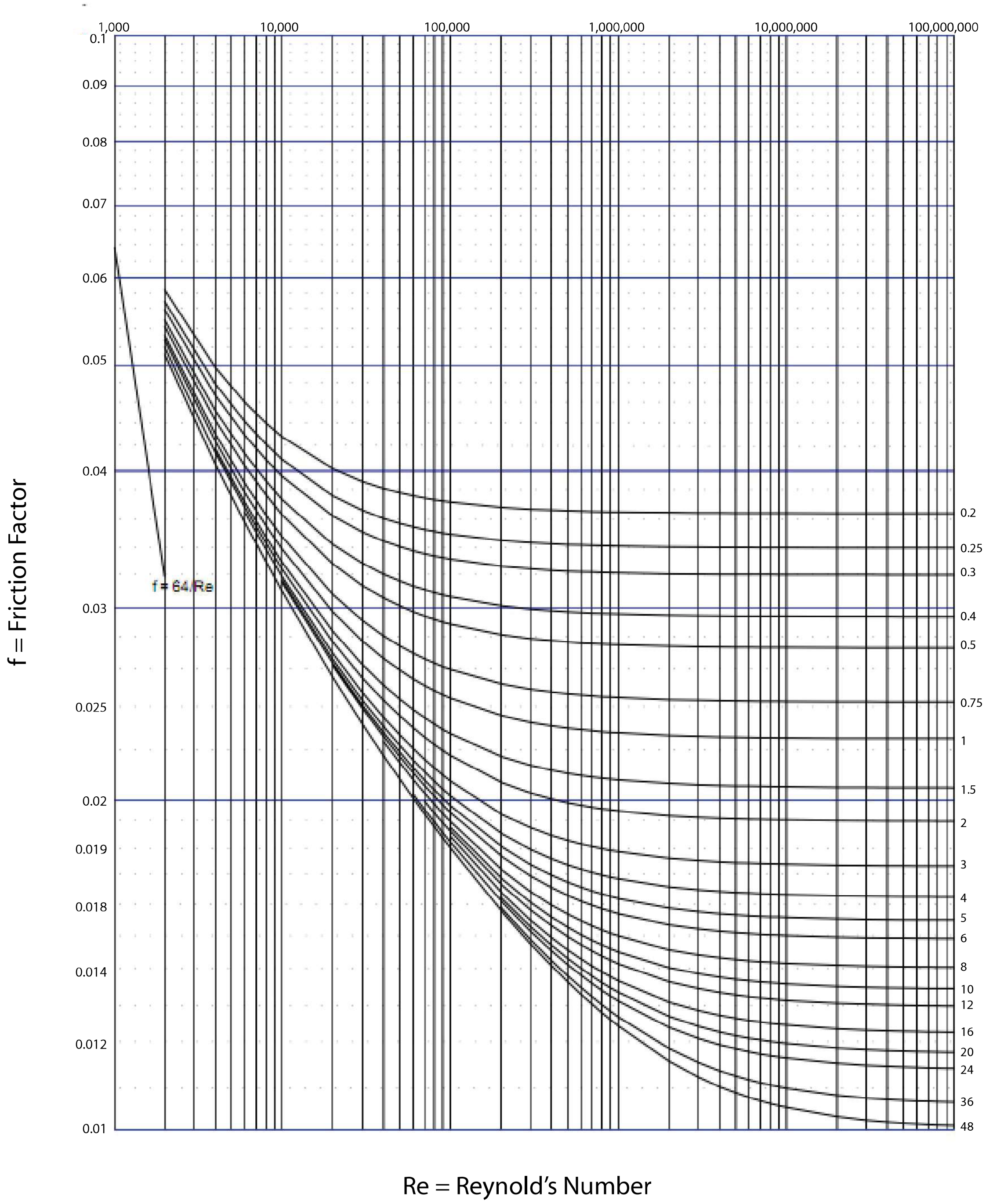
Where :

V = Velocity (m/s)

Q = Flow rate (m^3/hr)

A = Area (m^2)

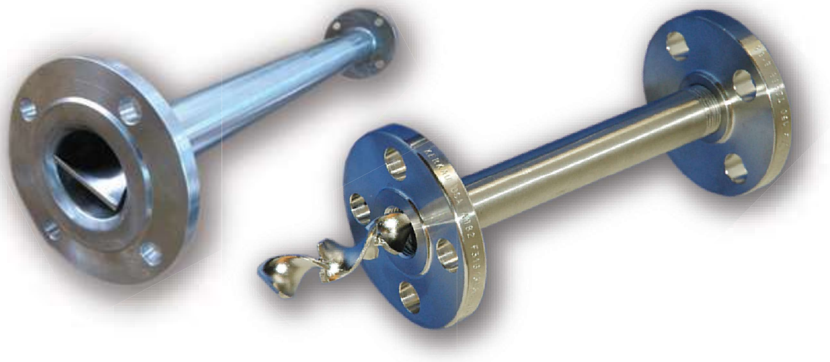
FRICTION FACTORS FOR CLEAN COMMERCIAL STEEL
AND WROUGHT IRON PIPE



Viscosity and Density of Liquids

1. μ = Dynamic Viscosity (N-s/m²)
2. υ = Kinetic Viscosity (m²/s)

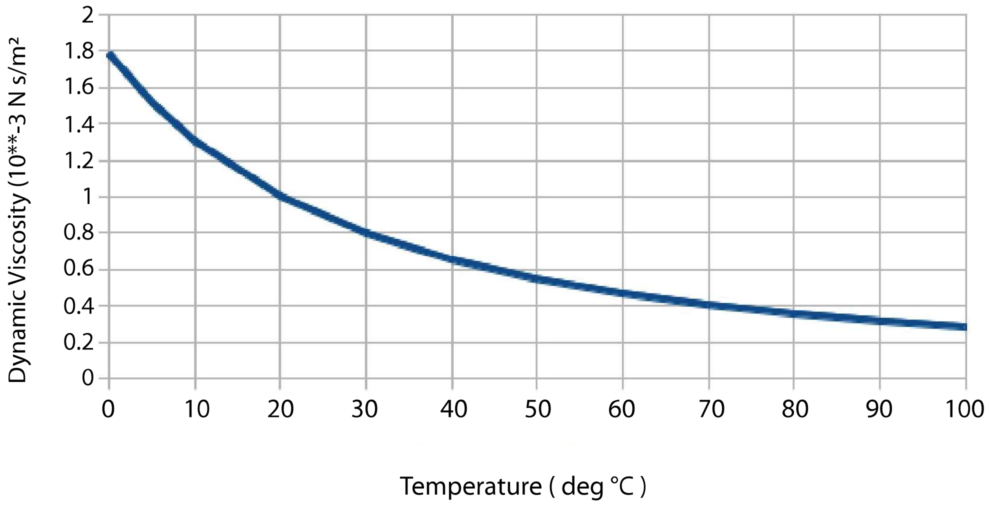
$$\upsilon = \frac{\mu}{\rho}$$



Material	T (°C)	μ (Pa.s)	ρ (kg/m³)
Liquids			
Water	0	1.79×10^{-3}	999
Water	20	1.00×10^{-3}	998
Water	40	0.664×10^{-3}	992
Water	60	0.466×10^{-3}	983
Water	80	0.355×10^{-3}	972
Water	100	0.281×10^{-3}	958
Ethanol	20	1.20×10^{-3}	790
Gycerol	20	1.490	1261
Edible oils	20	0.05-0.2	920-950
Edible oils	100	$5\text{-}2 \times 10^{-3}$	880-900
Milk	20	2×10^{-3}	1032
Milk	70	0.7×10^{-3}	1012
Beer	0	1.3×10^{-3}	1000
Honey	25	6	1400

Water

Temperature and Dynamic Viscosity



Head Loss in Static mixer

Darcy –Weisbach Equation

$$h_f = f\,\frac{Lv^2}{D2g}$$

Where :

f = coefficient of friction (Darcy – Weisbsch)
L = length of static mixer (m)
D = diameter of pipe (m)
V = velocity in the pipe (m/s)
G = acceleration due to gravity (9.81 m/s^2)

For smooth pipe Reynolds number would give the following relationships between f and Re

$$f = 0.048(R_e)^{-0.20} \qquad 10^4 < R_e < 10^6$$

$$f = 0.193(R_e)^{-0.35} \qquad 3 \times 10^3 < R_e < 10^4$$

The required number of elements can also be approximated via different kinds of mixing namely ;

Number of Elements	Applications
1 - 4	- Mixing of gas low viscous fluids
4 - 6	- Mixing of low viscous fluids - Homogenization of high viscous fluids - Uniformization of temperature
6 - 12	- Gas - liquid contraction - Blending of heavy oils - Alkali washing - Aeration
12 - 18	- Mixing of medium viscous fluids - Extraction / emulsification
18 - 24	- Mixing of high viscous fluids - Mixing of two component resins / adhesives
>24	- Heat exchange / reactor - Specific purposes

InLine Static Mixer

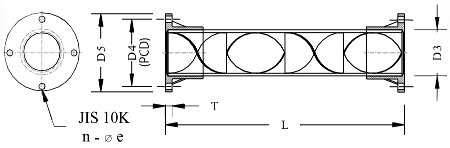
Ordering Information

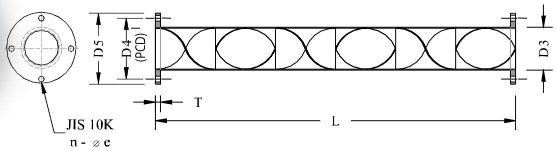
Model: SMxxxxA-xxxxx
- Connection
- No. of Elements
- Nominal size (mm.)
- Material Code

Material Code
- T : SS 304
- U : SS 316
- V : PVC

Conection
- P : Plain
- T : Threaded Pipes
- G : Flanged
- U : Union

UPVC





Stainless Steel

4 Elements

Part Number	Nominal Size		Approx. Dimensions (mm)						
	mm.	Inch	D3	D4	D5	L	T	n	øe
SMV020A-V004G	20	3/4	27	75	100	130	14	4	15
SMV025A-V004G	25	1	33	90	125	165	14	4	19
SMV040A-V004G	40	1-1/2	48	105	140	250	16	4	19
SMV050A-V004G	50	2	60	120	155	325	16	4	19
SMV065A-V004G	65	2-1/2	73	140	175	395	16	4	19
SMV080A-V004G	80	3	89	150	185	490	18	8	19
SMV100A-V004G	100	4	114	175	210	635	18	8	19
SMV150A-V004G	150	6	168	240	280	955	21	8	23
SMV200A-V004G	200	8	219	290	330	1,250	21	12	23

6 Elements

Part Number	Nominal Size		Approx. Dimensions (mm)						
	mm.	Inch	D3	D4	D5	L	T	n	øe
SMV020A-V006G	20	3/4	27	75	100	185	14	4	15
SMV025A-V006G	25	1	33	90	125	235	14	4	19
SMV040A-V006G	40	1-1/2	48	105	140	365	16	4	19
SMV050A-V006G	50	2	60	120	155	475	16	4	19
SMV065A-V006G	65	2-1/2	73	140	175	580	16	4	19
SMV080A-V006G	80	3	89	150	185	720	18	8	19
SMV100A-V006G	100	4	114	175	210	940	18	8	19
SMV150A-V006G	150	6	168	240	280	1,415	21	8	23
SMV200A-V006G	200	8	219	290	330	1,855	21	12	23

8 Elements

Part Number	Nominal Size		Approx. Dimensions (mm)						
	mm.	Inch	D3	D4	D5	L	T	n	øe
SMV020A-V008G	20	3/4	27	75	100	240	14	4	15
SMV025A-V008G	25	1	33	90	125	305	14	4	19
SMV040A-V008G	40	1-1/2	48	105	140	480	16	4	19
SMV050A-V008G	50	2	60	120	155	625	16	4	19
SMV065A-V008G	65	2-1/2	73	140	175	765	16	4	19
SMV080A-V008G	80	3	89	150	185	955	18	8	19
SMV100A-V008G	100	4	114	175	210	1,245	18	8	19
SMV150A-V008G	150	6	168	240	280	1,875	21	8	23
SMV200A-V008G	200	8	219	290	330	2,460	21	12	23