

stamixCO GX Static Mixer Product Bulletin

For Mixing & Dispersing Viscous Fluids.....

INTRODUCTION

For more than 25 years, Type GX static mixers have been used successfully for the mixing and/or dispersing of viscous fluids. They are capable of mixing materials with equal or very different viscosities and volumetric flow rates.

The number of mixing elements and pipe diameter required for a specific application is a function of the customer's process and system requirements with consideration for the desired homogeneity, pressure drop limitations and fluid properties such as flow rates, viscosities, densities, etc.

The GX mixing elements are available in metal construction (see Figure #1) and in plastic construction (see Figure #2).



Figure #1: Metal Type GX Mixing Elements are available in sizes as small as 9.8 mm (0.39") diameter and in much larger sizes.

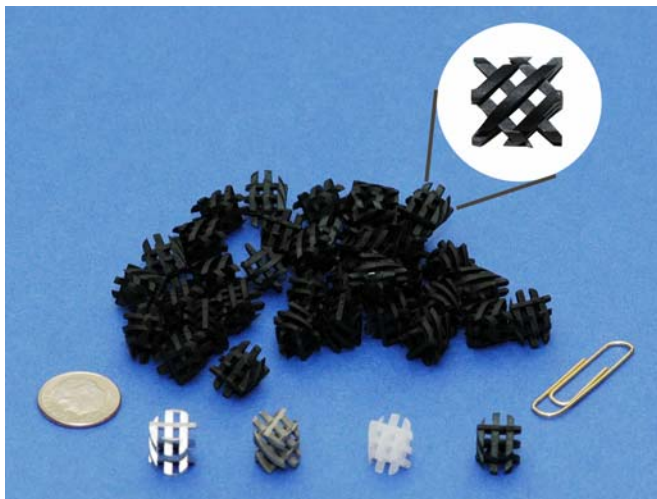


Figure #2: Plastic GX Mixing Elements are available in nominal 9.4 mm OD size in 50% glass-filled Polyamide (Nylon) 66 (PA66) plastic (black units) and Polypropylene (PP) plastic (white units).

To create a mixing element assembly with the required number of mixing elements for the application, the mixing elements are welded together (see Figure #3). Adjacent mixing elements are oriented 90° relative to each other. They are then inserted into a pipe housing (see Figure #4).

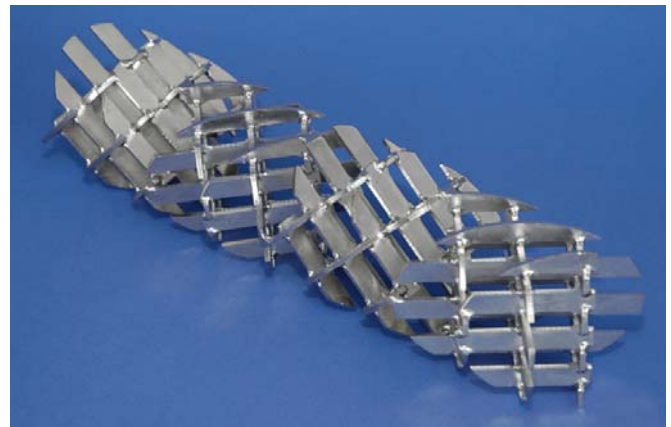


Figure #3: Type GX Mixing Element Assembly with 4-mixing elements

The Type GX mixing element creates a very high degree of mixing in a short length. Each mixing element has a length-to-diameter ratio of approximately 1.0. A typical mixing element assembly ranges from 2-mixing elements for simple applications to as many as 20-mixing elements for very difficult applications.

Applications for the GX mixing elements include the extrusion of plastics, polymer and fibers synthesis, and the general processing of viscous materials such as Liquid Silicone Rubber (LSR), Adhesives, Polyurethanes, Sealants, Polyol, Foods, etc.



Figure #4: Type GX mixing elements installed inside a pipe with beveled ends prepared for welding (left), threaded pipe (center) and in a flanged housing (right).

MIXING PERFORMANCE

The number of Type GX mixing elements required for a specific application in laminar flow conditions is shown in Table #1 and Table #2 and is visualized in Figure #5.

Table #1: Number of Type GX Mixing Elements required in laminar flow conditions (viscosity ratios up to 100:1)

Volumetric Ratio of Components To Be Mixed A : B	Viscosity Ratio of Components to be Mixed A : B	NUMBER OF MIXING ELEMENTS REQUIRED*		
		"Pre-Mix Quality" Homogeneity 80% Degree of Mixing Achieved (CoV** = 0.2)	"Good Quality" Homogeneity 95% Degree of Mixing Achieved (CoV = 0.05)	"Very Good Quality" Homogeneity 99% Degree of Mixing Achieved (CoV = 0.01)
1 : 1	1 : 1 – 100 : 1	4	6 - 7	9 -10
9 : 1	1 : 1 – 100 : 1	6	9	12
99 : 1	1 : 1 – 100 : 1	9	12	15
999 : 1	1 : 1 – 100 : 1	11	14	17

Notes for Table #1:

- * The number of GX mixing elements required is approximate and can deviate depending on the viscosity behavior of the media to be mixed. The validity of the table is limited to materials that at the operating conditions are soluble in each other in every mixing ratio.
- ** CoV: Coefficient of Variation of mixing (request literature for more information on CoV)

If the viscosity ratio of Component A (the major component) - to - Component B (the minor component) is greater than 100:1 (high viscous material A : low viscous material B), the number of mixing elements noted in Table #1 must be increased by the number of mixing elements noted in Table #2.

Table #2: Number of Additional Type GX Mixing Elements Required to those Indicated in Table #1 for materials with viscosity ratios of greater Than 100:1

Viscosity Ratio A : B	100 – 300 : 1	300 – 1,000 : 1	1,000 – 3,000 : 1	3,000–10,000 :1
Additional Type GX Mixing Elements Required	2 - 3	3	3 - 4	4

PRESSURE DROP, MIXER LENGTH & POWER REQUIREMENTS

The pressure drop across the Type GX static mixing unit is provided by the pumps feeding the materials to the static mixer. By varying pipe diameter in combination with the number of mixing elements required for the specific application, virtually any system pressure drop limitation can be accommodated.

In laminar flow applications with the Type GX mixing element design, the approximate pressure drop (Δp_L) is calculated as shown in Equation #1. The below formulas are guidelines where calculation by StaMixCo is recommended which incorporates other factors not listed in this literature.

Equation #1

$$\Delta p_L = \sim 8.9 \times 10^{-8} (Ne Re_D) \frac{\mu M}{\rho D^3} (N)$$

The length of the Type GX mixing element assembly required for the mixing task is a function of the inside pipe diameter and the number of mixing elements and is calculated as shown in Equation #2:

Equation #2

$$L = \sim D \times N$$

The power required to overcome pressure drop through the static mixer is shown in Equation #3:

Equation #3

$$P = \sim 5.8 \times 10^{-4} (Q \Delta p_L)$$

Nomenclature:

- D : Inside pipe diameter [in]
- L : Approximate Length of complete mixing element assembly consisting of N mixing elements [in]
- M : Mass throughput [lb/hr]
- N : Number of mixing elements [-]
- $Ne Re_D$: $\sim 1,200$ [-] for Type GX mixing elements in laminar flow which is the product of the Newton number (Ne) [-] and the Reynolds number (Re) [-].
- P : Power required [hp]
- Q : Volumetric flow rate [gpm]
- Δp_L : Pressure drop across static mixer [psi]
- μ : Viscosity [cp]
- ρ : Density [lb/ft³]

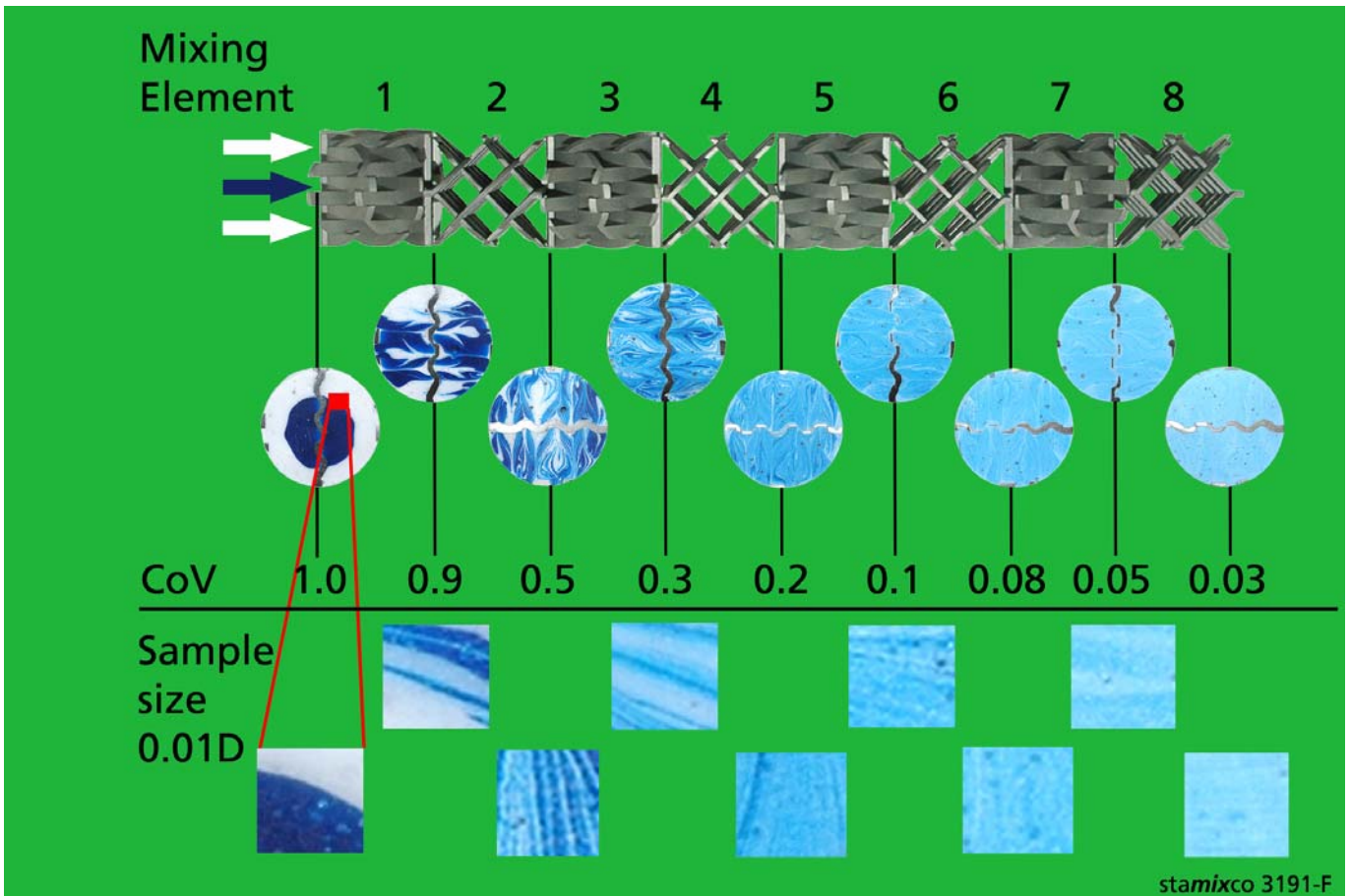


Figure #5: The Coefficient of Variation of mixing (CoV) for the Type GX static mixer in laminar flow is visualized in the above photographs.

- **Top Photograph:** Eight (8) Type GX Mixing Elements are shown where each mixing element is oriented 90° relative to the adjacent mixing element.
- **Center Photograph:** Mixing of Blue and White viscous resins (1:1 volumetric ratio and similar viscosity) is demonstrated where the blue resin is injected into the center of the tube containing the Type GX static mixing element assembly. The cross-sectional cuts along the mixing length show the rapid increase of layers formed. The degree of mixing achieved at the outlet of each mixing element is shown along with its corresponding degree of mixing achieved which is noted as the Coefficient of Variation of mixing (CoV) as described in Tables #1 and #2. Notice the blending of the blue-and-white resins follows the geometric pattern of the eight mixing bars within each mixing element.
- **Bottom Photograph:** Close-up views of 0.01D (where D is the diameter of the pipe) are shown at the outlet of each mixing element in the exact same spot in the piping system as depicted by the red-square at the entrance to the first mixing element. After 4-mixing elements, Pre-Mix Quality Homogeneity (CoV = 0.2) is achieved; after 7-mixing element; Good Quality Homogeneity (CoV = 0.05) is achieved; and after 8-mixing elements; a near Excellent Quality Homogeneity (CoV = 0.03) is achieved where 10-mixing elements are normally considered to achieve Excellent Quality Homogeneity with a CoV = 0.01

AVAILABILITY OF MIXING ELEMENTS

• Materials of Construction

Type GX mixing elements are available in 316L S/S construction as the standard material. Other common materials available upon request include Heat Treated 17-4 PH stainless steel, Alloy 20, Hastelloy C, etc.

• Sizes

Standard mixing elements are made to fit Sch. 40 pipe in sizes, 3/8", 1/2", 3/4", 1", 1-1/2", 2" and all larger pipe sizes. Units to fit other pipe Schedules and tubing sizes are available upon request.

• Housings

Complete ready to install units are available in tubing and most pipe schedules with housing plain ends, ends prepared for welding, threaded ends, and with flanged end connections (see Figure #4). Mixing elements can also be supplied to retrofit existing customer housings.

- Type GX Mixing Elements are available in Metal Construction (see Table #3) and in Plastic Construction (see Table #4)

Figure #6: Dimensions of Standard GX mixing elements. For Metal Mixing Elements, see Table #3 and for Plastic Mixing Elements, see Table #4.

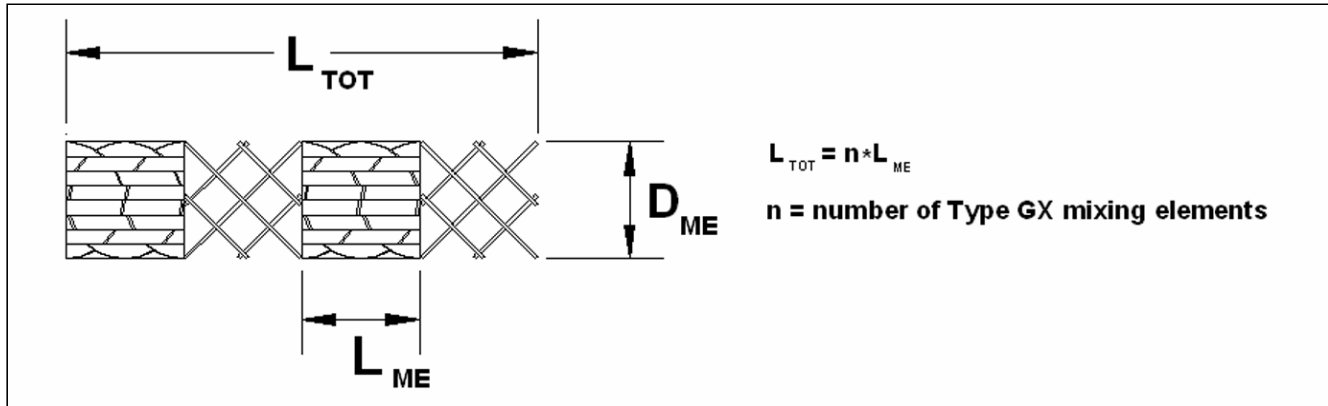


Table #3: Metal Type GX Mixing Element Key Dimensional Parameters as shown in Figures #6.

MODEL NUMBER	Nominal Pipe Size ¹⁾		Standard Pipe Dimensions			Mixing Element Dimensions ¹⁾		Length (L _{TOT}) of Mixing Element Assembly with n number of mixing elements			
	Diameter (in)	Pipe Schedule	Pipe O.D. (in)	Pipe Wall Thickness (in)	Pipe I.D. (in)	D _{ME} (in)	L _{ME} (in)	4 Mixing Elements	8 Mixing Elements	12 Mixing Elements	16 Mixing Elements
GX-DN10	-	-	-	-	-	9.8 mm	9.8 mm	39.2 mm	78.4 mm	117.6 mm	157.6 mm
GX-0.375	3/8"	40	0.675"	0.091"	0.493"	0.49"	0.49"	2.0"	4.0"	6.0"	8.0"
GX-0.5	1/2"	40	0.840"	0.109"	0.622"	0.62"	0.62"	2.5"	5.0"	7.5"	10.0"
GX-0.75	3/4"	40	1.050"	0.113"	0.824"	0.80"	0.77"	3.1"	6.3"	9.5"	12.5"
GX-1.0	1"	40	1.315"	0.133"	1.049"	1.04"	1.06"	4.3"	8.7"	13.0"	17.3"
GX-1.5	1-1/2"	40	1.610"	0.145"	1.610"	1.59"	1.59"	6.4"	12.9"	19.4"	25.8"
GX-2.0	2"	40	2.375"	0.154"	2.067"	2.05"	2.07"	8.3"	16.7"	25.0"	33.4"
GX-2.5	2-1/2"	40	2.875"	0.203"	2.469"	2.40"	2.47"	9.9"	19.9"	29.9"	40.0"
GX-3.0	3"	40	3.500"	0.216"	3.068"	3.06"	3.07"	12.3"	24.7"	37.0"	49.4"
GX-4.0	4"	40	4.500"	0.237"	4.026"	3.99"	4.03"	16.2"	32.5"	48.8"	65.0"
GX-5.0	5"	40	5.563"	0.258"	5.047"	4.99"	5.05"	20.2"	40.5"	60.8"	81.0"
GX-6.0	6"	40	6.625"	0.280"	6.065"	6.02"	6.07"	24.3"	48.8"	73.0"	97.5"
GX.8.0	8"	40	8.625"	0.322"	7.981"	7.90"	8.00"	32.2"	64.4"	96.8"	130.0"
GX-10.0	10"	40	10.750"	0.365"	10.02"	9.92"	10.04"	40.2"	80.6"	120.8"	161.0"
GX-12.0	12"	40	12.750"	0.406"	11.938"	11.87"	11.90"	47.7"	95.4"	143.0"	190.60"

Notes:

¹⁾ Standard Mixing Elements are 316L S/S construction made to fit Sch. 40 pipe size. Mixing Elements can however be manufactured in most materials of construction and to fit most pipe and tubing diameters and schedules.

Table #4: Plastic Type GX Mixing Element Key Dimensional Parameters as shown in Figures #6.

Model Number	Material of Construction	D _{ME} (mm)	L _{ME} (mm)	Length (L _{TOT}) of Mixing Element Assembly with n number of mixing elements	
				4 Mixing Elements	8 Mixing Elements
GX-DN10-PA	50% glass-filled polyamide (Nylon) 66 (PA66) resin For High Strength Requirements	9.4 mm	9.5 mm	38.0 mm	76.0 mm
GX-DN10-PP	Polypropylene	9.3 mm	9.5 mm	38.0 mm	76.0 mm

RETENTION OF GX MIXING ELEMENTS INSIDE OF HOUSING

There are a number of techniques to retain metal Type GX mixing elements inside a housing depending on installation requirements which are described below.

• Non-Removable Mixing Elements (weld mixing elements into housing technique)



Figure #5

The most common and least expensive method of retaining the mixing element assembly inside a housing is to weld the first and last mixing element to the inside of the pipe wall at the points where the 8-mixing bars contact the pipe ID.

This non-removable mixing element retention technique can be used with any pipe or tube and with any end connection such as ends prepared for welding, threaded or flanged connections.

• Removable Mixing Elements (downstream retaining bar technique)



Figure #6

When removable mixing elements are required for fouling service applications that require removal, inspection or cleaning, the least expensive technique for retaining the mixing elements inside a housing is to weld two round bars/plates to the downstream end of the housing. This retains the mixing elements and allows the mixing element assembly to be removed by pulling it out of the upstream end of the housing.

This downstream retaining bar technique for removable mixing element requirements can be used with any pipe or tube and with any end connection such as ends prepared for welding, threaded or flanged connection.

• Removable Mixing Elements (ring retaining technique)

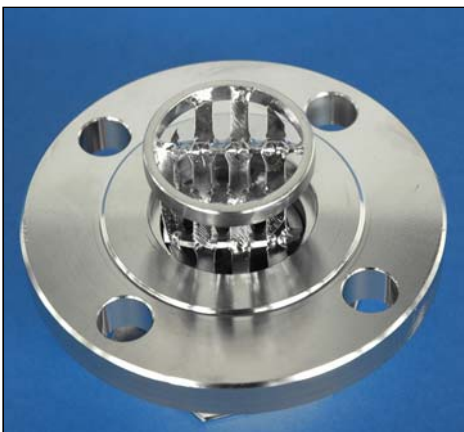


Figure #7

When long lengths of mixing elements are required for the process application and when removable mixing elements are also required for fouling service duty, the Ring Retaining technique is best.

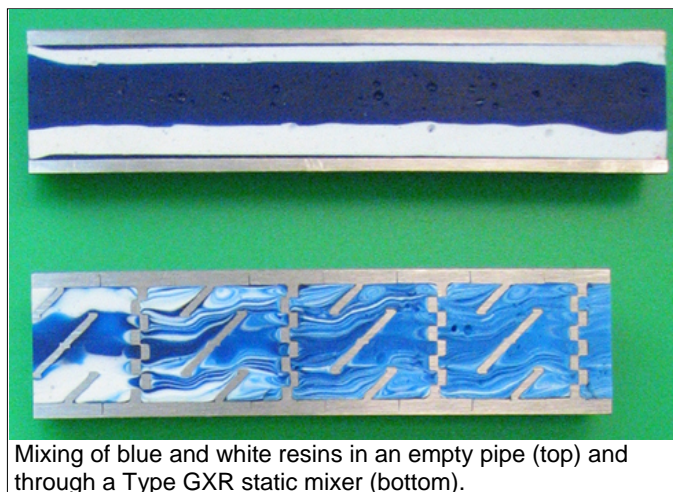
A long mixing element assembly is split into 2-assemblies (an upstream and a downstream assembly) where removal of shorter assemblies is easier than removal of one long assembly. At the end of each mixing element assembly is welded a ring that countersinks into a machined recess of the housing Raised Face Weld Neck Flange.

This removable mixing element technique is available for any pipe housing where a Weld Neck Flange connection is used.

stamixco

Static Mixing, Reaction & Heat Transfer Technology Products

Static Mixing Technology is our only business. We offer a complete line of static mixer designs for both laminar flow and turbulent flow applications. Our designs are briefly described below.



Mixing of blue and white resins in an empty pipe (top) and through a Type GXR static mixer (bottom).



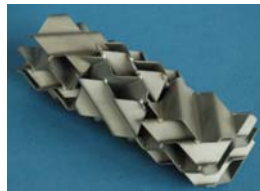
Type "GX": *High Performance*
Mixing of high viscosity liquids with similar and extreme viscosity and volumetric ratios; inducing plug flow; boosting viscous heat transfer; and the processing of molten polymers



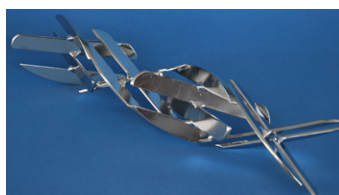
Type "GXR": *High Performance*
Primary use is for Plastics Extrusion, Injection Molding, Silicone and Resin processing where a high degree of mixing in a short length and a nearly indestructible static mixer design is required.
* Licensee of Bayer AG, Germany



Type "GX-L": *Moderate Performance*
Primary use is heat transfer plug flow reactors and viscous mixing applications where pressure drop is an issue.



Type "V": *High Performance*
Primary use is for turbulent flow, liquid-liquid and gas-gas mixing applications, immiscible liquid dispersion and gas-liquid contacting



Type "GX-LR": *Moderate Performance*
Primary use is for transitional flow applications with viscosity differences where low pressure drop and fouling service are issues.



Type "H": *Low Performance*
Primary use is for small diameter simple turbulent and laminar flow mixing and heat transfer applications where low pressure drop and fouling service are issues.

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A young company with over 50 years of employee accumulated experience in mixing technology.

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