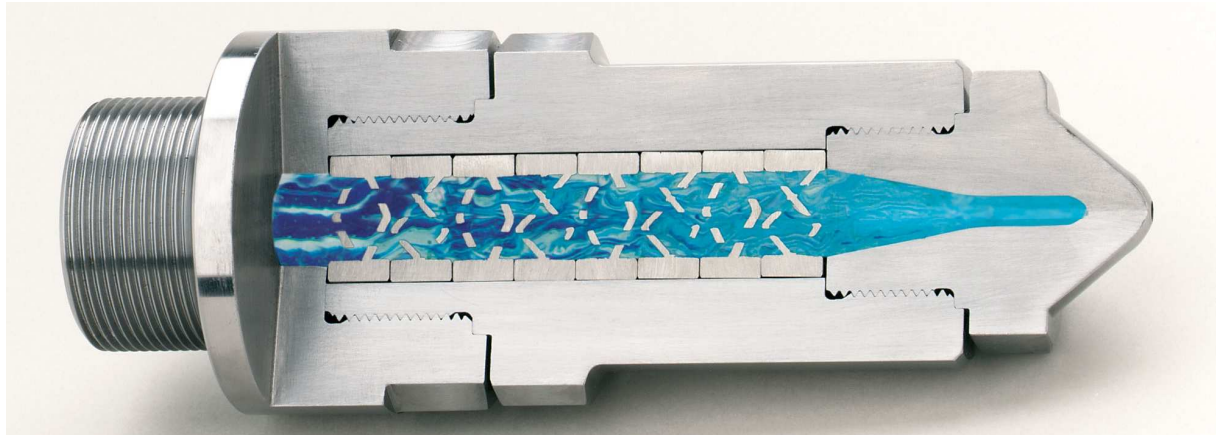


# Injection Moulding Mixing Nozzle

*High Quality melt flow means .....  
 .....better cash flow.*



## INTRODUCTION

**We are living in a world of consumption. On a daily basis, Product Specialists and Injection Moulders must deal with many different tools, formulations, colours additives and mastebatches. Production rate, yield and high quality are Keys for Success.**

The StaMixCo SMN Injection Moulding Mixing Nozzle contains eight (8) very efficient static mixing elements that homogenize the polymer melt during injection. This homogenization is achieved by the continuous division of the molten polymer and its recombination when processed through the geometric structure of the mixing bars (Figure #1).

Figure #1 shows the laminar flow behaviour of two resins (white and blue) when injected into an empty pipe (left) and through eight (8) SMN static mixing elements (right). These eight(8) SMN static mixing elements reduce polymer non-uniformity by a factor 6.



**Fig. #1:** *Mixing of blue and white epoxy resins. Empty tube (left) provides no mixing. Eight (8) SMN mixing elements (center and right) provide an almost perfect mix.*

The SMN mixing elements are extremely resistant due to their monolithic cast construction where the mixing bars are joined to each other and to the external ring wall via a single molten metal pour. They are made of heat treated high strength 17-4 PH stainless steel and are virtually indestructible. Pressure drop through the static mixing elements is low.



**Fig. #2:** *A Ready-to-Install StaMixCo SMN Injection Moulding Mixing Nozzle with eight (8) mixing elements, nozzle body, heater bands and thermocouple.*

## MIXING QUALITY

The optimum polymer melt quality for injection moulding is reached when at each location inside the polymer melt volume, a uniform distribution of colorant, additives and melt temperature exists. Using the StaMixCo SMN mixing elements, 80% of mixing (CoV = 0.2) is reached after eight elements and 97% (CoV = 0.03) after 16 elements as shown in Figure #3.



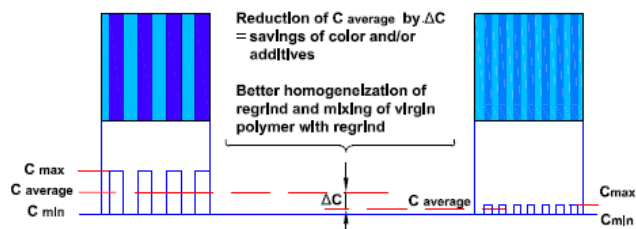
**Fig. #3:** Evolution of mixing through the SMN Static Mixer Elements with Blue and White resins (1:1 volumetric ratio). After 8 mixing elements, 80% and after 16 elements 97% of mixing efficiency is achieved.

Outstanding mixing of the polymer melt prior to injection results in the following benefits:

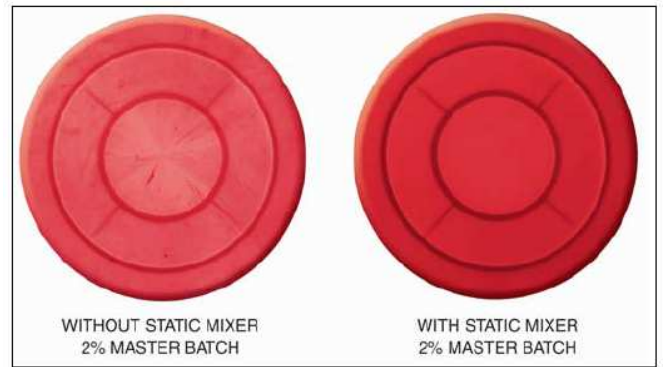
## BENEFITS

- Reduced spots, streaks and clouds of colour
- Reduced colorant usage (up to 40% less) with comparable part colour density
- Narrower part tolerance
- Reduced reject rates
- Less part distortion
- Less part weight variation
- Improved part quality when using regrind material and increased use of regrind.
- Shorter cycle times
- Improved surface and mechanical properties
- Blended thermal degradation products (i.e., PET)
- Improved melt flow, uniform filling of multi-cavity moulds
- Expanded operating range of older machines

## ILLUSTRATION OF BENEFITS MASS HOMOGENEIZATION

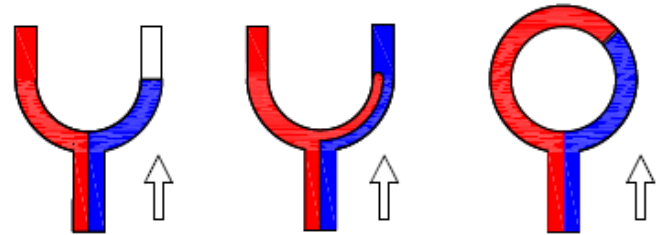


**Fig. #4:** Illustration of colour concentrate distribution profile achieved WITHOUT a StaMixCo static mixer (left) and WITH a StaMixCo SMN static mixer (right).

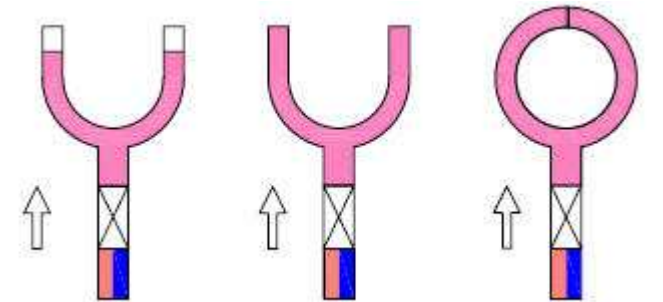


**Fig. #5:** Reduction of colour concentrate additives of as much as 30% can be achieved with comparable part colour density

## HOMOGENEIZATION OF TEMPERATURE

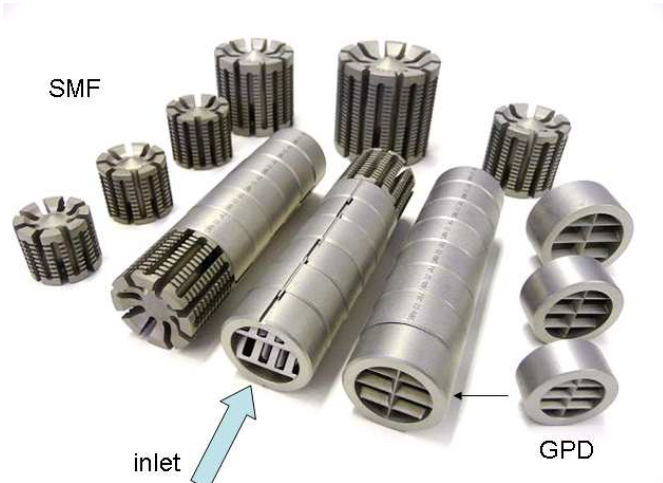


**Fig. #6:** Polymer melt WITHOUT a static mixer is illustrated when a larger temperature gradient in the polymer melt creates asymmetrical filling and uneven cooling of an injection molded part. Large distortions and weight differences result which results in HIGH REJECT RATES



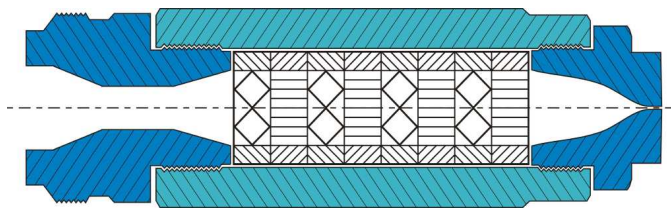
**Fig. #7:** Polymer melt WITH a StaMixCo static mixer results in homogeneous polymer melt with a narrow temperature gradient. This results in symmetrical filling and even cooling of the parts without distortion. Identical weight of each injection moulded part means a SMALL REJECT RATE

## FILTER AND GRID PROTECTION DISK



**Fig. #8:** The SMF Filter and GPD Grid Protection Disk are placed at the inlet or outlet of the SMN mixing element. On the left, the first SMN mixing element has been replaced by a GPD protection Disk at the inlet. For more information, please contact us.

## NOZZLE SELECTION

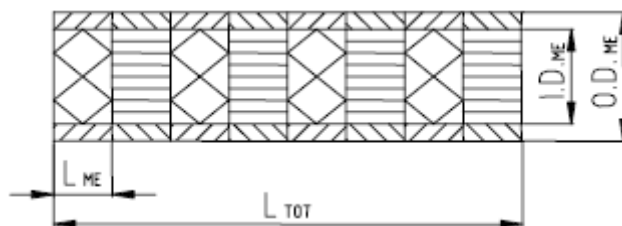


**Fig. #9:** Longitudinal cut through a complete SMN mixing nozzle

The proper size of the SMN Mixing Nozzle is a function of the injection flow rate and viscosity of the polymer melt at the specific operating conditions. The SMN Mixing Nozzle (Figure #9) consists of a centre barrel section that holds the standard eight (8) mixing elements (licensee of Bayer AG, Germany). The left side threaded adaptor connects to the injection moulding machine. The right side adaptor with nozzle tip connects to the mould. The entire mixing nozzle is heated by heater bands whose temperature is controlled by a thermocouple (not shown in above sketch—see Figure #2).

### MIXING ELEMENTS – MATERIAL

The SMN mixing elements are made of high strength 17-4 PH heat treated stainless steel. The outside diameter and faces of the mixing elements are machined. The SMN mixing elements (see Figure #2) are extremely strong due to their monolithic cast construction where the entire



**Fig. #10:** Key dimension of a Standard eight (8) SMN mixing element assembly that is installed in a nozzle body.

mixing element is made via a single molten metal pour. This means that the neighbouring mixing bars of the mixing grid are connected to each other and their ends are connected to the ring wall. There are therefore no unsupported fingers that can break off. The above described fabrication technique coupled with the use of high strength heat treated stainless steel results in a mechanical structure that is virtually indestructible.

### NOZZLE SIZE

The size of mixing nozzle to be installed depends on volumetric flow rate ( $\text{cm}^3/\text{s}$ ) and the viscosity of the polymer melt (Pa-s). The below Table #1 provides a rough estimate for the suitable mixing nozzle size for your application. To perform more accurate design calculations, the polymer rheology information (shear rate vs. viscosity at operating conditions) is required.

Screw Size Range (mm)	Injection Flow Rate		Mixing Nozzle Type	Mixing Elements			8 Mixing Elements $L_{TOT}$ (mm)	Nozzle Bore (mm)
	Low Viscosity Polymer ( $\text{cm}^3/\text{s}$ )	High Viscosity Polymer ( $\text{cm}^3/\text{s}$ )		I.D. ME (mm)	O.D. ME (mm)	$L_{ME}$ (mm)		
20-50	300	200	SMN-12-8	12	18	8.0	64.0	18
40-75	1,000	700	SMN-18-8	18	26	11.25	90.0	26
50-90	1,800	1,200	SMN-22-8	22	30	13.5	108.0	30
70-120	3,400	2,300	SMN-27-8	27	35	16.5	132.0	35
80-140	6,200	4,000	SMN-33-8	33	42	20.0	160.0	42
100-180	11,000	7,400	SMN-40-8	40	50	24.0	192.0	50
Especially Strong Design Suitable for Very Viscous Materials (e.g., PET)			SMN-52S-8	52	62	31.5	252.0	62
Tolerances (category/mm):					f7	0/-0.1	0/-0.8	H7

**Table #1:** For larger sizes, please contact us. Dimensions are approximate.

Tolerances are recommendations only and depend on installation method and operating conditions.

→ For condensed version of “Start-up and Operating Guidelines” see next page. ←

## START-UP AND OPERATING GUIDELINES

(Condensed Version – for more information refer to the Installation & Operation brochure)

### MAXIMUM OPERATING CONDITIONS

An SMN Mixing Element Assembly with eight (8) static mixing elements (Fig. #2) is designed for the following maximum operating conditions:

- a) 300 °C (572 °F) maximum continuous operating temperature
- b) 150 bar (2,175 psi) maximum allowable pressure drop

Where these limits are expected to be exceeded, special mixing element assemblies are available.

### INSTALLATION DIRECTION OF MIXING ELEMENTS

The Mixing elements may be installed with flow in any direction under the condition that no alignment pins extends beyond the front and rear rings of the mixing elements. The Filter can be installed on the feed side (inlet) of the nozzle body (near injection moulding machine) or at the outlet of the mixing section to protect the nozzle tip, the hot runner system or the mould from undesired solids. The Grid Protection Disk is installed only on the feed side of the static mixing elements to protect against a "Cold Start".

### TEMPERATURE SENSOR

The Mixing Nozzle housing must be equipped with a temperature sensor to control housing heater band operation on a dedicated circuit.

### START-UP AND OPERATION OF SMN MIXING NOZZLE

The SMN Mixing Nozzle must be allowed to soak at the operating temperature so that all internal parts of the mixing element fingers and frozen polymer within the mixing elements is melted and is at operating temperature prior to processing polymer. **Proper heat-up is required to prevent a cold-start induced mixing element failure.**

- a) Heat the nozzle until it reaches its normal operating working temperature and the controller switches on-and-off regularly for 5 minutes. Wait for an additional amount of time to allow complete melting of the polymer inside the nozzle: Recommended additional heating time ranges from 10 min for our SMN-12-8 up to 40 min for our SMN-40-8.

Extreme caution is required for any location upstream of the static mixing nozzle where a solid "rod" of frozen polymer exists.

A GPD Grid Protection Disk placed on the upstream side of the SMN mixing elements will protect them from a "Cold-Start". These areas must be heated for complete melting prior to processing into the mixer section. Extreme caution is required because a frozen slug of solid polymer takes longer to melt than the same frozen slug of polymer within the mixing elements. A "dead-head-cold start" event can cause destruction and tear-out of the mixing element fingers that may subsequently damage the nozzle tip, hot runner system and mold.

- b) When the additional heat-up time has elapsed, force molten polymer continuously in the extrusion mode into the air. Extrude at low rpm. If any major resistance of the melt is felt, stop and soak for another 5 minutes and start again with extrusion mode. Compare temperature of molten polymer and nozzle body. As soon as the difference is only slight, normal production may begin. When the polymer is flowing regularly out of the nozzle, switch to injection mode.

- c) Inject the first 3 to 5 shots using an injection time that is 3-5 times longer than normal operating conditions. Reduce injection time in 2 to 3 steps to reach normal operating conditions. Then begin normal production operations.

### INTERRUPTION TO INJECTION MOULDING OPERATIONS

For brief interruptions of injection moulding operations, temperature to the Mixing Nozzle housing may be lowered about 10-20°C (~20-40°F). During longer interruptions, the heating should be stopped to avoid burning of polymer. For normal and emergency shutdowns when thermally sensitive polymers are being processed, normal purge procedures prior to shut-down should be followed.

### COLOUR CHANGES

The SMN Mixing Elements have a very narrow residence time distribution as compared to an empty pipe. This means that when changing polymers or colour, the contents of the mixing elements will be purged completely in a short period of time by the new material (~ 5 mixing element volume residence times).

For cleaning of the mixing elements fluidized bed bath or vacuum pyrolysis can be used. Heating above 400 °C and open flame/blow torch cleaning is not recommended since the strength of the heat treated mixing element material will be affected.

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

Europe, Asia-Pacific, Africa  
StaMixCo AG  
Ebnetstrasse 8, P.O. Box  
CH-8474 Dinhard, Switzerland  
Tel: +41 52 338 17 11  
Fax: +41 52 338 17 33  
E-mail: info@stamixco.com

North and South America  
StaMixCo LLC  
235 – 84<sup>th</sup> Street  
Brooklyn, NY 11209, USA  
Tel: +1 (718) 748 4600  
Fax: +1 (718) 833 8827  
E-mail: stamixco@msn.com

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