SMB-R/OM-V.O5

Installation, Start-Up & Operating Instructions Manual
for
StaMixCo SMB-R Extursion Melt Blemder

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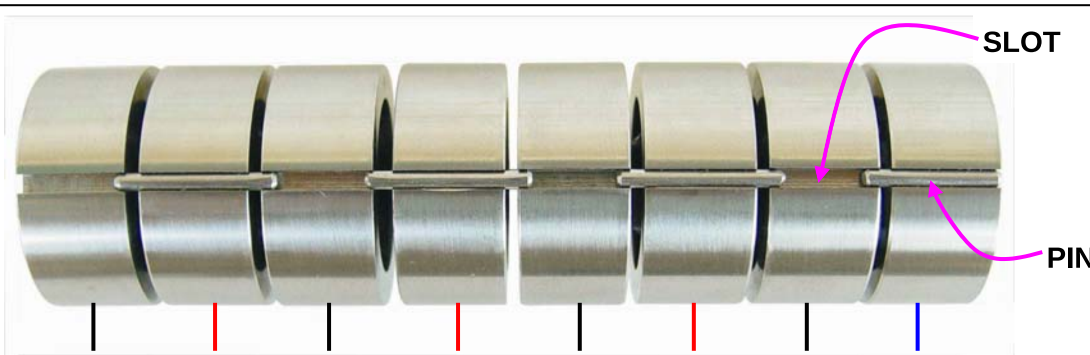
Installation, Start-up & Operating Instructions Manual For StaMixCo SMB-R Extrusion Melt Blender

A) SMB-R Extrusion Melt Blender Mixing Element Construction and Orientation

The standard SMB-R eight (8) mixing element assembly is shown in Figure #1. The Alignment Pin & Slot arrangement on the mixing element outside diameter assures that the mixing elements are oriented 90^{o} relative to each other. The mixing elements can be assembled in only one way with the condition that no pins extend beyond the front and rear face of the mixing element assembly.

The mixing element assembly is flow symmetrical and can therefore be installed into the Melt Blender Housing in either direction. The mixing elements are made of high strength 17-4 PH stainless steel material which has been heat treated. The mixing element design is licensed from Bayer AG, Leverkusen, Germany.



P2 P1 P2 P1 P2 P1 P2 P3

STANDARD SMB-R MIXING ELEMENT ASSEMBLY WITH 8-STATIC MIXING ELEMENTS

P1: Orientation Pins Extending on Both Sides of Mixing Element (3 Pieces)
P2: Slots Only - No Orientation Pins (4 Pieces)
P3: Orientation Pins Extending on One Side Only (1 Piece)

Figure #1: *Standard SMB-R Ring Type Mixing Element Assembly with 8-mixing elements slightly separated for visual clarity. Individual mixing elements can be separated and inspected from both sides. Slot and Pin arrangement assures adjacent mixing elements are oriented 90^{o} relative to each other. The mixing element assembly is flow symmetrical and can therefore be installed into the Melt Blender Housing in either direction.*

B) SMB-R Melt Blender Element Dimensions and Selection

The standard arrangement of the Melt Blender contains eight high performance SMB-R mixing elements that homogenize the polymer melt as it enters the extruder die. The correct size Melt Blender is a function of flow rate and viscosity of the polymer melt. SMB-R mixing element dimensions and sizing are as shown in Figure #2 and Table #1.

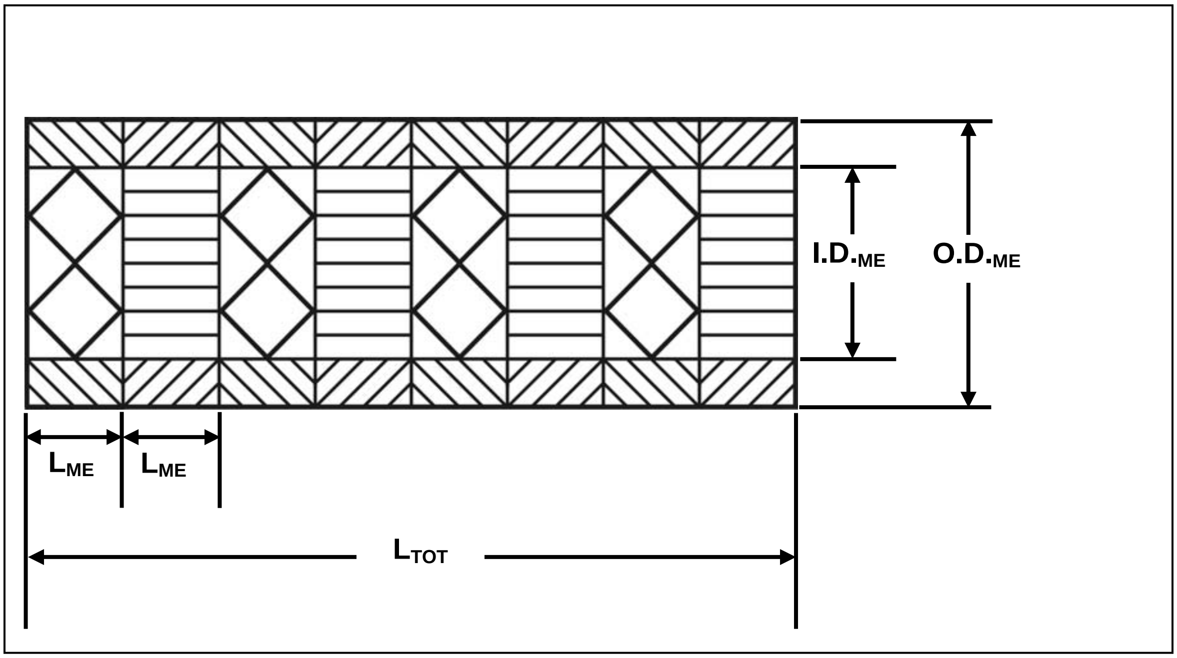


Figure #2: *Dimension parameters of eight (8) SMB-R Type mixing elements*

***Table #1**: Key Sizing and Dimensional Parameters for SMB-R Mixing Elements are shown in Figures #1 and #2.*

Extruder Screw Diameter (mm)		**Melt Blender**	**Mixing Elements**				**Housing**
High Viscosity Polymer	Low Viscosity Polymer	Type (◆Stock Item)	$I.D._{ME}$ (mm)	$O.D._{ME}$ (mm)	L_{ME} (mm)	L_{TOT} 8 Mixing Elements	Bore (mm)
10 mm	20 mm	SMB-R12/18-8 ◆	12 mm	18 mm	8.0	64	18
10 mm	25 mm	SMB-R18/25-8	18 mm	25 mm	11.2	90	25
" " "	" " "	SMB-R18/26-8 ◆	" " "	26 mm	11.2	90	26
25 mm	30 mm	SMB-R20/25-8	20 mm	25 mm	12.5.	100	25
" " "	" " "	SMB-R20/28-8 ◆	" " "	28 mm	12.5	100	28
25 mm	35 mm	SMB-R22/30-8 ◆	22 mm	30 mm	13.5	108	30
25 mm	45 mm	SMB-R27/32-8	27 mm	32 mm	16.0	128	32
" " "	" " "	SMB-R27/35-8 ◆	" " "	35 mm	16.5	132	35
35 mm	50 mm	SMB-R33/42-8 ◆	33 mm	42 mm	20.0	160	42
50 mm	60 mm	SMB-R40/48-8	40 mm	48 mm	24.0	192	48
" " "	" " "	SMB-R40/50-8 ◆	" " "	50 mm	24.0	192	50
60 mm	75 mm	SMB-R52/60-8 ◆	52 mm	60 mm	30.0	240	60
75 mm	100 mm	SMB-R66/75-8 ◆	66 mm	75 mm	37.5	300	75
90 mm	120 mm	SMB-R80/90-8 ◆	80 mm	90 mm	45.0	360	90
120 mm	150 mm	SMB-R102/115-8	102 mm	115 mm	57.5	460	115
150 mm	200 mm	SMB-R126/140-8	126 mm	140 mm	68.8	560	140
200 mm	240 mm	SMB-R154/175-8	154 mm	175 mm	85.5	684	175
Tolerances			-	f7	0/-0.1	0/-0.8	H7

For other O.D. and larger sizes, please contact us. Dimensions are approximate

C) <u>Basic Housing Design and Installation of the Mixing Elements</u>:

There are two principle methods of installing SMB-R mixing elements into Melt Blender housing:

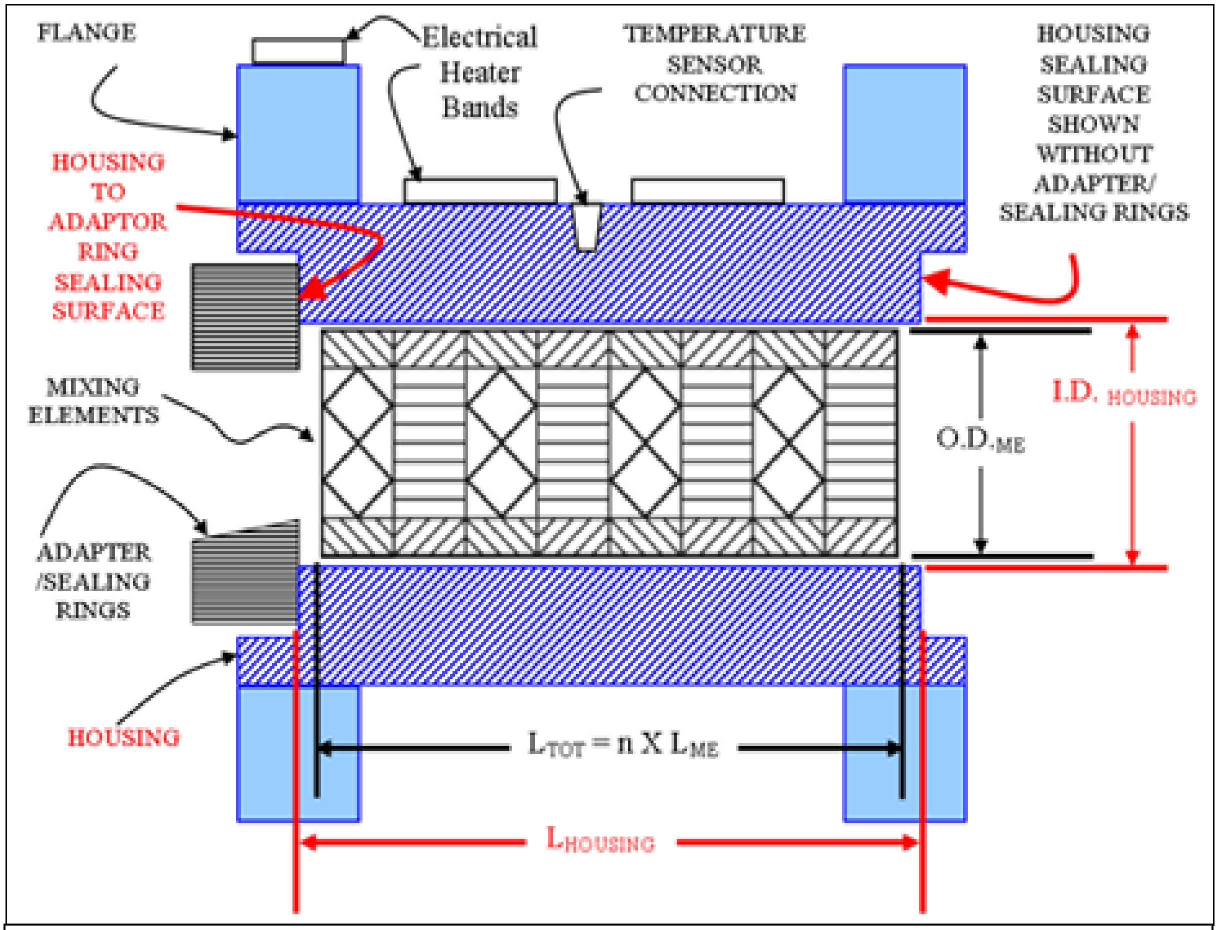
- <u>Tight Installation Method</u>:
  The "Tight Installation Method" is defined as when installing the mixing elements into the housing body with a narrow gap between the O.D. of the mixing elements and the I.D. of the housing body and with the sealing rings sealing against the housing as well as the front and last mixing element. This machining operation requires tight tolerances over a bore L/D ~5 – 6 which is sometimes difficult to achieve in average machine shops. This technique is useful with thermally sensitive polymers are being processed and where the less expensive housing floating mixing element installation ("Floating Installation Method") described below is not acceptable.

- <u>Floating Installation Method</u>:
  The "Floating Installation Method" is defined as when installing the mixing elements into the housing body where there is a small gap between the mixing element O.D and the housing body I.D. and when the housing length is slightly longer than the mixing elements. In operation, this gap is filled with polymer.

StaMixCo prefers the Floating Installation Method for normal applications. Figure #3) shows the basic design and principle methods of installing SMB-R mixing elements into a housing. This information and the noted tolerances are based on experience, but more importantly, the methods are based on an FEA (finite element method analysis) study conducted at the University of Winterthur ZHW, Switzerland in April – July 2004.

<u>Definitions</u>

- n = Number of Mixing Elements
- L_{ME} = Length of one (1) mixing element
- L_{TOT} = Length of n mixing elements
- $L_{HOUSING}$ = Length of Housing sealing surface–to–sealing surface
- $O.D._{ME}$ = Outside diameter of mixing elements
- $I.D._{HOUSING}$ = Inside diameter of housing



1) **Tight Installation of Mixing Elements in Housing Bore**

Tolerances

I.D. $_{HOUSING}$	F7	or	H6
O.D. $_{ME}$	H6		G6

$L_{HOUSING}$ = L_{TOT} (thermally sensitive polymers) = or = L_{TOT} + 0.3 to 0.5 mm (not thermally sensitive polymers).

2) **“Floating” Installation of Mixing Elements into Housing Bore**

I.D. $_{HOUSING}$ = O.D.$_{ME}$ + 0.2 to 0.3 mm

$L_{HOUSING}$ = L_{TOT} + 0.3 to 0.5 mm

3) **Adaptor / Sealing Rings**

The Inside diameter of the Adaptor / Sealing Ring may be straight or tapered. However, the side facing the mixing element must have the dimension ID_{ME} as shown in Table #1, Column #4.

4) **General Comments on Threads**

a) Flanges: If the Melt Blender is to be permanently mounted on an extruder, it is recommended that a fine-thread be used to connect the flanges to the housing barrel. If frequent flange change-out is required to relocate Melt Blender to extruders with different connections, a coarse-thread is recommended to avoid thread stripping.

b) Temperature Sensor Connection: A second temperature sensor connection is suggested to avoid thread stripping in the event the Melt Blender is required to be frequently relocated to other extruders that require different thermocouple types.

Figure #3: *Principle Methods of Installing SMB-R Mixing Elements into Melt Blender Housing.*

D) Basic Start-Up and Operating Guidelines

The following key points should be considered for Melt Blender design and operation.

1) Maximum Operating Conditions

   A standard SMB-R Mixing Element Assembly with eight (8) static mixing elements is designed for the following maximum operating conditions:

   a) 300 ^{o}C maximum continuous operating temperature
   b) 80 bar maximum allowable pressure drop

   Where these limits are expected to be exceeded, special Melt Blenders are available.

   If the end user has any questions regarding the ability to use a Melt Blender in a specific application, contact the supplier for rating the equipment for the application.

2) Apply anti-seize copper containing grease compound to all housing threaded connections to assure ability to unscrew the Melt Blender housing parts after operation and to assure good heat conductivity between the individual housing parts.

3) Installation Direction

   Mixing elements may be installed with flow in any direction with the proviso that no alignment pins extend beyond the front and rear rings of the mixing elements. For discussion on proper orientation of adjacent mixing elements, see Section A) of this document.

4) Temperature Sensor

   Melt Blender housing should be equipped with a temperature sensor to control housing heater band operation on a dedicated circuit. This is required to assure heat is supplied to the housing to prevent possible damage of the mixing elements during start-up and operation. For thermocouple installation and operation, follow the instructions of the thermocouple supplier.

5) Heater Bands

   The Melt Blender housing must be heated on the outside surface. Housing heater bands and thermocouple must be connected to a dedicated auto tuned control zone to assure than an accurate housing temperature is maintained. The recommended heating capacity is 4 to 5 W/cm^2 of heated surface. If the housing is flanged, it is advisable to provide heater bands for flanges with outside diameters greater than 200 mm. Installation and operation of the heater bands should be made in accordance to the supplier's instructions

   Assurance of good tight contact between the heater bands and housing body should be verified before and after the first heat-up. Once in operation, continued good contact between heater band and housing body should be checked periodically.

6)

Start-Up and Operation of SMB Melt Blender

The SMB Melt Blender must be allowed to soak at operating temperature, or at some 20 C^o higher if the polymer can tolerate the temperature, so that all internal parts of the mixing element bars 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. It is also important that transition pieces upstream of the Melt Blender are properly heated.

a) Heat the Melt Blender 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 noted in Table #2 below to allow complete melting of the polymer inside the mixing elements.

   The reason heat-up time increases with increasing mixer diameter is that the frozen polymer "rod" inside the mixing elements is large in diameter and must be melted by thermal conductivity alone. Polymer melts are insulators which mean they have very low thermal conductivity. The polymer layer thickness in the screw section is much thinner and thus takes less time to melt completely. Any transition pieces upstream of the Melt Blender where a "rod" of frozen polymer exists should also be heated for complete melting prior to processing into the mixer section. The upstream empty pipe transition pieces will take longer to melt than polymer within the mixing elements because the mixing element finger bars provide "fin-effect" heating via thermal conductivity through the metal to the frozen polymer while the empty pipe transition pieces have no such enhanced heat -up assistance.

Table #2: *Recommended additional heating time after controller switches on-and-off for 5 minutes*

	Mixing Elements		
Melt Blender Model	I.D.	O.D.	Recommended Additional Heating Time
SMB-R12/18	12 mm	18 mm	~ 10 minutes
SMB-R18/25	18 mm	25 mm	~ 15 minutes
SMB-R18/26	" " "	26 mm	
SMB-R20/25	20 mm	25 mm	~ 20 minutes
SMB-R20/28	" " "	28 mm	
SMB-R22/30	22 mm	30 mm	~ 20 minutes
SMB-R27/32	27 mm	32 mm	~ 25 minutes
SMB-R27/35	" " "	35 mm	
SMB-R33/42	33 mm	42 mm	~ 30 minutes
SMB-R40/48	40 mm	48 mm	~ 35 minutes
SMB-R40/50	40 mm	50 mm	
SMB-R52/60	52 mm	60 mm	~ 40 minutes
SMB-R66/75	66 mm	75 mm	~ 45 minutes
SMB-R80/90	80 mm	90 mm	~ 50 minutes
SMB-R102/115	102 mm	115 mm	~ 55 minutes
SMB-R126/140	126 mm	140 mm	~ 60 minutes
SMB-R154/175	154 mm	175 mm	~ 60 minutes

b) When the additional heat-up time has elapsed, slowly force molten polymer continuously through the mixer for about 5 minutes while extruding at low rpm at approximately 20% of the normal flow rate. If any major resistance of the melt is observed (machine sound, pressure measuring instruments, power draw), stop and soak for another 5 minutes and start again

c) Compare temperature of molten polymer and housing set point temperature. As soon as the difference is only slight, slowly increase throughput until normal production levels are reached.

7) <u>"Cold Start" Protection</u>
If the extruder operator feels uncomfortable assuring that all polymer is completely molten upstream of the mixing elements and inside the mixing elements during start-up (to prevent a cold-start induced mixing element failure), it is recommended that upstream and downstream breaker plates be installed where the holes are about 1/10th of the inside diameter of the mixing elements.

a) Upstream Breaker Plate:
An upstream breaker plate will prevent a "rod" of frozen polymer from upstream equipment striking the mixing elements. This "rod" of frozen upstream polymer originates from empty transition pieces connecting the filter, gear pump and mixer. When a "Cold Start" mixing element failure occurs, most instance are the result of a "rod" of frozen polymer originating in improperly heated upstream transition pieces which an upstream breaker plate could have stopped.

b) Downstream Breaker Plate:
A downstream breaker plate will protect the downstream die from being damaged during a cold start mixing element failure induced by start-up with frozen polymer within the mixing element assembly or upstream of the mixing element assembly.

8) <u>Interruption of Extrusion Operations</u>

a) For brief interruptions of extrusion operations, temperature to the Melt Blender housing may be lowered about 10-20 C^{o}.

b) During longer interruptions, the heating should stop (burning of polymer).

c) For normal and emergency shutdowns when thermally sensitive polymers are being processed, normal purge procedures prior to shut-down should be followed. The static mixer should be purged with polyethylene or a purging compound so that upon next start-up, the long soak time required does not cause polymer degradation. Polymer degradation may cause carbonization within the mixing elements, housing and transition pieces requiring auxiliary equipment burn-out.

d) In all above cases, the above procedures starting with step 6) above must be followed for re-start of normal operations.

9) Color Changes

The SMB-R Mixing Elements have a very narrow residence time distribution. This means that when changing polymers or color, the contents of the mixing elements will be purged completely in a short period of time by the new material (~ 5 mixing element residence times). In the event streaks of color are observed after a color change, it is probably material that is hung-up somewhere downstream of the mixing elements that is breaking-off/purging slowly/intermittently. If a hue of color appears continuously or intermittently that is blended throughout the extruded polymer, it is probably material that is hung-up somewhere in the upstream equipment such as the extruder screw flights, filter, gear pump assembly or upstream transition pieces which is breaking-off/purging slowly/intermittently and is being mixed by the mixing elements. The SMB mixing elements will mix all upstream color hang-up breakthrough material so that a well blended hue of color will appear. Continue color change-over operations until the equipment upstream and downstream of the static mixer have purged.

A useful technique for achieving rapid color changes/purging is to heat the Melt Blender above normal operating temperatures which decreases the viscosity of the polymer inside the mixer, and at the same time decrease the temperature of the polymer in the screw that increases the viscosity of the polymer. Purging a low viscosity polymer with a high viscosity polymer push will enhance color purging.

10) Cleaning of Mixing Elements

a) Open flame cleaning of mixing elements is prohibited because it is detrimental to the 17-4 PH mixing element material heat treatment.

b) If the mixing elements require cleaning, a purge compound is recommended. If a complete removal of polymer is required, a fluidized bed bath or a vacuum pyrolysis oven is recommended. Maximum cleaning temperature should be 400 ^{o}C to retain the integrity of the 17-4 PH mixing element material heat treatment.

c) If removing the mixing elements from the housing is necessary for inspection or cleaning, a number of options are available for removal:
   - With Melt Blender installed on extruder, remove downstream equipment and while polymer is still warm, slowly extrude the mixing elements out of the housing.
   - With the Melt Blender installed on extruder, if the polymer is frozen in the housing, remove downstream equipment, warm the housing slightly to melt polymer near the wall and then extrude the mixing elements out of the housing.
   - If bench removal of the mixing elements is desired and must be done cold, the mixing elements may be rammed out of the housing with the stipulation that the rod used to ram the mixing elements out of the housing (normally aluminum or wood for light weight) is flat at the end and is near the full inside diameter of the housing so that the force of ramming is carried by the outside ring of the mixing elements and that no force is imparted on the finger bars of the mixing elements.

11)

Flat Sheet and Flat Film Extrusion Applications

a) For flat sheet and flat film extrusion applications, the last mixing element (just in front of the die) should be installed so that the eight (8) parallel bars of the mixing element run parallel (same direction) to the width of the die.

b) This is especially true for foamed films and sheet.

c) For sheets thicker than 4 mm, a distance of 1 – 2 pipe diameters between mixer outlet and die inlet is recommended.

12) Extruder Layouts with Polymer Flow Direction Changes

The mixing elements should always be installed in front of the die. This is especially important in applications such as blown film lines where a 90^{o} change in polymer direction is necessary to feed the die. Elbow induced flow patterns must be eliminated to properly control the blow film.

13) Process improvements

Process Improvements are normally observed after installation of the SMB Melt Blender. Process improvements fall into the general categories of improved mass/color homogenization of the polymer melt and improved thermal homogenization of the polymer melt.

The following process improvement should be focused upon to maximize the financial return on the investment of the Melt Blender.

a) Streak free product

b) Improved homogeneity of resin and additives

c) Reduction of colorant and/or additives

d) Additive distribution improvement

e) Wall thickness and gauge uniformity and easier thickness adjustment

f) Foam cell size and distribution uniformity

g) Increased use of regrind

h) Improved mechanical properties

i) Reduced warp due to temperature differences

j) Surface quality improvements

E) Other Types of Extrusion Static Mixers Supplied by StaMixCo

StaMixCo manufactures all four types of commercially proven static mixer designs for extrusion service which are discussed below.

The Type SMB-R static mixer supplied for your installation is in our opinion the best-available-technology for extrusion service. The SMB-R excels in providing the most important features required for extrusions service:

- A very high degree of mixing in a short length.
- Very high strength due to its monolithic cast construction.
- Ability to disassembly mixing element assembly for inspection and cleaning.

The standard SMB-R is made of individual rings surrounding each mixing element as shown in Figure #1 (page 1). As shown below in Figure #4, the Type SMB-S design is available which has the identical monolithic cast construction of the SMB-R, but where the entire assembly is made of one piece for ease of removal and installation in deep bore one-direction access installations.

Figure #4: *SMB-S Sleeve Type Mixing Elements where the 8-SMB-R Mixing Elements are welded together into a single assembly. Used for special applications where single-piece construction is required such as in deep bore one-direction access applications.*

As previously mentioned, StaMixCo manufactures all four types of commercially proven static mixer designs for extrusion service as shown in Figure #5. Each of the designs has unique features in their construction that make them the best-available-technology for the specific design. A brief description of each of the designs in included in Figure #5 where detailed specifications are available in other documentation.

Figure #5: *StaMixCo manufactures all four (4) commercially proven static mixer designs for extrusion service. Each of the designs has unique features in their construction or surface finish that make them the best-available-technology for the specific design.*

#1) SMB-R: High mixing performance grid type static mixer of monolithic cast construction and very high strength.
#2) SMB-RX: High mixing performance grid type static mixer. Hand made from plate and welded together and therefore capable of being manufactured in any diameter.
#3) SMB-CRX: High mixing performance grid type static mixer. All mixing elements cast as one assembly with integral longitudinal support rods.
#4) SMB-RH: Low mixing efficiency Helical type static mixer machined from a solid rod of metal with no welding and with surface finishes of RMS 12. Exhibits the lowest pressure drop of any static mixer design.

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

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