fluitec
mixing + reaction solutions

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Fluitec CSE-X® Micro / Macro Mixer

for the Man-Made-Fibre Industry

A homogeneous melt before the spinneret is a key point for the production of high quality man-made fibres. The novel CSE-X® Micro / Macro Fibre Mixer was developed especially to tackle this problem. Highest mixing performance is achieved while at the same time the pressure drop is reduced to a minimum. The CSE-X® Micro / Macro Fibre Mixer will definitely replace the widespread helical mixers, a technology of the sixties of last century.

CSE-X® Micro / Macro Mixer
The CSE-X® Micro / Macro Mixer consists out of a rig of bars which are inclined against each other. The novel Micro / Macro concept now adapts the number of bars to the mixing task of interest. It is thereby guaranteed that the goods to be mixed are first well distributed over the cross-sectional area (macro mixing: globally) and afterwards thoroughly mixed (micro mixing: locally). At the entrance of a mixer section, for example, elements consisting out of 4 bars are used to perform first a regular distribution (macro mixing) followed by elements with an increasing number of bars (micro mixing). More than 8 bars per mixing element are not uncommon.

The Fibre Module
A homogeneous melt before the spinneret is a key point for the production of high quality man-made fibres. Static mixing elements are used for decades for the radial homogenisation of polymer layers with different residence times, temperatures and thus of different viscosities.

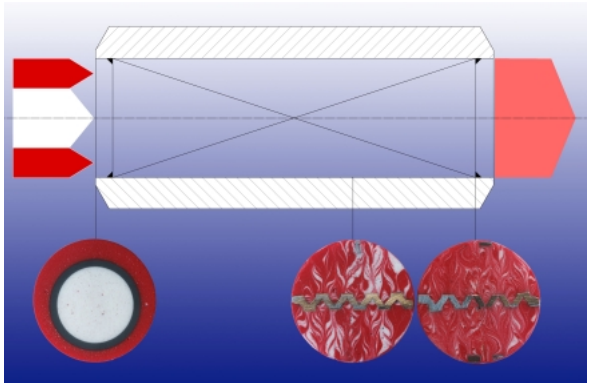

Fig. 1 Mixing performance of the CSE-X® Micro / Macro Fibre Mixer at a length of L/D = 2 (2D-module) and at a length of L/D = 3 (3D-module)

Static mixers, also commonly described as fibre modules, are homogenising the polymer melt before it is distributed to the spinning cabinets. Additional mixing elements are normally mounted direct before the spinneret, since the outlet of the spinneret consists of numerous drillings. Nowadays, static mixers of the type "X" (CSE-X, Fig. 2) and helical mixers (CSE-W, Fig. 3) are mainly used.

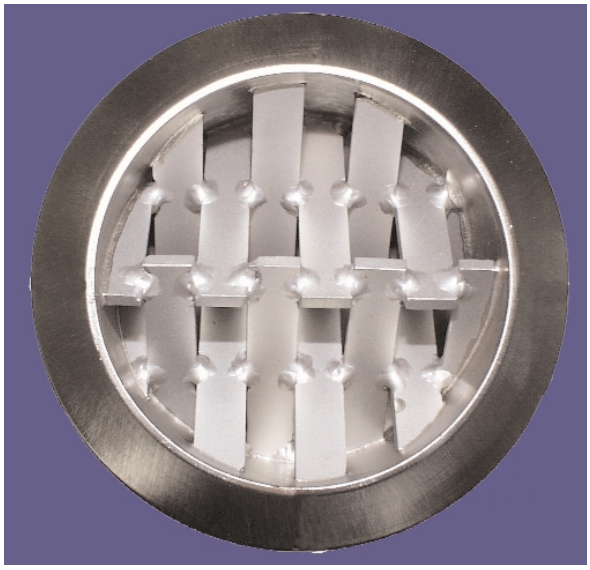

Fig. 2 CSE-X/8 Fibre Module 3D, brazed

The CSE-X® Mixer
The radial mixing performance of the CSE-X® Mixer is unbeaten. As very reliable components in the fibre production they are used as 4-bar or as 8-bar mixers. The residence time distribution is remarkable narrow (see Technical Information No. 11.102) and they are dedicated for the mixing of melts of different viscosities. This mixer type belongs indisputably to the most reliable type of static mixers and is therefore preferred for most compounding processes, such us the

adding of flatting agents, flame resistances, dying agents and static-inhibitors.

The Helical CSE-W® Mixer
Using a helical mixer, a fibre module normally consists out of 6 elements. It has a remarkable low pressure drop and produces a mixture, based on exponential multi-layers. It is much longer than comparable CSE-X® mixers and the micro mixing performance is significantly weaker. This technology was developed in the sixties of last century.

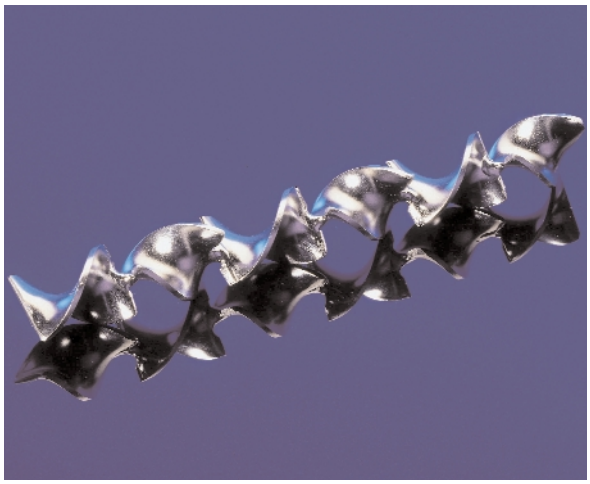

Fig. 3 Helical CSE-W® mixer

Comparing the 3 Mixing Principles
The following parameters are relevant if comparing static mixers:
- mixing performance
- pressure drop
- cost/performance ratio

Fig. 4 shows three cut views of epoxy-resin mixtures, produced under comparable conditions. The cut to the left shows a CSE-X/8 mixer after an L/D ratio = 3. The cut in the middle is of a helical mixer after 6 mixing elements (L/D = 9.6). The picture to the right is of a CSE-X® Micro / Macro Mixer with an L/D ratio = 3. The CSE-X® Micro / Macro Mixer shows clearly the highest mixing performance and the highest homogeneity. The mixing performance of the CSE-X/8 is comparable to the cut of the helical mixer. Still, the CSE-X/8 has the higher local energy dissipation, thus it is coping better with high ratios

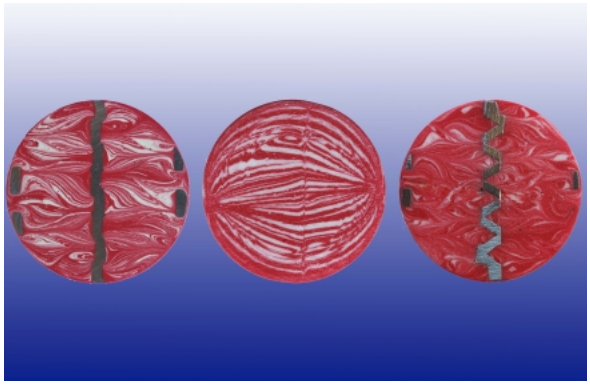

Fig. 4 Cut views of epoxy-resin mixtures

in viscosities. The pressure drop in the laminar flow can be described as:

$$\Delta p_l = (Ne\,\mathrm{Re}\cdot L)\cdot \frac{w\cdot \eta}{D^2} \qquad \text{Eq. 1}$$

If comparing the different mixer types at the same viscosity η, the same diameter D and the same velocity (in an empty tube) W, than the product of the NeRe-number and the length L can be used directly as a factor of laminar resistance. These factors for laminar resistance can be described as:

CSE-X/8 Fibre Module: NeRe x L = 3600 (3D)
CSE-X/4 Fibre Module: NeRe x L = 2400 (3D)
CSE-W Helical Mixer: NeRe x L = 2200 (9.6D)
CSE-X® Micro / Macro Mixer: NeRe x L = 3200 (3D)
CSE-X® Micro / Macro Mixer: NeRe x L = 1990 (2D)

The CSE-W helical mixer shows the lowest resistance factor (2200). If the CSE-X® Micro / Macro Mixer is built as a 2D module, however, the resistance factor is only about 1990, resulting in a 10% reduced pressure drop. Considering the polymer melt as structural viscous, the pressure drop should be reduced additionally due to the higher shear rate in the CSE-X® Mixer. The mixing quality at an L/D = 2 is comparable to the mixing quality of the helical mixer (9.6 D), due to the significantly higher micro mixing efficiency.

Advantages using the CSE-X® Micro / Macro Mixer
The advantages of the CSE-X® Micro / Macro Mixer can be summarised as follows:
- reduced pressure drop at high mixing performance
- narrow residence time distribution and excellent self cleaning efficiency
- attractive cost/performance ratio
- well controllable braze points due to the reduced length. Braze connections of up to 100% can be realised for the first time.

Fig. 5 CSE-X® Fiber module with injection