fluitec
mixing + reaction solutions

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Static mixer for laminar flow

CSE-X®, CSE-X/4®

The Fluitec mixer CSE-X® is used for applications with highest demands. The small pressure drop of the CSE-X® together with highest mixing performance, opens a large field of applications. The CSE-X® mixer is very well established for two-phase operations such as gasification, for the effective control of the residence time distribution or for a perfect mix of liquids of extreme differences in viscosity.

CSE-X Mixer

The rigid CSE-X mixing elements consist of bars, mounted crosswise in a way that they fit into one another. Thereby, each section is turned 90° in its axial axis in relation to the previous section. Process conditions and the mixers size are defining the number of bars used for the mixing elements. Standards are CSE-X mixers consisting of 4, 6 or 8 bars.

Fig. 1: CSE-X/8 polymermixer DN400 / PN320

CSE-X/4 mixer for small-scale applications

CSE-X mixers with many bars require more welding connections, thus making the production process more expensive. Fluitec has analyzed this problem by a number of experiments using mixers with different numbers of bars. The results made clear, that the mixing efficiency at small-scale is almost independent of the number of bars. Because of this fact, pressure drop could be reduced by 35 % at the same diameter.
In addition, Fluitec found a new way to produce this small-scale mixing elements at significantly reduced cost. These CSE-X/4-G standard elements are smaller than two inches in diameter and available in stainless steel.

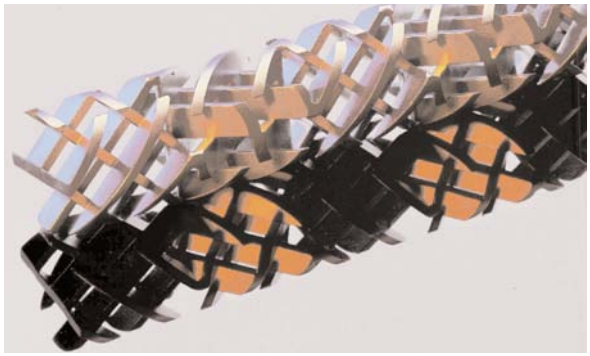

Fig. 2: Standard elements of the CSE-X/4 mixer series

Mixing efficiency of the CSE-X/4 mixers

The quality of a mixing process at laminar flow conditions is mainly a function of the flow rate ratio of the two soluble liquids. Fluitec is using its well established calculation software, to take additional influences such as viscosities, shear forces, residence time and Froude number into account. Fluitec usually uses the variation coefficient to define the mixing performance. Detailed basics on the calculations are described in the Fluitec documentation "Pressure Drop and Mixing Efficiency in Static Mixers".

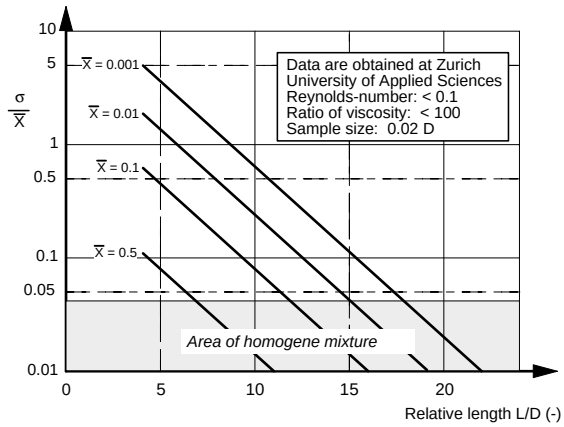

Fig. 3: Mixing performance at laminar flow conditions

Pressure drop of CSE-X mixers
The relative length L/D and the NeRe-number are used, to compare pressure drops of different kind of static mixers. Determinations are done with mixers of the same diameter and by achieving a constant mixing quality of a variation coefficient of 0.01. According to this definition, the pressure drop number is defined as:
Pressure drop number = NeRe-number x relative length (at specified diameter and mixing quality).

Comparison of CSE-X mixers

CSE-X/4 mixer with 4 bars
Relative length L/D = 19, NeRe = approx. 750
Pressure drop number = 19 x 750 = 14'250

CSE-X/8 mixer with 8 bars
Relative length L/D = 17, NeRe = approx. 1200
Pressure drop number = 17 x 750 = 20'400

For a comparable mixing efficiency, the Fluitec mixer CSE-X/4 with 4 bars requires only 2 mixing elements more than the CSE-X/8 mixer with 8 bars. However, the CSE-X/4 generates 35 % less pressure drop, leading to a significantly reduced energy consumption. Because of these facts, Fluitec has specialized on the CSE-X/4 mixer for small diameters. On request, larger diameters can be supplied also with 6, 8, 12 or 18 bars.

Fig. 4: CSE-X/4 mixer for applications in the food industry (electropolished)

Residence time distribution of the CSE-X/4 mixer
The high mixing efficiency at short installation length, is a typical characteristic of the Fluitec CSE-X mixer. Various investigations also proved the narrow residence time distribution of the CSE-X, generating an almost ideal plug flow (Fig. 5). This is of special importance for self-cleaning processes in food and pharma industry. A Dirac-pulse of dye visualized the excellent self-cleaning efficiency of the CSE-X/4 elements, whereas in the empty tube a colored zone remained close to the wall over a long time. All experiments shown in Fig. 5 and 6 were carried out using glucose syrup with a viscosity of 10 Pa s to 40 Pa s.

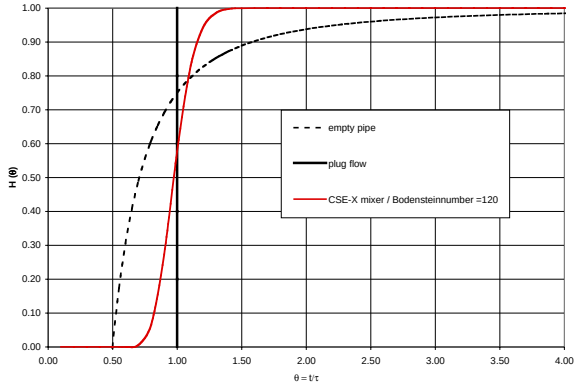

Fig. 5: Residence time distribution of the CSE-X mixer

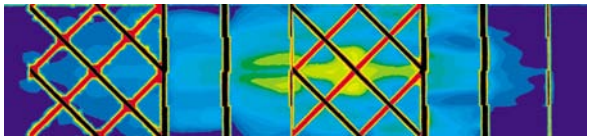

Fig. 6: CFD calculations (CSE-X/4 Mixer)

Mixer / Heat Exchanger
By combining static mixing elements with shell-and-tube heat exchangers, basic operations such as mixing, heat and mass transfer for chemical reactions are now possible even for highly viscous liquids. The excellent heat transfer performance together with the high mixing efficiency of the CSE-XR, allows delicate operations even at laminar flow. The new CSE-XR Mixer / Heat Exchanger or Reactor opens cost-saving opportunities in the field of chemical reactions and polymerization processes. Using especially designed static mixing elements, a strongly defined cross sectional mixing behavior and a high surface renewal rate are achieved, making the CSE-XR suitable for strong exo- and endothermic chemical reactions. Temperature control and equilibration is achieved exactly and completely at all flow conditions.

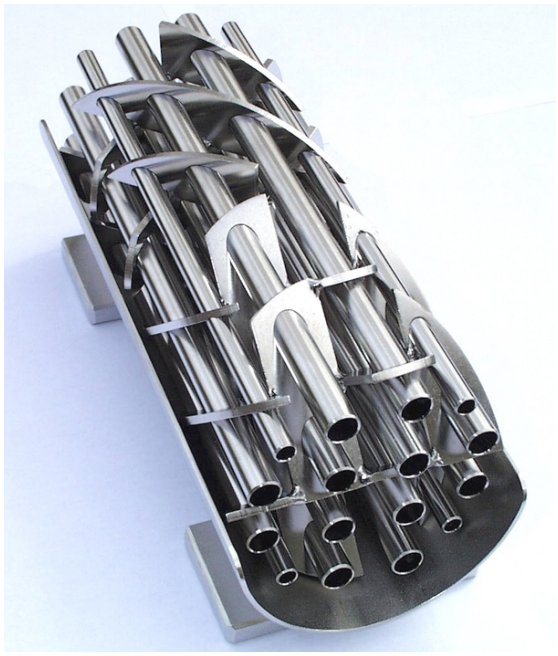

Fig. 7: CSE-XR Mixer / Heat-Exchanger