DESIGN AND ANALYSIS OF MICROMIXER FOR ENHANCING ITS MIXING PERFORMANCE

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ABSTRACT:
This paper depicts the summary of the “Design and analysis of various micro-mixers for enhancing the mixing performance by using COMSOL Multiphysics 4.4”. The shape of micro channels is an important design variable to achieve the desired mixing performance. However if obstacles and wavy channels are integrated into the channel design, mixing improves. Micro-mixer with obstacles located at the centre of the channel with different configurations is used to enhance mixing performance, so as to reduce the mixing length. Different shapes of obstacles such as rectangle, square and rhombus are analysed by comparing it with plain Y shape circular chamber mixer. For the same boundary conditions, the rectangular obstacles at the centre of the chamber, generally gives minimum mixing length.

KEY WORDS: Micro-mixer, Y channel, Mixing Performance, COMSOL etc.

1. INTRODUCTION:
Mixing is an important process in a microfluidic system such as micro total analysis systems. The aim of microfluidic mixing is to achieve a thorough and rapid mixing of multiple samples in micro scale devices. The term ‘mixing’ means a physical process where both the stirring and the diffusion occur simultaneously. Here, the word stirring means the advection of material blocks subjected to mixing without diffusive action. In other words, we can say that good mixing of low diffusivity materials occurs in two stages; stirring in the first stage and diffusion in the second stage. These mixers are differentiated by the hydrodynamic principle employed.

2. THEORETICAL ANALYSIS:
It is essential to consider two characteristic dimensionless numbers, Reynolds number (Re) and the Peclet number (Pe), in order to determine the effective operation condition of a passive micro mixer. So, $Re = \frac{\mu d v}{\rho}$ and $Pe = \frac{vd}{D}$

The transverse diffusion time can be estimated by $t = \frac{d^2}{D}$

Where $d$ = Channel width, $D$ = Diffusivity coefficient

The characteristic mixing length ($L$) of the micro mixer to achieve complete mixing is $L = \frac{dt}{d^2} = \frac{d^2}{D} Pe d$

3. DESIGN AND ANALYSIS:
The basic design for a micro-mixer is represented by Y shaped channel. The mixing process in this type of micro mixer is obtained by guiding the two liquids, to be mixed in a flow channel. Mixing for Y shaped micromixers, solely depend on diffusion of the species at the interface between the two liquids, hence the mixing is rather slow and a long mixing channel is required.

3.1 Geometry of Channel:
Geometries affect on fluid mixing that will enhance advection in the mixing of fluids. If a single straight channel is used the fluid will tend to stay very laminar and have no advection mixing. However if obstacles and wavy channels are integrated into the channel design, mixing improves.

3.2 Specification of Problem:
The sample fluids used in the simulation were water and Benzoic Acid.

Means of mixing

<table>
<thead>
<tr>
<th>Chaotic Advection</th>
<th>Application range</th>
<th>Fabrication cost</th>
<th>Overall rank</th>
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<tbody>
<tr>
<td>Chaotic Advection</td>
<td>Broad</td>
<td>High</td>
<td>4</td>
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</tbody>
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5. FABRICATION OF MICRO-MIXER:
The AutoCAD drawing of Y shape circular chamber channel is printed on a transparency sheet which is called mask at a resolution of 12000 dpi.

Steps require to carry out Photochemical Machining and PDMS Mold making are shown in following flow charts A and B respectively.

6. CONCLUSION:
Mixing length in the channel generally depends upon diffusion coefficient, width and height of the channel, inlet velocities of the fluids, viscosity of the channel and geometric layout of micro-mixer. As the width of channel increases, the mixing length of micro-mixer channel is increases. Increase in diffusion coefficient leads to decrease in mixing length of micro-mixer channel. Decreasing the inlet velocities of the incoming fluids, decreasing the mixing length of micro-mixer channel. Different obstacles like rectangular, square and rhombus when placed at the centre of the channel also affect the mixing length of the channel. The shape and size of the obstacles also affecting the mixing length. For the same boundary conditions, the rectangular obstacles placed on the wall of the channel, generally gives minimum mixing length.

REFERENCES: