Lightnin Static Mixer with Perforated Holes a Review

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Abstract- *In the past decade, there has been much more research in static mixer which effectively mixing fluid of various properties. Various models and parametrs have been applied to find out mixing efficiency of static mixer. Modified Lightnin Static mixer is the Lightnin Static Mixer with perforated holes on the blade like Modified Kenics Static Mixer. For effective mixing the values Friction factor and Reynolds number will be in good agreement with the classical theory of mixing. In this paper the review of CFD modeling of Modified Lightnin Static Mixer is represented.*

Keywords- Friction factor, Modified Lightnin Static Mixer.

I. INTRODUCTION

A static mixer is a component of mixing unit which is subjected to inline mixing and blending during its operation. It deals with pressure drop as higher pressure-drop leads to more power consumption. The proper design of mixing blade or element has to design according to the need. i.e. minimum pressure-drop and maximum efficiency. For improving the efficiency of the mixing, the following objectives are to be considered:

First objective is to validate model of Lightnin static mixer with previous literature data with the help of advanced cad and analysis software such as SOLIDWORKS and ANSYS fluent that gives results for pressure drop. Then suggest a new or modified model of Lightnin static mixer based on literature data to minimize the pressure drop and effective mixing of fluids. It may be concluded that optimum pressure-drop and more flow division gives better mixing which leads to minimization of capital costs & material as well as saving of time. Figure-3 shows Modified Ligthnin Static Mixer with Perforated Holes

II. LITERATURE SURVEY

[1] Mr. Thakur et al. in "Static Mixers in The Process Industries" 2003 investigated field of static mixers including recent improvements to industrial processes and applications. The most generally used static mixers were compared and described. Their advantages as well as limitations were emphasized. Efficiencies of static mixers were compared experimentally and theoretically through the literature. The operations from the usage of static mixers, were explored, namely, mixing of miscible fluids, gas–liquid interface generation and liquid–liquid, heat transfer and liquid– solid dispersion. Design parameters governing the performance of the various mixers in these applications are highlighted for the selection of a compared mixer.

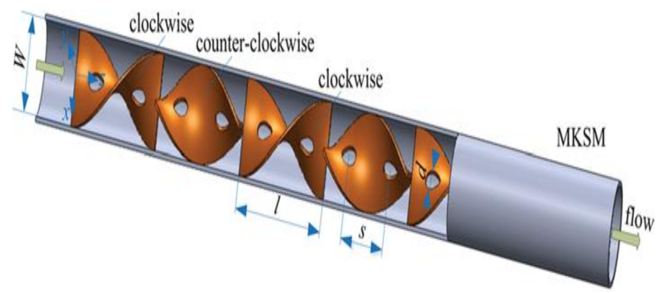

Figure 1 MKSM

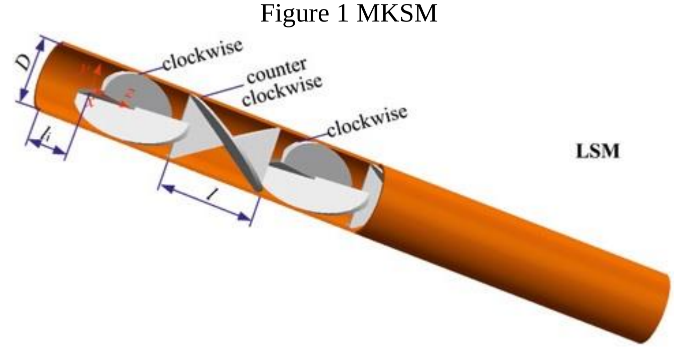

Figure 2 LSM

[2]. M. Heniche and P. A. Tanguy et al. "Helical Flows and Chaotic Mixing in Curved Micro Channels.," 2004 simulated results of SMX and KSM. With the help of CFD it first validates pressure drop vs number of mixer element with experimental data. The parameters such as Lyapunov exponent, intensity of segregation, stretching, and mean shear rate have been selected for the test. It was easily understood by flow patterns and mixing parameters of SMX and KSM. It concludes that curve blades were more efficient than flat blade. KSM gives more pressure drop than SMX.

[3]. Vimal Kumar, Vaibhav Shirke, K.D.P. in "Performance of Kenics static mixer over a wide range of Reynolds number," 2008 et al. mixing action and flow pattern's numerical simulations were obtained in between Reynolds number 1 to 25000 on three different sets of Kenics Static Mixers. The number of elements of mixers were 3, 9 and 25 respectively. In the laminar to turbulent region, it tested for circumferential and

axial velocity profiles as well as pressure drop. That setup used air as a fluid. In the three mixers setup, it was found that pressure drop per unit element were not dependent on number of blending elements. The obtained pressure drops simulated results were compared with experimental data.

[4]. Fourcade et.al "CFD calculation of laminar striation thinning in static mixer reactors," 2001 developed a new method for calculating the average value of rate of striation thinning α in the static mixer as simulated by Computational Fluid Dynamics (CFD). Structure of new making striations was concluded by executing a particle tracking method for obtained CFD flow field. This particle tracking method was applied to both mixer configurations, Kenics as well as SMX elements. The obtained results give good support to the micro-mixing theory.

[5]. Ramin K. Rahmani et.al "Three-Dimensional Numerical Simulation and Performance Study of an Industrial Helical Static Mixer",2005 for single-phase viscous liquids static mixing processes were described by numerical simulations. Numerical simulations gave good results for flow pattern in a Helical Static Mixer (KSM). Navier-Stokes equations in the region laminar to turbulent was solved by using of 3-D finite volume CFD code. For the different set of Reynolds numbers, the flow properties were calculated and the static mixer action for different Reynolds number value (from creeping flows to turbulent flows) was studied. For the quantitatively mixing, introduced new parameters that measures degree of mixing.

[6]. Hyun-Seob Song∗, Sang Phil Han et al. "A general correlation for pressure-drop in a Kenics static mixer" 2005 CFD simulated pressure drop data gave new pressure drop correlation that are achieved by eliminating experimental drawbacks. The setup gave good pressure drop correlation for Kenics Static Mixer. Unitless factor such as friction factor, Aspect ratio and Reynold's number (Re), were executed through CFD simulations on Kenics Static Mixer. The pressure drops correlations that were obtained from that setup had good agreement with master curve and it was good fit into that master curve. That correlation set covered wide range of Reynolds number i.e. laminar to turbulent. The various pressure drop data which was obtained from CFD gave good agreement with literature.

[7]. Ramin K. Rahmani et al. "Numerical Simulation and Mixing Study of Pseudoplastic Fluids in an Industrial Helical Static Mixer" 2006 last work expanded the industrial Helical Static Mixer. The single-phase viscous flow mixing was illustrated via numerical simulations for Helical Static Mixers. Pseudo plastic fluid and liquid flow pattern get improved results via CFD analysis. For obtaining mixer's performance 3-d CFD code is solved. For different set of Reynolds number, velocity and pressure drop were calculated. The existing experimental data is compared with simulated data. Mixer action compared for Newtonian and pseudo plastic fluids. For the pseudo plastic fluids, numerical predictions were done for different Reynolds numbers. From these two models were compared to existing experimental data. Degree of mixing was not affected by different fluids. Fluid properties like viscosity and density had more impact on pressure drop across the mixer.

[8] Regner et al. "Effects of geometry and flowrate on secondary flowand the mixing process in static mixers" 2006 helicity and the rate of striation thinning was measured by using Z-factor with the help of CFD for helical mixers. Secondary flow that includes vortices and their effects on static mixers showed good agreement with pressure drop. LSM and KSM series 45 static mixers were studied. Blades and their curvatures possess formation of secondary flow which were optimised. LSM had more intensity of the vortices than that of KSM because of edges in the middle of the LSM. Between the Reynolds number 10, the LSM and KSM vortices were studied for aspect ratio 1.5. It was found that LSM has more power of the vortices than that of the KSM. The distribution of striation thickness and the rate of striation thinning was observed for Z-factor and magnitude of helicity.

[9] Marten Regner et.al "Influence of Viscosity Ratio on the Mixing Process in a Static Mixer: Numerical Study On chaotic advection in a static mixer" 2008 VOF method was used for immiscible which was actually used for miscible fluids. By using VOF and CFD performance and mixing process of LSM series 45 was investigated. The Reynolds number and flow rates for two liquids were 1 and 70, and 0.1 m/s respectively. The viscosities for two different liquids were 0.003 Pa and 51.2 Pa and also volumetric flow rates were 1/1 and 1/4. Striation thinning was used as a parameter to examine mixing performance. It was found that rate of elongation was different for different liquids due to their different equilibrium in shear stress. Mixing performance was high when both liquids had lower viscosity. It also concludes that the mixing performance was reduced when the viscosity difference was more. It is possible to use VOF for mixing of different liquids when mixing elements are less.

Meng 2016 el.at "Enhancement of Laminar Flow and Mixing Performance in a Lightnin Static Mixer," 2016 [10] laminar chaotic flow and mixing performance of a viscous fluid for Lightnin Static Mixers (LSM) executed numerically with the help of Lagrangian particle tracking method. The Lagrangian particle tracking method were used for Re = 0.1−100. In LSM, the product of Reynolds number and friction factor was significantly higher than that of KSM. Effects of Reynolds number and aspect ratio were studied. For every aspect ratio mixing performance were optimised by extensional efficiency and stretching rate. The stretching rate in LSM with Ar = 1, 1.5, 2 is normally higher by 45.91 %, 36.05% and 24.32% as compared to that of KSM with Ar = 1.5 figure-2 shows LSM [10]

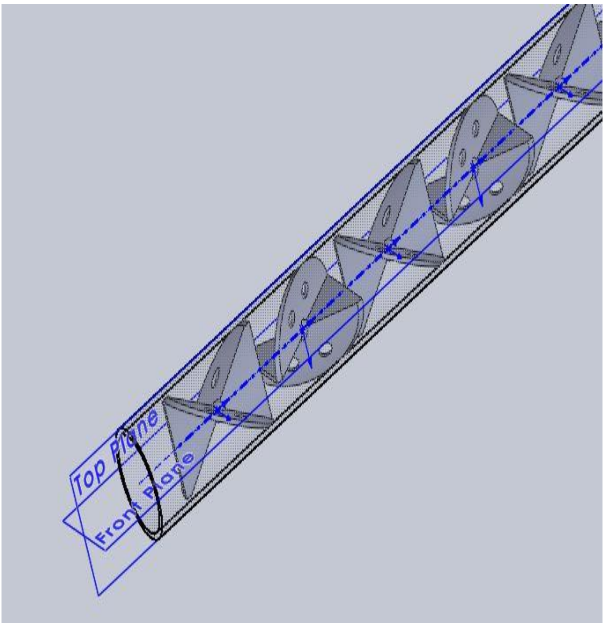

Figure 3 MLSM

Meng el.at "Laminar flow and chaotic advection mixing performance in a static mixer with perforated helical segments," 2017 [11] Figure-1 investigated mixing performance of MKSM and KSM with the help of numerical simulation. The results were compared which were obtained for laminar flow and chaotic advection of a viscous fluids in the range of Re equals to 0.1-100. The parameters such as Darcy friction coefficient, stretching rate and Lyapunov exponent were used to examine the impact of aspect ratio Ar. The product of Fd x Re were measured for mixing performance of both MKSM and KSM. It was noted that the shear rate in the initial perforated hole of mixing blade, moderately gives more values by 1.10%-11.78% than that of the second perforated hole as Reynolds number increases

[12]. E. Saatdjiana, Motab et.al "Chaotic Advection in Static Mixers," 2006 3-D flow and chaotic advection studied for KSM. Momentum equations were solved and that helps to optimise mixing performance of static mixers. Two dimensional and three-dimensional equations of flow were solved for chaotic flow. The first position of blade of mixer plays vital role in mixing performance. For creation of secondary flow and then for flow deviation first few blades are more effective. Later the effects of blade get reduced. After correcting the geometry, the extensional efficiency increased marginally and more uniform distribution of fluid obtained.

III. CONCLUSION

This paper reviewed the research work had been done regarding methods of CFD modelling of Static Mixers. In three dimensional CFD modeling effect of pressure drop and friction factor are considered. In case of flow simulation VOF is better for evaluating results Lightnin Staic Mixer with control range of Reynolds number (0 to 100).

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