131g Design of a Static Mixer Using CFD and Experiments

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ABSTRACT

Mixing is one of the most common unit operations in process industries. Many different types of mixers have been created and many impellers designs were developed for the most different operations. Among these developments the static mixers have presented a large study and application growth, mainly after its analysis with the techniques of computational fluid dynamics what helped researches to better understand their complex flow principles and behaviors. Consisting basically of a length of pipe or tube with different kinds of baffles that determine mixing performances the static mixers use the pumping energy (pressure drop) to provide mixing action. The present work proposed to create and study several different designs of static mixers analyzing their performances by means of CFD. These designs were created with the intention to generate sufficient flow division and deflection to achieve good mixing uniformity. The best results of this phase were conceptually analyzed and then modified so that their theoretical performances could be improved by means of enhancement of fluid flow division and deflection. Based upon these new results, two new types of static mixers were developed and had their performance conditions validated on a completely automatic pilot plant were flow rate, pressure drop and mixing degree (by means of mixed-fluid conductivity measurements) were compared to the CFD analysis results for the same flow and product characteristics (laminar and turbulent flow patterns). The parameter used to evaluate mixing uniformity was the same proposed by Streiff (1979) where the coefficient of variation cv (s/C) defines the mixing uniformity, commercially accepted as 0,05 for most industrial purposes. The parameter ÄP.(L/D) used by Heywood, N.I., et al (1984) and Alloca (1982) permits to compare the pressure drop (ÄP) affected by the ratio of length to diameter of the static mixer (L/D). This parameter was also analyzed in this work for the ratios L/D equal to 4,6,8 and 12, depending on the static mixer design. Considering some model simplifications necessaries because of computational method reasons, the results achieved were compatible and consistent with the pilot plant experimental data, resulting into two static mixers designs (Kroma EDA and Kroma ALT) with optimized performances. In order to compare the mutual effects of the coefficient of variation (cv) and pressure drop (ÄP) for the static mixers studied, their product (cv.ÄP) was compared with the same data available for the most known commercial static mixers available in the market: Sulzer SMX and Kenics. For laminar flow, the static mixer Kroma ALT presented intermediate (cv.ÄP) values compared to literature data about commercial Sulzer SMX and Kenics static mixers. For turbulent flow, the static mixer Kroma EDA presented better results for (cv.ÄP) values than Sulzer SMX available data for the same conditions.