Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary information

Experimental optimization of a passive planar rhombic micromixer with obstacles for effective mixing in a short channel length

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Fitting model, $\log_{10}(Re)$ was used for *M* results and *Re* for *dP* data. The *Re* space was divided in two regions that can be approximated reasonably well by two independent Response Surface Methodology (RSM) models: low *Re* regime (from 0.1 to 5.9) and high *Re* regime (from 5.9 to 117.6). The regimes intentionally overlap with each other.

When considering all known mathematical models in which the response surface is continuous over the region being studied, the most suitable in this case seems to be a second-order (quadratic) (*M*(1); *M*(2); *M*(3) and *dP*) model expressed in a canonical form:

$$Y_k = \sum_{i=1}^{q} \beta_i X_i + \sum_{i=1}^{q-1} \sum_{j=i+1}^{q} \beta_{ij} X_i X_j + \sum_{i=1}^{q} \beta_{ii} X_i^2 + \beta_0 \qquad \text{eq. (S1)}$$

This function connects each characteristic response (Y_k) with defined *q* factors (X_i) taking into account main effects (β_i), 2nd order interactions (β_{ij}), squared factors (β_{ii}) and an intercept value (β_o for $i = 0$).

Model improvement for each response was evaluated based on a summary of fit (*i.e.* the least square regression) parameters summarized in Table S1 in Supplementary information.

The following parameters were considered:

$$R^2 = 1 - \frac{SS_{residuals}}{SS_{total}} \qquad \text{eq. (S2)}$$

$$R^2\text{ - }adj = 1 - \frac{\frac{SS_{residuals}}{n-K}}{\frac{SS_{total}}{n-1}} \qquad \text{eq. (S3)}$$

where R^2 is the coefficient of determination and R^2-adj is an adjusted coefficient of determination . An R^2 parameter of 1 means that the prediction model represents actual data with no error, while the 0 value indicates that the prediction model serves no better than the overall response mean. The R^2-adj adapts the R^2 and makes it more comparable within models with different number of parameters.

The experimental data points were sieved to eliminate those that do not follow the most pronounced trend, probably due to a gross error (see Table S1).

Table S1. Summary of data sieving and corresponding model validation parameters based on least square regression. N is the number of observations.

regime	**response**	**initial data**			**after data sieving**			**difference**		
		R^2	R^2**-adj**	N	R^2	R^2**-adj**	N	R^2	R^2**-adj**	N **[%]**
low ***Re***	$M(1)$	0.93	0.93	120	0.96	0.95	113	0.03	0.02	6
	$M(2)$	0.96	0.95	120	0.96	0.96	118	0	0.01	2
	$M(3)$	0.93	0.92	120	0.96	0.95	112	0.03	0.03	7
	dP	0.98	0.98	120	data sieving not needed					
high ***Re***	$M(1)$	0.87	0.87	160	0.91	0.90	149	0.04	0.03	7
	$M(2)$	0.89	0.88	160	0.91	0.91	152	0.02	0.03	5
	$M(3)$	0.89	0.89	160	0.91	0.91	156	0.02	0.02	3
	dP	0.98	0.98	156	data sieving not needed					

The model for each response was validated basing on analysis of *F*-ratio statistics (*F*-ratio) and the ANOVA probability (Prob > *F*). The larger *F*-ratio value, the greater the likelihood that the differences between the means are due to something other than chance alone (*F*-ratio > 1). The Prob > *F* value is a probability of obtaining a *F*-ratio greater than 1 calculated if there is no difference in the population group means. Values smaller than 0.05 are considered evidence that the predicted model is statistically better than the overall response mean. The ANOVA significance probabilities (Prob > *F*) for fitted models are lower than 0.0001 supporting the fitting accuracy. The obtained *F*-ratio values are much higher than 1 (*F* above 150) indicating that the models for all responses are much better than the overall response means. The *F*-ratio values for *M*(1), *M*(2) and *M*(3) are almost two times higher at low *Re* (*F*-ratio of 260; 296 and 258, respectively) than at high R*e* regime (*F*-ratio of 152; 166 and 168, respectively). Conversely, the *F*-ratio calculated for *dP* is significantly higher for high *Re* regime (*F*-ratio of 906) due to the lower accuracy of measurements of *dP* for low *Re* (*F*-ratio of 667, note that at low *Re*, *dP* was obtained from linear extrapolation of data measured at larger *Re*, due to detector noise; see section 3.3). A higher order non-linear dependence was not detected for any of the responses under consideration. Therefore, a more-complex model is not required, and the lack of fit comes from difficulties associated with accurate measurements of those responses (i.e. method limitations).