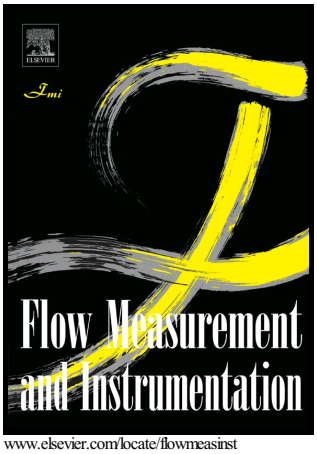
Enhancement of inline mixing with lateral synthetic jet pairs at low Reynolds numbers: The effect of fluid viscosity

Qingfeng Xia, Shan Zhong



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Enhancement of inline mixing with lateral synthetic jet pairs at low Reynolds numbers: The effect of fluid viscosity

Qingfeng Xia[a,b], Shan Zhong[a*]

[a]School of Mechanical, Aerospace and Civil Engineering, University of Manchester, Manchester, M13 9PL UK
[b]Department of Engineering Science, University of Oxford, Oxford, OX1 3PJ, UK

[*]Corresponding author. shan.zhong@manchester.ac.uk

Abstract

In this paper, mixing between two liquid streams of the same flow rate in a planar mixing channel enhanced by means of three lateral synthetic jet pairs is examined using PLIF and PIV at net flow Reynolds numbers of $\mathbf{Re_n}$=2, 10 and 83. The changes in the flow Reynolds numbers are produced with the use of fluids with different dynamic viscosities. The synthetic jet pairs are operated 180^o out-of-phase and at a range of actuation frequencies (characterized by the dimensionless Strouhal number ***Str***) and displacements (characterized by the dimensionless stroke length ***L***). It is found that at a sufficiently high frequency or dimensionless stroke length, a homogenous mixing can be achieved. Our experimental evidence shows that the synthetic jet pairs enhance mixing via two key mechanisms, i.e. vortex interaction and entrainment; tearing and stretching of liquid interface. A functional relationship among $\mathbf{Re_n}$, ***Str*** and ***L*** to ensure a nearly homogenous mixing is also obtained by best fitting the experimental data. It can be used for selecting the synthetic jet operating conditions to ensure a good mixing for a scaled version of this fluid mixer. This correlation indicates that the effectiveness of mixing has a weak dependence on $\mathbf{Re_n}$, implying that the fluid mixers of such a design can be effective over a wide range of net flow Reynolds numbers and for fluids of different viscosities.

Keywords: Synthetic jets, jet mixing, liquid mixing, PLIF, PIV, low Reynolds numbers