CHAOTIC MIXING ANALYSES BY DISTRIBUTION MATRICES

Patrick D. Anderson and Han E. H. Meijer

Materials Technology, Dutch Polymer Institute, Eindhoven University of Technology
P.O. Box 513, 5600 MB Eindhoven, The Netherlands
Fax: x31.40.2447355
E-mail: patricka@wfw.wtb.tue.nl and han@wfw.wtb.tue.nl

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1 INTRODUCTION

Fluid mixing processes receive a considerable amount of recognition because of their importance in nature and industry. Although in many cases mixing is associated with turbulent fluid motions, mixing of very viscous fluids constitutes an important class of mixing occurrences. These are typical for polymer blending, compounding, food processing etc, and some new models to study these flows are overviewed in this paper. It is well known that even for laminar flow at very low Reynolds numbers mixing can lead to complex flow patterns, and that the exposure of such patterns may be understood by imporing the theory of dynamical systems [3]. The motion of passive particles in such a flow is described by the set of ordinary differential equations,

\[ \dot{x} = u(x, t) \]
ance, but also important fundamental information about the flow itself. The calculation reveals the self-replicating pattern of interface orientation that arises in periodic flows. When the flow is globally chaotic, this pattern displays an exponential growth rate for interfacial area. Spatial analyses of the one-period dynamics for interface stretching can be performed, to reveal which parts of the flow field are most effective at small-scale mixing.

One disadvantage of the present calculation is that it is subject to numerical diffusion. This restricts its quantitative accuracy, especially when studying the long-time behaviour of a flow. However, the short-time behaviour is accurately predicted, and we expect that the relative performance of different mixing protocols will be predicted quite accurately, provided one uses the same size mapping steps for both protocols. This makes the extended mapping method a useful engineering tool.

A topic of the current research in our laboratory, is the extension of the mapping method technique to more complex, industrial, mixers. Examples include the multiflux static mixer, described by Sluijters [32], an example of a three-dimensional space-periodic flow, and the closely intermeshing, corotating twin screw extruder, which can be regarded as either time- or space-periodic. Moreover, an experimental set-up of the cubic cavity flow will be used to validate the computational results for e.g. the four-step mixing protocol, and to study the influence of visco-elastic effects on mixing.

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**BIOGRAPHY**

Han Meijer received his Ph.D. degree from the University of Twente in 1980 with Prof. J.F. Ingen Housz as his supervisor. He joined DSM research, and was active in the area of Polymer Processing Modelling and Explorative Research. In 1985 he became part-time professor at the department of Polymer Chemistry and Technology in the area of applied rheology. In 1989 he became full professor in Polymer Technology in the Division of Computational and Experimental Mechanics of the Department of Mechanical Engineering. He has been chairman of the Dutch Society of Rheology since 1995 and is currently president-elect of the Polymer Processing Society. Patrick Anderson graduated in Applied Mathematics at the University of Eindhoven in 1994 under the supervision of Prof. A.A. Reusken. He received his Ph.D. degree in the research group Materials Technology lead by Prof. H.E.H. Meijer and Prof. F.P.T. Baaijens where he studied distributive mixing processes. After a six month leave at Océ Technologies he joined the Materials Technology group as an Assistant Professor.
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