

Numerical methods for viscous flows with moving boundaries

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A review of numerical algorithms for the analysis of viscous flows with moving interfaces is presented. The review is supplemented with a discussion of methods that have been introduced in the context of other classes of free boundary problems, but which can be generalized to viscous flows with moving interfaces. The available algorithms can be classified as Eulerian, Lagrangian, and mixed, ie, Eulerian-Lagrangian. Eulerian algorithms consist of fixed grid methods, adaptive grid methods, mapping methods, and special methods. Lagrangian algorithms consist of strictly Lagrangian methods, Lagrangian methods with re zoning, free Lagrangian methods and particle methods. Mixed methods rely on both Lagrangian and Eulerian concepts. The review consists of a description of the present state-of-the-art of each group of algorithms and their applications to a variety of problems. The existing methods are effective in dealing with small to medium interface deformations. For problems with medium to large deformations the methods produce results that are reasonable from a physical viewpoint; however, their accuracy is difficult to ascertain.

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1. INTRODUCTION

A moving boundary problem is a problem where the domain of interest has an unknown boundary which has to be determined as part of the solution procedure. This is also sometimes referred to as a free boundary problem and/or a moving interface problem. Problems of this class are important in many technological applications in which moving fluid interfaces play a dominant role. Such applications include capillarity, melting and solidification, crystal growth, flame propagation, nuclear fusion, wetting, seepage, metal and glass forming processes, and many other areas in engineering and science. The quantitative description of such problems depends on the understanding of the physical processes taking place on the interfaces and on the

successful solution of the corresponding moving boundary problems. The present state of knowledge in both these areas is far from complete.

The physical conditions occurring at a boundary between two immiscible fluids are described in Batchelor (1967) and Davies and Rideal (1963). When the interface has only the equilibrium property of a uniform surface tension, the appropriate interfacial boundary conditions are

$$V_A \cdot n = V_B \cdot n = V \cdot n, \quad (1)$$

$$V_A \cdot t = V_B \cdot t, \quad (2)$$

$$n \cdot (T_A - T_B) = 2\sigma n, \quad (3)$$

Numerical Methods For Steady Viscous Freesurface Flows

Didier Musso



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