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回转体匀速垂直入水早期空泡数值模拟研究

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NUMERICAL SIMULATION OF EARLY AIR-CAVITY OF CYLINDER CONE WITH VERTICAL WATER-ENTRY

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摘要 基于VOF(Volume of Fluid)方法和有限体积法求解气、水两相流动的RANS方程,并结合动网格技术,对物体垂直入水空泡流动进行了数值计算研究。通过对球体垂直入水早期空泡形态进行数值计算,并将计算结果与May A 理想空泡模型拟合结果进行对比分析,二者具有较好的一致性,验证了数值计算方法的有效性。在此基础之上,进一步研究了150°锥角回转体垂直入水空泡生成过程,空泡壁面运动特性和空泡表面闭合特性,给出了垂直匀速入水空泡形态随时间变化规律,空泡壁面随入水过程时间变化运动规律,以及空泡表面闭合时间与入水速度之间的关系。

关键词: 垂直入水   VOF   入水早期空泡   表面闭合   圆锥

Abstract: Computational simulation of the water-entry cavity following the water-entry is carried out. During the computation, the Navier-Stokes equations are solved with the discretization of Finite-Volume Method, and VOF (Volume of Fluid) and dynamic mesh method are used for the multiphase flow and the movement of the water-entry body, respectively. The computation results of the air-cavity shape of water-entry of sphere are directly compared with the 'ideal cavity' proposed by A. May, showing that the computation methodology properly captures the key features in the early stage of constant speed vertical water-entry cavity, and in particular gives a reasonable prediction of the outline of air-cavity in the early stage of water-entry, and of the history of the maximum radius of the air-cavity. At the same time the water-entry cavity history and air-cavity wall kinematics of the inverted truncated cone of 150 degree in the early stage life of the water-entry are investigated by computation, and the results show that the history of air-cavity wall movement following the water-entry body with different outline features are similar. And at the end of this paper the time of the surface closure of the air-cavity of the inverted truncated cone of 150 degree are also investigated.

Key words: vertical water-entry   VOF   air-cavity   surface closure   inverted truncated cone

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