论文

近自由面的多个水下爆炸气泡相互作用研究

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摘要　将气泡运动阶段周围的流场假设为无黏、无旋、不可压缩的理想流体，运用边界积分法模拟流场中气泡的运动，并开发了三维计算程序，计算值与实验值吻合较好. 用该方法模拟了近自由面多气泡之间的相互作用，包括同相气泡和异相气泡. 通过计算发现，气泡的周期随两气泡中心的距离减小而增大，这是由于多气泡之间存在抑制作用，特别是对异相气泡，这种抑制作用更加明显，称之为多气泡之间的抑制效应. 无论有、无自由面存在，多气泡之间均存在抑制效应，由于抑制效应导致同相与异相气泡相互耦合作用的动态特性存在巨大的差异，这些现象可为将来研究多个同时或延时产生的水下爆炸气泡的威力提供参考.

关键词　水下爆炸　多气泡　边界积分　自由表面　抑制效应

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The interaction between multiple underwater explosion bubbles near free surface

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Abstract

  A boundary integral method is adopted to simulate the bubble motion in the fluid field on the assumption that the fluid field is inviscid, irrotational and incompressible. A corresponding three-dimensional computation program is exploited and the calculated results agree well with the experimental data. The interaction between multiple bubbles near the free surface including in-phase and out-of-phase bubbles is simulated with the program presented here. From calculation it's found out that the bubble period increases along with the decrease in the distance between bubble centers because of the depression effect among multiple bubbles and the effect is more evident especially for out-of-phase bubbles. The depression effect exists between all bubbles no matter whether there is a free surface or not. There are great differences on the dynamic behavior of in-phase bubble coupling and that of out-of-phase bubble coupling due to the depression effect. These phenomena can provide reference for the future research on the power of underwater explosion bubble induced by multiple charges exploding simultaneously or continuously.

Key words　underwater explosion　multiple bubbles　boundary integral　free surface　depression effect

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