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基于奇异分解和自适应BEM积分算法的水下航行体机械噪声预报

Prediction of underwater vehicle vibration-noise based on singularity-decomposition and self-adaptive BEM quadrature

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中文关键词: 机械噪声 改进边界元法 奇异分解 自适应BEM积分

英文关键词:mechanical noise modified-BEM singularity-decomposition self-adaptive BEM quadrature

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中文摘要:

提出一种改进的声学边界元法(M-BEM)用于准确计算水下航行体发动机振动引起的近场辐射噪声。分别采用奇异分解技术和自适应边界元积分算法解决了Helmholtz积分方程在求解近场声压时出现的超奇异积分和奇异积分问题。采用一脉动球源的声辐射算例对方法进行验证,数值解与精确解误差小于1.5 dB。结合有限元方法并考虑流固耦合作用预报了水下航行体机械振动噪声,将航行体近场声场可视化实现了主要发声部位的定位。进一步分析航行体的辐射声功率谱,对突出线谱噪声进行了定量分析。通过降低发动机环形隔振圈的刚度,使得突出线谱处的声功率向宽频域发生了转移,有效地抑制了线谱噪声,达到了减振降噪的目的。

英文摘要:

A modified boundary element method(M-BEM) was proposed to calculate the engine vibration induced underwater near-field noise of a submerged structure.A singularity-decomposition scheme and a self-adaptive BEM quadrature algorithm were adopted to overcome Helmholtz hyper-singular and singular integral when calculating near-field sound pressure.A numerical case of a pulsating sphere was investigated to validate the M-BEM algorithm.Then M-BEM coupled with FEM were applied to predict underwater vehicle vibration-noise considering fluid-structure interaction effects.By visualization the near-field sound pressure distribution,high sound pressure area was localized.Finally,the underwater radiated sound power was calculated and the peak frequencies were identified.Reduction of the engine periodic-isolator's stiffness can effectively transfer the sound power of peak frequencies to band-spectrum and the vibration noise of the line spectrum is controlled.