衛星燃料槽濺動現象之研究

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摘 要

一般衛星設計型構常採用的表面張力球型燃料槽，此種燃料 槽內無隔膜分開充壓氣體(氮或氦氣)與聯胺推進劑，故衛星因姿 態改變時，將導致槽內燃料濺動(Sloshing)，液體流動時會反覆 衝擊燃料槽內壁，引起干擾轉矩而影響衛星姿態穩定，甚或充壓 氣體滲入燃料供給管路，造成推進器啟動時之性能劣化。本研究 藉由墜落實驗設備觀察結果驗證無重力狀態下液氣介面運動行 為，並進依步模擬衛星執行科學任務拍照時，衛星燃料槽內流體 運動行為與液氣界面空間分佈。理論模型則係基於暫態之連續與 動量、守恆方程式並利用SIMPLEC 數值方法以決定濺動流場參 數。液氣界面採用連續表面張力(CSF)模式以模擬表面張力效應 對時變界面運動特性的影響，配合選擇分段線性界面重建(PLIC) 方法以準確計算出容積分率場以及液/氣界面動態位置。分析結 果與實驗數據比對後，可驗證理模型正確性，且延伸應用模擬程 式於中華二號衛星球形燃料槽之濺動分析，得出燃料槽之干擾轉 矩分析遠低於設計值，質心移動狀態相對應衛星大小偏低，可觀 察出在衛星軌道上進行Pitch 和Roll 狀態下對衛星影響不大。

關鍵詞 : 衛星、微重力、燃料槽、聯胺、液氣界面、濺動

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