行政院原子能委員會
委託研究計畫研究報告

電漿火炬相關流場之研究

Numerical Study on Flow Characteristics of Plasma Torch

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中文摘要

電漿熔融爐系統是一複雜且包含了物理、化學變化的三維流場。然而對於數值模擬而言，此系統的結構設計太過於複雜，對於數值計算上以及網格模型的建構有其一定的難度。因此本研究針對此一系統採取分別探討的策略。由於此系統可以概分為三個部份，一是電漿火炬內部流場，二是電漿熔融爐內部流場，以及冷卻水系統。本研究首先利用有限體積法建立二維軸對稱程式，求解磁流體方程模組，以模擬井式 1.2MW 傳輸型直流電漿火炬內部流場，並求解連續方程式、動量方程式、能量方程式和紊流模組來模擬電漿熔融爐三維流場模擬，以及冷卻水系統三維數值模擬，其中冷卻水系統的本體部份則只求解溫度方程式，得以解析電漿熔融爐內部流場的重要物理特性。

本研究目的在建立一電漿熔融爐系統內部流場的數值分析模式，可計算電漿火炬內部流場重要物理特性，以提供電漿熔融爐設計工作所需的性能參數估算。

關鍵字：傳輸型直流電漿火炬、電漿熔融爐、數值模擬。

Abstract

Plasma melt furnace system is a three-dimensional complex flow and includes the physics and chemistry variations. The structure of plasma melt furnace is complicated for the numerical computation and grid generation. This study will sort the furnace become three parts, first is the simulation of plasma torch, and second is the inner simulation of plasma melt furnace, and the last is cooling system of plasma torch. This investigation solves the Magnetohydrodynamic equations by the finite volume method and simulates the flow field inside the 1.2MW transferred DC plasma torch. The velocity, pressure and temperature field inside the plasma melt furnace are quantitatively obtained through solving the continuity equation, the momentum equation and energy equation by a finite volume discretization method. A k-ε model is employed to account for the turbulent effects inside the plasma melt furnace. Use the CFD method to analyze the flow field in the plasma melt furnace system.

This study successfully develops a numerical approach to model the plasma flow field inside the plasma melt furnace system and offer a reasonable performance parameter.

Keywords：DC Transferred Plasma Torch, Plasma Melt Furnace, Numerical Simulation.