HIGHER TECHNICAL INSTITUTE

DEPARTMENT OF MECHANICAL ENGINEERING

DIPLOMA PROJECT

COMPUTER - BASED EULERIAN PROPERTY DESCRIPTION OF A GASEOUS INCOMPRESSIBLE FLOW

M/881

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Computer-based Eulerian Property Description of a Gaseous Incompressible Flow

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Abstract:

Nanostructured materials are a new class of synthetic materials with ultrafine microstructures, somewhat arbitrarily defined as structures smaller than 100 nanometres. These materials may be composed of metals, ceramics, polymers, and their composites. The materials can be in the form of powders, thin films, porous media, or dense structures.

The objective is to establish at H.T.I a Nanomaterials Research Center (**NRC**) with the target of being a leader in the rapidly emerging field of nanostructured materials and to achieve rapid growth and attractive industrial feedback from its proprietary position. The mission statement of the **NRC** is provided in the Appendices.

The breadth of the Center's technology places it in a position to achieve a strong proprietary position in both the manufacture and application of nanostructured powders. The Center's potential opportunity areas include the Spray Conversion Process for making nanostructured powders, the powder products of that process, processes for creating net-shaped parts from nanostructured powders, such as PIM, and nanostructured net-shape parts. **NRC** is focused on maximizing the commercial potential of its technology.

This project carries the title: "Computer-base Eulerian Property Description of a gaseous Incompressible Flow" and its major objective was to establish the Eulerian description of the reactor's flow.

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INTRODUCTION:

The processing of materials from chemical precursors offers the potential for lower cost production of novel materials with homogenous ultrafine microstructure (nanostructures) and improved properties. The technology grained its initial prominence as the preferred route for synthesizing ceramic materials. Today, there is growing interest in the applicability of chemical processing technology to the production of metallic materials.

At H.T.I, we have been developing new capabilities for the synthesis and processing of nanostructured powders, starting from water soluble precursor compounds. After an extensive evaluation of alternative synthesis routes, "Spray Conversion Processing" has emerged as the most versatile and reproducible. The new processing method consists of three coordinated steps:

(1) Preparation and mixing of aqueous solutions of the precursor compounds to fix the composition of the starting solution;
(2) Spray drying of the starting solution to form a chemically homogenous precursor powder;
(3) Thermochemical conversion of the precursor powder to the desired nanostructured end-product powder.

The latter step may be performed in a fixed bed reactor when the amount of powder being processed is small. However, for the thermochemical processing of large quantities of powder, it is advisable to use a fluid bed reactor, so as to ensure a uniform conversion rate for all the particles in the bed. All three steps in the process are readily scaleable. An integrated manufacturing technology for the production of nanostructured composite powders has been developed by H.T.I.

Thermochemical conversion of the precursor powder in a fluid bed reactor is also an important step in the integrated process. This is because the local environment with respect to temperature and gas concentration in the fluid bed reactor is the same for all parts of the bed, which ensures uniform conversion of the precursor powder to the end-product powder. This is not the case in a fixed bed reactor, where uniformity of gas percolation and temperature is difficult to maintain throughout the powder aggregate.

To fully characterize the thermochemical conversion in the fixed bed reactor, we have to establish the Eulerian flow properties i.e. in-situ pressure measurement, in-situ velocity measurement, and in-situ mass flow measurement and in-situ temperature measurement. In this project we have implemented the in-situ temperature and mass flow measurement and exemplified the inherent difficulties in measuring the velocity and pressure inside the reactor.

This work in conjunction with the manufacturing aspect, it has resulted in implementing a fully characterized thermochemical reactor with maximum flow control.