Salt Fingers In Two And Three Dimensions

A thesis

submitted by

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Declaration by the Research Scholar

I, **Manoj Dhiman**, declare that this thesis titled, **"Salt fingers in two and three dimension"** and the work presented in it are carried at Indian Institute of Technology Mandi, under the supervision of **Dr. Om Prakash Singh**. I confirm that this work was done wholly or mainly while in candidature at this Institute and not submitted elsewhere. In keeping the general practise, due acknowledgements have been made wherever the work described is based on the findings of other work.

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THESIS CERTIFICATE

This is to certify that the thesis titled **"Salt fingers in two and three dimensions"** submitted by **Manoj Dhiman**, to the Indian Institute of Technology Mandi for the award of the degree of **Master of Sciences(by Research)**, is a bona fide record of the research work done by him under my supervision. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

In keeping with the general practice of reporting scientific observation, due acknowledgements have been made wherever the work described is based on the findings of other investigators.

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This thesis is the result of my stay at IIT Mandi for three and half years. In this long period the warmth of friendship has never left me alone to feel the first three bone chilling winters. There was lot of learning from unique character of each other.

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Abstract

Double diffusive convection (DDC) is the buoyancy-driven flow, with density depending on two different diffusing scalar components, distributed such that faster diffusing component gravitationally stabilise the fluid and slower one destabilise it. The presence of DDC is universal from oceans to stars. In oceans the two components heat and salt are convected from top to depths of oceans affecting the climate of earth and life in deep sea. The stable stratification of molten constituents in the interiors of planets and gases in stars is disturbed due to this instability, reducing the background gradients to change their internal structure. Our study involves numerical solutions of transient *Navier-Stokes* equations by *Finite Volume Method* using *SIMPLER algorithm.* Majority of our work is done at wide range of diffusivity ratio, density ratio and Rayleigh numbers employing 2D model. For 3D model, a new 3D code was developed, and the effect of Rayleigh number and density ratio is studied on the evolution of DDC system. To expedite the increased size of 3D problem, parallelisation was done in one direction using OpenMP. The results show that initial growth of fingers is arrested by density inversion. Rayleigh number has strong effect, as compared to density ratio and diffusivity ratio, on the scale of fingers and magnitude of constituents fluxes. At different values of Rayleigh number and density ratio variety of planforms are observed. The formation of diffusive staircases in 3D case at low density ratio is unlike its 2D counterpart, where constituents spread uniformly without any hint of vertical layers.

The purpose of this thesis is to examine the salt finger morphology and mixing characteristics of double diffusive convection (DDC) for variety of fluids.

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