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Physical Analysis of Thermal–Particulate Interaction in Heat-Assisted Sedimentation Processes within Inclined Cells

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Extended Abstract

This work proposes a physical analysis of the sedimentation process of fine particles in inclined configurations with localized heating, emphasizing the interaction occurring near the heated inclined wall. The study focuses on understanding how an imposed thermal gradient generates an ascending flow that modifies the sedimentation process in inclined configurations. The research is based on previous experimental observations in a trapezoidal cell [1], complemented by prior numerical studies that analyzed the same phenomenon under controlled conditions [2].

The experimental system consists of an acrylic cell with one inclined copper wall, on which a controlled electrical power input is applied using a Peltier module to produce localized heating. Diluted suspended glass particles in distilled water were used, with initial concentrations of 1500 and 3000 ppm. Spatial measurements of concentration revealed complex interactions between the ascending thermal flow induced by heating and the gravitational settling of the particles. In particular, improvements in clarification and the formation of clear fluid zones were observed for higher concentrations and greater electrical power input. In contrast, localized resuspension near the heated wall was also detected under lower concentration conditions.

The novelty of this work lies in the proposed coupling between the thermally induced flow and the flow generated by the Boycott effect, which has not been explicitly addressed in previous studies of inclined sedimentation systems. Building on these observations, this study proposes a basic physical model that describes how the ascending thermal layer induced by heating interacts with the settling dynamics governed by the Boycott effect in inclined geometries.

The analysis will combine tools from fluid dynamics, heat transfer, and suspension physics, aiming to build a coherent interpretation of the observed effects and provide physical criteria to explain the system's behavior. Although detailed flow visualization near the inclined wall is unavailable, the global experimental results provide evidence to support a physical analysis that characterizes the main interactions between thermal flow and suspended particles.

This study seeks to contribute to the understanding of the thermally modified Boycott effect in inclined geometries and to advance toward a better description of the local physical mechanisms that govern sedimentation under localized heating.

References

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