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Abstract

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An Analysis of Natural Convection in Room Geometries

A. Gadgil, F. Bauman and R. Kammerud

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Lawrence Berkeley Laboratory University of California/Berkeley

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DISCLAIMER

AN ANALYSIS OF NATURAL CONVECTION IN ROOM GEOMETRIES[†]

A. Gadgil, F. Bauman, and R. Kammerud
Passive Solar Group
Lawrence Berkeley Laboratory
Berkeley, California 94720

A program has been initiated to study convective air flow within thermal zones; both analytic and experimental work are included. Using the results of these projects, temperature stratification, stack effects, and convective heat transfer across zones can be studied. Initial results from both projects will be presented.

The analysis technique which has been developed allows the convection to be naturally driven by differential boundary surface temperatures or to be forced by pressure gradients created by air flow boundary conditions. The computer program models the flow using a hybrid differencing scheme that can switch between Central Difference Scheme (CDS) and Upstream Difference Scheme (UDS), depending on the local grid Péclet number. This permits the spatial grid on which continuity and the momentum and energy balance are applied to assume dimensions of the order of feet. The governing difference equations have been numerically solved for two-dimensional geometries. In the future, this analysis will be extended to fully turbulent flow and to three dimensions.

In a separate coordinated project, an experimental apparatus for measuring steady-state natural convective processes has been designed and constructed. The apparatus is scaled to table-top size and allows both measurement and observation of convection properties of both single-zone and two-zone configurations. The instrumentation permits measurement of (1) the temperature distribution(s) within the space(s) and (2) the heat transfer rate across (between) the zone(s).

Both the analytic and experimental techniques will be described and results from both of these projects will be presented. In particular, the validation of the analysis program using the data from the scaled experiment will be described. Initial results will be presented on the experimentally measured temperature profiles in single- and two-zone configurations, and on two-zone coupling strengths. Preliminary calculations of stack effects in multi-story atrium spaces will be presented.

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TECHNICAL INFORMATION DIVISION
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720