AEC-NASA TECH BRIEF

Surface-Renewal Models for Heat-Transfer Between Walls and Fluidized Beds

Models previously presented for the transfer of heat between a wall and a fluidized bed have been reviewed (ref.); attention is focused on penetration-type models requiring knowledge of the residence times of the fluidized particles at the wall.

Equipment was designed to measure heat-transfer coefficients and residence times of particles at the identical wall surface under the same conditions. This was done by constructing a heat-transfer surface and a transparent surface that could be placed in a wall cavity for measurement of heat-transfer coefficients and residence times, respectively. The heat-transfer surface was an adiabatic heater. Residence times were measured by repeated photography of wall of the bed, with the transparent surface mounted in the cavity; heat-transfer coefficients could thus be related experimentally to the residence times of particles at the heat-transfer surface.

Cellulose acetate, glass, copper, aluminum, and alumina were used in sizes ranging from 0.001 to 0.01 ft. Residence times were measured for only the glass and the cellulose acetate; the other residence times were obtained from a dimensionless correlation between residence time and gas velocity, using the glass and acetate data. Air was used as the fluidizing gas. Use of a stirred, bubble-free bed simplified residence-time measurements.

Two surface-renewed models are presented to describe heat-transfer between the wall and the fluidized bed. Model-I considers transient heat-transfer to a "packet" or "clump" of particles at the wall, a nonzero wall-to-packet thermal resistance being assumed. Model-II considers the transient heating of a particle at the wall, gaining heat by convection from the surrounding fluid and losing heat to the bulk of the bed behind. Both models gave predictions within an average 30% of the data for glass.

Both models, being of the film-penetration type, require knowledge of the heat-transfer coefficient at minimum fluidization. The residence times were such that essentially a penetration mechanism was in effect. Pure penetration variants of these models (which do not require knowledge of minimum-fluidization heat-transfer coefficients) could thus be used with equal accuracy.

Methods are also presented for estimation of mean residence times of particles at the surface, their age densities, and the average transport coefficients by observation of only the total tracer-particle counts at the transporting surface. Two methods, employing the autocovariances and spectral density of the counts, are outlined and tested on computer-simulated counts and true counts experimentally observed at the wall of the fluidized bed. Although there is some deviation in the predicted age densities from the correct values, the average residence times and the average transport coefficients agree with the true values.

Reference:

Patel, R. D.: Surface-Renewal Models for Heat Transfer between Walls and Fluidized Beds. ANL-7353, Argonne National Laboratory, 1 Nov. 1967.

Notes:

1. This information may interest the petroleum, chemical, plastics, and coating industries.

(continued overleaf)

2. Inquiries concerning this innovation may be directed to:
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Patent status:

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