

FUNDAMENTAL PROCESSES IN GAS FILTRATION

R. CLIFT

DEPARTMENT OF CHEMICAL ENGINEERING
UNIVERSITY OF SURREY, GUILDFORD, GU2 5XH, ENGLAND

SUMMARY Renewed interest in generation of electrical power from coal has revived interest in the filtration of gases by beds of granular solids, as a possible means of cleaning gases derived from combustion or gasification of coal. In addition to the practical engineering problems, development of granular bed filters raises a number of fundamental problems in fluid mechanics and physics, some of which are reviewed in this paper.

Starting with a fresh filter bed, we first require dust particles carried by the gas to come into contact with the granules of the filter bed through which the gas is passing. This process is known as capture or collection, and is normally dominated by one or more of three distinct mechanisms. Collection by Brownian diffusion is a process which is relatively well understood, and described well by conventional results for mass transfer. Inertial impaction is less quantifiable, and attempts to describe inertial collection by calculation of particle trajectories have met with limited success. The reasons for this are explored. Collection by the influence of electrostatic forces is even less understood but the contributory processes and governing groups are identified.

Once a dust particle has contacted a collector, it must remain in contact and not bounce or re-entrain. Retention is determined by the balance between adhesion energy and kinetic energy on impact, with fluid drag normally being of secondary importance. It is shown that trajectory calculations can lead to order-of-magnitude estimates for conditions under which a collected particle is retained by the collector.

As collected dust particles accumulate, the structure of the filter changes. In most applications, it is desirable for the dust to build up a filter cake on the upstream face of the filter. Some previously unpublished work is summarised which shows that electrostatic effects are dominant in determining whether a cake forms but which suggests that the structure of any cake may not be influenced strongly by electrostatic effects.