EROSION AND RELATED PROBLEMS IN GAS-SOLID SUSPENSION FLOWS

V. K. AGARWAL

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CERTIFICATE

This is to certify that the thesis entitled "EROSION AND RELATED PROBLEMS IN GAS-SOLID SUSPENSION FLOWS" has been a record of bonafide work carried out under our guidance. It is further certified that the thesis has attained a standard required for a Ph.D. degree. The results presented in this thesis have not been submitted in part or full to any other University or Institute for the award of any degree or diploma.

Professor J.P. Sharma
Industrial Tribology Machine Dynamics & Maintenance Engg. Centre
Indian Institute of Technology,
Hauz Khas, New Delhi 110016
INDIA

Dr. David Mills
School of Mechanical Engg.
Thames Polytechnic
Wellington Street SE 18 6PF
London
U.K.

Abstract

In the recent past, pneumatic conveying, which is an eminently suitable means of transporting powdered and granular materials for in-plant situations has received the attention of researchers to a great deal. It is mainly due to the fact that the subject is still in its early stage of development and quite often the design of such systems is rated more of an art rather than a science. Erosion of plant items; especially of pipe bends which is considered to be a serious but least understood problem is the main feature of the work reported here. Apart from erosion other problems associated with a successful design of the pneumatic conveying system have also been considered. Before presenting the experimental results, an introduction to the subject, importance of the current work and the research plants used in this investigation are discussed.

The use of rubber as a potential bend material for conveying different products in gas-solid suspension mode has been investigated in detail. It is shown that the erosive wear behaviour of rubber and mild steel is very much product dependent. Over a range of phase density rubber is a better bend material than mild steel for conveying of sand. For Alumina and Coke, rubber eroded faster than mild steel. Some anomaly in the order in which the bend failed during this programme led to evaluate the acceleration length by measuring erosion of bends. Results of the test programme with two grades of sand viz. 230 μ m and 70 μ m are presented. An acceleration length of 40 pipe diameters is recommended for coarse sand. No clear pattern is established for the finer sand. The results presented have shown that erosive wear measurements can be successfully used for determining acceleration lengths.

Conveying characteristics for any product are very useful in the design of pneumatic conveying systems. Conveying characteristics for sand conveyed in dilute phase through several different pipelines have been presented. The use of such data for system design is illustrated and scaling parameters are derived for conveying distance and the influence of the bends in the pipeline. It is shown that equivalent horizontal length for a bend is about 8.8 m.

The use of inserts immediately before a bend for reduction of erosive wear has also been investigated. It is shown that the use of inserts is a potential solution for the erosive wear control and more work could be undertaken. It has been shown that erosion of bends is significantly reduced

when the tests are carried out with inserts in the pipeline. Also, the bends not protected by the inserts show considerable reduction in the mass loss when compared to the results of the same bends in the test programme without inserts.

Since particle degradation can be a major problem with conveying of certain friable products like mustard seed and coke, the results of a specific programme to study the particle degradation are presented, in addition to the particle size results of other test programmes. It is shown that the bench type rigs could be of more value for investigating such aspects. Problems of particle segregation in the receiving hopper, obtaining the representative sample and the limitations in the use of pilot plants are also discussed.

Finally, an attempt has been made to examine if the bench tests could be used to study the bend erosion problem in pneumatic conveying. Erosive wear measurements on a sand blast type rig are presented for mild steel, rubber and glass. These results have been compared with those obtained on the pilot plant. It is found that bench rigs could be of use for certain types of problem e.g. comparative evaluation of erosion reistance of several materials, study of particle degradation etc. Before making a final decision on the use of bend materials, full scale tests, however, would be required.

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