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**Separation of Clods and Rocks
in a Fluidized Bed**

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Separation of Clods and Rocks in a Fluidized Bed

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Cooperating Institution(s): Agricultural Engineering Department, Texas A & M
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Principal Investigator

Faltzman

Institution's Authorizing Official

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B.

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C. ABSTRACT

A preliminary study of separation in a fluidized bed medium (FBM) showed that this method is promising. It was found that sand would be a good, inexpensive medium for this purpose and the process's parameters were determined. An experimental model for continuous separation was developed and tested. For examination of this method under field conditions, a pilot plant for separating potatoes from clods and stones was built and tested.

The method of separation in an FBM was used also for separating flower bulbs. To examine this method, a fluidized bed potato separator was modified to separate flower bulbs. An experimental fluidized bed separator for flower bulbs was developed and tested in continuous operation in a packing house.

Research on air distributors for FBM separators for agricultural products was carried out.

A system for tracing the sink motion of spheres through a gaseous fluidized bed was developed and tested.

An analytical analysis was carried out of a separation process in an FBM. A mathematical model was developed to describe the separation process and a numerical analysis was carried out. Predicted characteristics were found to be similar to the observed phenomena and the experimental results.

D. DESCRIPTION OF THE RESEARCH RESULTS

The research work was carried out in two directions: development of equipment for separating clods and stones in a FBM, and investigations of basic parameters of the FBM with respect to agricultural product separation.

A preliminary study of separation in a FBM showed that this method is promising. It was found that sand would be a good, inexpensive medium for this purpose and the process's parameters were determined. An experimental model for continuous separation was developed and tested. For examination of this method under field conditions, a pilot plant for separating potatoes from clods and stones was built and tested. The results of field tests showed that the machine can efficiently separate potatoes from clods and stones.

The method of product separation in a FBM, which was tested first for potatoes, was used for separating flower bulbs from clods and stones. A preliminary study of contamination of flower bulbs showed no contamination during treatment of bulbs in a sand fluidized bed. To examine this method, a fluidized bed potato separator was modified to separate flower bulbs. The results of the test showed good separation effectiveness, which is dependent on the content of product being separated and on the feed rate.

An analysis was made of material flow from a field to different stages of mechanical processing in the packing house for flower bulbs. The data show that mechanical harvesting of flower bulbs increases greatly the amount of manual labor needed for separation, in comparison with hand harvesting.

An experimental fluidized bed separator for flower bulbs was developed and tested in continuous operation in a packing house. The tests showed good separation effectiveness for the mixture with a high content of clods and stones.

Research was carried out on air distributors for FBM separators for agricultural products and different types of air distributors were tested. High-density polyethylene porous plates were found to be suitable for separating agricultural products under different fluidizing conditions. Stainless steel porous distributors were found appropriate for very heavy work conditions.

A system to trace the sink motion of spheres through a gaseous fluidized bed was developed. Spheres of different diameters and mass densities were thrown onto a fluidized bed of several depths from different drop heights. Acceleration of bodies as a function of time was recorded and velocities and paths were calculated and plotted. The influence of the physical properties on character of motion was discussed. Useful data for optimal separation chamber design for devices utilizing differences in mass densities of agricultural products and waste materials were obtained.

An analytical analysis was made of a separation process in a FBM.

A mathematical model was developed to describe the separation process with zero-order initial velocity of the body introduced into a fluidized bed and the process with certain initial velocity of the body introduced.

The numerical analysis was carried out for different parameters influencing the separation process. Predicted characteristics were found to be similar to the observed phenomena and the experimental results.

A detailed description of the research results is provided in the paragraph "Research on Air Distributors for FBM Separators for Agricultural Products" and the enclosed reprint and manuscripts of scientific papers which have been submitted for publication in scientific journals.

Research on Air Distributors for FBM Separators for Agricultural Products

The primary function of the distributor is to introduce the fluidizing gas into the bed. The requirements for a satisfactory distributor are that it should promote uniform and stable fluidization, minimize attrition of bed material, minimize erosion damage, and prevent flowback of bed material during normal operation.

Experience has shown that distributors should have a sufficient pressure drop to achieve equal flow through the bed. The pressure drop across the distributor should be considerably larger than the inherent resistance to rearrangement of the incoming gas.

A special device for research on air distributors has been developed (Fig. 1). It includes three cylinders made of Perspex with diameters of 100, 200 and 300 mm, air resistance and flow rate gauges, and a stand on which they are mounted. Dune sand and glass spheres were selected as the medium for the fluidized bed. The bed depth was up to 500 mm. It was accepted that good fluidizing conditions exist when the gas bubbles are distributed equally on the bed depth and surface, and are relatively small.

The simplest gas distributors for low fluidizing temperatures are porous plates produced at a wide resistant range.

High-density polyethylene porous plates, 3.5 and 5 mm in thickness, were chosen and tested in different assembly versions:

<u>Assembly Symbol</u>	<u>Plate Thickness, mm</u>
1A	5
1B	3.5
A1 x 2	10
A1 x 3	15
A1 x 2 + 1B	13.5

The relationship between air resistance and air velocity for different porous plates is shown in Fig. 2. High-density 5-mm-thick polyethylene porous plates with an average porosity of 70% and air resistance of 100-300 mm W.G., were found to be suitable for separating agricultural products under different fluidizing conditions. Stainless steel porous distributors were found appropriate for very heavy work conditions.

E. DESCRIPTION OF COOPERATION

Excellent relations and communication were developed between the project leaders while performing the research project. Dr. Zaltzman and Dr. Feller, during their trips to Texas A&M University, discussed the research plan with the Cooperating Investigator, Dr. Coble. Dr. Zaltzman, during his visit to Texas, reported to the Cooperating Investigator and scientific staff of the Agricultural Engineering Department of Texas A&M University, on the results of the research carried out in Israel. He visited agricultural experiment stations in Texas and studied the possibility of using FBM separation for different products.

Fig. 1

Fluidized-bed testing system

1. Cylindrical transparent chambers
2. Pressure regulator
3. Thermometer
4. Flow meters
5. Total pressure manometer
6. Medium system pressure gauge
7. Barometer
8. Hygrometer
9. Valve system for chamber air distribution
10. Valve system for monitoring the chamber pressure

Fig. 2 - Pressure drop vs. velocity through different porosity plates.

In coordination with Dr. Coble, it was decided to test a small FBM machine for separating onion seeds from clods at the Weslaco Agricultural Research Station of Texas A&M University in the Rio Grande Valley. Sketches of the separator were made in Israel and sent to the U.S.A.

Dr. Coble studied the progress made in the research during his visit to Israel in the third year of the project and gave valuable advice for successful completion of the research plan.

F. BENEFIT TO AGRICULTURE

The research will result in both scientific and economic contributions to the agriculture of the U.S.A. and Israel.

The introduction of fluidized bed technology to agriculture is an important scientific contribution. This technology is widely used in the chemical industry, but is not yet applied in agriculture. The data from this study will enable the development of FBM separators for agricultural products. The analytical model and experimental investigations will lead to a better understanding of the separation process in FBM.

The development of an efficient machine for clod separation would result in increasing the world production of products which grow on cloddy soils. The first steps in this direction were made within the framework of the research project.

G. LIST OF PUBLICATIONS

Enclosed are reprints of a published paper, and manuscripts of scientific papers which have been submitted for publication in scientific journals:

1. Zaltzman, A., R. Feller, A. Mizrach and Z. Schmilovitch (1983).
Separating potatoes from clods and stones in a fluidized bed medium.
Trans. Am. Soc. Agric. Engrs. 26(4): 987-999, 995.
2. Zaltzman, A., A. Mizrach, Z. Schmilovitch and H. Vigodsky-Haas.
Separating flower bulbs from clods and stones in a fluidized bed medium.
3. Zaltzman, A., Z. Schmilovitch and A. Mizrach.
Separating flower bulbs in a packing house.
Submitted for publication in Canadian Agricultural Engineering.
4. Mizrach, A., A. Zaltzman, G. Manor and Z. Nir (1982)
Motion of spheres in a fluidized bed.
ASAE Paper No. 82-3057. St. Joseph, Michigan.
Submitted for publication in the Transactions of the ASAE.
5. Zaltzman, A., A. Mizrach and Z. Schmilovitch.
Analytical model of a separation process in a fluidized bed medium.
Submitted for publication in the Journal of Agricultural Engineering Research.
6. Zaltzman, A., A. Mizrach and Z. Schmilovitch.
A fluidized bed separator.
Patent Application in Israel, No. 58170 (1981).
United States Patent No. 4,322,287 (March 30, 1982).