Case Study 216

Toroidal fluidised bed reactor for mineral processing

Toroidal fluidised bed reactor

Case Study Objective

To demonstrate the benefits of using a toroidal bed reactor to dry, heat or expand materials.

Potential Users

Applications for this technology can be found in most process industries.

Investment Cost (1990 prices)

£136,000

Savings Achieved

£102,400/year

Payback Period

16 months

Case Study Summary

The expansion and exfoliation of crude vermiculite ore produces the basic material used in the manufacture of fire protection and industrial insulation products. Excessive operating and maintenance costs, and serious environmental problems, prompted Cape Industrial Products Ltd to replace their five rotary furnaces used for the exfoliation process, with a toroidal fluidised bed reactor.

The new reactor maintained the same level of production as the five rotary furnaces and reduced overall energy consumption and vermiculite wastage. Other benefits included lower maintenance costs and much improved environmental conditions.

The savings achieved by this project resulted in a payback period of 16 months on an investment of £136,000.

"... it has been one of the best capital investments that Cape has made ..."

BEST PRACTICE PROGRAMME

Energy Efficiency Office
DEPARTMENT OF THE ENVIRONMENT

Host Organisation

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Mr P Gamble

Background

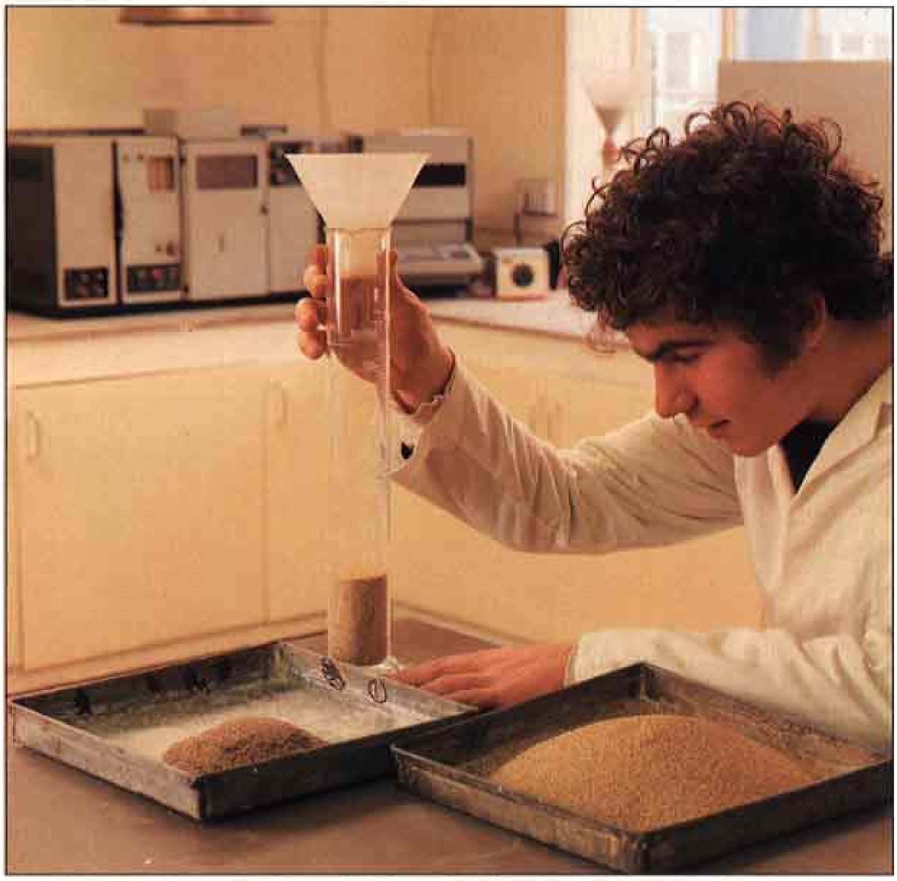
An essential part of Cape Industrial Products' manufacturing process is the expansion and exfoliation of crude vermiculite ore. The vermiculite is then used in the manufacture of fire protection and industrial insulation products.

Original Exfoliation System

The expansion and exfoliation of vermiculite was carried out in five rotary furnaces rated at 0.75 tonnes/hour. Each furnace was a plain steel cylinder, with a diameter of 300 mm and length 1,200 mm, fired by a nozzle-mix gas burner with fan-blown combustion air. Dilution air was naturally aspirated. Due to its design, the basic furnace did not supply an even, mixed gas temperature for exfoliation; the gas temperature remained constant only if the draught remained constant and raw material continued to flow.

The basic furnaces had longitudinal vanes which tumbled the vermiculite as it passed through the furnace. To achieve 450°C, the ideal temperature for exfoliation, a large quantity of excess air was required to lower the temperature in the furnace. This meant that the process was very inefficient in terms of energy consumption.

Due to inherent deficiencies, the plant had an availability of only 60% and was very costly to maintain. Other problems included frequent spillage of vermiculite, unacceptable atmospheric emissions and an unpleasant working environment.



Vermiculite before and after exfoliation showing the 10:1 increase in volume

New System

In an effort to overcome these problems the Company decided to install a toroidal fluidised bed reactor to replace the old furnaces. The reactor has a refractory-lined and insulated chamber which retains the heat after a short warm-up cycle. This means that a smaller burner can perform the same duty as the original system.

The vermiculite particles, which are fed into the top of the reactor continuously, must be heated rapidly to allow the interlaminar water to expand them. The vermiculite is distributed around a fixed ceramic blade ring by a stainless steel cone. Combustion gases between 1,100 - 1,300°C pass from the underside of the ceramic blade ring through angled slots to, and through, the layer of vermiculite on the blade ring. This process has two effects on the vermiculite layer:

- it is suspended above the blade ring in a well packed bed;
- it rotates around the blade ring as a toroid producing excellent mixing and heat transfer characteristics.

Heat from the combustion gases is transferred to the vermiculite which is then exfoliated. After exfoliation the vermiculite is carried out of the reactor with the exhaust gases.

The rate of raw material feed controls the combustion gas temperature. If the raw material flow is disrupted, the resulting increase in gas temperature shuts the plant down at a set point of 550 - 600°C.

When the installation of the new equipment was planned, it was decided to upgrade the raw materials handling plant. A sealed pneumatic system was installed to replace the previous bucket conveyor and associated equipment. This has proved to be beneficial because the sealed system is largely responsible for reducing the airborne dust to only 3.5% of that previously measured. The toroidal bed reactor also contributes to this because it operates under a slight depression instead of positive pressure.

Savings Achieved

The total energy saving being achieved is 2,800 GJ/year worth £13,000. The sealed conveying system, coupled with the efficient exfoliation process, produces savings worth £89,000/year mostly due to lower labour costs and the reduction in wastage of vermiculite.

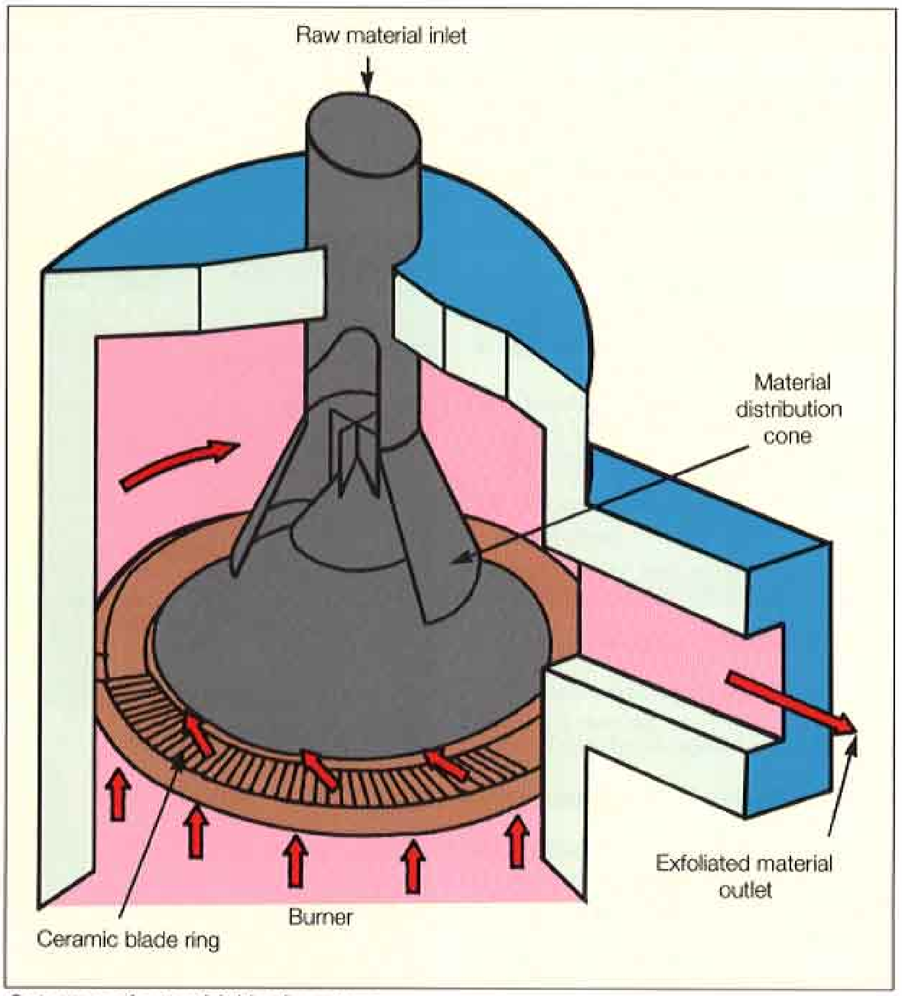
The cost of the installation was £136,000 in 1990. The simple payback period for this project based on all the savings is 16 months.

The installed plant is, however, capable of greater output. When running at full capacity, overall savings from the new equipment would be about £180,000/year. This saving would give a payback of just nine months.

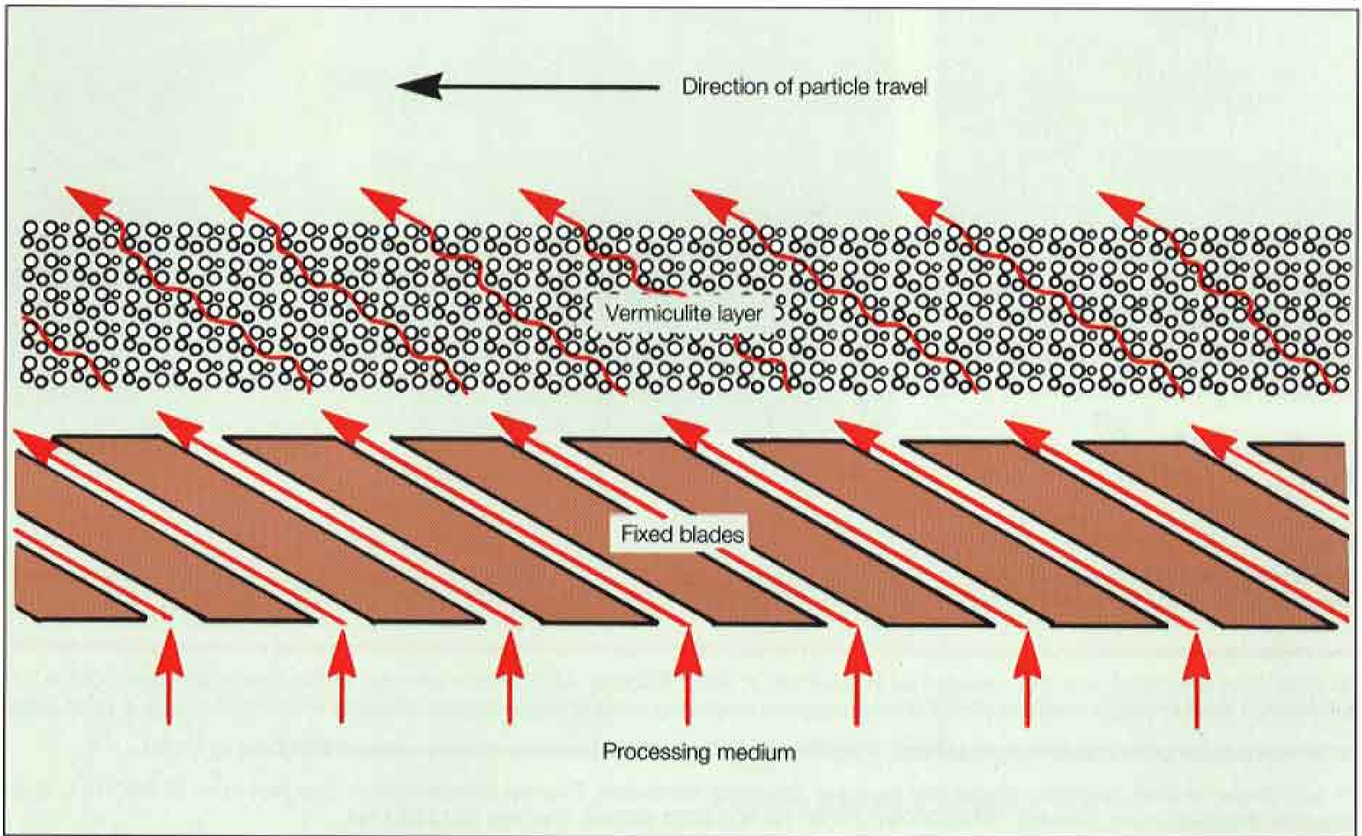
Environmental Aspects

When the original system was being used, atmospheric emissions resulted in complaints from people living nearby, the District Environmental Health Department and Her Majesty's Inspectorate of Pollution (HMIP). The working environment was unacceptable because of airborne dust, excessive heat and noise and the plant was under threat of a prohibition notice from HMIP.

As a result of the new installation, working conditions around the exfoliation process are now the same as the rest of the factory and unacceptable emissions have been eliminated. The improvements are now used by HMIP as a reference. The installation has also gained a commendation in a National Environmental Award promotion.



Cut away of a toroidal bed reactor



Section through ceramic blade ring and vermiculite layer

Comments from Cape Industrial Products Ltd

An essential part of our manufacturing process is the expansion and exfoliation of crude vermiculite ore, which was carried out in rotary gas-fired furnaces.

This plant had a poor availability, was costly to maintain and was an environmental liability.

I decided the best way forward was to install the new plant despite knowledge of earlier problems with the process.

The new plant was installed and commissioned in less than one month. Even allowing for a few costly failures, it has surpassed my expectations and produced the following benefits:

- fuel costs have been greatly reduced;
- working conditions improved;
- uncontrolled emissions eliminated;
- spillage and wastage virtually eliminated;
- reliability and downtime improved to 95%;

In short, it has been one of the best capital investments that Cape has made and is being implemented in similar factories within the Group.

W Farrell
Director and General Manager
Cape Industrial Products Ltd

Cape Industrial Products Ltd

Cape Industrial Products Ltd

Cape Industrial Products Ltd has been manufacturing its products at Germiston Works in the Springburn district of Glasgow since 1952. The company employs 108 people and manufactures non-combustible board for use in the marine, construction and industrial markets.

The installation described here was selected as an example of Good Practice, which is one element of the Energy Efficiency Office's (EEO) Best Practice programme, an initiative aimed at advancing and promoting ways of improving the efficiency with which energy is used in the UK.

For further copies of this publication or other Best Practice programme literature please contact BRECSU or ETSU.

For buildings-related projects: Enquiries Bureau, Building Research Energy Conservation Support Unit (BRECSU), Building Research Establishment, Garston, Watford WD2 7JR. Tel No: 0923 664258. Fax No: 0923 664787.

For industrial projects: Energy Efficiency Enquiries Bureau, ETSU, Harwell, Oxfordshire OX11 0RA. Tel No: 0235 436747. Fax No: 0235 432923. Telex No: 83135.

Information on participation in the Best Practice programme and on energy efficiency generally is also available from your Regional Energy Efficiency Office.