

# PARTICULATE TECHNOLOGY LAB

## SOLIDS HANDLING STUDY BENCH

### DESCRIPTION

The characteristics of the flow of solid materials are relevant to many process industries, particularly in the handling of powders, pellets, crystals and aggregates. The equipment supplied with this bench consists of a number of simple items, each of which is designed to introduce students to a single but different aspect of solids behaviour. The experiments may be undertaken separately from each other, thus increasing the cost effectiveness of the bench over a series of laboratory periods. The following basic solids handling elements are included:

- 1) *Sieves and Vibratory Shaker:*
- 2) *Cylindrical Hopper:*
- 3) *Horizontal Cylinder:*
- 4) *Solids Mixing Vessel:*
- 5) *Ball Mill:*
- 6) *Cyclone and Pneumatic Conveying:*



## **FILTRATION UNIT**

### **DESCRIPTION**

Filtration Unit has been designed to demonstrate the application of Darcy's Law of Filtration. The unit is equipped with a fully functional Plate and Frame filter unit, the most commonly used dead end, batch filter design. As an option, a continuous, tangential flow filter is available which uses an industry standard, hollow fibre cartridge system.

In the case of batch filtration, measurement of operating pressure, volumetric flow rate and optical absorbance enables, cake and medium filtration resistances, benefits of filter aid, mass balancing and washing regimes to be investigated. For tangential flow filtration, similar measurements enable membrane flux and transmission relationships and washing regimes to be examined.

The unit consists of:

- Control console
- Feed tank
- Feed pump
- Plate and frame filter unit
- Optical sensor



# FIXED AND FLUIDISED BED APPARATUS

## DESCRIPTION

The upward flow of fluid through a bed of particles is a situation encountered both in nature and in industry. Natural occurrences include the movement of ground water, the movement of crude petroleum or the movement of natural gas through porous media. Industrial occurrences include operations such as back-washing filters, ion-exchange processes, extraction of soluble components from raw materials and certain types of chemical reactor.

It is well known that if the particles are loosely packed and the pressure drop due to the flow through the bed is equivalent to the weight of the bed then the phenomenon of fluidisation occurs. The fluidised state occurs naturally in so-called 'quick sands'. The high rate of solids mixing that accompanies fluidisation is utilised in various industrial operations such as drying, coating, heat transfer and chemical reaction.

The equipment consists of:

- Water circuit
- Air circuit

### Granular materials for the beds

The two sizes of the glass bed

Type 1: 230/320 microns

Type 2: 400/520 microns



# SEDIMENTATION STUDIES UNIT

## DESCRIPTION

The characteristics of very small particles settling in water are of great importance in both naturally occurring systems (rivers, canals etc.) and in process plant, particularly that involving water treatment.



The removal of undesirable suspended solids from water may be achieved in many ways, including the use of cyclones, centrifugals, sedimentation tanks and 'thickeners'. The latter two equipment types are the most commonly used in industry, because the capital and operating costs are relatively low. The great majority of sewage treatment plants employ several sedimentation tanks in the primary treatment stage, and both these and thickeners are found extensively as final water treatment stages in effluent disposal systems of chemical and metallurgical process plants.

The study of how particles settle in a liquid is therefore of importance to many industries, and the sedimentation studies rig provides students with the opportunity of observing settling or sedimentation phenomena in a simple and readily identifiable manner. Students are able to measure settling rates as a function of particle size, density and concentration in a static water system. From these results, batch settling curves may be deduced, which can then be used for the design of industrial settlers and thickeners. The equipment supplied also allows industrial

tests to be made on any slurry system of interest.

The equipment also contains a flowing sedimentation tank system - the 'Sedimentation Tank', the use of which would follow directly from experiment in the apparatus described in this manual. In addition, the simpler situation of the settling characteristics of single particles may be studied in the item "Drag coefficients study system".

# FLUID MIXING APPARATUS

## DESCRIPTION

Mixing of liquid liquid or solid liquid systems is a complex operation to analyze and subject to many variables. The choice of mixer for a particular application depends on the degree of bulk movement or shear mixing required by the process. In order to predict full scale requirements it is usual to model the system and apply dimensional analysis.

Before the dimensional analysis can be used three conditions must apply:

1. *Geometric Similarity* - This will define the boundary conditions; corresponding dimensions will have the same ratio.
2. *Kinematic Similarity* - This requires that velocities at corresponding points must have the same ratio as those at other corresponding points.
3. *Dynamic Similarity* - This requires that the ratio of forces at corresponding points is equal to that at other corresponding points.



Two modes of flow behaviour exist in a mixer: laminar and turbulent flow. Both these flow conditions may be described dimensionally but for turbulent flow its behaviour is less significant. In particular the Power number becomes independent of Reynolds' number beyond a certain turbulence range.

A further factor to consider is surface waves which are described by the Froude number group. In a mixer this phenomena is usually a function of the height of the vortex which forms.

The equipment can be used to predict the power consumption of a full-sized mixer by equating Reynolds' number and Froude number. The effect of placing baffles in the mixer vessel is also investigated.

# TEST SIEVE APPARATUS

## DESCRIPTION

The Test Sieve is an economical, compact and portable vibrating shaker designed to conduct sieve tests in conjunction with sieve stacks for particle sizing of various material samples. By utilizing an electromagnetic drive and natural rubber spring mounts the power required is extremely low to produce the movement needed for basic sieve tests.

The Test Sieve is a fixed amplitude shaker, operated by a single process timer which provides a range of incremental periods or continuous running.

Model:	Minor	
Voltage:	230	110
Frequency:	50 Hz	60 Hz
Power consumption:	80 VA	60 VA
Vibration speed:	3 000 per min at 50 Hz	3600 per min min at 60 Hz

Sieve Diameters: Max. No. of Sieves in Stack:

8 Full Height	200mm or 8"	
15 Half Height	200mm or 8"	
12 Full Height	100mm or 3"	
23 Half Height		100mm or 3"

