CE SERIES

Solids Handling Studies – CEN-MKII

The flow and handling characteristics of granular materials are relevant to many process industries, particularly in the handling of powders, pellets, crystals and aggregates.
The CEN-MKII introduces students to the behaviour of granular materials and is available as three units that can be purchased separately or as a complete set.

CEN-MKII-12 Powder handling

CEN-MKII-13 Vibratory shaker and sieves

CEN-MKII-11 Shown with Vee blender installed and ball mill

Experimental Content

CEN-MKII-11 – Solids handling

- Reducing the size of granular material using a ball mill (comminution)
- Dry blending using a ball mill
- To examine the efficiency of mixing of granular materials (powder to powder) in a Vee blender

CEN-MKII-12 – Powder handling

- Measuring bulk density, particle density and porosity (voidage) of granular materials
- To determine the bulk density of various solids and to examine the influence of moisture content and compaction of the bulk density
- To determine the natural angle of repose for a variety of materials using a Hele-Shaw cell and to examine the influence of moisture content on the repose angle

CEN-MKII-12 – Powder handling (continued)

- To observe the natural stratification and agglomeration of various materials using a Hele-Shaw cell
- To investigate how the discharge (flow) rate of solids from a hopper is related to the diameter of the issuing orifice and whether the head of material over the orifice has any effect on the flow rate
- To demonstrate the operation of a pneumatic conveying system for solids and to show how a cyclone is used to separate the solids from the air stream

CEN-MKII-13 – Solids handling

- To determine and analyse the size distribution of a fixed granular solid by using a test sieve stack and a vibratory shaker

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URL: http://www.armfield.co.uk/cen
Applications
ChE ME CE IP

Description

CEN MKII

The flow and handling characteristics of granular materials are relevant to many process industries, particularly in the handling of powders, pellets, crystals and aggregates. The CEN-MKII introduces students to the behaviour of granular materials and is available as three units that can be purchased separately or as a complete set, as follows:

CEN-MKII-11 SOLIDS HANDLING

The equipment consists of interchangeable ball mill and Vee blender assemblies that are operated inside a protective enclosure. The enclosure, constructed from solid PVC, incorporates an electric motor with quick release coupling and manually adjustable speed control. A single-piece transparent hinged cover over the top and front of the enclosure allows access to the mill or blender and allows the user to safely observe the operation of the equipment. A safety interlock prevents the motor from operating when the cover is raised.

Ball Mill

The ball mill is a type of grinder that is used to reduce the size of solid materials using porcelain balls as the grinding medium. The ball mill can also be used to mix different powdered / granular materials. The mill supplied consists of a PVC cylindrical drum that rotates in the horizontal plane. The two ends of the drum are constructed from clear acrylic to aid viewing of the milling operation.

Vee Blender

The Vee blender is the most gentle and cost effective way to blend powdered materials together. The blender supplied consists of a shallow V shaped vessel that is constructed from clear acrylic to aid viewing of the blending / mixing operation.

CEN-MKII-11 SOLIDS HANDLING

CEN-MKII-12 POWDER HANDLING

The equipment consists of several different pieces of apparatus, mounted on a common backboard that is constructed from solid PVC.

Hele-Shaw Cell

The maximum stable slope of a pile of granular material is called the angle of repose and this will vary with different materials and the moisture content. The Hele-Shaw cell consists of two parallel clear acrylic plates between which the granular material is poured showing a section through the conical pile and allowing the slope to be measured. The behaviour of mixtures of solids with different grain sizes can also be observed.

Hopper Discharge

The apparatus supplied consists of a pyrex glass cylindrical hopper with a conical base that terminates in a circular outlet. A disk mounted adjacent to the outlet allows the flow of granular material through four different sizes of orifice to be tested by timed collection using a stopwatch (not supplied).

Pneumatic Conveying and Cyclone separation

It is common in industrial processing for granular materials to be moved from one location to another using compressed air as the conveyor and a cyclone to separate the material from the air stream at the final destination. The apparatus supplied provides a visual demonstration of the principles of pneumatic conveying using the cylindrical hopper as the cyclone. The low pressure created by a stream of compressed air from an external source (not supplied) through a Venturi is used to draw the granular material into the conveying system.

CEN-MKII-12 POWDER HANDLING

CEN-MKII-13 VIBRATORY SHAKER AND SIEVES

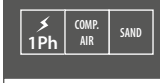
The granular materials with different particle sizes can be separated/ graded using a stack of sieves with different mesh sizes mounted on a vibratory shaker. After a period of operation the different 'fractions' can be collected from each of the sieves and weighed using a suitable balance (supplied with CEN-MKII-00 only).

CEN-MKII-13 VIBRATORY SHAKER AND SIEVES

CEN-MKII-00 COMPLETE SOLIDS HANDLING STUDIES BENCH

This option consists of a CEN-MKII-11, CEN-MKII-12 and CEN-MKII-13 with the addition of a 5kg digital balance for weighing samples.

Requirements



Scale

Electricity Requirements:

CEN-MKII-11-A:	230V / 1ph / 50Hz @ 0.5 Amps
CEN-MKII-11-B:	110V / 1ph / 60Hz @ 1.0 Amps
CEN-MKII-11-G:	220V / 1ph / 60Hz @ 0.5 Amps
CEN-MKII-13-A:	230V / 1ph / 50Hz @ 0.5 Amps
CEN-MKII-13-B:	110V / 1ph / 60Hz @ 0.6 Amps
CEN-MKII-13-G:	220V / 1ph / 60Hz @ 0.5 Amps

Compressed air supply:

CEN-MKII-12 requires a clean supply of compressed air at a pressure of at least 1 barg (15 psig). Maximum supply pressure must be limited to 13 Barg (188 psig).

Materials for processing:

Sand, rock salt, brown rice, lentils etc. depending on the exercise to be carried out.

Consumables:

1kg of Wash graded sand or
1kg of Rock salt

Ordering specification

CEN-MKII-11 Solids Handling

- Protective enclosure with transparent lid allowing safe operation of a ball mill or Vee blender
- Variable speed ball mill using porcelain balls as the grinding medium. Clear acrylic sides allow visualisation of the process
- Variable speed Vee blender constructed from clear acrylic for visualisation of the process with dust-tight access cover

CEN-MKII-12 Powder Handling

- Freestanding PVC backboard to support the various pieces of apparatus
- Hele-Shaw cell constructed from clear acrylic to measure angle of repose and demonstrate the behaviour of mixtures of granular materials
- Pyrex glass cylindrical hopper with conical base fitted with 4 interchangeable orifices
- Lid for cylindrical hopper creating a cyclone inside the hopper for pneumatic transport demonstrations
- Air pressure regulator and Venturi ejector for pneumatic transport demonstrations
- Glass beaker supplied for determining bulk density / particle density / porosity (voidage)

CEN-MKII-13 Vibratory Shaker and Sieves

- Fixed amplitude vibratory sieve shaker with variable process timer and 6 sieves

CEN-MKII-00 Solids Handling Study Bench

- Consists of a CEN-MKII-11, CEN-MKII-12 and CEN-MKII-13 with the addition of a 5kg digital balance for weighing samples

Overall dimensions

Dimensions	CEN-MKII-11	CEN-MKII-12	CEN-MKII-13
Length	0.650m	0.500m	0.26m dia
Width	0.385m	0.330m	-
Height	0.380m	0.679m	0.17m (no sleeves fitted)
Packed and crated shipping specifications			
Volume	0.30m^3	0.30m^3	0.30m^3
Gross weight	45kg	48kg	34kg

Recommended instrumentation

Hand held refractometer or conductivity meter to measure salt concentration in samples when blending materials using CEN-MKII-11.

Essential accessories / equipment

Stopwatch
Balance to weigh samples (supplied with CEN-MKII-00)

Technical specifications

CEN-MKII-11	
Blender	
Speed	Variable from 0 to 50 RPM
Total volume	1.2 litres
Working volume	0.35 litres
Ball mill	
Speed	Variable from 0 to 50 RPM
Total volume	3.5 litres
Grinding medium	Porcelain balls – 3.5kg supplied
CEN-MKII-12	
Hele-Shaw cell	
Internal width	20mm
Construction	Clear acrylic
Cylindrical hopper	
Construction	Pyrex glass
Inside diameter	99mm
Parallel height	258mm
Orifice diameters	5mm, 10mm, 15mm & 20mm
CEN-MKII-13	
Vibratory shaker	
Process timer	1 to 60 mins. or continuous
Vibrations per min	3000 at 50Hz, 3600 at 60Hz
Sieves	
Construction	Brass frame with stainless steel mesh
Standards	BS410-1 / ISO3310-1
Mesh sizes	0.25mm, 0.355mm, 0.5mm, 0.71mm, 1mm, 2mm

Ordering codes

CEN-MKII-11 - A/B/G Solids Handling
CEN-MKII-12 - Powder Handling
CEN-MKII-13 - A/B/G Vibratory shaker and sieves
CEN-MKII-00 - A/B/G CEN-MKII-11 + CEN-MKII-12 + CEN-MKII-13 + 5kg balance