TECHNICAL NOTE ON AN IMPROVED CYCLOSIZING TECHNIQUE

By

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INTRODUCTION

The design and operating characteristics of the hydraulic cyclone elutriator were described in detail by Kelsall and McAdam (1963), and the method of operation of the commercially available version, the Cyclosizer, is described in the manufacturer's pamphlet (Anon). Complete details of the operating procedure are given in the relevant operating manual (Anon, 1964).

The cyclones which form the basis of the Cyclosizer (Fig. 1) under normal operating conditions produce typical cut sizes of 44, 33, 23, 15, and 10 μm for cyclones one to five respectively for material with a specific gravity of 2·7. At the end of the selected elutriation period each sized fraction is discharged and collected for subsequent assay or analysis but all material rejected by the fifth cyclone (e.g. minus 10 μm quartz) normally passes to waste.

When this material is needed for separate study, although its amount and average analyses can be calculated by difference, it may be necessary to collect more than 250 l. of very dilute suspension, flocculate the solids, allow to settle, and decant off the supernatant liquid.

This procedure is cumbersome and inconvenient and the simple technique to be described may offer some advantages. The temperature of the water fed to the Cyclosizer is maintained at a constant value for added reproducibility.

PROCEDURE

The present overall treatment of the subsieve material (minus 37 μm) fed to the Cyclosizer incorporated several refinements compared with normal operation and these may be best illustrated by an actual example.

Material to be cyclosized (25 to 100 g depending on size distribution and specific gravity) is completely dispersed in water at 23°C by vigorous stirring, using suitable dispersants if necessary, in a 2 l. beaker filled to a level marked 16 cm above the base. After a settlement period of 1 h, during which time a quartz sphere with a diameter of 6·5μm would settle 14·5 cm, the upper 14·5 cm of suspension is removed using a special syphon (Fig. 2) designed to ensure minimum disturbance of the lower 1·5 cm of suspension.

The lower 1·5 cm is diluted with water at 23°C, to make up to the 16 cm level, the system redispersed and the 1 h decantation cycle repeated. The same procedure is repeated a further twice and the four decant suspensions combined for subsequent flocculation, settling, dewatering, drying, weighing, and assaying.

The coarse solids remaining in the beaker after the fourth cycle are loaded into the Cyclosizer feed

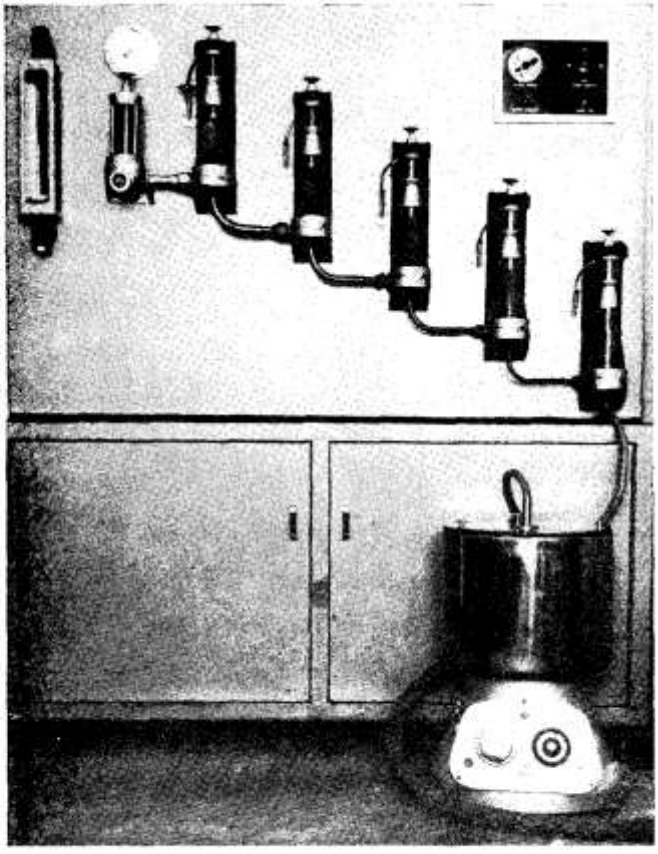

FIG. 1—Cyclosizer and centrifuge used in the improved sizing technique.

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container. The Cyclosizer is then operated as usual with water at 23°C but the water and material rejected by the fifth cyclone unit passes through a continuous centrifuge capable of retaining all solids with settling rates greater than that for a quartz sphere of 1·5 μm diameter.

Calculation, based on Stokes' Law, shows that the feed to the Cyclosizer (after the four decantation steps) contains only 0·1 per cent of 2 μm equivalent quartz sphere material and 0·01 per cent of ultrafine material. Consequently practically all of the original material to be sized is recovered in seven fractions, i.e. in units 1 to 5 of the Cyclosizer, in the bowl of the centrifuge, and in the fines from the four decantation steps. In the absence of a centrifuge, particles leaving the Cyclosizer may be recovered after allowing the effluent to settle for a few hours, without the need for flocculation, since all very fine solids have been removed by decantation.

EQUIPMENT

Water temperature control

A water temperature of 23°C for decantation and cyclosizing was chosen as a typical summer cold water maximum. Cyclosizing at fixed water temperature ensures that cut points do not vary from one sizing run to the next. The pump box of the Cyclosizer is fitted with separate ball valves, and a manually operated valve fitted in the hot water supply line permits coarse temperature adjustment to approximately 21°C, measured in the region where hot and cold streams are mixed. A 2 kW immersion heater, fitted in the same region, is switched on and off by a mercury-wire contact thermometer, located at the exit of the pump box, or pump intake, and set to hold a temperature of 23 ± 0·25°C. If cooling (approximately 1 kW) is provided, the discharge from the centrifuge—virtually free of solids in this technique—may be recycled to the Cyclosizer making it practical to use liquids other than water as the sizing medium.

Centrifuge

The continuous centrifuge, shown in Fig. 1, is of the solid bowl type, capacity 3 l., 26 cm in diameter and 12 cm deep, rotating under load at approximately 3000 rev/min. The minimum separation diameter of the bowl, i.e. the diameter of the top opening where the liquid overflows, is 12·5 cm.

Decantation equipment

The apparatus used for settling and decantation is shown in Fig. 2. The syphon tube is fitted with a horizontal disc and the supernatant suspension is removed through three short vertical slits located at the base of the tube but above the disc to avoid disturbance of the settled solids.

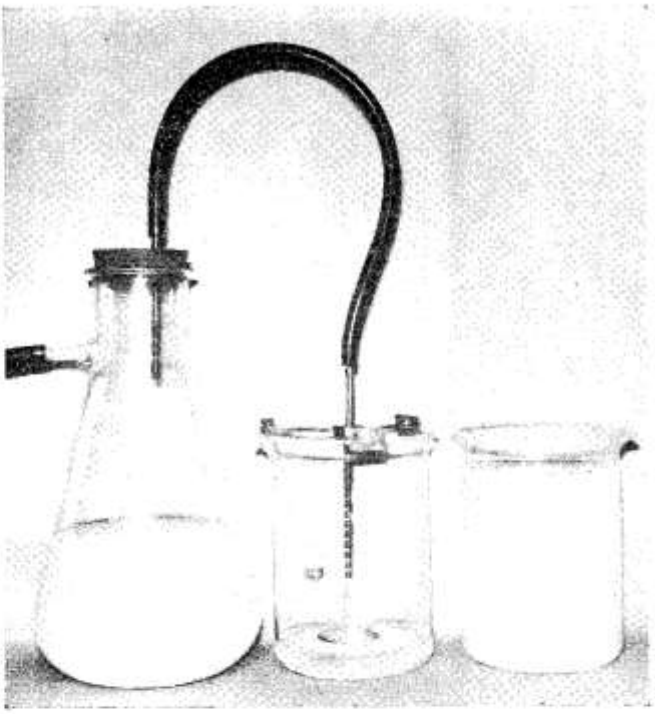

FIG. 2—Decantation apparatus.

GENERAL

Extrapolation to the finer sizes of the portion of the size distribution determined by the Cyclosizer, permits an estimate of the size corresponding to the weight fraction collected as decantation fines, i.e. of the effective decantation cut size. For a typical quartz size distribution this was found to be approximately 5·5 μm. Consequently the whole subsieve sizing operating produces seven separate fractions for assay. Thus for a typical quartz sample these are plus 44, minus 44 plus 33, minus 33 plus 23, minus 23 plus 15, minus 15 plus 10, minus 10 plus 5·5 and minus 5·5 μm respectively. Material balance is excellent.

REFERENCES

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