stress the basket excessively. The product enters centrally and is thrown outwards by centrifugal force and held against the filter cloth. The filtrate is forced through the cloth and removed via the liquid outlet; the solid material is retained on the cloth. The cake can be washed, if required, by spraying water into the centrifuge.

The centrifugal filter has been used for separating crystalline materials from the preparation liquor, e.g. in the preparation of drug crystals, and for removing precipitated proteins from, for example, insulin. It has the advantages of being compact and efficient, a 1 m diameter centrifuge being able to process about 200 kg in 10 minutes. It can also handle concentrated slurries which might block other filters. The spinning action gives a product with a low moisture content (typically around 2% w/w) which saves energy during subsequent drying.

The centrifuge described above is operated batch-wise, but continuous centrifuges are available for large-scale work. These have a means for automatic discharge of the cake from a basket, which rotates around a horizontal axis in contrast to the vertical axis. Most of the energy required to run a centrifuge is used to bring it up to the operating speed and little more is needed to maintain that speed. Continuous centrifuges are therefore cheaper to run but the initial cost is considerably higher.

Tubular-bowl centrifuges (centrifugal sedimenters)

These consist of a cylindrical 'bowl', typically around 100 mm in diameter and 1 m long, that rotates at a high speed, 300–1000 s^{-1}. The product enters at the bottom and centrifugal force causes solids to be deposited on the wall as it passes up the bowl, the clear liquid overflowing from the top (Fig. 25.8). This type of centrifuge can also be adapted to separate immiscible liquids. The inlet rate needs to be controlled so that there is sufficient time for sedimentation to occur before the product leaves the bowl.

The uses of centrifugal sedimenters include:

- liquid/liquid separation, e.g. during antibiotic manufacture and purification of oils from natural sources (e.g. fish oils)

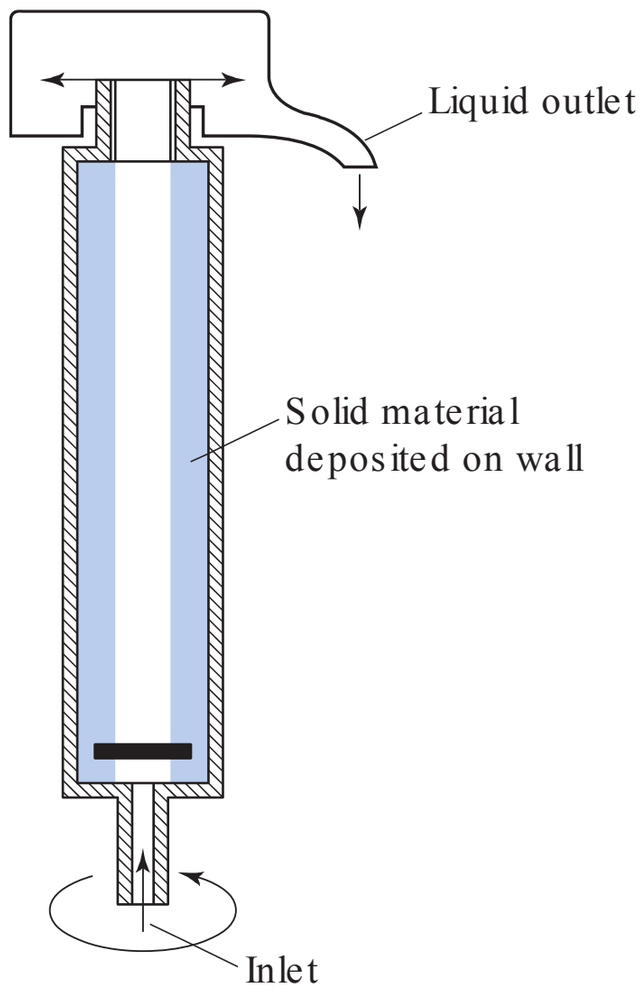

Fig. 25.8 • Tubular-bowl centrifuge.

- the removal of very small particles
- the removal of solids that are compressible or 'slimy' and which easily block filter media
- the separation of blood plasma from whole blood (a *C* of approximately 3000 is required)
- the separation of different particle size fractions
- examining the stability of emulsions.

These centrifuges are compact, have a high separating efficiency and are good for separating 'difficult' solids. However, they have a limited capacity and are complicated to construct in order to achieve the required speed and minimize vibration.

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