

revolutions/second. The propeller stirrer depends for its action on a satisfactory axial and radial flow pattern which will not occur if the fluid is too viscous. There must be a fast flow of fluid towards the propeller which can only occur if the fluid is mobile.

Turbine mixers

A turbine mixer may be used for more viscous fluids and a typical construction is shown in Figure 11.13. The impeller has four flat blades surrounded by perforated inner and outer diffuser rings. The rotating impeller draws the liquid into the mixer 'head' and forces the liquid through the perforations with considerable radial velocity, sufficient to overcome the viscous drag of the bulk of the fluid. One drawback is the absence of an axial component, but a different head with the perforations pointing upwards can be fitted if this is desired. As the liquid is forced through the small orifices of the diffuser rings at high velocity, large shear forces are produced. When mixing immiscible liquids, if the orifices are sufficiently small and velocity sufficiently high, the shear forces produced enable the

generation of droplets of the dispersed phase which are small enough to produce stable dispersions (water-in-oil or oil-in-water). Turbine mixers of this type (homogenizers) are therefore often fitted to vessels used for the large-scale production of emulsions and creams.

Turbine-type mixers will not cope with liquids of very high viscosity since the material will not be drawn into the mixer head. These liquids are best treated as semi-solids and handled in the same equipment as used for such materials (see below).

In-line mixers

As an alternative to mixing fluids in batches in vessels, mobile miscible components may be fed through an 'inline' mixer designed to create turbulence in a flowing fluid stream. In this case, a continuous mixing process is possible.

Mixing of semi-solids

The problems that arise during the mixing of semi-solids (ointments and pastes) stem from the fact that, unlike liquids, semi-solids will not flow easily. Material that finds its way to a 'dead spot' will remain there. For this reason, suitable mixers must have rotating elements with narrow clearances between themselves and the mixing vessel wall, and they must produce a high degree of shear mixing since diffusion mixing cannot occur.

Mixers for semi-solids

Planetary mixers

This type of mixer is commonly found in the domestic kitchen (e.g. Kenwood type mixers) and larger machines which operate on the same principle are used in the pharmaceutical industry (shown in Fig. 11.10). When used for the mixing of semi-solids, they are designed so that there is only a small clearance between the vessel and the paddle in order to ensure sufficient shear. However, 'scraping down' of the bowl is usually necessary several times during a run to mix the contents well, since some materials are forced to the top of the bowl.

Double planetary mixers that move material by rotating two identical blades (either rectangular or helical) on their own axes as they orbit on a common axis are often used for mixing highly viscous

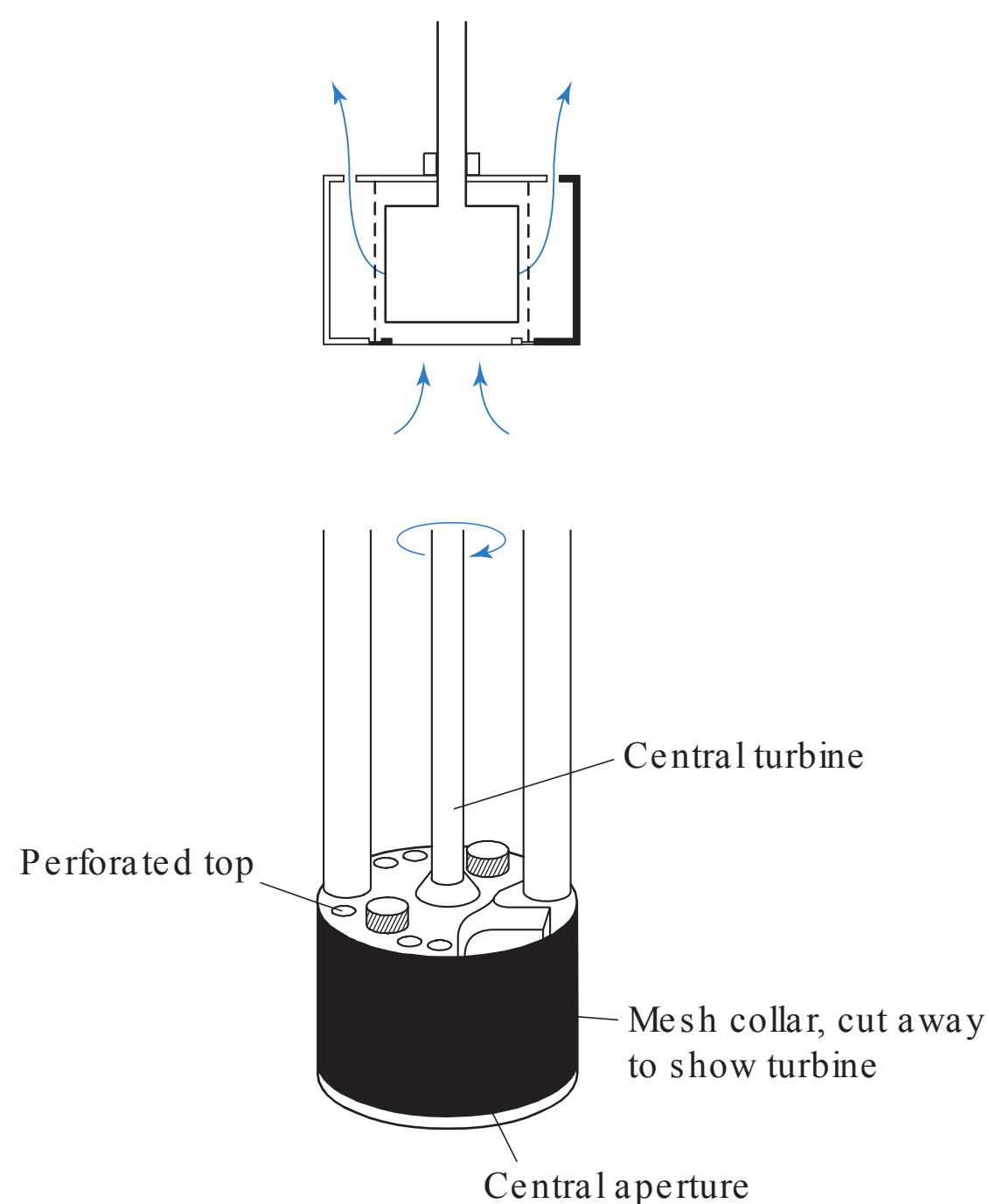


Fig. 11.13 • Turbine mixer.