NEW MACHINES AND EQUIPMENT

COMBINATION DRYER WITH A VORTICAL BED FOR DEWATERING
A SUSPENSION OF MCM COPOLYMER

V. Ya. Lebedev, E. P. Barulin,
V. S. Romanov, and V. N. Kisel'nikov

When producing a copolymer suspension of the sodium salt of methacrylic acid (MCM) a fluidized bed dryer was hitherto being used to reduce moisture from 42-47 to 25-30%. However, when drying at air temperature 110-120°C, caking of the copolymer was noticed and the product adhered to the walls and grid of the equipment necessitating frequent stoppage for cleaning the dryer.

In order to design a more effective and reliable dryer, the Ivanov Chemical Engineering Institute fabricated several designs of dryers with a vortical bed based on the results of innumerable investigations on drying materials with physical and chemical properties. These dryers were intended for dewatering highly moist free-flowing and pasty products [1, 2]. One of these dryers was installed for producing MCM copolymer (Fig. 1). The operation of the equipment is as follows. After separating the copolymer suspension in an NOGSh-type centrifuge, the moist material goes to a storage bunker from which a worm-screw feeder takes it to the first stage cyclone dryer in which it is dried by a jet of gases exiting from the injector. The gases leaving the vortical chambers are cleaned of dust particles which adhere to the wet charge. In order to reduce the adhesion of moist particles to the surface of the apparatus, the upper portion of the cyclone is made conical and the charging hopper placed on top of the chamber (Fig. 2). Such a design and method of feeding help reduce significantly the adhesion of the highly moist material to the walls [3]. The second and third stages are in the form of two countercurrent vortical chambers. The moist product moving against the torsional stream of air heated in heaters exiting from the vortex generator with a dissector in it is dried to the required final moisture level and is discharged from the dryer through a sluice discharger. To improve cyclone operation as a cleaning equipment and the material transport conditions from one stage to another, the chambers with vortical bed are connected with the inlet flange of the cyclone through a blower. The spent air from the dryer goes into the cyclone installed for purposes of dust trapping before being discharged into the atmosphere. The air heated in steam and electric heaters to the required temperature goes to the air-blown dryer.

The absence of a grid, static zones, insignificant residence of the product in the combination unit (up to 15-20 sec), and the high relative velocities of phase movement compared with those in the fluidized bed equipment help raise the air temperature at the dryer inlet to 210-240°C and thus the motive force of heat and mass transfer.

The operational reliability of cyclone and vortical dryers specially for dewatering highly moist material depends on the production quality of the equipment and the cleanliness of the inner surfaces since the dried product and the heat carrier traverse mainly along the walls of the chamber. Also important is the proper selection of auxiliary equipment — feeder, dried product discharging device, and the blower. The operational experience of the dryer showed that the uneven flow of the moist material significantly influenced the final moisture level of the solid particles and hence the charging unit should ensure uniform feeding. For feeding moist material having no thixotropic properties like the MCM copolymer, a worm-screw feeder (with one or two worms) could be used. A sluice feeder type PSh would be useful for discharging the dried product.

The shape and number of channels for introducing the heat carrier are of much significance in designing the vortical chambers as these determine the uniform gas distribution along the section of the apparatus and thus the uniform treatment of the dispersed products. Taking these requirements into consideration, a centrifugal type vortex generator has been designed (Fig. 3). It has leaf guide vanes bent along the radius Rv and positioned between the disk and the ring. Therefore, narrowing channels — nozzles — are formed between the vanes along...
Fig. 1. Combination dryer with a vortical bed: 1) storage bunker; 2) worm-screw feeder; 3) blower, 4) injector, 5, 10) cyclones, 6) vortical chamber, 7) dissector, 8) vortex generator, and 9) sluice discharger.

Fig. 2. Device for charging the moist product into the cyclone: 1) charging hopper, 2) exhaust, 3) cyclone cover, 4) cyclone, 5) injector, and 6) inlet flange.

Fig. 3. Vortex generator: 1) disk; 2) ring, 3) cone, 4) flanged joint, 5) converging tube, and 6) vanes.

the gas flow; further, the heat carrier entering the chamber moves tangential to the apparatus body. The vane radius may be determined from the formula

\[ R_I = 0.5 D_{vg} \frac{D_{vg} + (a - \delta) (a - \delta)}{D_{vg} + 2 (a - \delta) \cos \frac{360}{n}} \]

(1)