extract with alcohol, followed by sodium carbonate or sodium hydroxide. The sodium alginate solution is further separated from the algal residues by employing extensive separation procedures such as sifting, floatation, centrifugation, and filtration. The extracted sodium alginate is recovered by three methods: directly precipitated using alcohol, by alginic acid, and calcium alginate method.

In the alginic acid method, the dilute sodium alginate solution is further treated with mineral acid to form alginic acid, which can be easily separated from water. Then the collected alginic acid can be further treated with alcohol and sodium carbonate to form sodium alginates. In the second process of recovery using calcium salt, the sodium alginate solution is treated with calcium carbonate to form insoluble calcium carbonate fibers. The suspended calcium alginate fibers are then treated with acid to form alginic acid. The formed alginic acid as described in the alginic acid recovery process is further converted to sodium form of alginate by treating with alcohol and sodium carbonate. The sodium alginate recovered from the alcohol is extruded into pellets, dried, and milled to powder form [9, 16].

The soluble salts of alginate, i.e., potassium and ammonium salts, can be produced in a similar manner as that of sodium salt extraction using potassium carbonate and ammonium hydroxide, respectively, during the alkali treatment step. The calcium alginate and alginic acid can be extracted from the appropriate stages of sodium alginate recovery process, and after which the insoluble calcium fibers and alginic acid are thoroughly washed, dried, and milled. Figure 12.1 represents the commercial extraction procedure of various forms of alginates.

Propylene glycol alginate is an ester of alginic acid and has different uses and properties form the sodium alginate. The production of propylene glycol alginate involves reaction of alginic acid (that is partially treated with sodium carbonate) with propylene oxide (Figure 12.2) in a pressurized vessel at 80°C for 2 hours [17].

12.4 Physical, Chemical and Functional Properties of Alginate

The physical and chemical properties of the extracted alginates depend on their chemical composition and structure. Alginates are basically unbranched binary copolymers comprising of (1-4)-linked β-D-mannuronic acid (M) and α-L-glucuronic acid (G) residues, wherein the composition and sequence vary with the source from which they are extracted [9]. The chemical and physical properties of alginates are dependent on the distribution