CHAPTER 7

Elimination of Solid Particles – Especially Leaching of Salts

A solid product is incorporated into a solution of a polymer. The incorporated solid substance must not be dissolved by the solvent used for the polymer. After impregnation, coating or film forming and drying the solid substance is extracted with a non solvent for the polymer [1–5, 13, 14]. At every place that the incorporated product has been, pores are created.

Polymers [7, 57] which are suited are: polyurethanes [40], polyamide [5, 8, 17, 19], soft PVC [10, 12], rubber [9, 51, 54], copolymers of olefinic monomers or their derivatives [6, 16, 30].

This method of leaching salts is mainly used for solutions of polymers. Plastisols [17, 26], which may contain additional solvent [11, 23, 33, 44], can be used in the leaching process too. A plastisol is a suspension of PVC in powdered form in a plasticizer or a mixture of plasticizers.

A special method of leaching is the incorporation of a solid substance in a thermoplastic material on a calender [22–25, 47, 49]. After film forming the substance may be leached out especially under tension. Polyurethanes are especially mentioned [50] for this method.

Thermoplastic polymers, such as PVC plasticizer-plastisols, are treated with a water-soluble substance like sodium chloride, sucrose, PVA, starch, etc. and transformed into a film. Then the material is treated with a swelling solvent, the water-soluble substance is leached, then the foil is heated to eliminate the swelling agent [62].

Polyolefins may be treated with a plasticizer like dioctyl phthalate, transformed into a film, then treated with water to eliminate the plasticizer at least partially. The microporous foils are suited to the filtering or packaging sector [63].

Leaching may also be used for porous adhesive coats [15, 34, 41]. An impregnation of nonwovens [42, 45, 46] or fabrics [56] will become porous after leaching out incorporated substances.

Besides salts like ammonium chloride [22], sodium chloride [36, 42, 43, 48], sodium hydrogen carbonate other electrolytes have been mentioned. Oxides [7] are also suited. Organic substances like caprolactam [59], sugar [16, 42] and urea [42] are suited for a leaching process. Silica particles in PVA films can be leached by lithium, sodium or potassium hydroxide [64].

High molecular products [28, 31, 34, 38] can also be leached according to this method: polyvinyl alcohol [13, 20, 27, 29, 37, 52, 55, 61], polyvinylpyrrolidone (5 [63]), carboxymethyl cellulose [34, 42], powdered cellulose [56] polyacrylate [42, 45] and starch [9, 33, 51, 53]. Sometimes these polymers also assist in the
application of polymers by modifying the viscosity, etc. [60]. The leaching of starch may be assisted by the addition of an enzyme in the leaching bath [51, 53, 70].

PVC-plastisols are mixed with a water-based solution of polyvinyl alcohol to get a water-in-oil emulsion. The emulsion is transformed into a film, heated to gel the PVC and polyvinyl alcohol is leached out afterwards [72].

Natural polymers [59] like starch, casein, or gelatin may be leached in textile jet-dyeing machines by the assistance of sodium sulfosuccinic ester of 2-ethylhexylalcohol as an emulsifier [58]. Clay [24] can also be leached.

Not only powders but also specially formed components like fibers [21, 35, 44, 55] are suited for the leaching process. Water is the mostly used leaching agent. Acids to assist the leaching of carbonates of earth-alkaline metals [56] or emulsifying agents [41] may be added to water. Organic substances like wax may be leached with solvents [18].

To assist the formation of pores, blowing agents may also be added [9, 45]. Thermoplastic compounds like PVC-plastisols are treated with salts, emulsifiers and a polymer, able to build a “channel” in the film. After leaching of the salt a microporous sheet is formed [65].

Borax, which is able to split off water when it is warmed up [32], is also named as an additive.

Leaching may also be used in an indirect process [67]: microporous films can be produced by coating a releasing surface with a salt-containing polyurethane solution in DMF. After evaporating the solvent, transferring the film onto a textile substrate and stripping the releasing surface, salt is washed out. A microporous coating is then produced [69].

A two-component polyurethane mixture with an excess of isocyanate is coated on a releasing surface, then a polyurethane solution in DMF containing a leachable substance is applied. The polyurethane is coagulated and the substance leached. The isocyanate excess in the first coat improves the adhesion of the first to the second coat [68].

Nonporous films of a polyurethane containing keratin or leather powder are treated after application with an enzyme, a protease, to create microporosity [73–75]. After film forming, the incorporated substances are surrounded by the polymer. It is difficult to get the leaching agent into contact with the incorporated substances. Extending and stretching of the films during the process improves the leachability of the incorporated substances – even an electric field may help [5, 9].

Water-based mixtures may also be applied: a polyurethane dispersion and a PVA solution in water are mixed and coated onto a nonwoven textile. After evaporation of the water, polyvinyl alcohol is extracted from the coating which becomes microporous [71].

The leaching technique is also suited for impregnations: Textile substrates may be impregnated with a polyurethane solution in an organic solvent containing 1–20-µ particles of sodium or potassium chloride, sulfate or carbonate. Preferably the solution should contain an alkylene oxide adduct of a phosphorus ester. After evaporating the solvent, the salt is leached [66].

Advantages of the leaching method are that leaching can be broadly used – almost no special equipment is needed, and it is easy to incorporate salts or other