polymer. Nonionic hydrogels show low to medium pH-independent swelling, less swelling dependency on salt, and good mechanical properties (Xue and Hamley 2002).

Despite the fact that functional groups and ions mainly determine the swelling balance of a hydrogel, the amount and type of crosslinker critically affect the swelling properties (Castelli et al. 2000). For a hydrogel with a given hydrophilic/hydrophobic balance value, fewer crosslinkers result in high swelling. The addition of more crosslinks offsets the driving forces for the swelling, and the hydrogel eventually disintegrates at very high crosslinker concentration. This feature has been utilized in making superdisintegrants, which are used to disintegrate tablet and capsule pharmaceutical dosage forms. Swelling is improved with bifunctional crosslinkers as opposed to tri or more functional crosslinkers. As cross-linking and functionality increases, the hydrogels become more stiff and rigid. While the solid part of the composite controls the swelling forces and pressure, the other two phases, water and air, significantly improve the swelling kinetics.

The water component in the dry composite is bound water that comes from the synthesis step. Generally, the amount of the bound water is about 1–5% and cannot be removed during the drying process; however, freeze-drying the hydrogels can minimize the water. Water can affect the composite properties positively by plasticizing the polymer, which expedites the initial swelling or diffusion process. A negative effect of water is that it reduces the molecular interactions between the polymer chains and the rigidity of the composite. Water can also facilitate hydrolysis and oxidation reactions during hydrogels storage. The air component in the composite facilitates the diffusion of external materials into the polymer structure by reducing the intermolecular interactions between the polymer chains. As shown in Fig. 18 with highly porous superabsorbent hydrogels the interconnected pores provide a rapid diffusion by increasing the capillary action of the transport process.

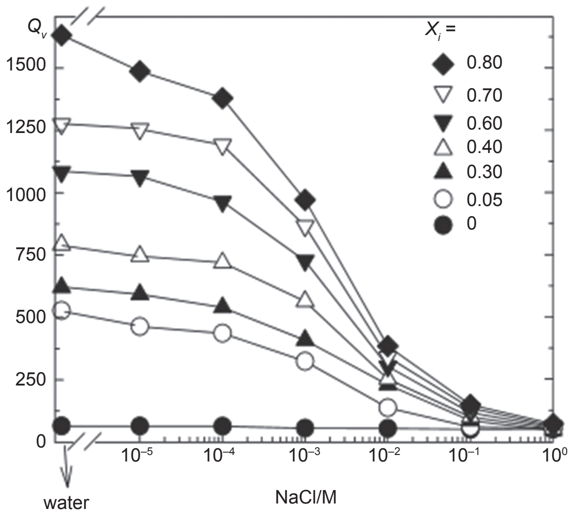

Fig. 17. Swelling of the ionic PAAm hydrogels of various charge densities and in different aqueous NaCl solutions (Durmaz and Okay 2000).