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TSS Water Course

Module 8

Electro-Deionization

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Module 8
ELECTRO-DEIONIZATION

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8.1 Fundamentals

Electro-Deionization, or EDI, is a process that evolved from conventional ion exchange technology. EDI provides continuous demineralization at recovery rates of 90% or more. In EDI, just as in conventional ion exchange, cations and anions in the feed water are exchanged for hydrogen and hydroxyl ions in the ion exchange resins, producing demineralized water. The key operational difference is that with EDI, the ion exchange resin is regenerated continuously, while with conventional ion exchange, chemical regeneration is performed intermittently.

Continuous regeneration in EDI is achieved electrochemically, by means of ion conducting membranes and an imposed electric current. The hydrogen and hydroxyl ions necessary for regeneration are formed in-situ, without addition of chemical reagents, by means of the familiar water dissociation reaction, sometimes called water splitting. **Figure 8.1-1** is an illustration representing a water molecule splitting into hydrogen and hydroxyl ions.

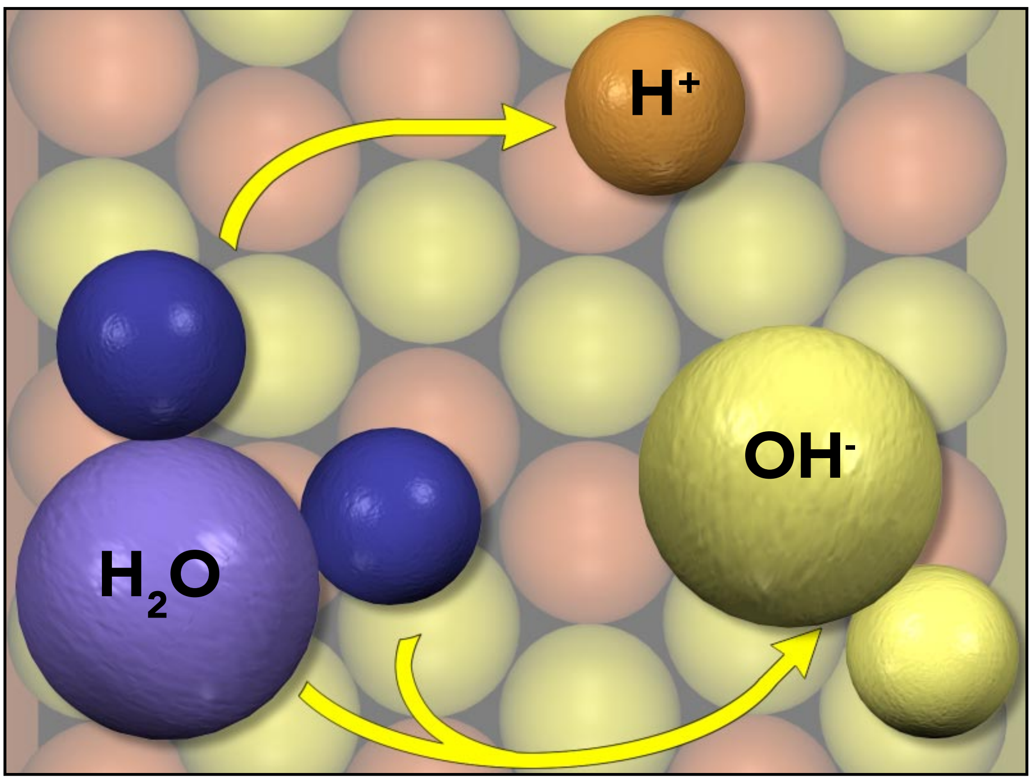

Figure 8.1-1: Water Molecule Splitting

To understand how Electro-Deionization (EDI) removes ions from water, we need to understand the components of an EDI stack and the function of each. An EDI stack consists of multiple beds of ion-exchange material sandwiched with membrane walls and open channels between two electrodes.

The two electrodes are located at opposite ends of the stack, as seen in **Figure 8.1-2**. These electrodes supply an electric current to the water flowing inside the cells. One of these electrodes is the cathode. It is negatively charged and is a source of electrons. The cathode attracts cations (positively charged ions).

The second electrode is the anode. This electrode is positively charged and attracts anions (negatively charged ions). This attraction occurs because opposite charges attract and like charges repel. Therefore, a negatively charged cathode attracts positively charged ions, and a positively charged anode attracts negatively charged ions.

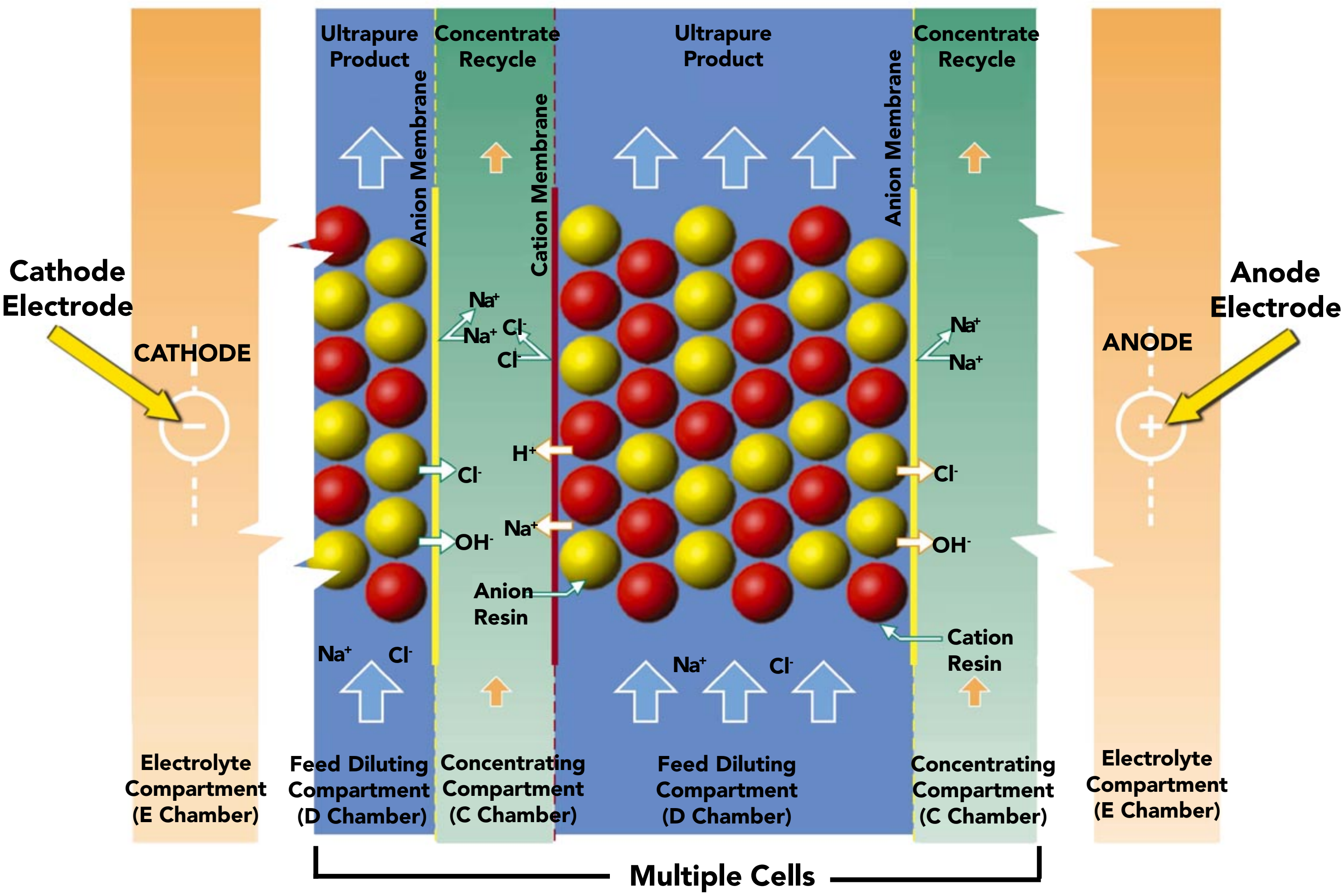

Figure 8.1-2: View of an EDI Cell with Electrodes Indicated

The next items we need to notice are the membranes that separate the chambers. **Figure 8.1-3** below shows an EDI stack with the membranes highlighted. There are two types of membranes: anion membranes and cation membranes. Using the same reasoning used for the electrodes, the anion membranes allow only negatively charged ions (anions) to permeate, and the cation membranes allow only the positively charged ions (cations) to permeate. Water does not permeate these membranes.

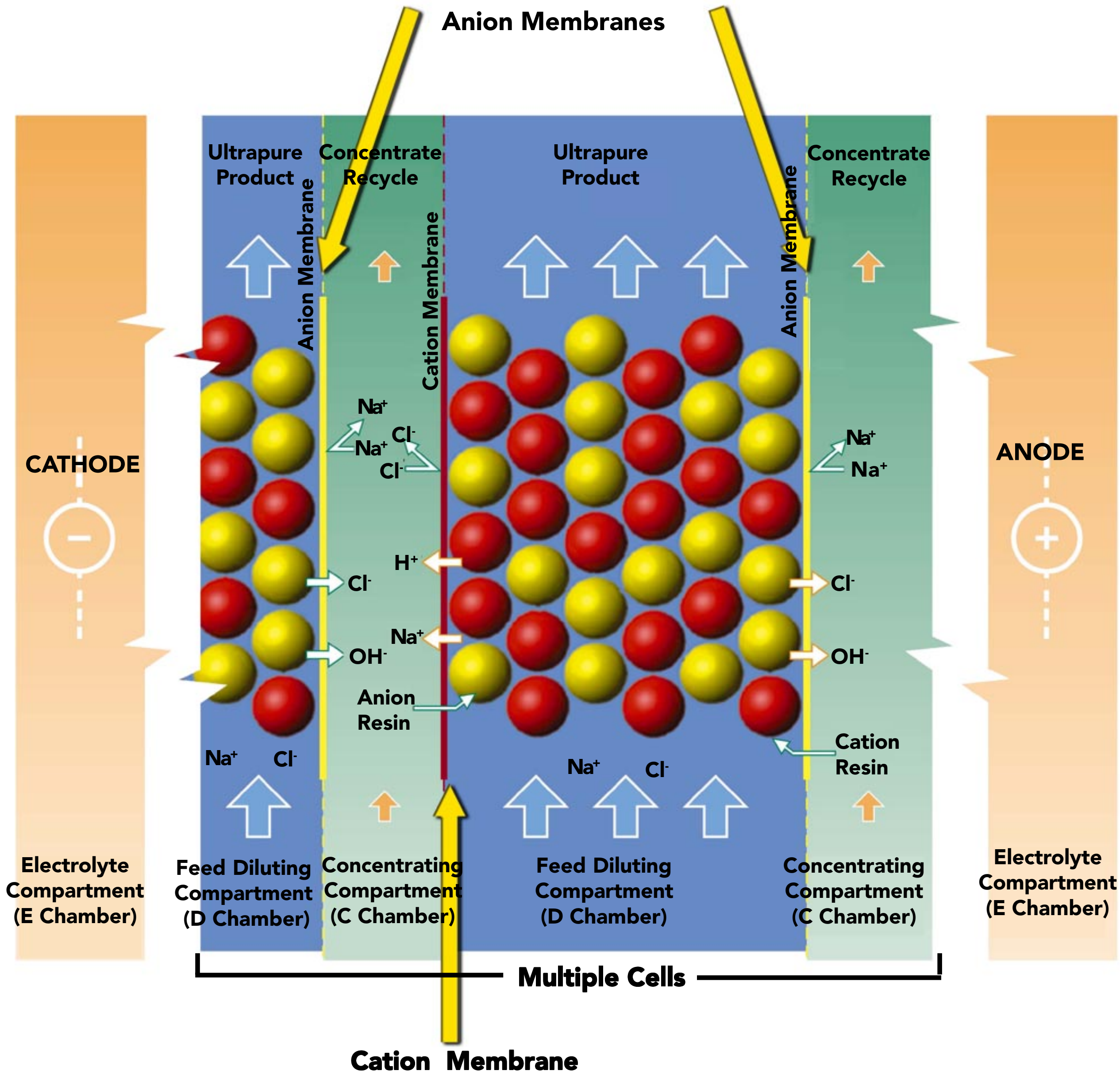

Figure 8.1-3: View of an EDI Cell with Membranes Indicated

The membranes are situated so that they become the walls that separate chambers. There are three types of chambers; the Dilute or "D" chambers, the Concentrate or "C" chambers, and the Electrolyte or "E" chambers. **Figure 8.1-4** shows an EDI stack with the three different types of chambers indicated.

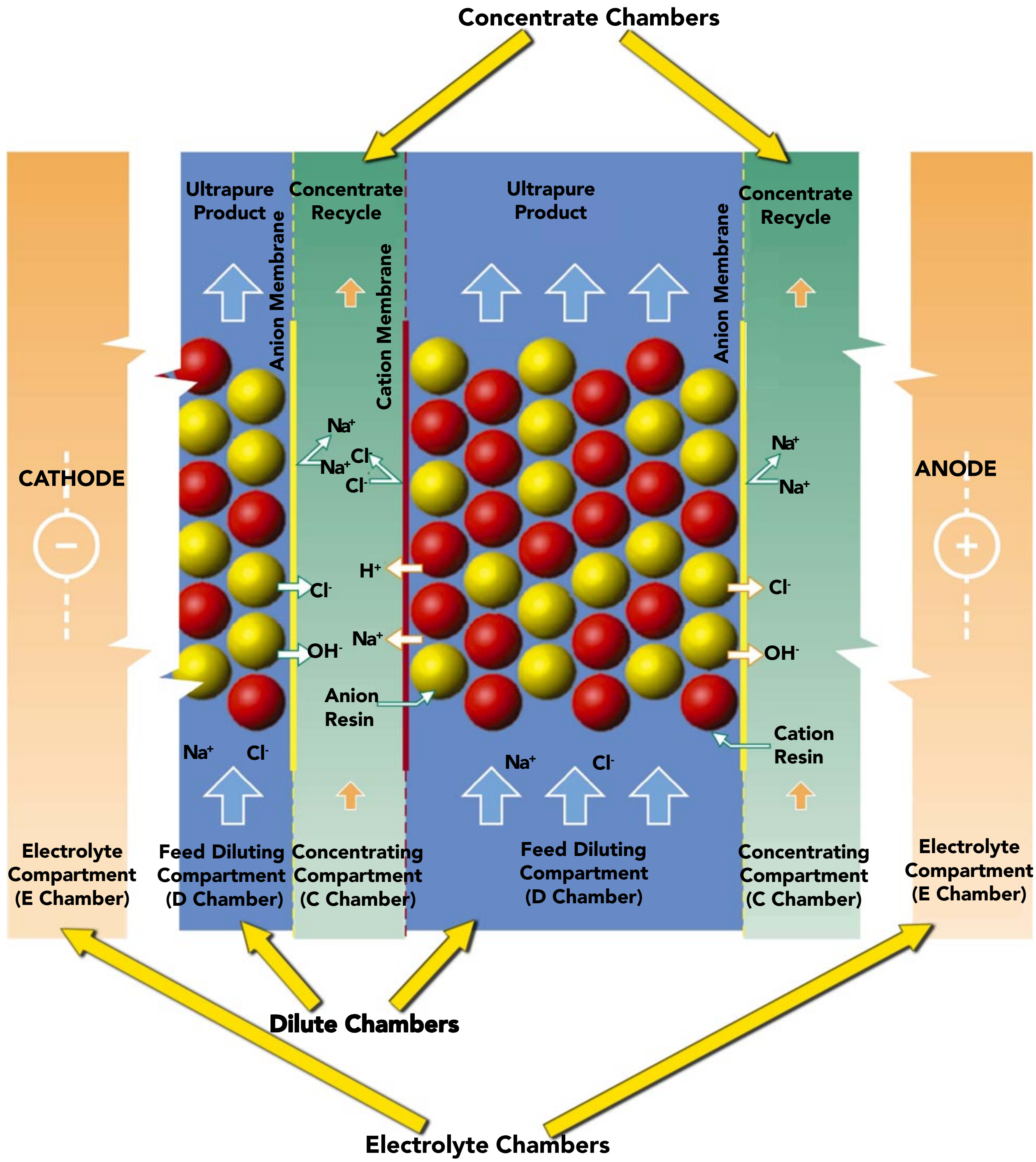

Figure 8.1-4: View of an EDI Cell with Chambers Indicated

Water to be treated is fed into the Dilute or "D" chamber. This chamber contains a resin bed that consists of cation and anion beads compressed between an anion membrane and a cation membrane. These resin beads allow the ions to adsorb into the respective beads and travel through the beads toward the membranes.

Once contaminant ions pass through the membranes, they are in the Concentrate or "C" chamber. Ions are swept away by a recirculating flow (the concentrate loop) which has a bleed to prevent an excessive buildup of ions, and a corresponding makeup flow to introduce more fresh water. **Figure 8.1-5**, below, shows a graphic of an EDI stack with the concentrate loop highlighted.

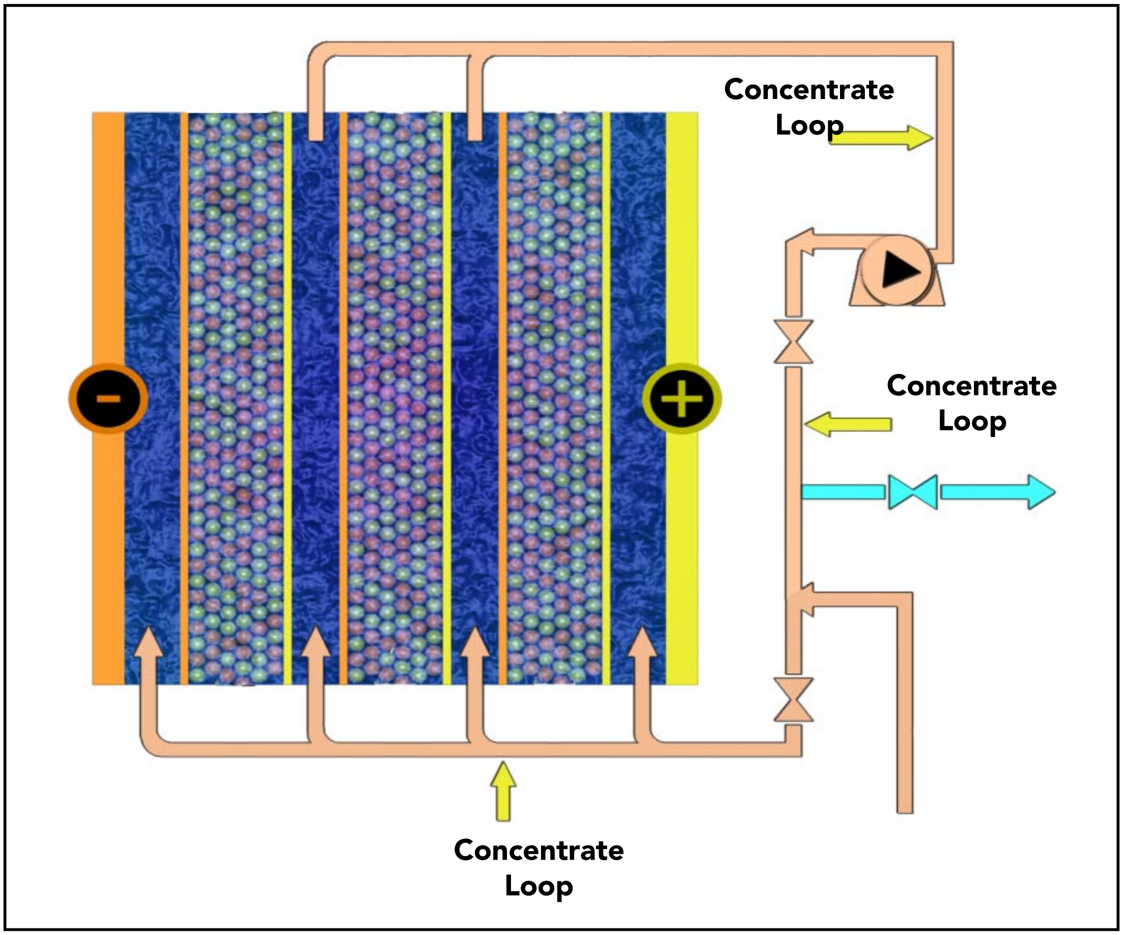

Figure 8.1-5: Graphic of an EDI Stack with the Concentrate Loop Highlighted