

Why Should You Use a Higher Cross-Linked Resin?

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Session Outline

- ▶ Resin Structure and Chemistry
- ▶ Gel vs. Macroporous Resin
- ▶ Economical Chlorine Resistance
- ▶ Q & A



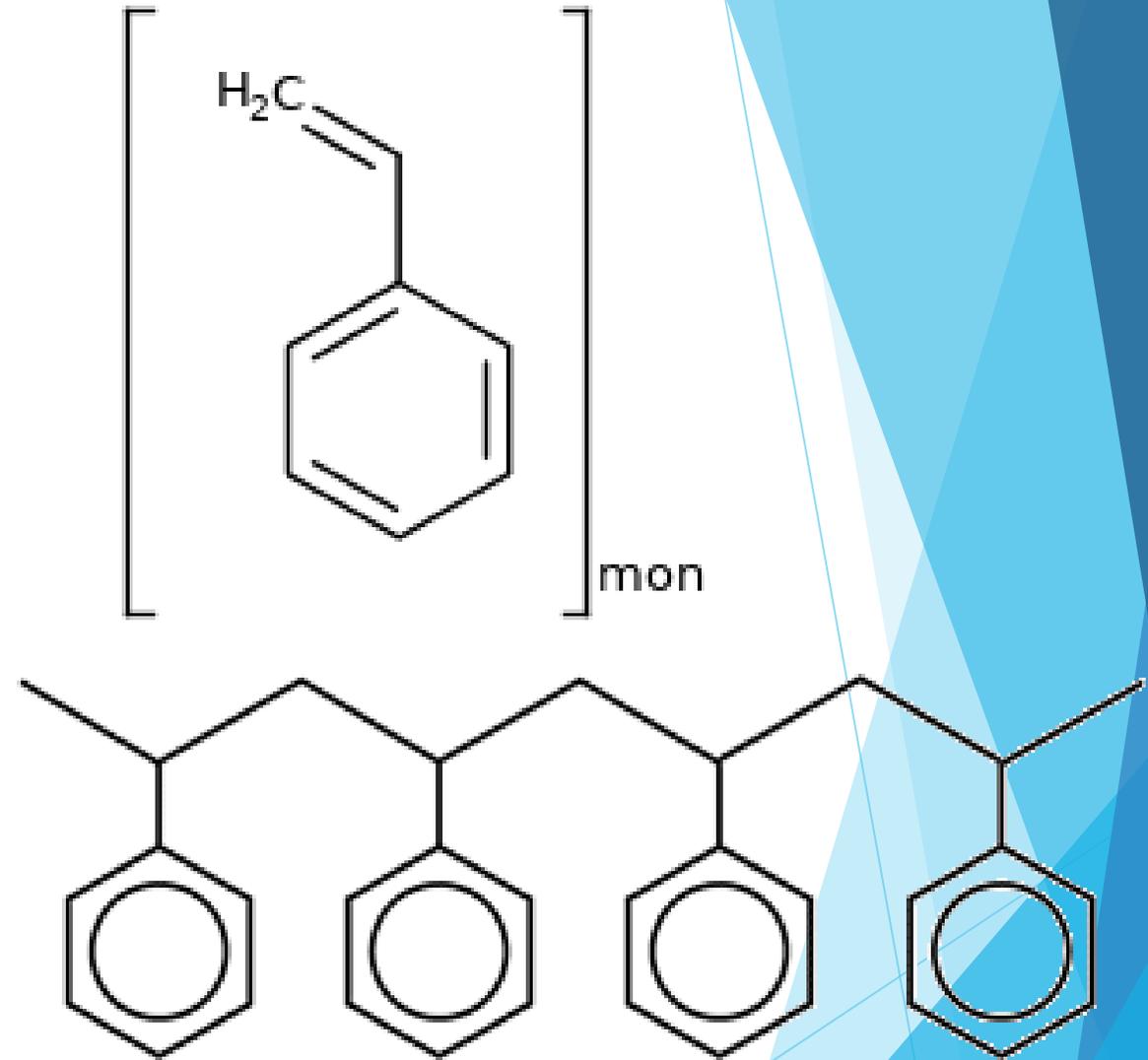
What is Resin?

- ▶ Resin is a synthetic polymer media used to exchange ions in many chemical applications including water treatment.
 - ▶ Most common = Softening
- ▶ This process is heavily influenced by the internal chemical structure of the resin.



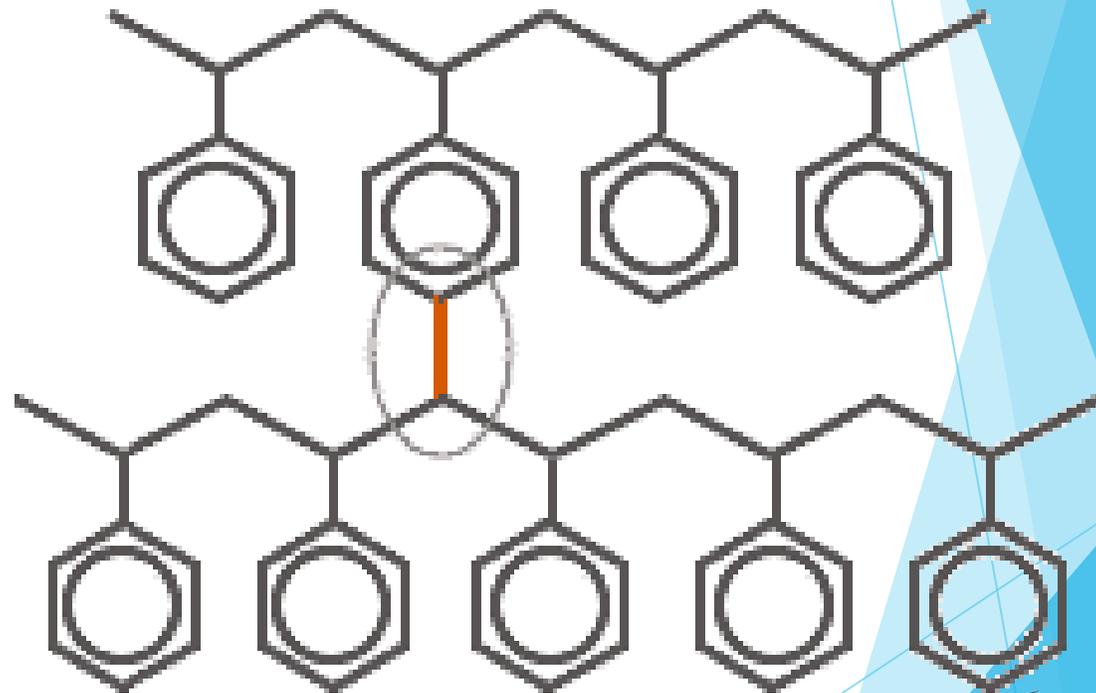
How is resin made?

- ▶ The resin manufacturing process begins with styrene molecules that are polymerized into long chains.
- ▶ The resulting “globules” are stirred and broken into small droplets.



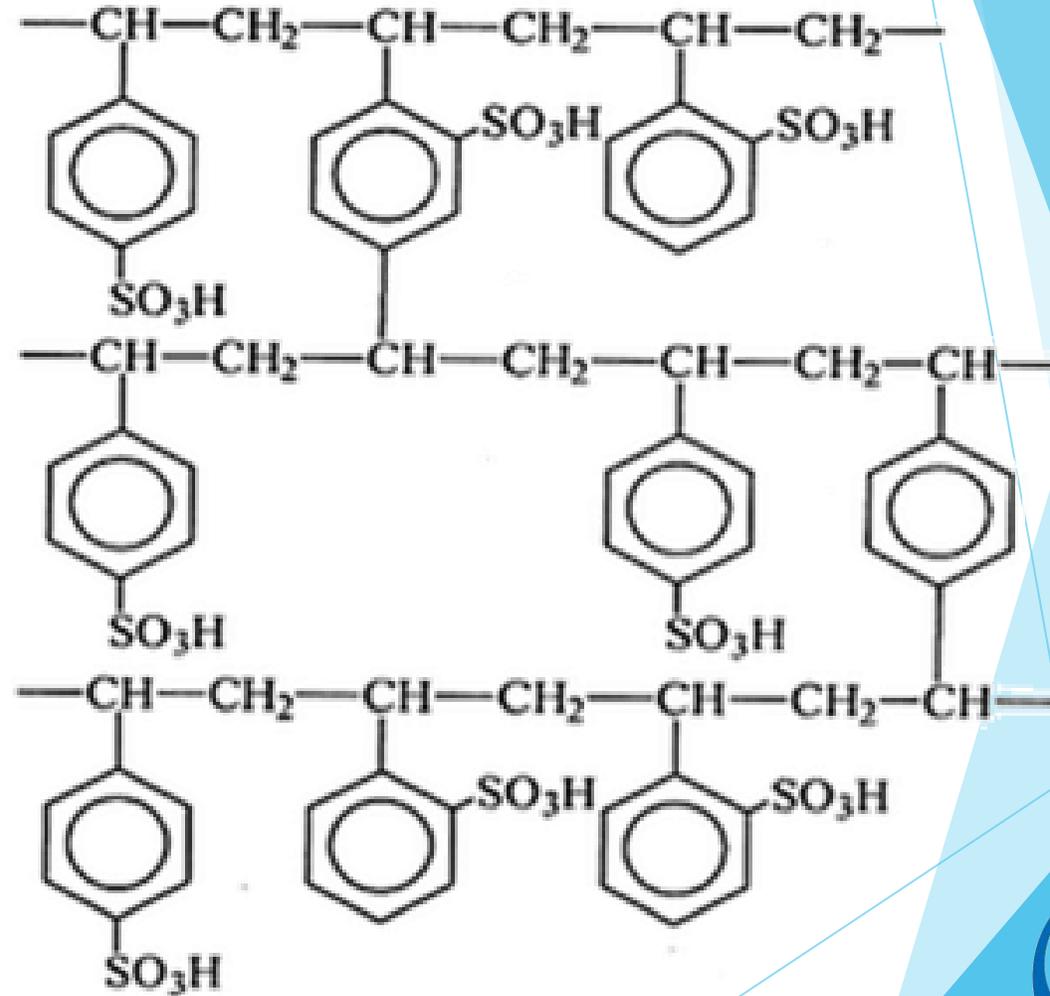
How is resin made?

- ▶ To build the resin's internal structure, divinylbenzene (DVB) is added in an exothermic reaction forming small plastic beads.
 - ▶ 2% - 20% is the DVB range for most resins.
- ▶ This is the Cross-linking that gives the beads strength.
- ▶ Higher DVB beads are resistant to shrinking and swelling.



How is resin made?

- ▶ At this point the resin is only a small inert plastic bead and must be chemically formed into either a cation or anion resin.
- ▶ In the case of softening, a cation resin must be made by attaching a negative functional group to the resin's molecular structure.
- ▶ These functional groups form the "Active Exchange sites" for ions in solution.



Ion Exchange Bead Requirements

- ▶ Insoluble
- ▶ In the form of spheres vs. irregular shape in order to guarantee a “void volume” within the resin bed to facilitate flow.
- ▶ Resistant to fracture controlled by the swelling during exhaustion and regeneration.
- ▶ Active sites must be permanently attached.





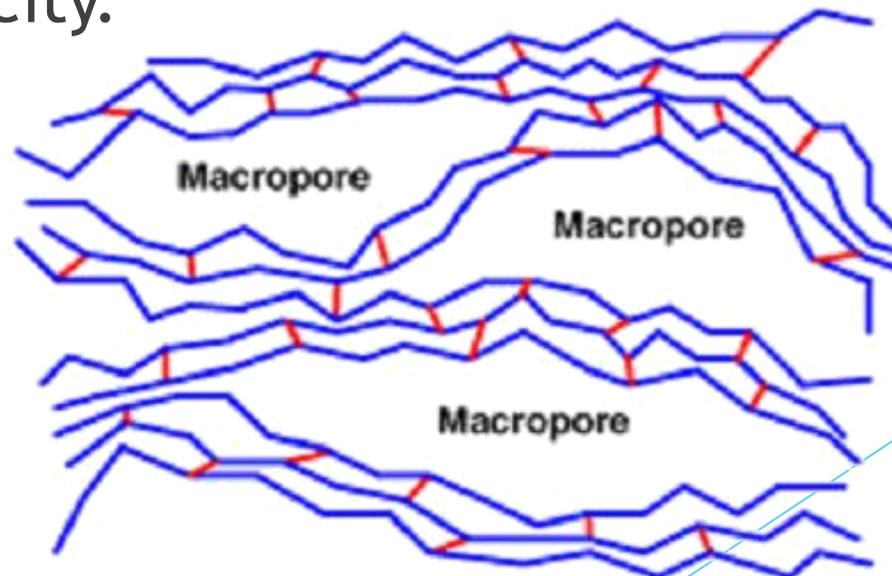
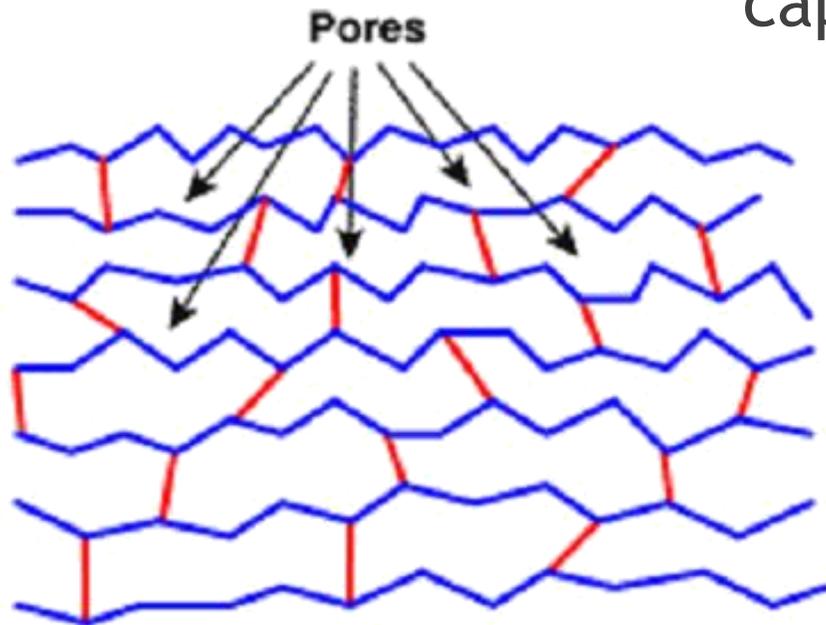
Gel Resin

- ▶ Most common resin available.
- ▶ Exchange sites distributed evenly through bead.
- ▶ 10% of the resin's exchange capacity is found on the surface.
 - ▶ 90% is within the bead
- ▶ 8% is most common DVB content.



Macroporous Resin

- ▶ A sponge like structure Allows:
 - ▶ High level DVB without affecting kinetics.
 - ▶ Increases bead toughness.
 - ▶ Large pores allow capture of large molecules.
- ▶ Bead contains less exchange sites contributing to lower capacity.
- ▶ Pores take up to 10% - 30% of the capacity.



Gel vs. Macroporous

Gel

- ▶ Higher operating efficiencies
- ▶ Less costly

Macroporous

- ▶ Better physical stability
- ▶ Eliminates breakage from osmotic stress
- ▶ More resistant to organic fouling
- ▶ Better oxidation resistance
 - ▶ Chlorine



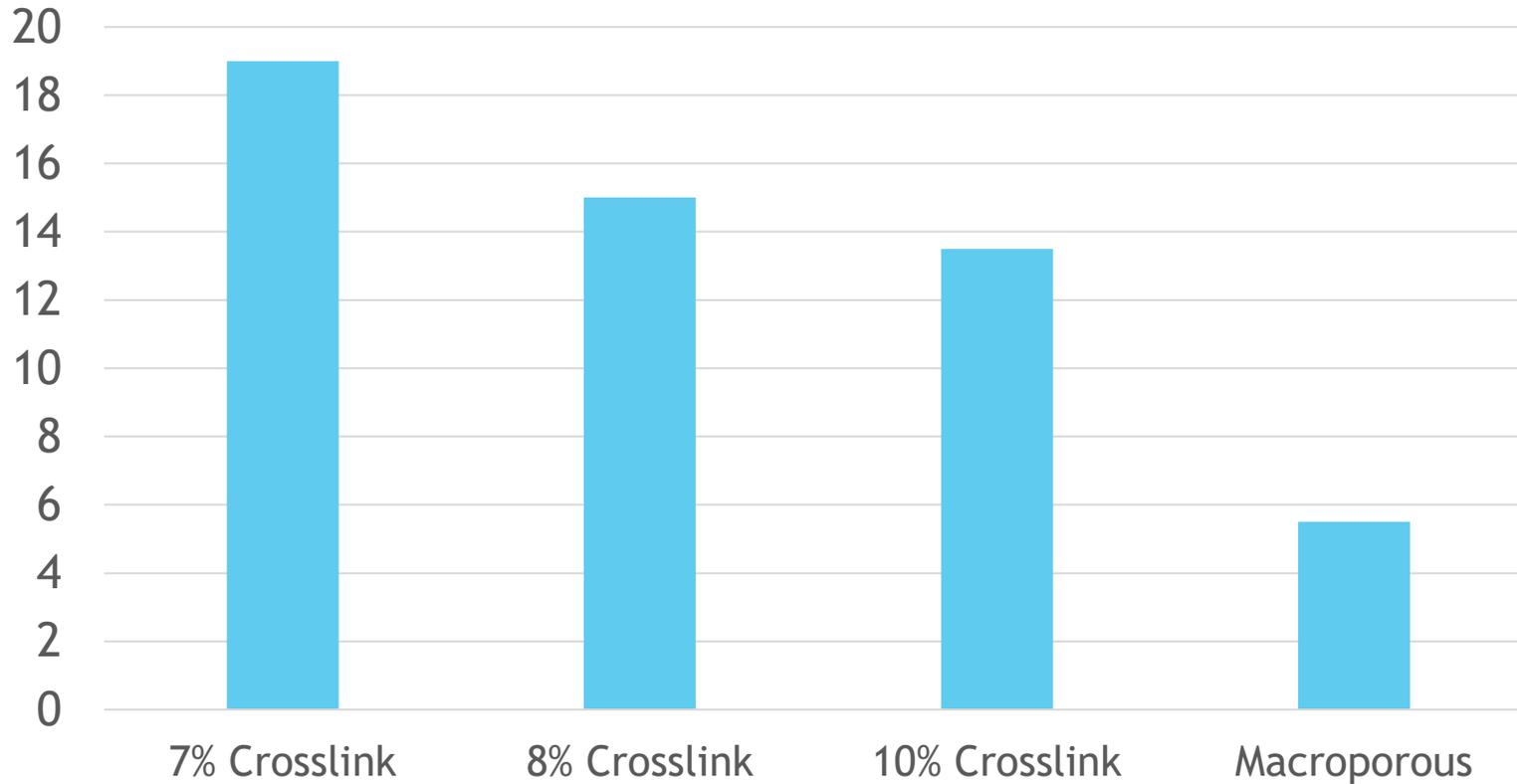
Why use higher cross-linked resins?

- ▶ Higher cross-linked (XL) resins have greater resistance to oxidative attack.
 - ▶ Any oxidant: Chlorine, Chloramine, Ozone, Peroxide, Bleach.
- ▶ Higher XL resins will last longer in water with elevated levels of oxidant.
- ▶ Higher XL resins are more efficient at removing tannins, color, organics, TOC



Ion Exchange Basics

Percent Moisture Increase



**Accelerated
Oxidation
test:**

**6% H₂O₂
1,000 ppm
Fe Na Form**

**4 hrs. of
vigorous
agitation**



Affect of Oxidants on resin life?

- ▶ Rule of thumb: Influent oxidant level <1 ppm for normal life is 6-8 years for an 8% XL resin.
- ▶ Every 1 ppm increase, resin life cut in $\frac{1}{2}$
 - ▶ < 1 ppm = 6-8 years
 - ▶ 2 ppm = 3-4 years
 - ▶ 3 ppm = 1.5 - 2 years
 - ▶ 4 ppm = 9 - 12 months
 - ▶ 5 ppm = 5-6 months



Case Study: Oxidant level vs. Resin life?

- ▶ Study was performed using a 1 cu.ft. softener in a home.
- ▶ Influent oxidant level: 5 ppm
- ▶ 8% gel, 10% gel, and Macroporous resin tested.
- ▶ Rule of thumb: Expect 6 months @ 5 ppm
- ▶ Resin replaced when flow (& pressure drop) problems persisted.



Resin Choice vs. Relative Cost

Relative Performance:

- ▶ 8% gel lasted 8 months
- ▶ 10% gel lasted 3 years
- ▶ MP lasted 5 years

Relative Cost:

- ▶ 8% gel = “\$X” per cubic foot
- ▶ 10% gel = “\$1.2X” per cubic foot
- ▶ MP = “\$2.0X” per Cubic foot



Case Study: Economics Over 10 Years

- ▶ 8% gel costs “X” and lasted 8 mo. means the home-owner replaces resin 15 times in 10 years.
 - ▶ Cost = 15 X
- ▶ 10% gel costs “1.2X” and lasted 3 years. means the home-owner replaces resin 3.3 times in 10 years.
 - ▶ Cost = 4 X
- ▶ Macroporous costs “2X” and lasted 5 years. means the home-owner replaces resin 2 times in 10 years.
 - ▶ Cost = 4 X



Why use a higher cross-linked resin?

- ▶ Using any higher cross-linked resin is more economical for home-owner in long run.
- ▶ Much lower frequency of resin change-out.
- ▶ This does not account for service costs.

Questions?



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