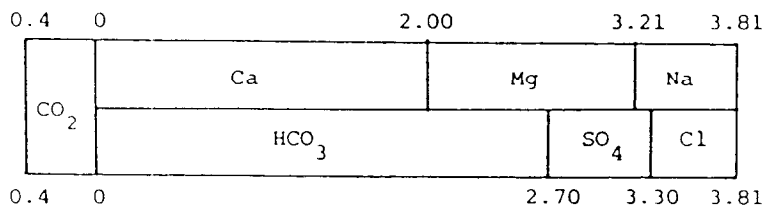


11.20 The water defined by the analysis given below is to be softened by excess lime treatment. (a) Sketch an meq/l bar graph. (b) Calculate the softening chemicals required. (c) Draw a bar graph for the softened water after recarbonation and filtration assuming 80% of the alkalinity is in the bicarbonate form.

$\text{CO}_2 = 8.8 \text{ mg/l}$        $\text{Alk}(\text{HCO}_3^-) = 135 \text{ mg/l}$   
 $\text{Ca}^{2+} = 40.0 \text{ mg/l}$        $\text{SO}_4^{2-} = 29.0 \text{ mg/l}$   
 $\text{Mg}^{2+} = 14.7 \text{ mg/l}$        $\text{Cl}^- = 17.8 \text{ mg/l}$   
 $\text{Na}^+ = 13.7 \text{ mg/l}$

11.20     $\text{CO}_2 = 8.8/22.0 = 0.40 \text{ meq/l}$   
            $\text{Ca} = 40.0/20.0 = 2.00$                $\text{Alk} = 135/50.0 = 2.70$   
            $\text{Mg} = 14.7/12.2 = 1.21$                $\text{SO}_4 = 29.0/48.0 = 0.60$   
            $\text{Na} = 13.7/23.0 = 0.60$                $\text{Cl} = 17.8/35.5 = 0.51$



| Component                          | meq/l | Lime        | Soda ash    |
|------------------------------------|-------|-------------|-------------|
| CO <sub>2</sub>                    | 0.40  | 0.40        | 0           |
| Ca(HCO <sub>3</sub> ) <sub>2</sub> | 2.00  | 2.00        | 0           |
| Mg(HCO <sub>3</sub> ) <sub>2</sub> | 0.70  | 1.40        | 0           |
| MgSO <sub>4</sub>                  | 0.51  | <u>0.51</u> | <u>0.51</u> |
|                                    |       | 4.31        | 0.51        |

Lime required =  $4.31 \times 28 + 35 = 156 \text{ mg/l CaO}$

Soda ash required =  $0.51 \times 53 = 27 \text{ mg/l Na}_2\text{CO}_3$

