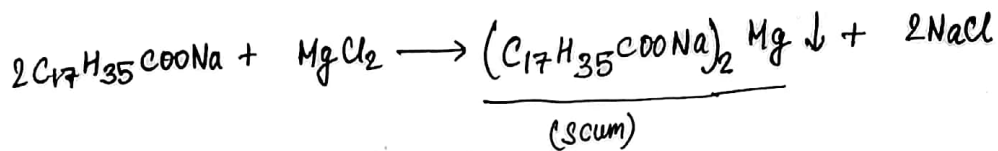


## Ch- Water and its treatment

sources :-

- (I) Surface
- (II) Underground
- (III) Rain
- (IV) Sea

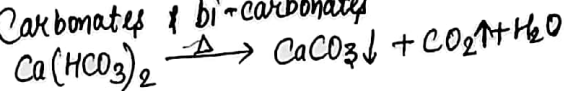
Hardness of water  $\rightarrow$  Soap consuming capacity of water



\* Temporary Hardness :-

~~Chlorides and Sulphates~~

Carbonates & bi-carbonates



\* Permanent Hardness :-

Chlorides and Sulphates

$$\text{Hardness} = \text{Mass of hardness producing substance (mg/L)} \times \frac{\text{Chem. Eqv. of } CaCO_3}{\text{Chem. Eqv. of hardness producing substance}}$$

Q: The water sample 403 mg of  $CaSO_4$  per litre. Calculate the hardness in terms of ~~of  $CaCO_3$  eqv.~~  $CaCO_3$  eqv.

Soln:

Q How many grams of  $MgCO_3$  dissolve per litre gives 84 ppm of Hardness.

Soln

$$84 = m \times \frac{50}{84}$$

$$m = 84$$

\* Disadvantage of Hard water:-

i) Domestic:-

(a) Scum formation results in more soap consumption.

(b) Cooking needs more fuel

ii) Industrial:-

(a) Boiler corrosion

(b) Scale & Sludge

(c) Priming and foaming

(d) Caustic Embrittlement

(b) Scale and Sludge :-

Ionic product  $>$  solubility product  $\Rightarrow$  precipitate formation.

\* Factors:-

•  $Ca(HCO_3)_2 \rightarrow$

• Deposition of  $CaSO_4$

• Hydrolysis of Mg-salt

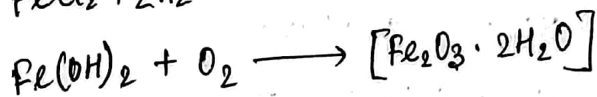
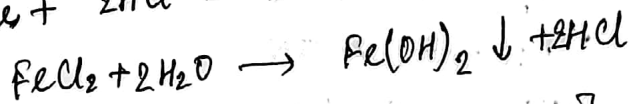
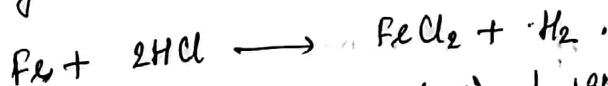
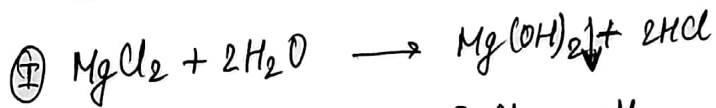


## \* Method to prevent scale and sludge :-

- External method
- Internal method — Add some ~~resistant~~ substance inside the boiler.  
Carbonates, phosphates, Calgon conditioning.

(a) Boiler corrosion :- Decay or disintegration of boiler material either due to chemical reactions or electrochemical reactions with its environment.

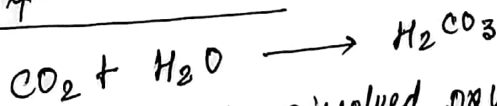
### • Factors :-



(II) Presence of D.O.

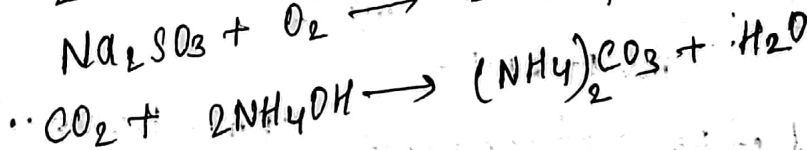
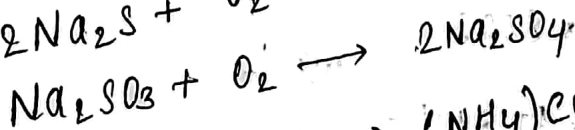
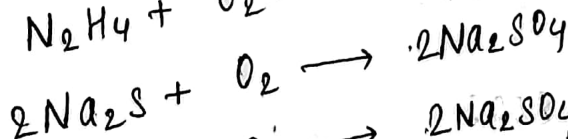
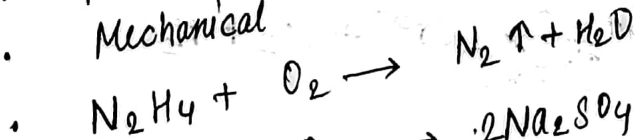


(III) Presence of  $\text{CO}_2$  :-



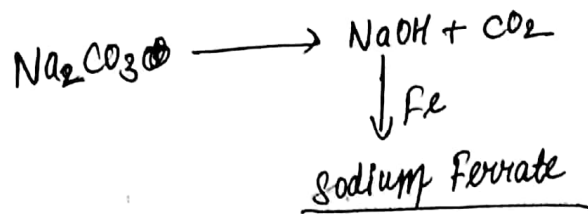
\* Methods to prevent Dissolved oxygen :-

- Pre heating
- Mechanical



#### (d) Caustic Embrittlement :-

It is the phenomenon during which the boiler metal becomes brittle due to accumulation of caustic ~~substances~~ substances. This type of corrosion is caused by the use of highly alkaline in high pressure boiler.



#### \* Factors :-

(I) Tannin or Lignum.

(II) Sodium phosphate

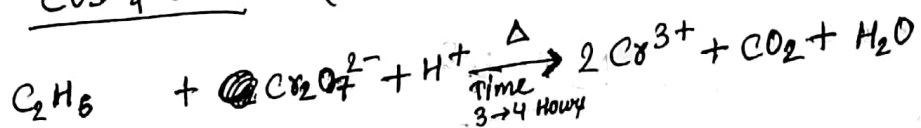
(III)  $\text{Na}_2\text{SO}_4$

$$\frac{[\text{Na}_2\text{SO}_4]}{[\text{NaOH}]} = \begin{cases} 1:1 \longrightarrow 10 \text{ atm} \\ 2:1 \longrightarrow 20 \text{ atm} \\ 3:1 \longrightarrow 20 \text{ atm} \end{cases}$$

#### \* Methods to prevent caustic embrittlement :-

- I) Lime soda process
- II) Zeolite
- III) Ion-exchange
- IV) COD & BOD

#### iv) COD & BOD :- (Chemical O



$$\text{COD} = \frac{(A-B) \times M \times 8000}{\text{ml of sample}} \text{ mg/L}$$

A = ml of FAS req<sup>d</sup> for Blank

B = " " FAS " " Sample

M = Molarity of FAS

(FAS = Ferrous Aluminium Sulphate)

\* BOD

{ Specific temp.  
aerobic condition  
time of incubation

$$COD > BOD$$

$$\begin{aligned} COD &= \text{Total oxidisable ion} \\ &= \text{Bio-degradable ion} + \text{Non-biodegradable ion} \\ &= BOD + x \end{aligned}$$

$$\therefore \underline{COD > BOD}$$

$$\frac{COD}{BOD} > 1$$

\* When  $\frac{COD}{BOD} = 1 \rightarrow$  all <sup>ions</sup> are bio-degradable ions

$$i) BOD_5 = \frac{(DO_i - DO_f)}{p} \text{ mg/L}$$

~~p~~ p = dilution factor  
 $p = \frac{\text{volume taken}}{300}$

$$ii) BOD_5 = \frac{(DO_i - DO_f) - (1-p)(Bi - Bf)}{p} \text{ mg/L}$$

$$iii) BOD_t = L_0 (1 - e^{-Kt})$$

$$iv) K_T = K_{20} \theta^{(T-20)}$$

$$\theta = 1.054$$

Q.1 If the initial D.O. and D.O. after 5 days incubated at 20°C in 1% dilution sample is 5 and 4 mg/L respectively. Determine the  $BOD_5$  of sample.

Q.2 If  $BOD_5$  of a waste water sample measured at 20°C is 250 mg/L, rate constant  $K$  is  $0.35 \text{ d}^{-1}$ . Calculate its ultimate B.O.D. and  $BOD_3$ .

Q.3 If  $BOD_5$  of a sample measured at 20°C is 250 mg/L, determine the  $BOD_3$  of the sample. Assuming BOD rxn rate constant  $K$  is  $0.23/\text{day}$ .

1.

$$BOD_5 = \frac{(5-4)}{0.01} = 100 \text{ mg/L}$$

2.

$$BOD_5 = L_0(1 - e^{-0.35 \times 5})$$

$$\Rightarrow 250 = L_0(1 - e^{-0.35 \times 5})$$

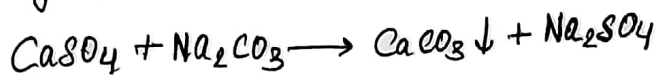
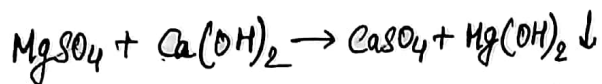
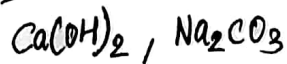
$$\Rightarrow L_0 = \underline{\hspace{2cm}}$$

$$BOD_3 = L_0(1 - e^{-0.35 \times 3})$$

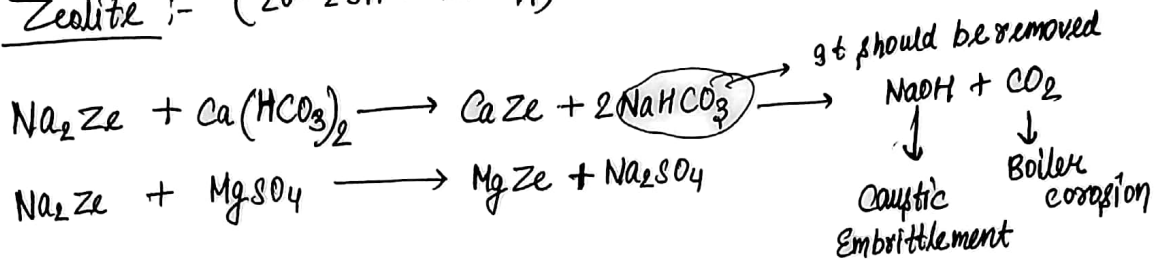
$$= \underline{\hspace{2cm}}$$

3.

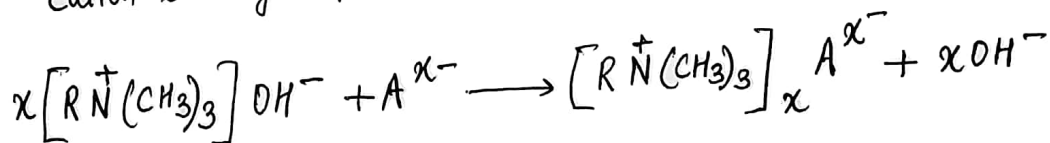
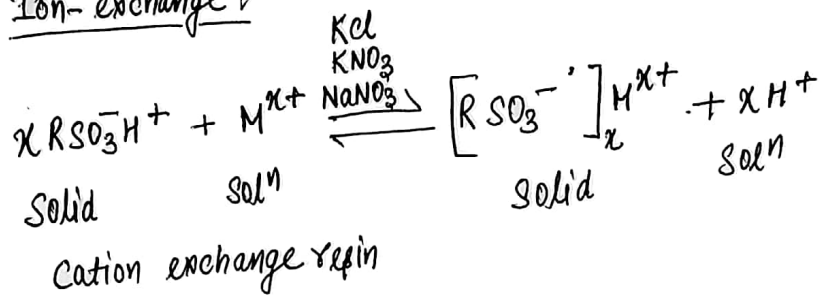
### i) Lime-Soda



### ii) Zeolite :- (20-25 ppm hardness)



### iii) Ion-exchange :-



Anion exchange resin

