

# Process Design Technical Note

## TECHNICAL NOTE

### CARBON DIOXIDE SCRUBBING

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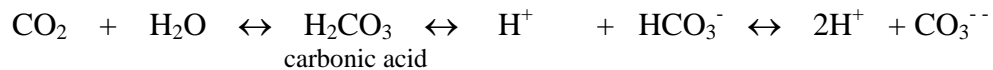
## 1.0 Carbon Dioxide Scrubbing

Atomic weight        44.01  
 Boiling point        -78.5 °C

### 1.1 Reactions of Carbon Dioxide

#### 1.1.1 Dissolution

The rate at which carbon dioxide comes into equilibrium with carbonic acid and its dissociation products is measurably slow.



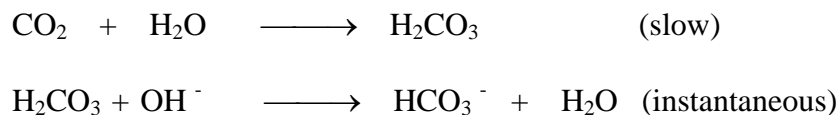
**Solubility** in water at 760mm Hg pressure:

3.35 g/l @ 0°C
2.32 @ 10°C
1.69 @ 20°C
1.26 @ 30°C
0.98 @ 40°C
0.02 @ 50°C

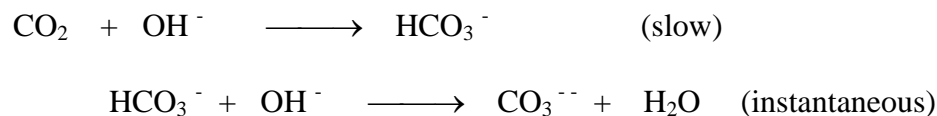
#### 1.1.2 Neutralisation

The neutralisation of CO<sub>2</sub> occurs by two paths.

**For pH <8**

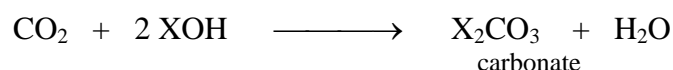


**For pH >10**



In the range pH 8 – 10 both reactions are important.

#### 1.1.3 Scrubbing



This is the principal reaction provided the pH of the scrubbing liquor is kept above pH10.

#### 1.1.4 Caustic solutions

The reaction outlined above take place with NaOH and KOH (X = Na, K).

## 1.1 Reactions of Carbon Dioxide(Cont.)

### 1.1.5 Solubilities

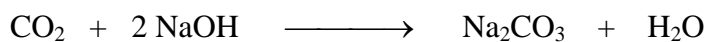
	Solubility in water				
	g/l				
	10°C	20°C	30°C	40°C	50°C
Na <sub>2</sub> CO <sub>3</sub>	ca.110				ca.144
NaHCO <sub>3</sub>	81.5	96	111	127	144.5
K <sub>2</sub> CO <sub>3</sub>	1080	1105	1137	1169	1212
KHCO <sub>3</sub>	277	332	391	454	524

If concentrations in the gas are high KOH is preferred to avoid the possibility of crystallisation; otherwise, NaOH is suitable with appropriate scrubber liquor changes before blockages can occur.

## 1.2 Heat of Reaction

### 1.2.1 NaOH

Heats of formation, ΔH <sub>f</sub> @25°C	CO <sub>2</sub> (g)	-94.05	kcal/mole
	NaOH (aq)	-112.19	
	Na <sub>2</sub> CO <sub>3</sub> (aq)	-275.13	
	H <sub>2</sub> O (l)	-68.32	

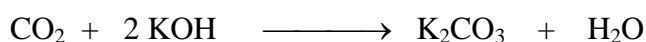


$$\begin{aligned} \text{Heat of reaction} &= -(-94.05 + (2 \times -112.19)) + (-275.13 + (-68.32)) \\ &= 318.43 - 343.45 \\ &= \underline{-25.02 \text{ kcal}} \end{aligned}$$

i.e. **25 kcal/mole carbon dioxide** exotherm

### 1.2.2 KOH

Heats of formation, ΔH <sub>f</sub> @25°C	CO <sub>2</sub> (g)	-94.05	kcal/mole
	KOH (aq)	-114.96	
	K <sub>2</sub> CO <sub>3</sub> (aq)	-315.50	
	H <sub>2</sub> O (l)	-68.32	



$$\begin{aligned} \text{Heat of reaction} &= -(-94.05 + (2 \times -114.96)) + (-315.5 + (-68.32)) \\ &= 313.97 - 383.82 \\ &= \underline{-69.85 \text{ kcal}} \end{aligned}$$

i.e. **70 kcal/mole carbon dioxide** exotherm

## 1.3 Alternative Methods

If carbon dioxide is required for further use monoethanolamine can be used as scrubber liquor as CO<sub>2</sub> is totally soluble and can be subsequently regenerated easily.