

# Process Design Technical Note

## TECHNICAL NOTE

## CHLORINE SCRUBBING

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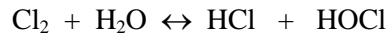
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## 1.0 Chlorine Scrubbing

Atomic weight	35.45
Melting point	-101°C
Boiling point	-34.9°C

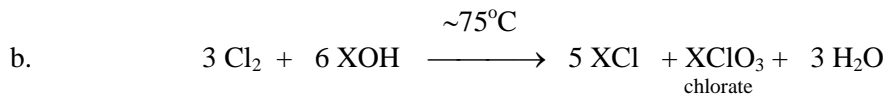
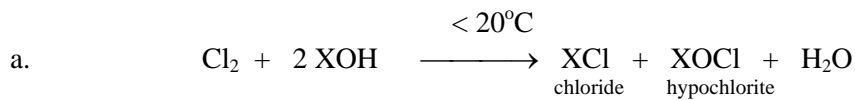
### 1.1 Reactions of Cl<sub>2</sub>

#### 1.1.1 Dissolution



Equilibrium concentrations @ 25°C: Cl<sub>2</sub> : 0.061 mol/litre i.e. 4.3 g/l Cl<sub>2</sub>  
 HOCl: 0.030 mol/litre i.e. 1.6 g/l HOCl

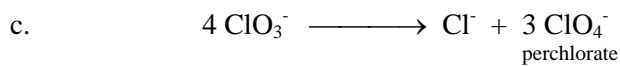
#### 1.1.2 Alkaline Scrubbing



Therefore, scrubbing reaction depends on temperature. XOCl solutions are stable below room temperature and reasonably pure solutions can be prepared. The disproportionation reaction to ClO<sub>3</sub><sup>-</sup> is slower than for bromine and requires a temperature of >75°C to give good yields.

The stoichiometry is similar for both reactions i.e. 2 moles XOH per mole Cl<sub>2</sub>

Further disproportionation can take place but it is slow even at 100°C



The reactions outlined above take place with NaOH and KOH.

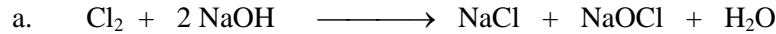
#### 1.1.3 Solubilities

	Solubility in water @ 0°C	Solubility in water @ 100°C
	g/l	g/l
NaCl	357	398
NaClO	260	1580
NaClO <sub>3</sub>	790	2300
NaClO <sub>4</sub>	1700	3200
KCl	276	567
KClO	?	
KClO <sub>3</sub>	33	570
KClO <sub>4</sub>	7.5	218

## 1.2 Heat of Reaction

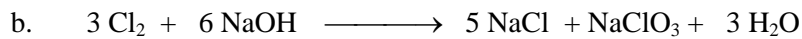
### 1.2.1 NaOH Liquor

Heats of formation, $\Delta H_f$ @25°C	$\text{Cl}_2$ (g)	0	kcal/mole
	$\text{NaOH}$ (aq)	-112.19	
	$\text{NaCl}$ (aq)	-97.32	
	$\text{NaOCl}$ (aq)	-82.8	
	$\text{NaClO}_3$ (aq)	-78.42	
	$\text{NaClO}_4$ (aq)	-97.66	
	$\text{H}_2\text{O}$ (l)	-68.32	



$$\begin{aligned} \text{Heat of reaction} &= -(0 + (2 \times -112.19)) + (-97.32 + (-82.8) + (-68.32)) \\ &= 224.38 - 248.44 \\ &= \underline{-22.06 \text{ kcal}} \end{aligned}$$

i.e. **22 kcal/mole chlorine** exotherm

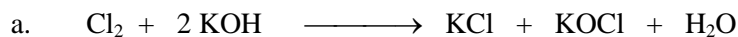


$$\begin{aligned} \text{Heat of reaction} &= -(0 + (6 \times -112.19)) + ((5 \times -97.32) + (-78.42) + (3 \times -68.32)) \text{ kcal} \\ &= 673.14 - 769.98 = \underline{-96.84 \text{ kcal}} \end{aligned}$$

i.e.  $96.84/3 = \mathbf{32.3 \text{ kcal/mole chlorine}}$  exotherm

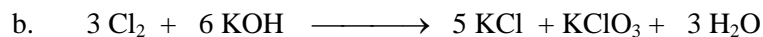
### 1.2.2 KOH Liquor

Heats of formation, $\Delta H_f$ @25°C	$\text{Cl}_2$ (g)	0	kcal/mole
	$\text{KOH}$ (aq)	-114.96	
	$\text{KCl}$ (aq)	-100.16	
	$\text{KOCl}$ (aq)	-86	<i>estimated</i>
	$\text{KClO}_3$ (aq)	-81.34	
	$\text{KClO}_4$ (aq)	-101.14	
	$\text{H}_2\text{O}$ (l)	-68.32	



$$\begin{aligned} \text{Heat of reaction} &= -(0 + (2 \times -114.96)) + (-100.16 + (-86) + (-68.32)) \\ &= 229.92 - 254.48 \\ &= \underline{-24.56 \text{ kcal}} \end{aligned}$$

i.e. **24.6 kcal/mole chlorine** exotherm



$$\begin{aligned} \text{Heat of reaction} &= -(0 + (6 \times -114.96)) + ((5 \times -100.16) + (-81.34) + (3 \times -68.32)) \text{ kcal} \\ &= 689.76 - 787.10 = \underline{-97.34 \text{ kcal}} \end{aligned}$$

i.e.  $97.34/3 = \mathbf{32.4 \text{ kcal/mole chlorine}}$  exotherm