

Adopting the Integrated Chlorine Dioxide Process for Pulp Bleaching to Comply with CREP Regulations

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CREP Guidelines – Pulp and Paper

Imposes requirements on wastewater, lime kiln, odour control, colour removal, chemical recovery, etc., **and:**

- Reduce AOX discharge to <1.0 kg/ADT

To achieve lower AOX targets will require a shift away from elemental chlorine (and hypo) bleaching.

AOX = Adsorbable Organic Halides

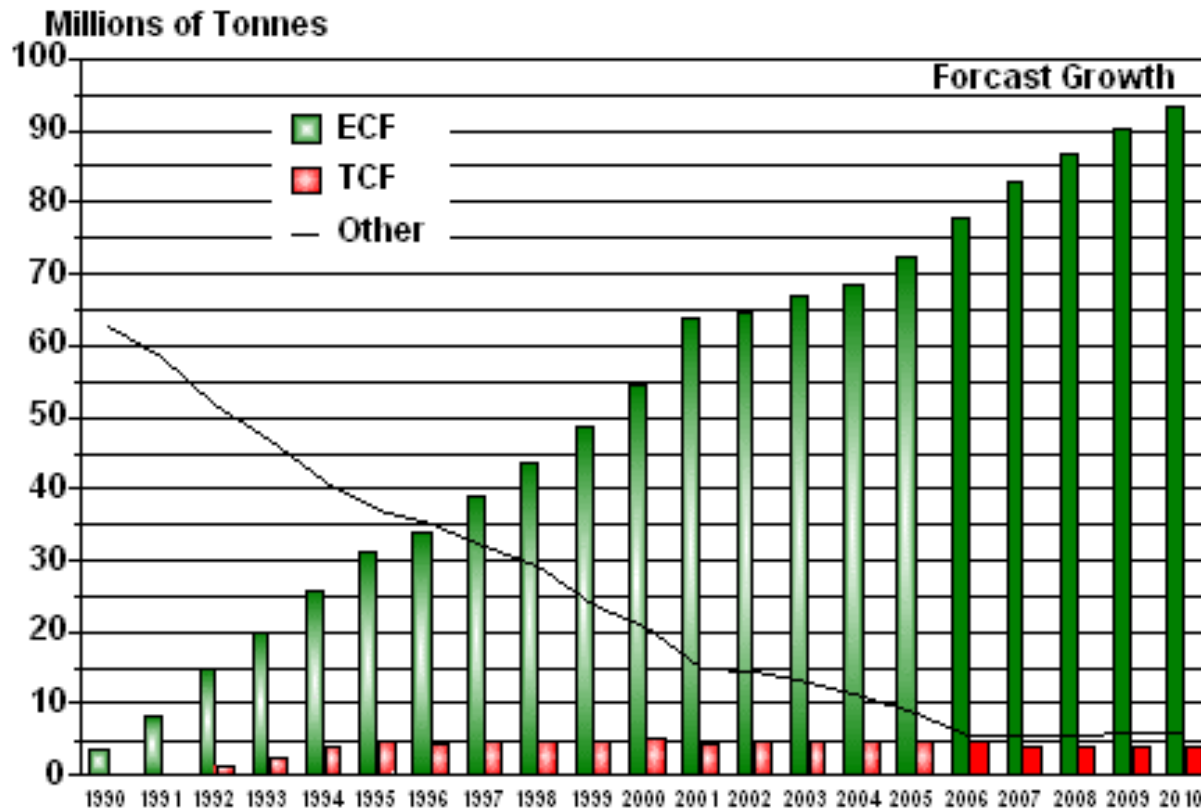
ADT = Air Dried Tonne of paper

ClO₂ Bleaching Dominates Worldwide

- 1990's debate between ECF and TCF bleaching is over now and less than 5% of the world's bleached pulp production is by TCF, and declining.
- U.S. 'Cluster Rules' endorsed ECF, and other countries have followed.
- ECF has market acceptance, and no new mills have adopted TCF in years.
- Chlorine dioxide is the predominant ECF pulp bleaching agent used worldwide.

Historical ECF Growth Worldwide

World Bleached Chemical Pulp Production
1990-2010 Millions of Tonnes (AET 2009)



Two Key Processes to Produce Chlorine Dioxide

The basic process involves the reduction of sodium chlorate under acidic conditions. There are two leading processes –

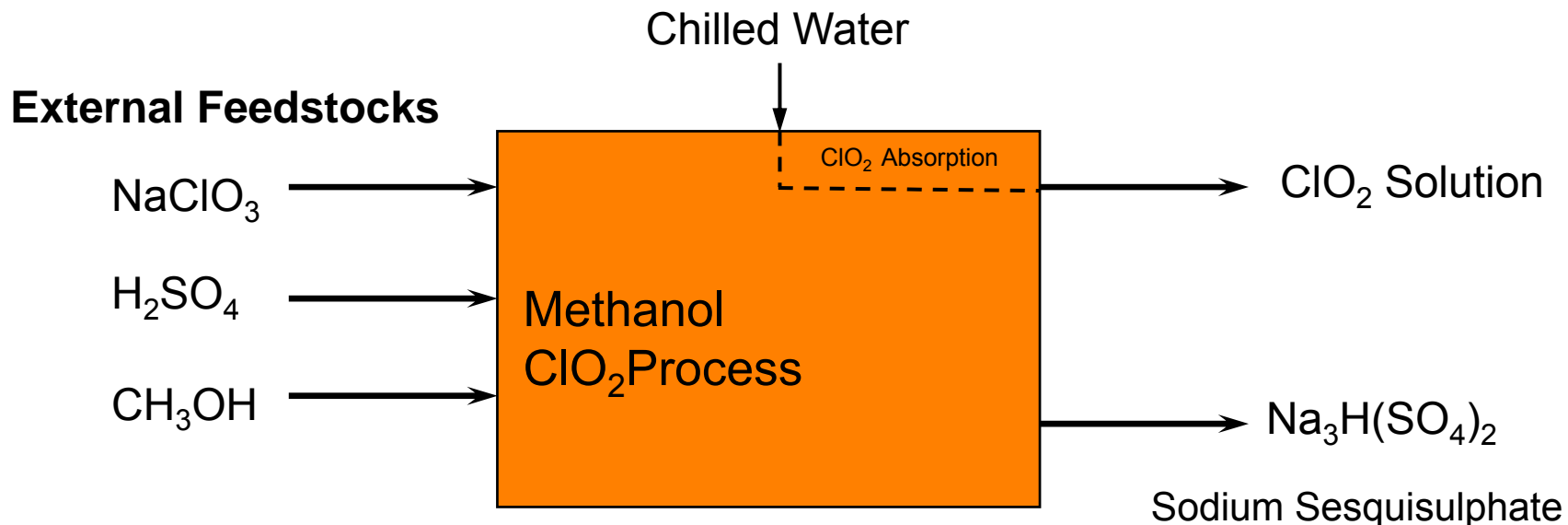
- **Integrated process**

- produces the sodium chlorate, acid, and reducing agent ‘in-situ’

- **Methanol process**

- requires the purchase of these feedstocks

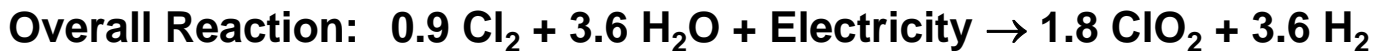
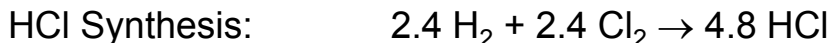
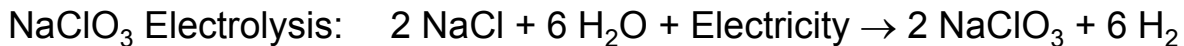
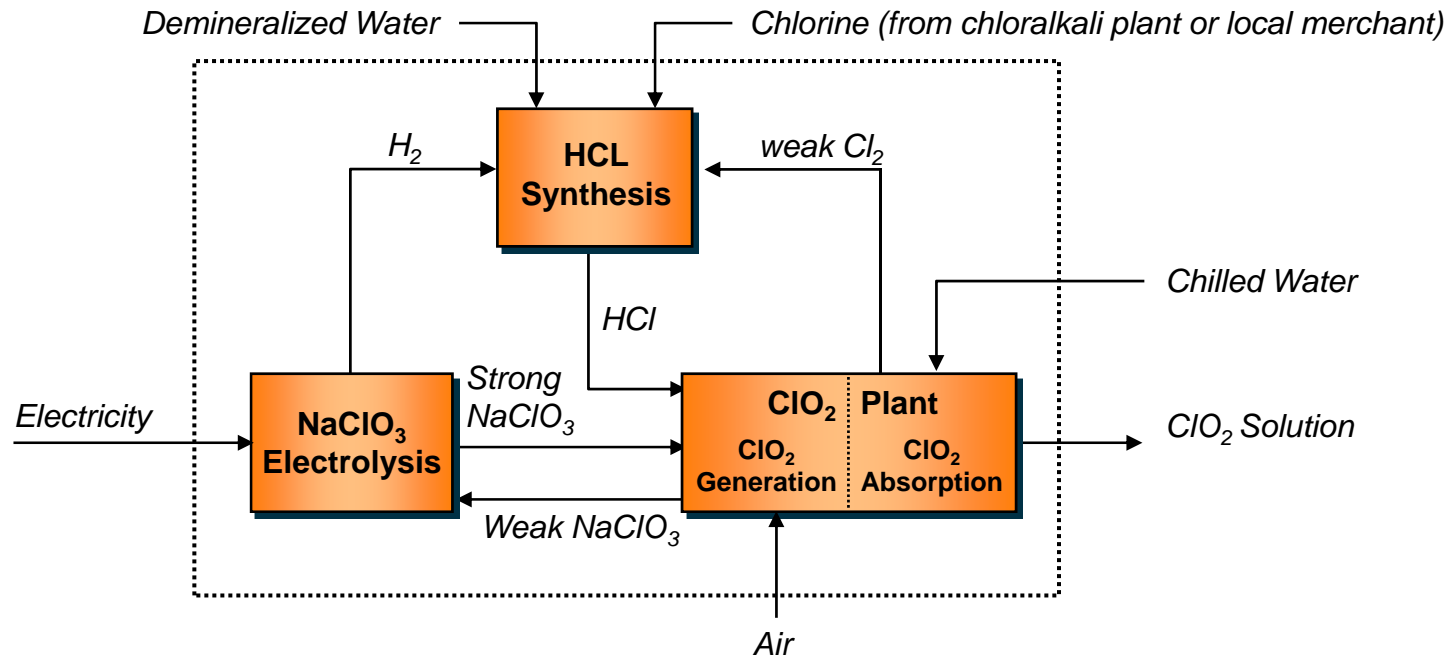
Methanol Chlorine Dioxide Process



Overall Reaction:



Aker Chemetics Integrated Chlorine Dioxide Process

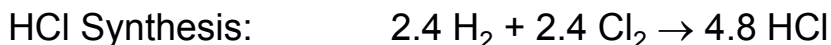
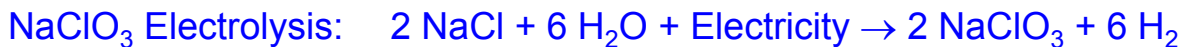
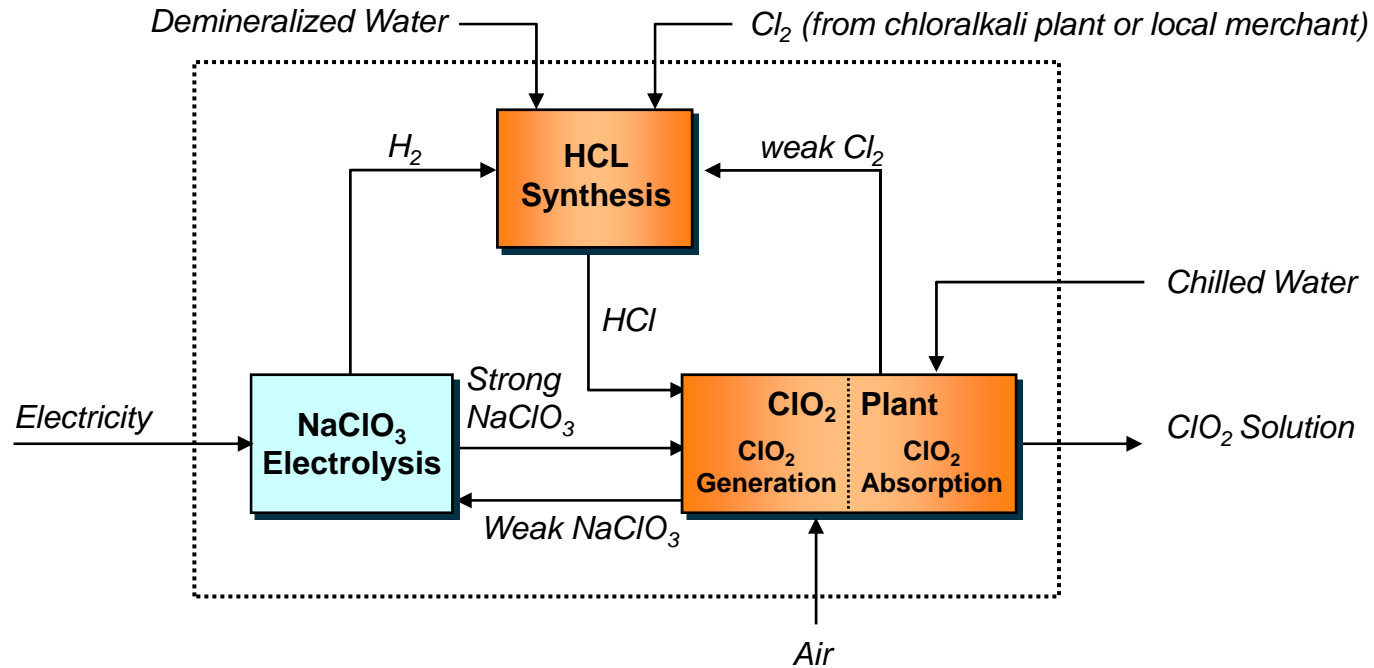


Overall Integrated Chlorine Dioxide Reaction

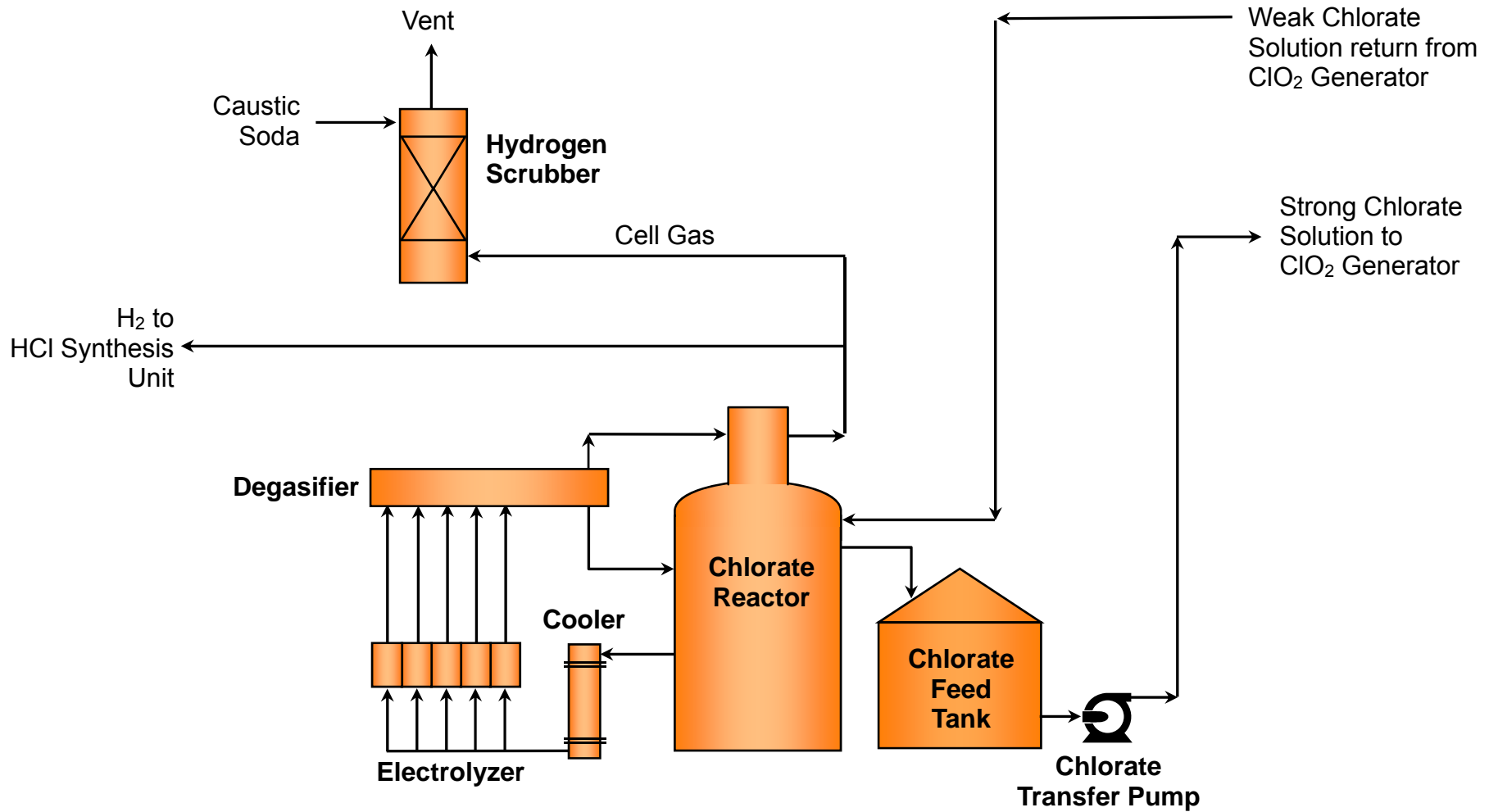
...Looks complicated, but overall reaction is simple...



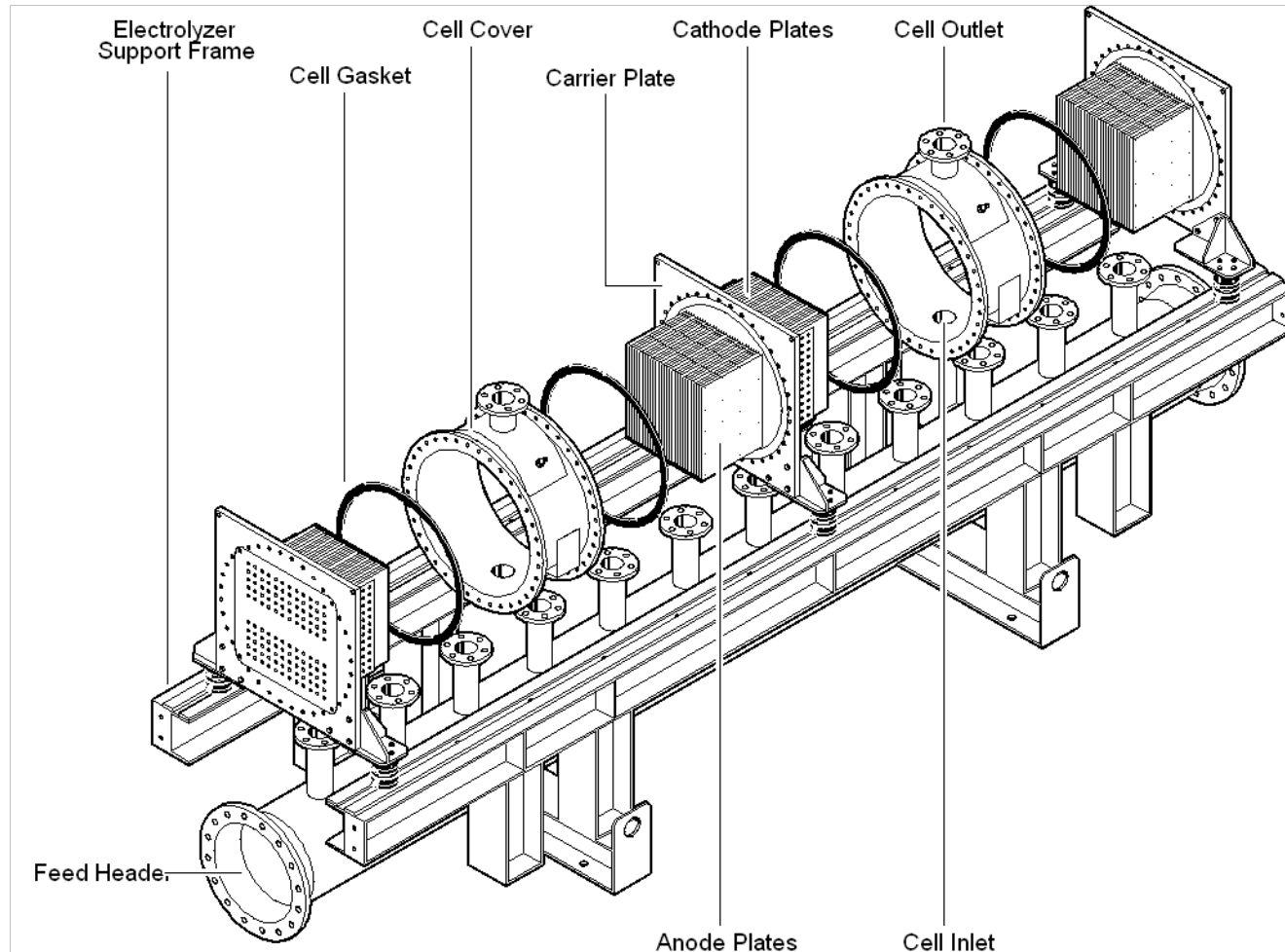
Sodium Chlorate Electrolysis



Sodium Chlorate Electrolysis



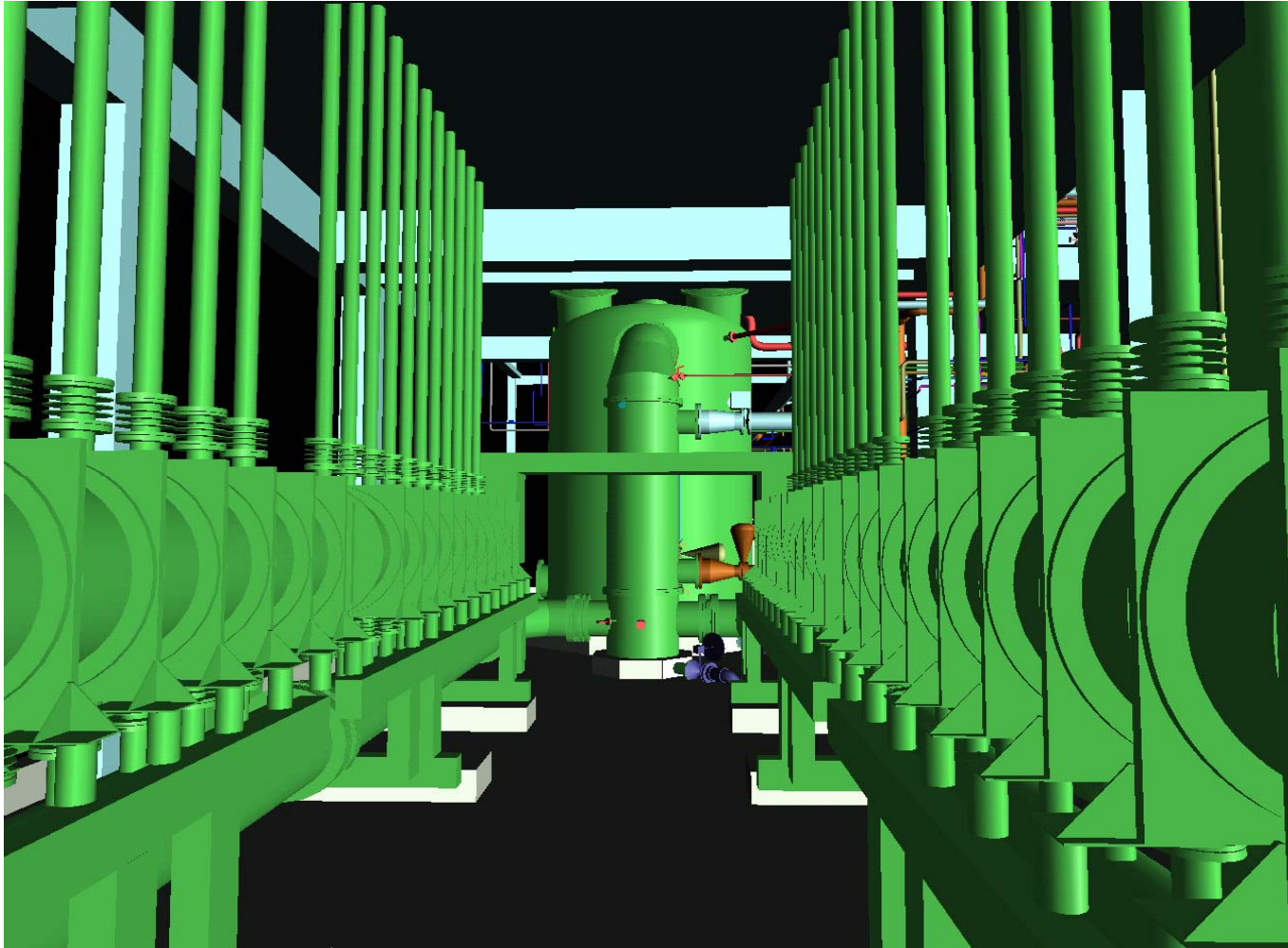
Sodium Chlorate Electrolyzer



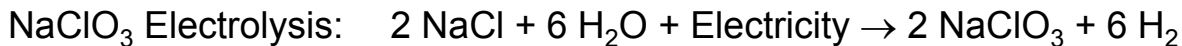
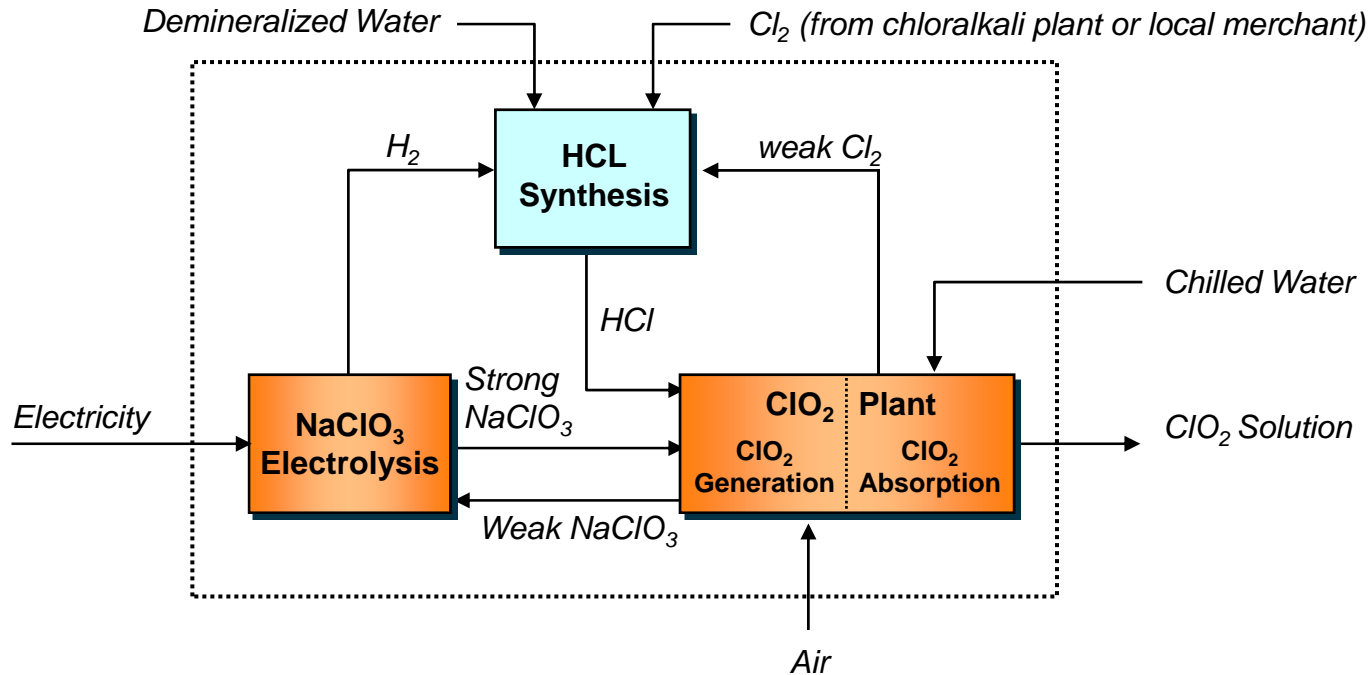
Pre-Assembled Chemetics Electrolyzer with Electrode Assembly



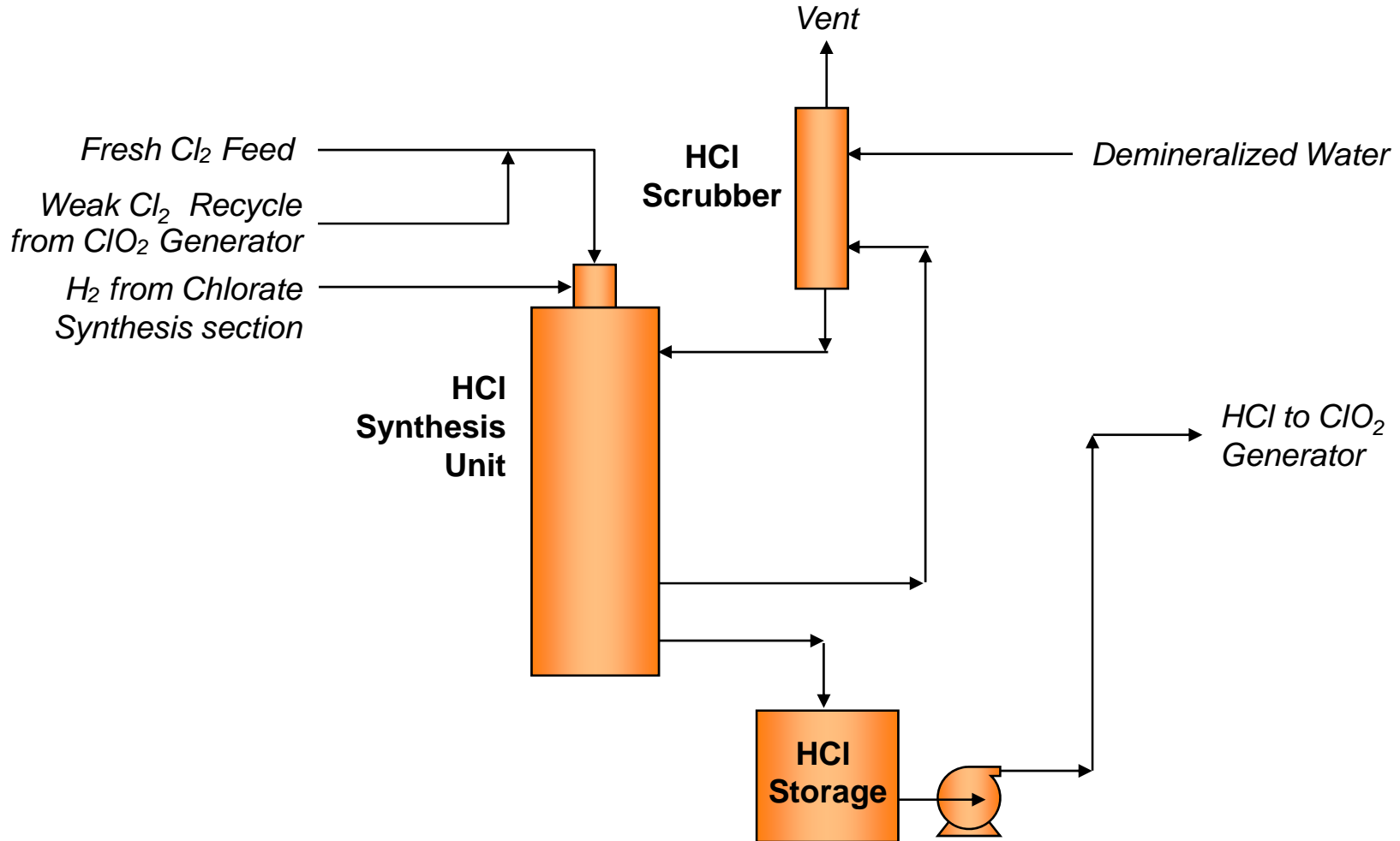
3D View of Two Electrolyzers



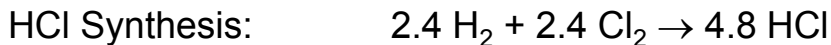
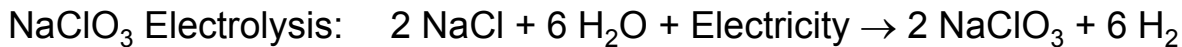
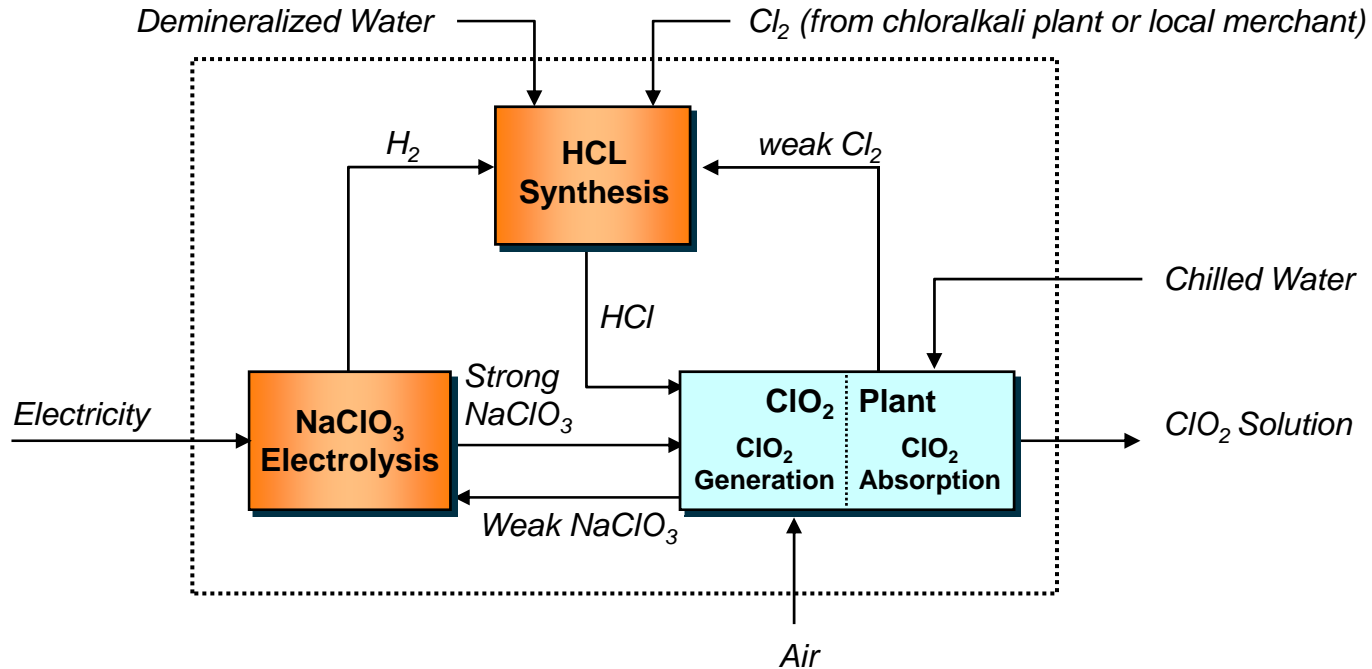
Hydrochloric Acid Synthesis



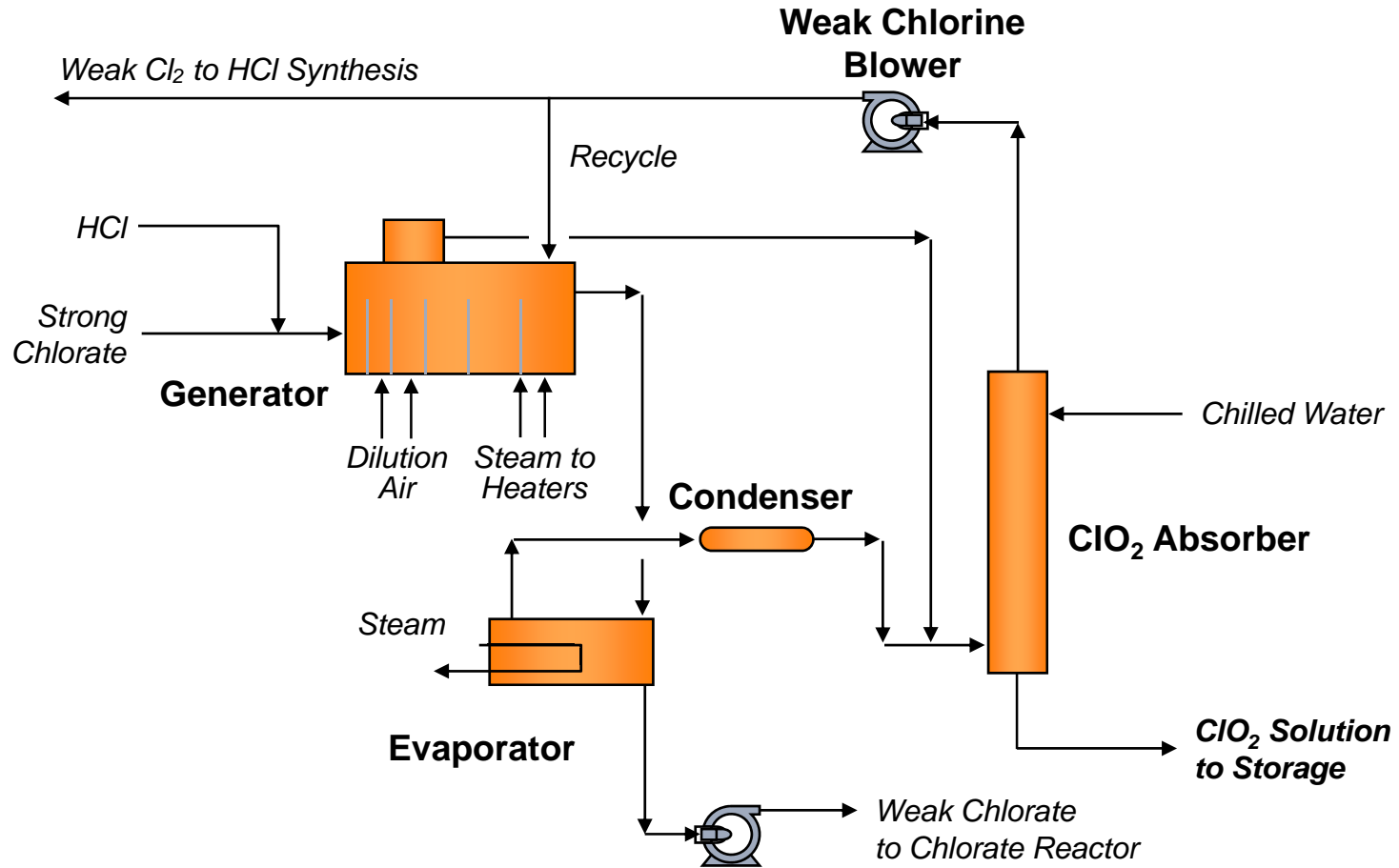
Hydrochloric Acid Synthesis



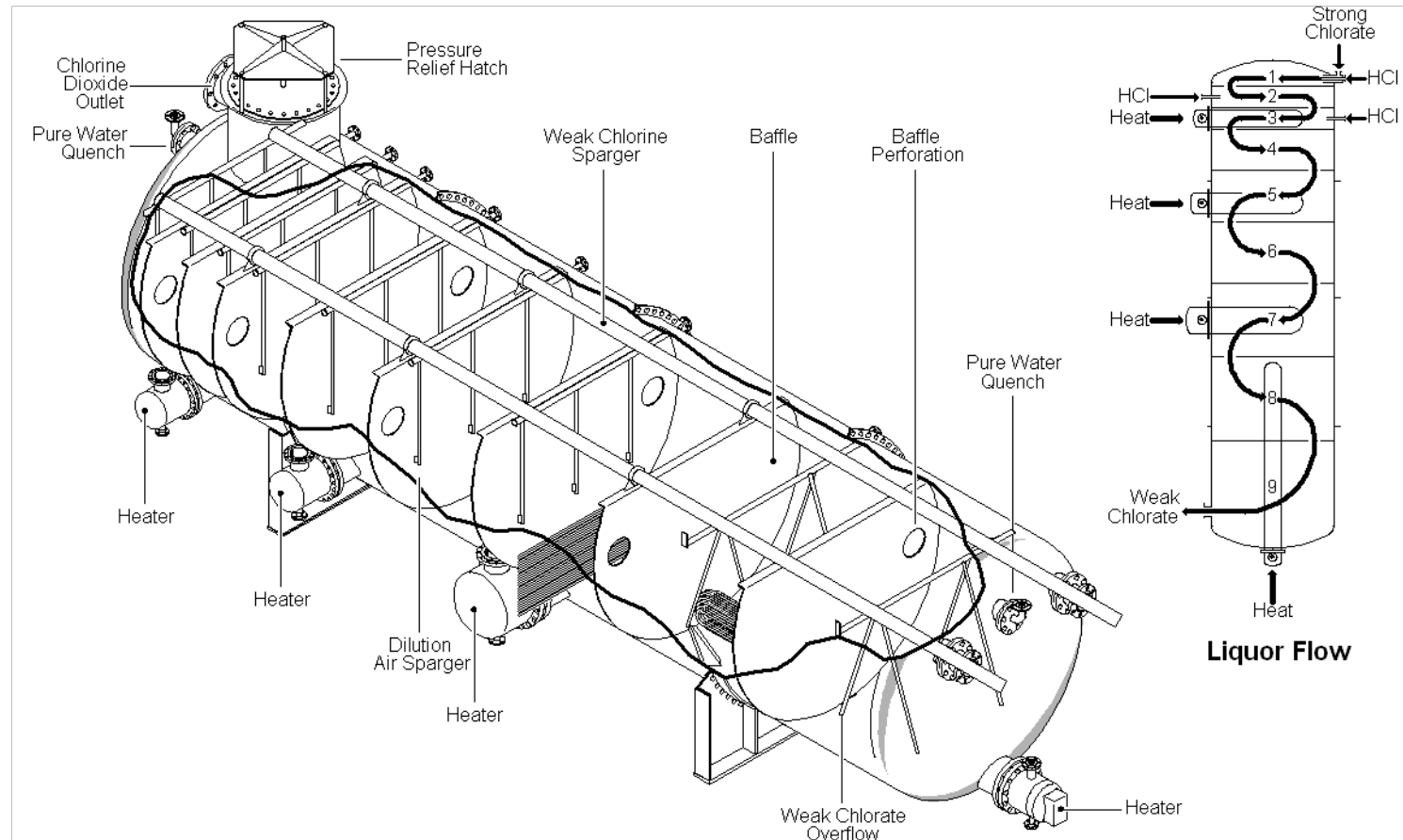
Chlorine Dioxide Generator System



Chlorine Dioxide Generator System



Chemetic's Horizontal Chlorine Dioxide Generator



Comparison of Chlorine Dioxide Processes

Feature	Integrated Process	Methanol Process
Capital Cost	Higher	Lower
Operating Cost	Lower	Higher
Dependency	Better	Good
Safety Issues	Cl ₂ , H ₂ Gas	H ₂ SO ₄ , MeOH, NaClO ₃ Transport / Storage / Handling

Comparison of Chlorine Dioxide Processes

Comparison of Consumptions (key cost items shown in red)

	Integrated t/t ClO ₂	Methanol t/t ClO ₂
Chlorine	0.73	0
Sodium Chlorate	0	1.64
Sulphuric Acid	0	1.0
Methanol	0	0.15
Steam	7	6
Electricity (MWh)	9	0.15

Comparison of Operating Costs (Integrated vs. Methanol - Typical)

Operating Costs	Integrated Process	Methanol Process
	Rs./ MT of ClO ₂	Rs./ MT of ClO ₂
Total Feedstock Cost	5738	86200
Total Utility Cost	36500	1688
Other Operating Cost	2,543	1,457
Total Production Cost (tonne ClO₂)	44780	89345

TABLE 1: Typical Operating Cost Comparison for Chlorine Dioxide Processes - Integrated vs. Methanol

Comparison of Chlorine Dioxide Processes

Comparison of Maintenance Requirements

Integrated Methanol

Generator Boil – outs	No	Yes
Solids Handling	No	Yes
Solids Filter	No	Yes
Generator Vacuum System	No	Yes

Advantages of the Integrated Process

- **No purchased chlorate, acid, or methanol** – and the corresponding dependence on outside supply and cyclical markets.
- **Significant operating cost savings over methanol process** – good payback of capital investment.
- **No solids to handle** – plugging, boil-outs, etc.
- **No sulphur or organic by-products** or effluents produced.
- **Better balance of mill NaOH / Cl₂ requirements** – consumes chlorine or HCl, possibly supplied directly from on-site chloralkali plant.

Aker Chemetics Integrated ClO₂ Projects Since 1990

Location	Capacity (t/d)	Start-Up
Sun Paper Pulp Mill, China	15	2009
<i>Century Pulp and Paper, India</i>	<i>12</i>	<i>2009</i>
<i>Tamil Nadu Newsprint and Papers, India</i>	<i>15</i>	<i>2008</i>
Hainan Jiang Lin, PRC	70	2005
Indah Kiat P&P, Indonesia (ClO ₂ #11)	50	2005
Lontar Papyrus P&P, Indonesia	25	2005
Shandong Rizhao Wood Pulp, PRC	12	2002
APP, Indonesia (Upgrade)	27	2001
Musi Pulp Mill, Indonesia	30	1999
Riau Andalan P&P, Indonesia	55	1999
<i>Andhra Pradesh Rayons, India</i>	<i>4</i>	<i>1998</i>
Guangning Renmin P&P, PRC	4	1997
Indah Kiat P&P, Indonesia (ClO ₂ #10)	25	1997

Aker Chemetics Integrated ClO₂ Projects Since 1990

Location	Capacity (t/d)	Start-Up
Kiani Kertas P&P, Indonesia	42	1997
Ya'an Bamboo, PRC	5	1997
Indah Kiat P&P, Indonesia (ClO ₂ #9)	25	1996
Riau Andalan P&P, Indonesia	55	1995
Indah Kiat P&P, Indonesia (ClO ₂ #8)	25	1994
Lontar Papyrus P&P, Indonesia	25	1994
Phoenix P&P, Thailand	12	1994
Weyerhaeuser Paper, USA	23	1992
Fort Howard, USA	8	1991
New Zealand Forest Products, New Zealand	18	1991



Aker Chemetics' Vitals

- A proven technology company, established in 1964
- Part of Aker Solutions – a leading global provider of engineering and construction services, technology products and integrated solutions
- Aker Chemetics supplies technology, plants, equipment, and services for chlor-alkali, bleaching chemicals (chlorate, chlorine dioxide, hypochlorite) and sulphuric acid production
- Headquarters in Vancouver, and a fabrication shop in Toronto
- Annual revenues of >\$100 million
- ~200 employees

Aker Powergas – Aker Chemetics' Partner in India

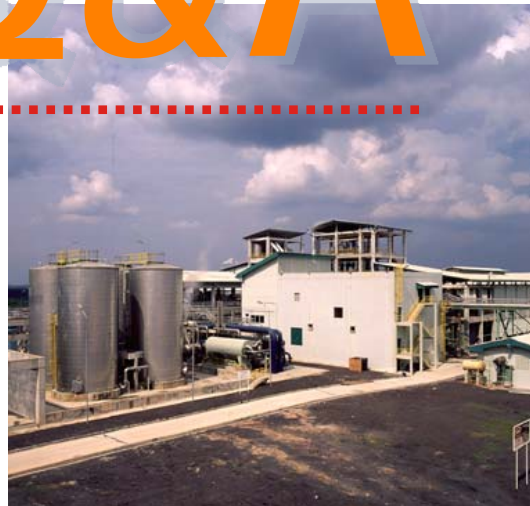
40 Years Experience in Detail Engineering, Project Management, Planning, Procurement Assistance, Inspection / Expediting & Construction Management Services For:

- **Pulp and Paper**
- Oil & Gas
- Refining
- Petrochemicals
- Synthetic Fibres
- Polymers
- Chemicals
- Agrochemicals
- Metals & Minerals





Q&A



World's Largest Integrated ClO₂ Plant (70 t/d)

