



# **Chlorine Scrubbing: Conversion from Batch to Continuous**

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# Powell Fabrication & Mfg., Inc.

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- Since 1964
- Sodium Hypochlorite production, Chlorine Scrubbing & Chlorine Shutoff Equipment
- Batch to Continuous Chlorine Scrubber conversions in US, Brazil, Chile, Mexico and other countries at major chlorine plants
- 75% of Sodium Hypochlorite in United States on Powell Equipment
- 90% of Sodium Hypochlorite in Canada on Powell Equipment
- Sodium Hypochlorite in other countries: 100% Chile; 50-70% Brazil, 100% Philippines, etc.

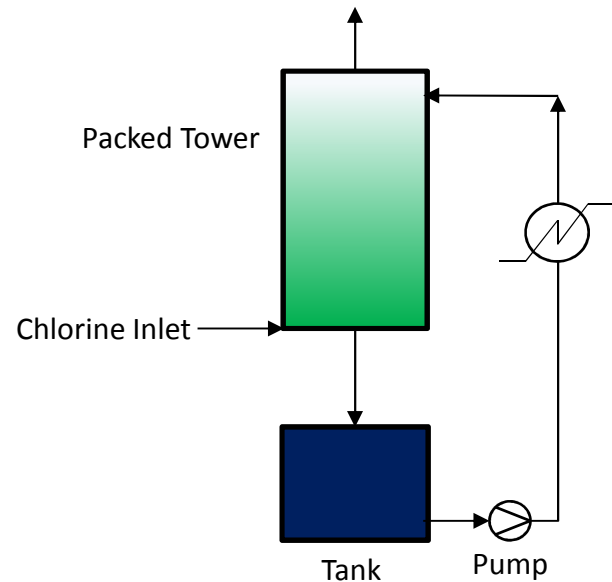
# Discussion Topics

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- Packed Tower Chemistry
- Sodium Hypochlorite (Hypo or Bleach) Chemistry - NaOCl
- Oxidation Reduction Potential (ORP/Redox)
- Batch to Continuous Chlorine Scrubbing
- Batch to Continuous Sodium Hypochlorite Production
- Chlorine Repackaging Scrubbing

# Initial Tower Cl<sub>2</sub> & NaOH Reaction

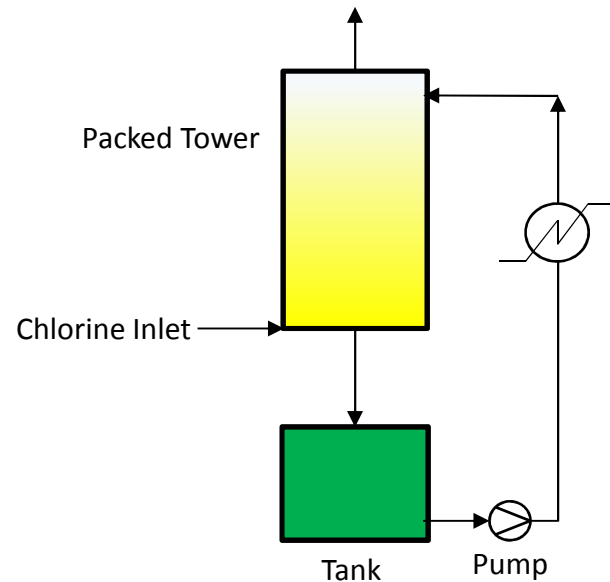
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- $\text{Cl}_2 + 2 \text{NaOH} = \text{NaOCl} + \text{NaCl} + \text{H}_2\text{O}$
- 17 - 20% NaOH typical scrubbing solution strength
- High Excess Caustic Reaction

# End of Batch w/ High Excess Caustic

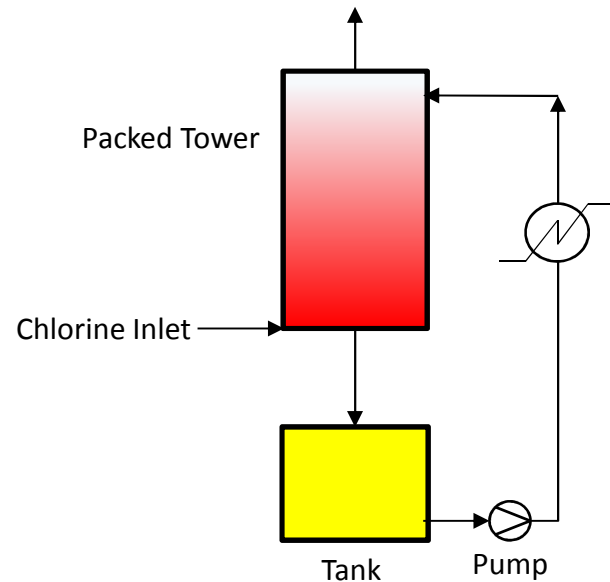
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- Top of tower – High Excess NaOH  
(NaOH – NaOCl – NaCl)
- Center of tower – Mod. Excess NaOH  
(NaOH – NaOCl – NaCl – Cl<sub>2</sub>)
- Bottom of Tower – Low Excess NaOH  
(NaOCl – NaClO<sub>3</sub> – NaCl – Cl<sub>2</sub>)

# End of Batch w/ Low Excess Caustic

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- $\text{Cl}_2 + \text{NaOCl} + \text{H}_2\text{O} = 2 \text{HOCl} + \text{NaCl}$
- $2 \text{HOCl} + \text{NaOCl} = \text{NaClO}_3 + 2 \text{HCl}$
- End reaction is:  
 $3 \text{NaOCl} = \text{NaClO}_3 + 2 \text{NaCl}$
- Occurs in low excess NaOH (low pH) regions at bottom of tower

# Packed Tower Advantages

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- Very good chlorine reactor
- Low gas pressure drop
- High inert gas loading
- Predictable results
- Low PPM chlorine outlet concentrations

# Packed Tower Disadvantages

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- Packed towers - Poor NaOCl production units
- Low excess caustic (NaOH) less than 2% - 3% w/w produces high NaClO<sub>3</sub>
- NaOCl side reaction to NaClO<sub>3</sub> creates more salt, potentially plugging the tower packing.
- Each 1 gpl of NaClO<sub>3</sub> loses 2.0 gpl of NaOCl
- Packed towers are limited in strength of NaOCl due to NaClO<sub>3</sub> side reactions creating NaCl and high excess caustic



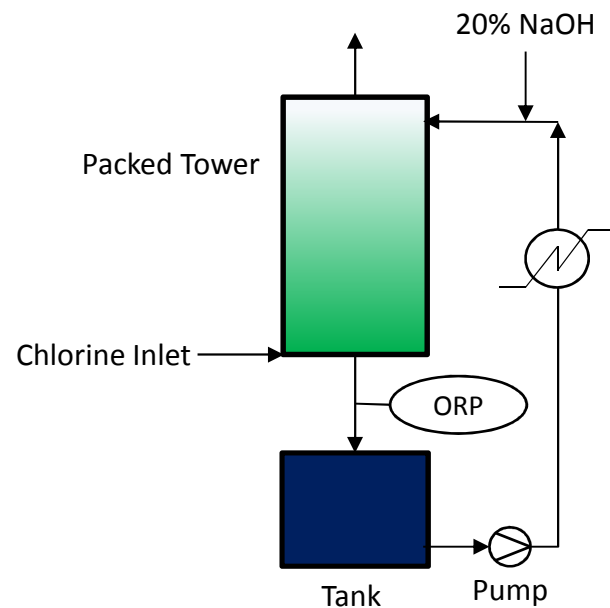
# Production Losses

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- Typical packed towers produce 135-155 GPL NaOCl with 12-15 GPL excess NaOH and 8-10 GPL NaClO<sub>3</sub>
- Packed towers typically operate with 10-15% raw material losses to NaClO<sub>3</sub>
- High quality hypo is 135 -155 GPL NaOCl, 3 GPL excess NaOH and 1.0 GPL NaClO<sub>3</sub>
- 25,000 MT of sodium hypochlorite per year (5,500,000 gallons) of high quality hypo versus packed tower hypo equals a savings of 305 tons of Cl<sub>2</sub> and 532 tons of NaOH @ 135 GPL

# Cl<sub>2</sub> Scrubbing w/ Hypo Production

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- 2-4% Minimum Excess Caustic
- 10-12% Excess Caustic Optional
- Feed Solution Downstream for Completion
- 20% NaOH feed direct to Tower Inlet
- Towers can be placed in series for NaOH & Cl<sub>2</sub>

# Production Improvements

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- Convert batch towers to continuous
- Operate towers at higher excess caustic such as 3-4% excess NaOH or greater
- Greatly increase operational safety
- Move hypo production downstream of chlorine towers
- Allows use of cooling tower water in lieu of chilled water for towers and hypo production

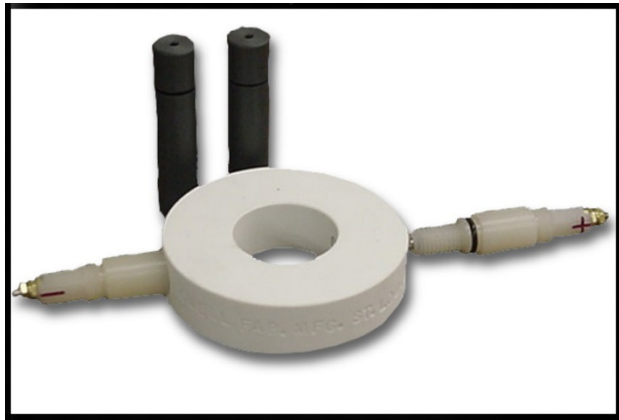
# Additional Production Improvements

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- Allows production of up to 16.5% w/w (200 GPL available chlorine)
- Reduce Excess NaOH to as low as 2-3 GPL
- Reduce NaClO<sub>3</sub> to as low as 1 GPL
- Reduce Operator Labor (elimination of 1 or more operators per shift)
- Reduce Shipping Cost

# ORP (REDOX) Instrumentation

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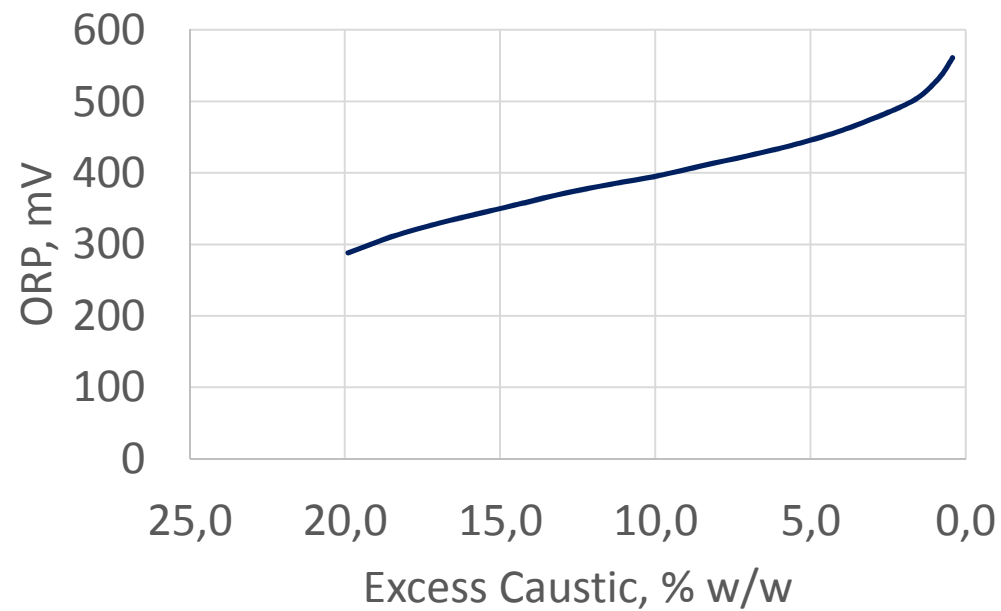


- ORP for chlorine scrubbers and hypo production
- Successful patented electrodes developed by Dow in 1960's
- Originally sold under license by Powell since 1963
- Voltage increases as sodium hydroxide decreases
- Typical KCL Wet ORP Electrodes do not work well

# ORP Indication

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ORP vs. Excess Caustic

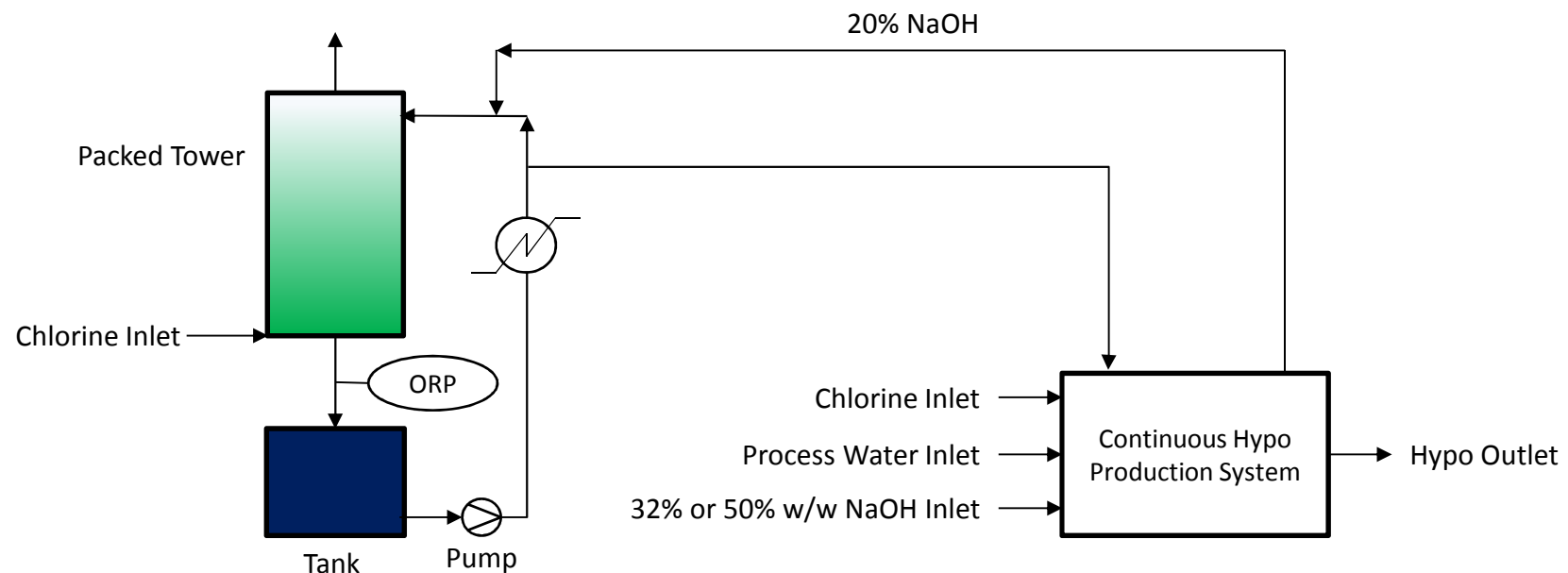


# Tower Design Changes

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- Add ORP electrodes, indication and alarms
- Location of electrodes depend on process design
- Convert from batch towers to continuous system
- Requires level control and ORP control for automatic caustic addition

# Hypo Production Downstream of Tower





# Downstream Hypo Production

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- Continuous Equipment to chlorinate tower hypo
- Uses scrubber solution from 3-4% excess NaOH and higher to maximum of 21% caustic
- Liquid and/or gas (wet or dry) chlorine for final chlorination
- Cooling Tower Water during production
- Chilled water used for some storage applications

## Cont'd

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- Hypo production during cell room maintenance if liquid chlorine is used
- Reduced shipping costs due to higher strength
- High turn down of production such as 250 ton/day down to 25 ton per day
- Totally automatic with extremely good repeatability of bleach strength and excess caustic

# Conversion of Batch to Continuous

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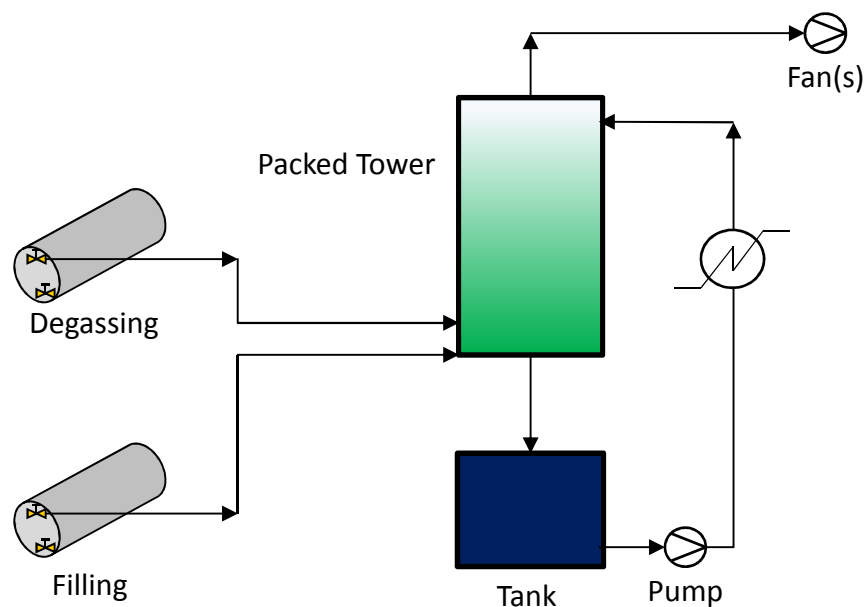
- Saves Raw Material Costs
- Saves Operator Time
- Saves Energy
- Improves Quality
- Improves Sales
- Improves Safety of Chlorine Scrubbers

# Project Summary

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- Automate Chlorine Towers by use of ORP
- Convert from batch towers to continuous systems
- Install downstream equipment for final hypo production
- Improve quality of hypo by final filtration
- Chill Stored Hypo to 15° C
- Dilute high strength hypo at loading rack with water and caustic (Membrane or Mercury) to meet customer's specification
- Install remote site production using packaged skids to remain competitive & reduce freight cost

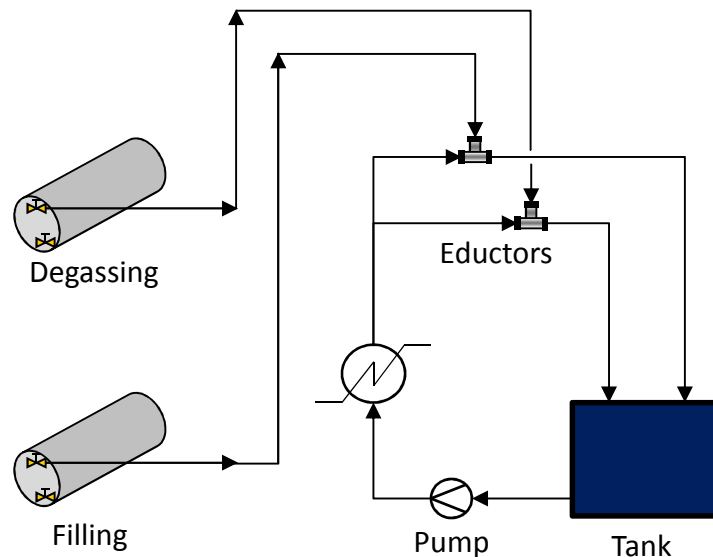
# Chlorine Repackaging Scrubbing



- Low vacuum (-25 mbar) provided by fan(s)
- Increased time for evacuating and filling cylinders.
- Significant maintenance on fan(s)

# Chlorine Repackaging Scrubbing

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- High vacuum (-846 mbar) provided by eductors
- Decreases time for evacuating and filling cylinders.
- Increased safety
- No moving parts
- Corrosion resistant
- Easy to install and maintain

# Powell Contact Information

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