

# Powell Continuous Bleach Plant

## General Information

### Introduction

The sodium hypochlorite process is a unique process utilizing liquid chlorine and fifty percent caustic. It will produce high quality bleach at a minimum operating cost and with maximum safety compared to other existing commercial processes.

The physical plant is constructed with the highest quality components available to insure long service life with a minimum of maintenance.

The plant is equipped with numerous safety devices, which are intended to shut down the plant if a process upset threatens personnel or product quality.

The plant is completely automatic, starts up readily on automatic control in a very short time and during operation, and requires only that someone be available to attend it if the alarm sounds.

### General Description

The continuous bleach plant is available in two basic designs. If the plant is to manufacture bleach to be marketed, it must utilize heat exchangers to remove the heat of reaction. If the plant is to manufacture low strength bleach such as 50 grams per liter and the bleach will be used in an internal process, no heat exchangers are required. The rate of production for low strength bleach is specified by the customer with a maximum flow rate of 180 gallons per minute. The higher the concentration, the lower the rate of production available, i.e. the maximum flow rate for 160 grams per liter is 150 gallons per minute. Every plant has the capabilities of make any strength desired up to 200 grams per liter by the addition of heat exchangers. A modified unit will also use vapor chlorine coming from a chlor-alkali cell.

The residual caustic can be controlled within very close tolerances. The maximum residual caustic for a standard plant can be controlled as high as 1% by weight, with higher concentrations of residual caustic available upon request.

The frame size of either plant is standardized to 7'W x 7'H x 20'L. This standardization enables the location of the equipment and piping to be basically the same on each plant. The weight of the plant without heat exchangers is approximately 6 tons (8 tons with heat exchangers).

### Advantages of Continuous System

The elimination of a chlorine vaporization system is a major advantage of this process. Since the continuous system uses liquid chlorine, all the equipment, services, and energy requirements of a chlorine vaporization system are eliminated.

Another major item that is eliminated is the mechanical refrigeration, which is required when high strength bleach is normally produced by other methods. Since the continuous system cools the bleach by using water from a cooling tower (typically 300 to 500 tons) a considerable savings in energy, equipment and maintenance cost is realized.

Another advantage of the continuous process is that it utilizes 50% caustic, eliminating the need for costly dilution tanks and production space.

Since this continuous plant is completely automatic, considerable man-hours are saved in comparison to other bleach operations. One man, including all material, handling, and testing can operate a typical plant, which will produce 24,000 gallons per 8 hour day of 200 grams per liter sodium hypochlorite.



Major cost savings in raw materials by the continuous process are due to a 98% plus efficiency in the use of raw materials, in contrast with the 93 - 96% efficiency experienced in batch operations. This increase in efficiency is from a decrease in the amount of chlorate produced. The following example will provide you with some insight on the possible savings due to the increase in efficiency:

Basis for example:

- 8 hours/day
- 5 days/week
- 50 weeks/year
- 2,000 hours/year

Note: Equivalent to 24.5 capacity base on 22 hour day.

20 trade % bleach (16.7 weight percent)

3,000 gal/hr x 10.58 #/gal = 31,737 #/hr

Cl<sub>2</sub> Demand

100% EFF (0.0% NaOCl<sub>3</sub>)                      5,051 #/1 hr

Dow 98% EFF (.16% NaOCl<sub>3</sub>)                      5,154 #/1 hr

Batch 93% EFF (.6% NaOCl<sub>3</sub>)                      5,431 #/1 hr

Difference between 98% efficiency = 277 #/hr

Caustic = 80/71 (277) = 312 #/1 hr

Annual cost savings based on the above figures would be:

277 tons of chlorine at \$100.00 per ton	\$27,7000.00
312 tons of caustic at \$100.00 per ton	<u>+ 31,200.00</u>
Total Material Savings	\$58,900.00

Using the example as a format, a saving may be figured for any bleach strength, rate of production and cost of raw materials.

Due to the accurate repeatability of the continuous bleach plant, considerable savings can be realized from less "product giveaway". Experience has shown that residual caustic specifications are lowered and the bleach strength specifications are brought close to the minimum limit when a continuous plant is placed into production.

## Principles of Operation

The following is a brief discussion of the continuous bleach plant. There are three control systems on the plant. The first one is the blending system, which controls the strength and rate of production of the bleach. The second is the reaction control system, which controls the degree of chlorination (or excess alkalinity). The third is a level control system, which controls the product level in a recycling tank and the product flow out of the plant.

The blending system operates in the following manner. A flow controller opens a water flow control valve. Water passes through an electronic flow transmitter and the transmitter sends a signal to a digital ratio station. The selected ratio output of the ratio station is sent to a digital controller who controls the valve position of a caustic flow control valve. An electronic transmitter measures caustic flow and the signal is sent to the digital controller. The digital controller compares the measure signal to the output of the ratio station and adjusts the caustic valve so the measured signal matches the selected ratio output of the ratio station.



A major feature of the blending system is that the ratio of caustic to water is adjustable. The ratio of caustic to water is selected by the operator and can be changed within seconds. This flexibility allows the plant to produce any strength bleach desired for any length of time. The blending system features are repeatability not found in other systems because the caustic flow transmitter is a positive displacement device not effected by viscosity and temperature changes in the caustic. Inherent in the blending system is alarm shutdown circuitry that activates when the caustic ratio is not maintained.

After the desired caustic strength has been established by the blending system, the next control system is the chlorine reaction control system. The function of the system is to properly add chlorine to the diluted caustic to produce sodium hypochlorite with a residual caustic of your choice. The chlorination process is controlled by the Oxidation-Reduction Potential (ORP) method.

Caustic is fed into a recycle loop consisting of a chlorine reactor, recycle tank and recycle pump with interconnecting piping. While the caustic is continuously flowing into the recycle loop, controlled liquid chlorine is mixed in the reactor with a continuous solution containing finished bleach and the diluted caustic. When the total solution leaves the reactor, the reaction of the solution is complete and the sodium hypochlorite is finished. Immediately after the reactor, primary set of ORP electrode measures the voltage of the finished solution. If the voltage of the solution is higher than a selected set point on the Oxidation-Reduction Controller, the controller will close the chlorine valve until the measure voltage matches the selected voltage. If the measure voltage is below the set point the controller will open the chlorine valve. With the ORP control system, the residual caustic and therefore the bleach strength can be closely controlled.

A secondary set of ORP electrodes is provided to be a safety monitor of the reaction process. Should any of the primary control systems fail, the secondary set with associated instrumentation will close a chlorine on/off valve to prevent over chlorination.

The third control system on the plant is a recycle tank level control used to maintain a selected level of sodium hypochlorite in the recycle tank and to control the flow of product out. Dilute caustic is continuously fed into the recycle loop, chlorinated, and pumped into the recycle tank. In order for the level in the recycle tank to remain constant, the level control opens or closes a product flow control valve, as required, so that the flow of the product out of the plant matches the total flow of raw materials into the plant.

Previously, it was indicated that for bleach production of the higher concentrations, process cooling would be required. Should this be the case, two heat exchangers are normally installed on the bleach plant. One heat exchanger is placed in the diluted caustic line and the other is located in the recycle loop downstream of the reactor. If the cooling requirements are low only one heat exchanger is needed and it is placed in the recycle loop downstream of the reactor.

## Energy and Material Requirements

The basic material and energy requirements are as follows:

- Liquid chlorine with a minimum pressure of 120 psig or higher.
  - Recommended chlorine line size is one inch.
  - Chlorine line must be insulated to prevent vaporization by direct sunlight.
- Fifty-percent caustic with a positive head pressure must be delivered to the inlet of the unit mounted caustic pump. Two-inch pipe size is recommended to the inlet. A remote caustic pump providing 70 to 80 psig may be used in lieu of the unit mounted caustic pump.
- Process water at desired flow rate with 70 to 80 psig pressure delivered to the bleach plant.
- Cooling water (not required for pulp mill machine)
  - The cooling requirements of 50 gallons per minute 20 trade percent bleach plant are approximately 3,600,000 BTU per hour.
  - All cooling necessary can be achieved with water provided with cooling towers.
  - Each bleach plant is individually sized for cooling as required.
  - Typical flow rate of cooling water is 600 gallons per minute, determine by the cooling load and plant location.
- A four-inch vent line is required from the bleach plant to a scrubber of simple design (typically a drum of 30 degrees Baume caustic or as required by code.)

- Dry instrument air at 80 psi with a recommended three horsepower compressor.
- Three phase electricity at 240, 260, or 550 volts. Note: 15 horsepower for a basic unit up to 75 GPM, plus caustic pump, water pump, cooling tower fan, instrument air compressor, padding air compressor, and any auxiliary transfer pumps.
- A motor starter center is available that is built into the basic unit to provide power for all associated equipment.

## Materials of Construction

All units are constructed of the best materials available to maximize the service life of the plant.

- Water, Caustic, and Chlorine Lines: Schedule 80 seamless steel pipe with 3000# forged steel screwed and or suitable flanged fittings.
- Cooling Water Lines (if required): Schedule 80 PVC pipe and fittings.
- Sodium Hypochlorite Lines: Steel pipelined with Kynar, Teflon, or Halar materials suitable for the use required. Schedule 80 PVC may be used on low-pressure areas of product piping to lower the capital cost of the unit.
- Water Pump: Berkeley (or your choice) close coupled with cast iron construction and mechanical seal.
- Caustic Pump: Duriron or Gould with Duromet 20 construction, graphoil packing, or seal of your choice.
- Sodium Hypochlorite Pump: Duriron or Gould with titanium construction, graphoil packing, or seal of your choice.
- Sodium Hypochlorite Recycle Tank: Steel tank with white chloro-butyl rubber lining.
- Heat Exchangers (if required): Titanium plates with EPDM gaskets.
- Pneumatic Control Valves: Fisher (normal).
- Instrumentation: Foxboro (normal).
- Electrical Motors: Customers preference of manufacturer's choice.

## Options

- Air padding compressor system with chemical air dryer for air padding chlorine tank car.
- Instrument air compressor system with mechanical air dryer.
- Remote operator control station designed as required.
- Dilution system deleted if not required.
- Repressuring system for increasing plant process water to require 70 to 80 psig. This may use process water from the cooling tower to reduce tower maintenance.

## General Information

Usually, construction time for a bleach plant will take five to six months from the date of the order to the shipping date. Before the units are delivered they are tested with water and all control systems are thoroughly checked and ready to run when delivered. Any customer who desires training before the unit is delivered is invited to come to our facilities while the unit is being tested. He is given the opportunity to run the unit while it is being water tested and familiarize himself with the controls. This instruction is given at no charge and is recommended for all customers.

The shipment of the unit is by common carrier, F.O.B. St. Louis, Michigan in a single load. The terms of the contract are negotiable but usually are 25% of the total contract accompanying the acceptance and additional 25% at 60 days and again at 90 days, and the balance upon completion.

When the unit is delivered, the customer must make all mechanical connections i.e. caustic, water, chlorine, air and electrical. After these connections have been completed, we can assist in startup. Startup is accomplished in a short time since all control systems are tested before the unit is shipped.



Fabrication & Manufacturing, Inc.  
 740 East Monroe Road  
 St. Louis MI 48880  
 Phone: 888.800.2310 (Toll Free)  
 989.681.2158 (Local)  
 Fax: 989.681.5013  
 email: info@powellfab.com  
 website: www.powellfab.com  
 www.valveclosures.com  
**800.12312009**