

# Comparison Of Costs - Chlorine Gas Versus Hypochlorites

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Perhaps one of the best ways to compare chlorine gas and the hypochlorites is to compare the costs of the systems. This includes both the equipment costs and operating costs (chemical, maintenance and service).

To accomplish this a series of situations will be established. Building costs are not considered but only the cost of equipment. The reader is left to determine the costs of buildings in their own areas based upon the local building codes and heating requirements.

To provide equivalent oxidizing potential, the following relationships are used:

- Chlorine Gas - one (1) pound (454 grams) of chlorine gas is equivalent to
- Sodium Hypochlorite Solution (12%) - 0.88 gallons (3.34 liters) or,
- Sodium Hypochlorite Solution (1%) (On-site generated) - 11.9 gallons (45.4 liters) or,
- Calcium Hypochlorite Powder (65%) - 1.54 pounds (699.2 grams) or,
- Calcium Hypochlorite Tablets (65%) - 1.54 pounds (699.2 grams).

For purposes of this comparison, there are three applications requiring chlorine feed listed below. Each application will require a different chlorine feed rate. From this the relative costs of each of the chemicals identified above are determined. The applications are:

**Application 1:** A well system pumping water at the rate of 1 MGD (157.5 m<sup>3</sup> per hour) and requiring a chlorine dose of 2 mg/l

**Application 2:** A surface water plant producing at the rate of 4 MGD (630 m<sup>3</sup> per hour) and requiring a chlorine dose of 3 mg/l

**Application 3:** A surface water plant producing at the rate of 10 MGD (1,575 m<sup>3</sup> per hour) and requiring a chlorine dose of 5 mg/l

### Application 1

**Chlorine gas** feed required - 1 MGD x 8.34 x 2 ppm = 16.7 PPD of chlorine or 157.5 m<sup>3</sup>/h x 2 mg/l = 315 g/h of chlorine

Basis - **Chlorine gas** supplied in two (2) 150 pound (70 kg) cylinders with fixed rate gas chlorinator with automatic switchover system (\$1700), gas detector (\$1400), electronic scale (\$1100), SCBA gas mask (\$1000) and booster pump (\$400).

Equivalent **sodium hypochlorite** - 16.7 x 0.84 = 14 gal. of 12.5 % sodium hypochlorite or 315 g/h x 0.00703 l/gr x 24 = 53.15 liters of 12.5 % sodium hypochlorite solution

Basis - **Sodium hypochlorite** supplied from 55 gallon (208 liter) drums into a 55 gallon (208 liter) day tank (\$400) and fed with two (2) chemical feed pumps (\$500), equipped with calibration cylinder (\$150), rubber gloves, rubber apron and goggles (\$75).

Equivalent **calcium hypochlorite (powder or tablet)**- 16.7 x 1.54 lbs hypo/lb Cl<sub>2</sub> = 25.7 pounds of 65 % or 315 x 1.54 x 24 = 11.64 kg of 65 %

Basis - **Calcium hypochlorite powder** supplied in 100 pound (45 kg) drums, a 55 gallon (208 liter) mix tank (\$500), a 55 (208 liter) gallon feed tank (\$400), two feed pumps (\$500), equipped with calibration cylinder (\$150), rubber gloves, rubber apron and goggles (\$75).

Basis - **Calcium hypochlorite tablets** supplied in 100 pound (45 kg) drums with a solid feeder (\$1500) and one (1) 55 gallon (208 liter) feed tank (\$400), two feed pumps with calibration cylinder (\$650) and gloves apron and goggles (\$75).

Disinfection Agent (3)	Total Equipment Cost (\$)	Yearly Equipment Cost (\$)(1)	Chemical Consumption per day	Chemical Cost (\$/unit)(2)	Annual Chemical Cost (\$)	Total Annual Cost (\$ (3)
Chlorine Gas	5,600	1,120	16.7 lbs	0.40/lb	2,438	3,558
Sodium Hypochlorite (12.5%)	1,125	225	14 gal	\$1.20/gal	6,132	6,357
Calcium Hypochlorite (Powder)	1,675	335	25.7 lbs	\$1.25/lb	11,725	12,060
Calcium Hypochlorite (Tablets)	2,625	525	25.7 lbs	\$1.25/lb	11,725	12,250

Notes:

1. Equipment costs are the sum of the costs of the equipment listed above and are averaged for five years
2. Chemical costs vary in each region/area depending upon many factors including freight, yearly supply contracts, volume used, etc. Local costs should be determined to predict operating costs more accurately.
3. Total costs are the five year average of the equipment cost plus the annual chemical costs. Not included are yearly maintenance costs (estimated at 10% of equipment cost), yearly operating (power) costs.

## Application 2

Chlorine gas feed required -  $4 \text{ MGD} \times 8.34 \times 3 \text{ ppm} = 100.1 \text{ PPD}$  of chlorine consumed or  $630 \times 3 = 1.89 \text{ kg/h}$  of chlorine gas consumed

Basis - **Chlorine** supplied in two (2) ton (2,000 pounds) (910 kg) containers with container mounted vacuum regulator with automatic switchover system (\$3,500), gas detector (\$1,400), two (2) ton container scale (\$2,500), SCBA gas mask (\$1,000), and booster pump (\$600), rubber gloves, rubber apron and goggles (\$75).

Equivalent sodium hypochlorite -  $100.1 \times 0.84 = 84.1$  gallons of 12.5 % sodium hypochlorite or  $1.89 \times 1000 \times 0.00703 \times 24 = 318.8$  liters of 12.5 % sodium hypochlorite

Basis - **Sodium hypochlorite** supplied from delivery trucks and pumped into one (1) 2,000 gallon (7.5 m<sup>3</sup>) on-site storage tank (\$2,500), and fed with two (2) chemical feed pumps (\$800), rubber gloves, rubber apron and goggles (\$75).

Equivalent calcium hypochlorite (powder) -  $100.1 \times 1.54 = 154.3$  pounds of 65 % or  $1.89 \times 1.54 \times 24 = 69.85 \text{ kg}$  of 65 %

Basis - Calcium hypochlorite powder supplied in 100 pound (45 kg) drums, a 500 gallon ( 2 m<sup>3</sup> ) mix tank with agitator (\$700), a 500 gallon (2 m<sup>3</sup>) feed tank (\$600), two (2) chemical feed pumps (\$800), rubber gloves, rubber apron and goggles (\$75).

(Note - **Calcium hypochlorite (tablet)** feed systems are usually less than 100 pounds per day (1.9 kg/h). Since Application 2 exceeds the normal feed requirements and a cost analysis is not included for tablets.)

Disinfection Agent	Total Equipment Cost (\$)	Yearly Equipment Cost (\$)(1)	Chemical Consumption per day	Chemical Cost (\$/unit)(2)	Annual Chemical Cost (\$)	Total Annual Cost (\$ (3)
Chlorine Gas	9,075	1,815	100.1lbs	0.20/lb	7,307	9,122
Sodium Hypochlorite (12.5%)	3,375	675	84.1 gal	.60/gal	18,418	21,793
Calcium Hypochlorite (Powder)	2,175	435	154.3 lbs	.65/lb	36,607	37,042

Notes:

1. Equipment costs are the sum of the costs of the equipment listed above and are averaged for five years
2. Chemical costs vary in each region/area depending upon many factors including freight, yearly supply contracts, volume used, etc. Local costs should be determined to predict operating costs more accurately.
3. Total costs are the sum of the yearly equipment cost plus the annual chemical costs. Not included are yearly maintenance costs (estimated at 10% of equipment cost), yearly operating (power) costs.

### Application 3

Chlorine gas feed required -  $10 \text{ MGD} \times 8.34 \times 5 \text{ ppm} = 417 \text{ PPD}$  of chlorine or  $1575 \times 5 = 7.875 \text{ kg/h}$  of chlorine

Basis - Chlorine supplied in four (4) ton (2000 pounds) (910 kg) containers, with two (2) two (2) ton liquid manifolds with liquid feed (\$1,000), two (2) chlorine vaporizers (22,000), two (2) automatic controlled chlorine feeders (\$9,000), one (1) induction mixer (\$4,000), one (1) chlorine residual analyzer (\$5,000), two (2) gas detectors (\$2,800), two (2) two ton container scales (\$6,000), two (2) SCBA gas masks (\$2,000), one (1) Chlorine Institute Emergency Kit B (\$2,500), rubber gloves, rubber apron and goggles (\$75).

Equivalent **sodium hypochlorite** -  $417 \times 0.84 = 350.3$  gallons of 12.5 % sodium hypochlorite or  $7.875 \times 0.00703 \times 1000 \times 24 = 1.32 \text{ m}^3$  of 12.5 % sodium hypochlorite

Basis - Sodium hypochlorite supplied from delivery trucks and pumped into a 10,000 gallon (37.8 m<sup>3</sup>) on-site storage tank (\$10,000), and fed with two (2) chemical feed pumps (\$4,000), one (1) chlorine residual analyzer (\$5,000), rubber gloves, rubber apron and goggles (\$75).

Equivalent **calcium hypochlorite (powder or tablet)** -  $417 \times 1.54 = 642.2$  pounds of 65 % or  $7.875 \times 1.54 \times 24 = 291.1 \text{ kg}$  of 65 %

(Note - **Calcium hypochlorite (powder and tablet)** feed systems are usually less than the 642.2 pounds per day (291.1 kg/h) of this application. Since Application 3 exceeds the normal feed requirements, a cost analysis is not included for powder or tablets.)

Disinfection Agent	Total Equipment Cost (\$)	Yearly Equipment Cost (\$) (1)	Chemical Consumption per day	Chemical Cost (\$/unit) (2)	Annual Chemical Cost (\$)	Total annual cost (\$) (3)
Chlorine Gas	54,375	10,875	417 lbs	0.15/lb	22,830	33,705
Sodium Hypochlorite (12.5%)	19,075	3,815	350.3 gal	0.40/gal	51,143	54,958

Notes:

1. Equipment costs are the sum of the costs of the equipment listed above and are averaged for five years
2. Chemical costs vary in each region/area depending upon many factors including freight, yearly supply contracts, volume used, etc. Local costs should be determined to predict operating costs more accurately.
3. Total costs are the sum of the yearly equipment cost plus the annual chemical costs. Not included are yearly maintenance costs (estimated at 10% of equipment cost), yearly operating (power) costs.

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Design improvements may be made without notice.  
Represented by:



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