State Water Resources Control Board
Division of Drinking Water
February 2018

Example Calculations of Chlorine Dosage

Note: Percent sodium hypochlorite (%NaOCl) is based on weight per volume (w/v) in the equations below. Specific gravity is incorporated as part of the solution strength (% w/v).

Equation 1A: Average Dose - Chlorine dosage (mg/L) measured as Cl_2:

Eq. 1A: Cl_2 Dosage, mg/L = $\frac{9{,}525 \times (\text{gallons of NaOCl solution injected}) \times (\%\text{NaOCl w/v})}{(\text{gallons of water produced})}$

Dosage Example 1: Over a seven day period, a system produced 40,000 gallons of water. In that time period, the system used 41.64 liters of 0.5% NaOCl solution (w/v). What is the average chlorine dosage in mg/L?

Step 1: Convert liters of NaOCl solution injected to gallons:

Unit conversion: 1 gallon = 3.785 L;

$$\#\,\text{gallons} = 41.64\ \text{L} \times \frac{1\ \text{gal}}{3.785\ \text{L}} = \mathbf{11\ gal}$$ (Use this value to input into **Eq.1**)

Solution, using Eq. 1A:

$$Cl_2\ \text{Dosage, mg/L} = \frac{9{,}525 \times (11\ \text{gal of NaOCl injected}) \times (0.5\%\ \text{NaOCl w/v})}{40{,}000\ \text{gallons of water produced}} = \mathbf{1.31\ mg/L\ as\ Cl_2}$$

Equation 2A: Chlorine dosage (mg/L) measured as Cl_2:

Eq. 2A: Cl_2 Dosage, mg/L = $\frac{2.52 \times (\text{mL/min of NaOCl solution injected}) \times (\%\text{NaOCl w/v})}{(\text{flow, gpm})}$

Dosage Example 2: The chemical feed rate is 40 mL/min of 0.25% NaOCl solution (w/v) and flow is 35 gpm. What is the chlorine dosage in mg/L as Cl_2?

Solution 1 using Eq. 2A:

$$Cl_2\ \text{Dosage, mg/L} = \frac{2.52 \times (40\ \text{mL/min of NaOCl injected}) \times (0.25\%\ \text{NaOCl w/v})}{35\ \text{gpm}} = \mathbf{0.72\ mg/L\ as\ Cl_2}$$

Example Calculations of NaOCl Solution Strength (% w/v)

Note: The equations for sodium hypochlorite solution strength preparation are based on mixing 12.5% NaOCl (w/w) to 10 gallons of water.

Equations 1B & 2B: Volume (ounces) of 12.5% NaOCl added to 10 gallons of water for target solution strength (valid between 0.047 to 3.5% NaOCl, w/v):

Eq. 1B (Valid between 0.047 to 1% NaOCl solution strength, w/v):

Ounces of 12.5% NaOCl added per 10 gallons of water = $6.2715 \times (\%NaOCl)^2 + 85.108 \times (\%NaOCl)$

Eq. 2B (Valid between 1 to 3.5% NaOCl solution strength. w/v):

Ounces of 12.5% NaOCl
added per 10 gallon of water = $9.2551 \times (\%NaOCl)^2 + 77.091 \times (\%NaOCl) + 5.6136$

%Solution Strength Preparation Example 1: How many ounces of 12.5% NaOCl added to 10 gallons of water are required to make a 0.5% NaOCl solution (w/v)?

Solution, using Equation 1B:

$$\text{Ounces of } 12.5\%\ \text{NaOCl} = 6.2715 \times (0.5\%\ \text{NaOCl})^2 + 85.108 \times (0.5\%\ \text{NaOCl}) = \mathbf{44\ oz}$$

(This is the volume amount of 12.5% NaOCl added to 10 gal of water)

Table 1 on the following page list the NaOCl solution strengths from 0.047 to 3.5% (w/v) based on the volume of 12.5% NaOCl added to 10 gallons of water.

For example, if 20 oz. (2.5 cups) of 12.5% NaOCl (w/w) with a specific gravity (SG) of 1.2 is added to 10 gallons of water, the percent strength (w/v) is 0.2307% (table).

To determine the amount of liquid chlorine (12.5%) added to 25 gallons of water, multiply the results for a 10 gallon solution by 2.5 (2.5 x 20 oz. = 50 oz.).

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Table 1: %NaOCl (w/v) based on volume of 12.5% NaOCl (w/w) added to 10 gallons of water.

oz	cups	L	Gal	% w/v NaOCl
4	0.50	0.12	0.03	0.0470
6	0.75	0.18	0.05	0.0701
8	1.00	0.24	0.06	0.0931
10	1.25	0.30	0.08	0.1162
12	1.50	0.35	0.09	0.1393
14	1.75	0.41	0.11	0.1623
16	2.00	0.47	0.13	0.1854
18	2.25	0.53	0.14	0.2076
20	2.50	0.59	0.16	0.2307
22	2.75	0.65	0.17	0.2538
24	3.00	0.71	0.19	0.2761
26	3.25	0.77	0.20	0.2982
28	3.50	0.83	0.22	0.3213
30	3.75	0.89	0.23	0.3437
32	4.00	0.95	0.25	0.3658
34	4.25	1.01	0.27	0.3879
36	4.50	1.06	0.28	0.4100
38	4.75	1.12	0.30	0.4326
40	5.00	1.18	0.31	0.4547
42	5.25	1.24	0.33	0.4768
44	5.50	1.30	0.34	0.4985
46	5.75	1.36	0.36	0.5206
48	6.00	1.42	0.38	0.5418
50	6.25	1.48	0.39	0.5635
54	6.75	1.60	0.42	0.6068
58	7.25	1.72	0.45	0.6498
62	7.75	1.83	0.48	0.6932
66	8.25	1.95	0.52	0.7353
70	8.75	2.07	0.55	0.7777
74	9.25	2.19	0.58	0.8199
78	9.75	2.31	0.61	0.8614
82	10.25	2.43	0.64	0.9027
86	10.75	2.54	0.67	0.9441
90	11.25	2.66	0.70	0.9856
94	11.75	2.78	0.73	1.0241
98	12.25	2.90	0.77	1.0647
102	12.75	3.02	0.80	1.1064
106	13.25	3.13	0.83	1.1470
110	13.75	3.25	0.86	1.1887
114	14.25	3.37	0.89	1.2294
118	14.75	3.49	0.92	1.2611
122	15.25	3.61	0.95	1.3018
126	15.75	3.73	0.98	1.3438
128	16.00	3.785	1.00	1.3641
134	16.75	3.96	1.05	1.4164
138	17.25	4.08	1.08	1.4572

oz	cups	L	Gal	% w/v NaOCl
142	17.75	4.20	1.11	1.499
146	18.25	4.32	1.14	1.540
150	18.75	4.44	1.17	1.572
154	19.25	4.55	1.20	1.613
158	19.75	4.67	1.23	1.645
162	20.25	4.79	1.27	1.686
166	20.75	4.91	1.30	1.719
170	21.25	5.03	1.33	1.760
174	21.75	5.15	1.36	1.792
178	22.25	5.26	1.39	1.833
182	22.75	5.38	1.42	1.866
186	23.25	5.50	1.45	1.907
190	23.75	5.62	1.48	1.939
194	24.25	5.74	1.52	1.970
198	24.75	5.86	1.55	2.013
204	25.50	6.03	1.59	2.064
210	26.25	6.21	1.64	2.118
216	27.00	6.39	1.69	2.161
222	27.75	6.57	1.73	2.215
228	28.50	6.74	1.78	2.266
234	29.25	6.92	1.83	2.320
240	30.00	7.10	1.88	2.363
246	30.75	7.28	1.92	2.415
252	31.50	7.45	1.97	2.469
256	32.00	7.57	2.00	2.500
264	33.00	7.81	2.06	2.564
270	33.75	7.98	2.11	2.608
276	34.50	8.16	2.16	2.660
282	35.25	8.34	2.20	2.704
288	36.00	8.52	2.25	2.758
294	36.75	8.69	2.30	2.800
300	37.50	8.87	2.34	2.844
306	38.25	9.05	2.39	2.899
312	39.00	9.23	2.44	2.940
318	39.75	9.40	2.48	2.985
324	40.50	9.58	2.53	3.026
330	41.25	9.76	2.58	3.071
336	42.00	9.94	2.63	3.116
342	42.75	10.11	2.67	3.168
348	43.50	10.29	2.72	3.202
354	44.25	10.47	2.77	3.254
360	45.00	10.65	2.81	3.289
366	45.75	10.82	2.86	3.330
372	46.50	11.00	2.91	3.375
378	47.25	11.18	2.95	3.420
384	48.00	11.36	3.00	3.462

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Example Calculations of NaOCl Feed Rate (mL/min)

Equation 1C: Chemical feed rate calculation:

Eq. 1C:

$$\text{Feed Pump, mL/min} = \frac{(Cl_2 \text{ dosage, mg/L}) \times (\text{Flow, gpm}) \times 0.3785}{\%\ \text{NaOCl solution (w/v)}}$$

Feed Pump Rate Example 1: Water flow is 35 gpm and chlorine solution strength is 0.7% NaOCl (w/v). What is the chemical feed rate (mL/min) needed to achieve a chlorine residual of 1.3 mg/L as Cl_2?

Solution, using Equation 1C:

$$\text{Feed Pump (mL/min)} = \frac{1.3\ \text{mg/L} \times 35\ \text{gpm} \times 0.3785}{0.7\%\ \text{NaOCl}} = \mathbf{25\ mL/min}$$

Feed Pump Rate Example 2: Water flow is 40 gpm and chlorine solution strength is 0.2307% NaOCl (w/v). Using the table below, what is the chemical feed rate (mL/min) needed to achieve a chlorine residual of 1.5 mg/L as Cl_2?

Solution, using Table 2:

From Table 2, go to the column that has 0.2307% NaOCl. Move down the column until you intercept the far left row that has 40 gpm.

The feed rate is 68.9 mL/min at 40 gpm for a target dosage of 1 mg/L as Cl_2. Since we want to target a chlorine residual of 1.5 mg/L, multiply the feed rate by 1.5 (68.9 mL/min x 1.5) and the required feed rate is 103 mL/min.

Note: If flow exceeds the table value (i.e., 80 gpm), then lookup the chemical feed rate for 40 gpm and double the results.

Unit conversions:

Using the results (103 mL/min) from Example 2, convert the units to L/hr, L/day, gal/hr and gal/day.

$$\#\frac{\text{L}}{\text{hr}} = \frac{103\ \text{mL}}{\text{min}} \times \frac{60\ \text{min}}{1\ \text{hr}} \times \frac{1\ \text{L}}{1{,}000\ \text{mL}} = \mathbf{6.18}\ \frac{\mathbf{L}}{\mathbf{hr}};$$

$$\#\frac{\text{gal}}{\text{hr}} = \frac{6.18\ \text{L}}{\text{hr}} \times \frac{1\ \text{gal}}{3.785\ \text{L}} = \mathbf{1.63}\ \frac{\mathbf{gal}}{\mathbf{hr}}$$

$$\#\frac{\text{L}}{\text{day}} = \frac{6.18\ \text{L}}{\text{hr}} \times \frac{24\ \text{hr}}{1\ \text{day}} = \mathbf{148}\ \frac{\mathbf{L}}{\mathbf{day}};$$

$$\#\frac{\text{gal}}{\text{day}} = \frac{148\ \text{L}}{\text{day}} \times \frac{1\ \text{gal}}{3.785\ \text{L}} = 39\ \frac{\mathbf{gal}}{\mathbf{day}}$$

Table 2:

Flow gpm	Chemical Feed Rate (mL/min) for a Target Dose of 1 mg/L as Cl_2 Based on %NaOCl Solution Strength (w/v)										
	0.04705% 4 oz	0.09309% 8 oz	0.13928% 12 oz	0.1854% 16 oz	0.2307% 20 oz	0.2761% 24 oz	0.3213% 28 oz	0.3658% 32 oz	0.4100% 36 oz	0.45471% 40 oz	0.4985% 44 oz
10	84.5	42.7	28.5	21.4	17.2	14.4	12.4	10.9	9.7	8.7	8.0
15	126.7	64.0	42.8	32.2	25.8	21.6	18.6	16.3	14.5	13.1	12.0
20	168.9	85.4	57.1	42.9	34.5	28.8	24.7	21.7	19.4	17.5	16.0
25	211.2	106.7	71.3	53.6	43.1	36.0	30.9	27.2	24.2	21.9	19.9
30	253.4	128.1	85.6	64.3	51.7	43.2	37.1	32.6	29.1	26.2	23.9
35	295.6	149.4	99.9	75.0	60.3	50.4	43.3	38.0	33.9	30.6	27.9
40	337.9	170.7	114.1	85.8	68.9	57.6	49.5	43.5	38.8	35.0	31.9
45	380.1	192.1	128.4	96.5	77.5	64.8	55.7	48.9	43.6	39.3	35.9
50	422.3	213.4	142.7	107.2	86.1	72.0	61.8	54.3	48.5	43.7	39.9
55	464.6	234.8	156.9	117.9	94.8	79.2	68.0	59.7	53.3	48.1	43.8
60	506.8	256.1	171.2	128.6	103.4	86.4	74.2	65.2	58.2	52.4	47.8

Flow gpm	Chemical Feed Rate (mL/min) for a Target Dose of 1 mg/L as Cl_2 Based on %NaOCl Solution Strength (w/v)										
	0.54177% 48 oz	0.6498% 58 oz	0.7777% 70 oz	0.9027% 82 oz	1.024% 94 oz	1.147% 106 oz	1.261% 118 oz	1.384% 130 oz	1.499% 142 oz	1.613% 154 oz	1.719% 166 oz
10	7.3	6.1	5.1	4.4	3.9	3.5	3.2	2.9	2.7	2.5	2.3
15	11.0	9.2	7.7	6.6	5.8	5.2	4.7	4.3	4.0	3.7	3.5
20	14.7	12.2	10.2	8.8	7.8	6.9	6.3	5.7	5.3	4.9	4.6
25	18.3	15.3	12.8	11.0	9.7	8.7	7.9	7.2	6.6	6.2	5.8
30	22.0	18.4	15.3	13.2	11.7	10.4	9.5	8.6	8.0	7.4	6.9
35	25.7	21.4	17.9	15.4	13.6	12.1	11.0	10.1	9.3	8.6	8.1
40	29.3	24.5	20.4	17.6	15.5	13.9	12.6	11.5	10.6	9.9	9.2
45	33.0	27.5	23.0	19.8	17.5	15.6	14.2	12.9	11.9	11.1	10.4
50	36.7	30.6	25.6	22.0	19.4	17.3	15.8	14.4	13.3	12.3	11.6
55	40.3	33.6	28.1	24.2	21.4	19.1	17.3	15.8	14.6	13.6	12.7
60	44.0	36.7	30.7	26.4	23.3	20.8	18.9	17.2	15.9	14.8	13.9

Flow gpm	Chemical Feed Rate (mL/min) for a Target Dose of 1 mg/L as Cl_2 Based on %NaOCl Solution Strength (w/v)										
	1.833% 178 oz	1.939% 190 oz	2.064% 204 oz	2.215% 222 oz	2.363% 240 oz	2.533% 260 oz	2.704% 282 oz	2.899% 306 oz	3.071% 330 oz	3.254% 354 oz	3.462% 384 oz
10	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2
15	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2.0	1.8	1.7
20	4.3	4.1	3.9	3.6	3.4	3.1	2.9	2.7	2.6	2.4	2.3
25	5.4	5.1	4.8	4.5	4.2	3.9	3.7	3.4	3.2	3.1	2.9
30	6.5	6.2	5.8	5.4	5.1	4.7	4.4	4.1	3.9	3.7	3.4
35	7.6	7.2	6.7	6.3	5.9	5.5	5.2	4.8	4.5	4.3	4.0
40	8.7	8.2	7.7	7.2	6.7	6.3	5.9	5.5	5.2	4.9	4.6
45	9.8	9.2	8.7	8.1	7.6	7.1	6.6	6.2	5.8	5.5	5.2
50	10.8	10.3	9.6	9.0	8.4	7.8	7.3	6.9	6.5	6.1	5.7
55	11.9	11.3	10.6	9.9	9.2	8.6	8.1	7.5	7.1	6.7	6.3
60	13.0	12.3	11.6	10.8	10.1	9.4	8.8	8.2	7.8	7.3	6.9

Note: The ounces (oz) below the % strength in each column is the number of ounces of 12.5% NaOCl (w/w) mixed with 10 gallons of water to produce the solution strength (% w/v).