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# CHEMIGATION OR FERTIGATION INJECTION RATE WORKSHEET FOR WATER CONCENTRATION-BASED APPLICATIONS

## Chemigation Calculation Worksheet Series

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# Chemigation or Fertigation Injection Rate Worksheet for Water Concentration-Based Applications

This worksheet helps growers, consultants, or fieldmen to calculate the necessary **chemical or liquid fertilizer** injection rate into irrigation systems when the goal is to **control the concentration of the injected solution in the water in parts per million (ppm)**.


Chemigation pump set up to inject fertilizers and agricultural chemicals for distribution to field crops with the irrigation water.

## Required Information:

1. Irrigation system flow rate.
2. Target product concentration in the water, specified in parts per million (ppm).
3. Percentage of active ingredient in the injected chemical solution from the label.
4. Specific gravity of the injected chemical solution. This is the ratio of the weight of the solution with respect to water. This is often found on the product label. Sometimes the label instead gives either the density or the specific weight, which is equivalent to the density, in pounds per gallon. This density number (lb/gal) is divided by the density of water, which is 8.35 lb/gal, to give the specific gravity. The specific gravity of the solution should be a number relatively close to one.

**Example:** Sodium hypochlorite (liquid chlorine or bleach) 12.5% solution is to be injected to control algae and bacterial growth in drip lines. The material safety data sheet (MSDS) sheet gives a specific gravity of 1.2 for the 12.5% solution. A continuous feed injection will occur to achieve a desired concentration of 3 ppm. The water flow rate is 460 gallons per minute. The run time is for 12 hours.

| INJECTION RATE: Determine the injection rate in gallons per hour. | | |
|---|---|---|
| | **Example** | **Your System** |
| **A. Flow Rate**<br>Irrigation water flow rate | **460 gal/min** | |
| **B. Injection Run Time**<br>Length of time to have desired product concentration in the irrigation water (hr) | **12 hr** | |
| **C. Product Concentration in Irrigation Water**<br>Desired chemical concentration in water in parts per million (ppm) | **3 ppm** | |
| **D. Product Active Ingredient Concentration**<br>Percentage of active ingredient of chemical from the product label | **12.5%** | |
| **E. Specific Gravity of the Solution**<br>From the label. Can be calculated using the chemical density in lb/gal and the density of water which is 8.3 lb/gal. (E = density ÷ 8.35) | **1.2** | |
| **F. Injection Rate**<br>(0.006* × Water flow (gal/min) x Chemical concentration ÷ Concentration as a % ÷ Specific gravity. (F = 0.006 × A × C ÷ D ÷ E) | 0.006 × 460 gal/min x 3 ppm ÷ 12.5% ÷ 1.2 =<br>**0.55 gal/hr** | |
| **G. Total Volume Used**<br>Volume of chemical used in gallons (Injection rate × Run time) (G = B × F) | 12 hr × 0.55 gal/hr =<br>**6.6 gal** | |
| *The 0.006 value included in the injection rate calculation is to account for the conversion of units, including hours to minutes, percentages, and parts per million (60 min/hr × 100 % ÷ 1,000,000 ppm = 0.006). | | |

## Diluting to Increase the Injection Rate to Match the Pump's Effective Range.

Most chemigation pumps are not capable of accurately injecting at such low injection rates (0.55 gallons per hour in our example). In this case, water is added to the chemical (diluted) to increase the total injected volume to a more convenient total volume. Some chemicals and their storage and delivery methods don't allow for dilution; in this case, a low volume (peristaltic) pump must be used.

To calculate the new injection rate for a diluted chemical, use the simple equation **Injection Rate = Volume ÷ Time**. In this example, water is added to the calculated 6.6 gallons of chemical (or the chemical is added to the water) to increase the total injected volume (including the chemical) to 150 gallons. This new volume is then used to calculate the new injection rate:

150 gal ÷ 12 hr = **12.5 gal/hr**

Alternatively, water can be added to match a targeted injection rate that the pump is capable of pumping accurately. The equation is rearranged to be **Volume = Injection Rate × Time**. For example, if the target injection rate was 18 gal/hr, the required total injected volume (including the chemical) can be calculated as:

18 gal/hr × 12 hr = **216 gal**

Therefore, in this case water would be added to the 6.6 gallons of chemical, or the chemical is added to water, to create a total volume of 216 gallons of injected chemical. This means adding 209 (216 total – 6.6 gallons of chemical) gallons of water.

Some helpful conversions for calibration testing:

| Multiply: | By: | To Get: |
|---|---|---|
| gallons/hour | 2.13 | ounces/minute |
| gallons/hour | 63.09 | milliliters/minute |

## Additional Resources

Burt, C., K. O'Conner, and T. Ruehr. 1998. Fertigation. San Luis Obispo: California Polytechnic State University.

Carpenter, J., and W.S. Johnson. 1997. Pesticide Chemigation through Pumped Irrigation Systems. *University of Nevada Cooperative Extension Publication* FS-97-37. University of Nevada.

DeValerio, J., D. Nistler, R. Hochmuth, and E. Simonne. 2015. Fertigation for Vegetables: A Practical Guide for Small Fields. *University of Florida IFAS Extension Publication* HS1206. University of Florida.

Haman, D. Z., and F. Zazueta. 2014. Chemigation Injection Methods for Irrigation. *University of Florida IFAS Extension Publication* CIR864. University of Florida.

Kranz, W., C. Burr, J. Hay, J. Schild, and D. Yonts. 2016. Using Chemigation Safely and Effectively: Training Manual. University of Nebraska Extension.

Liu, G., and G. McAvoy. 2015. How to Reduce Clogging Problems in Fertigation. *University of Florida IFAS Extension Publication* HS1202. University of Florida.

Peters, R.T., T. Hoffmann, and W.H. Neibling. 2011. Calculating Chemigation Injection Rates. *Washington State University Extension Publication* FS035E. Washington State University.

Use pesticides with care. Apply them only to plants, animals, or sites as listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.





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