Tech Brief

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Calibrating Liquid Feed Pumps

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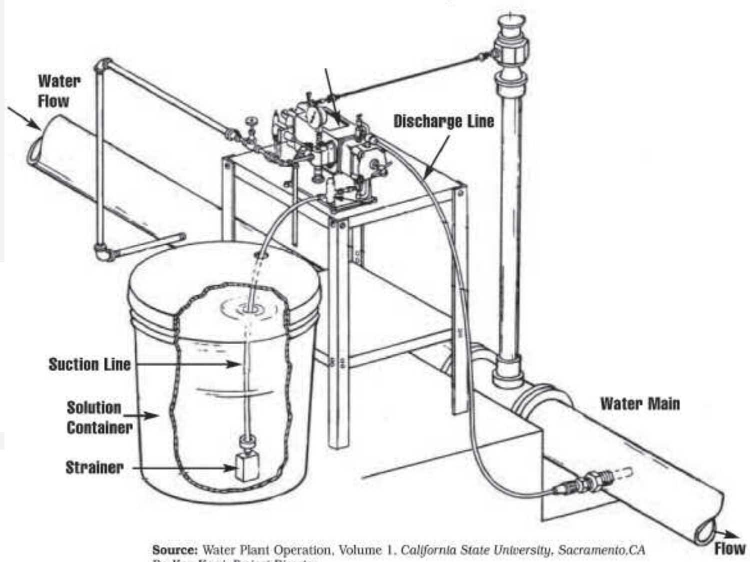
Summary

Liquid feeder pumps are used to inject various chemicals needed for effective water and wastewater treatment. Calibrating these pumps helps control and optimize feeding rates, which in turn provides better water quality at a lower cost. This *Tech Brief* discusses how to calibrate liquid feed pumps.

Chemical Feed Pump



Source: Water Plant Operation, Volume 1, *California State University, Sacramento,CA Dr. Ken Kerri, Project Director*

What is a liquid feed pump?

A liquid feed pump is a mechanical device that injects a chemical solution into a waterline, tank, or well. These pumps are used at various points in the treatment process, including adding coagulants and disinfectants. Because water treatment requires specific amounts of these chemicals, it is important that the feeder pumps be correctly calibrated so the doses are precise.

There are three main types of liquid feed pumps:

1. Peristaltic—A pump tube is placed around a roller. As the roller rotates, pressure is built up causing suction to occur on the inlet side of the tubing, similar to squeezing a toothpaste tube.
2. Motor Driven—These pumps can pump large volumes up to 3,000 gallons per day (GPD).
3. Metering Pump— Small electric motors run these pumps. They have a piston inside the pump that is attached to a round diaphragm. As the pump turns, it moves the diaphragm in and out, causing suction to occur.

Choosing a Liquid Feed Pump

When choosing a chemical feed pump, consider these factors:

- type of chemical to be pumped;
- GPD required or dose range anticipated;
- plant production rate, usually expressed as million gallons per day (MGD);

- pressure on the line being pumped into;
- type of fittings required (1/4”, 3/8”, or 1/2” tubing fittings or national pipe thread (NPT) fittings; and
- price range required or money available.

Sizing Liquid Feed Pumps

To determine the appropriate pump size, you’ll need three pieces of information:

1. The well pump output rate or the water plant production rate (do not confuse this with the flow rate, which is delivered by one or two taps in a home or building.) The well output rate measures how fast the well pump refills the pressure tank, normally expressed as gallons per minute (gpm);
2. The required dosage is normally expressed in parts per million (ppm) or milligrams per liter (mg/l). Jar testing can help you detemine the dosage.
3. The solution strength of the chemical you will be feeding is usually expressed as ppm.

From this information, write the formula as follows:

(Well Pump (Pump Output Rate (gpm)) x Required Dosage (ppm) x 1440) ÷ Solution Strength (ppm) = Feed Output in gal/day (gallons per day)

Calibrating Liquid Feed Pumps

To properly adjust a liquid feed pump, use the following materials:

- a 100 ml to 1,000 ml graduated cylinder, depending on the feeder size. In some cases larger measuring devices may be necessary;
- calculator;
- pencil and graph paper;
- a stopwatch, wristwatch, or clock to measure time with accuracy to the nearest second; and
- a straight edge or ruler.

If the chemical feeder discharges to an open surface tank, use the graduated cylinder to collect the liquid at the point of discharge. If the discharge line of the feeder doses into a pipeline that is under pressure, you may find it easier to calibrate the feeder from the suction side of the feeder. If you use the suction line to do the calibrating, be sure that the feeder is properly primed and that you subtract the volume of the suction line from the measured volume.

Adjust the feeder rate control to at least three, but preferably four to five different settings, keeping above 10 percent and below 90 percent on the rate control because of the reduced accuracy in these ranges. Normally you should perform three calibrations at each setting, and then average the results. Carefully measure calibration times using a stopwatch or wristwatch that has an accuracy to at least the nearest second. Use measured times from one to five minutes to conduct calibrations. However, you will achieve greater accuracy using longer time periods. Preferably express calibration units in milliliters per minute (ml/min). You can convert this unit later to gallons per day (gal/day).

To illustrate this, take some numbers as if you calibrated the liquid chemical feed pump and put them in a table:

Table 1

Feeder Setting (%)	ml/min
10	53
30	141
50	229
70	317
90	405

After performing the calibrations with three repetitions (averaged) at each setting for the full range of settings, plot a graph to establish the relationship of the settings to the feed rates. The plotted graph from Table 1 is usually a straight line (Figure 1).

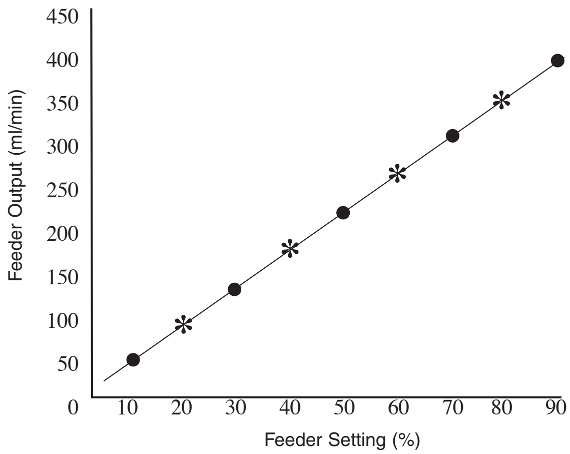


Figure 1

You can convert data from the feeder calibration in a number of ways. Here's a common example: Assume that a water plant, and thus the chemical feeder, will be operating around the clock. Using this approach, you can convert the calibration data (ml/min) to gallons per day (gal/day) as follows:

(ml/min) x (1 liter/1000ml x 1 gallon/3.785 liters x 1440 minutes/day) = gal/day

or

(ml/min) x 0.3804 = gal/day

Table 2

Feeder Setting (%)	ml/min	gal/day *Rounded to nearest 0.1*
10	53	20.2
20	*98	37.3
30	141	53.6
40	*185	70.4
50	229	87.1
60	*274	104.2
70	317	120.6
80	*362	137.7
90	405	154.1

**indicates data taken from the graph in figure 1*

Modify the data in Table 1 with the additional feeder settings from the graph (Figure 1).

Then determine the pounds of chemical to be fed per day based on the chemical solution feed strength. For example, some chemicals are mixed at 1/4 lb, 1/2 lb, or 1 pound per gallon of solution.

The conversion from gallons per day (gal/day) to pounds per day (lbs/day) is made by the following:

(gal/day) x (lbs/gal) = (lbs/day)

Let's use the example of a solution feed strength of 1/2 lbs/gal. In this case, the feeder calibration table will then be modified by adding another column as follows:

Table 3

Feeder Setting (%)	ml/min	gal/day *Rounded to nearest 0.1*	lbs/day
10	53	20.2	10.1
20	98	37.3	18.75
30	141	53.6	26.80
40	185	70.4	35.2
50	229	87.1	43.55
60	274	104.2	52.10
70	317	120.6	60.30
80	362	137.7	68.85
90	405	154.1	77.05

To get the final manipulation of the feeder calibration data, factor in the water production rate for the water plant using the formula:

ppm = lbs/MGD x 8.34

where;

ppm = parts per million or milligrams per liter (mg/l)

lbs = pounds per day

MGD = million gallons per day

8.34 = pounds is the weight of one gallon of water.

For example a small water plant with a design treatment capacity of 80 gpm would produce 115,200 gallons of water or 0.1152 MG (million gallons) in a 24-hour period (day).
At a 10 percent setting, calculate the chemical feed rate as follows:

ppm = 10.1/(.1152 x 8.34)

ppm = 10.5

By doing the same calculation for each feeder setting, you can modify the feeder calibration table by adding another column as follows:

Table 4

Feeder Setting (%)	ml/min	gal/day (Rounded to nearest 0.1)	lbs/day	ppm
10	53	20.2	10.1	10.5
20	98	37.3	18.75	19.5
30	141	53.6	26.80	27.9
40	185	70.4	35.2	36.6
50	229	87.1	43.55	45.3
60	274	104.2	52.10	54.2
70	317	120.6	60.30	62.8
80	362	137.7	68.85	71.7
90	405	154.1	77.05	80.2

Perform the calibrating procedures for each feeder and generate a table for each feeder. Make sure that a copy of these tables—similar to the above table (Table 4)—is accessible to all operating staff and even posted on the wall above each feeder to allow for quick, accurate adjustments of the chemical feed rates. Some operators prefer to graph the data provided in Table 4. See Figure 2 for a graphical representation of the "feeder setting" compared to "ppm" data in Table 4.

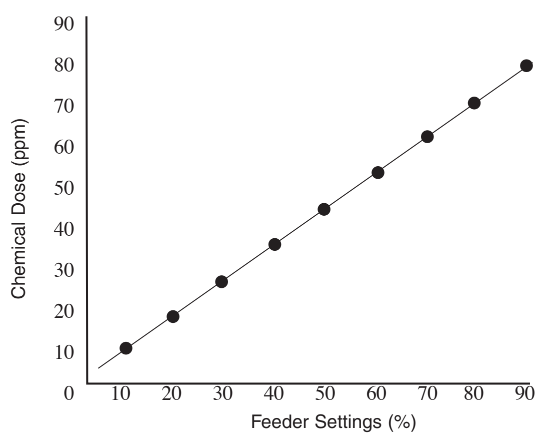


Figure 2

To get an idea of how to determine chemical feed rates, use the data in Table 4, or Figure 2. If you need chemical feed rates of less than 10 ppm, or greater than 90 ppm, reduce the chemical concentration. For example, reduce the concentration from 1/2 lb/ gallon to 1/4 lb/gallon, or increase from 1/2 lb/gallon to 1 lb/gallon.

You also will need to consider the saturation concentration of each chemical that you intend to feed. Some chemicals such as lime are very insoluble and require continuous mixing of the chemical solution tank.

The data in this *Tech Brief* will also indicate whether a particular chemical feeder is properly sized for the water plant production rate (MGD). The chemical feeder (equipment) represented in this *Tech Brief* will probably be too small for use at a five million gallon per day (MGD) or larger water plant, but should be useful in smaller applications.

Regardless of the treatment plant size, having correctly calibrated pumps means that the right chemical dosage is being applied. Not only is this critical for public health but it can also save your system money.

References:

Avery, John. 2007. "Chemical Feed Pumps—Beyond Disinfection." *Water Technology* (May).

Cobb, Craig. 1992. "Procedures Manual Memorandum." West Virginia State Health Department, Office of Environmental Health Services, Environmental Engineering Division. (March 18).

Pollard Water. 2008. *Water and Wastewater Catalog*. Accessed at *www.pollardwater.com*.

USA Blue Book. 2007. *Everything for Water & Wastewater Operations Catalog*. Accessed at *www.usabluebook.com*.

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