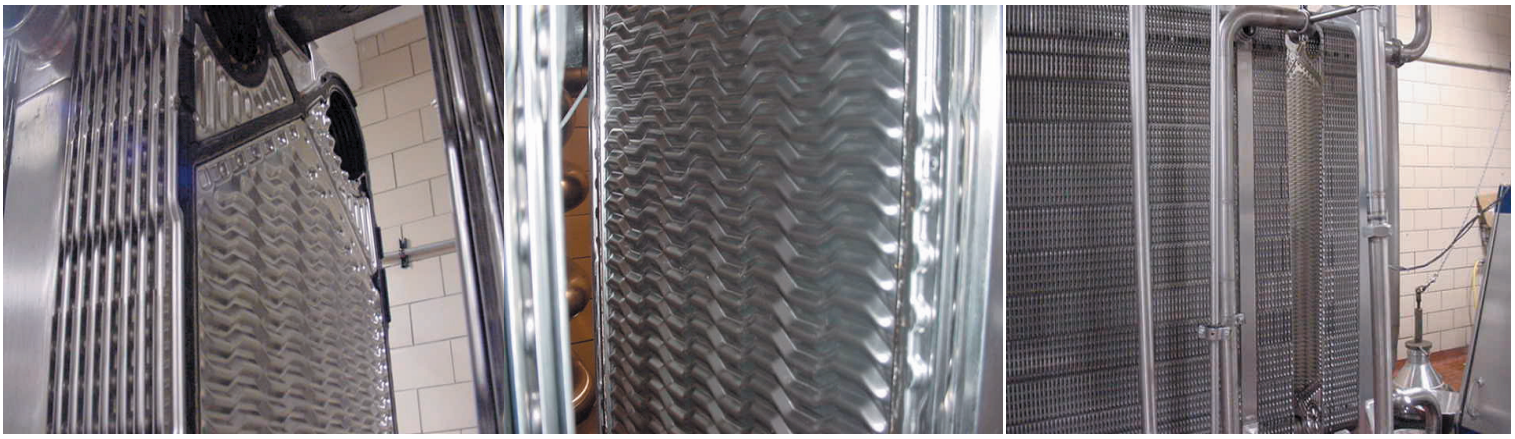

TECH TIPS

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How to Estimate the Volume of Pasteurizer

When putting together a bid for a prospects business or just starting up new business it sometimes becomes necessary to estimate the volume of a pasteurizer. Trying to establish the volume can be difficult because there isn't and easy way to measure a pasteurizer especially a plate heat exchanger based HTST. Here is a method I have found that is relatively quick, but not always easy. You will need a tape measure and a pad of paper and pen or pencil.

1st - Measure the balance Tank

This is pretty standard.
If it is a round tank, the old
"π r2 X H / 231" works. Or in other
words 3.142 times radius
(1/2 diameter) squared times the
height. Divide this by 231
(cubic inches per gallon)
to get the number of gallons.
If you want liters divide by 61.03.

For my example I will say the balance
tank is 36 inches in diameter and
16 inches in height.
That gives us 3.142 X 182 X 16 / 231.
(3.142 X 324 X 16 = 16288.)
Divide this by 231 and we get
70.5 gallons.
For metric it would be
91.4 centimeters/2 =45.7.
45.72 X 3.142 X 40.6 = 266,418.64
cubic centimeters or 266.42 liters.

If it is a rectangular or square balance tank take length times width times height in inches and divide by 231 to get gallons in the balance tank. Do the same in centimeters divide by 1000 to get liters.

If you want a real quick and dirty estimate of a HTST just double the balance tank. This is not very accurate at all, but is a quick way to guess.

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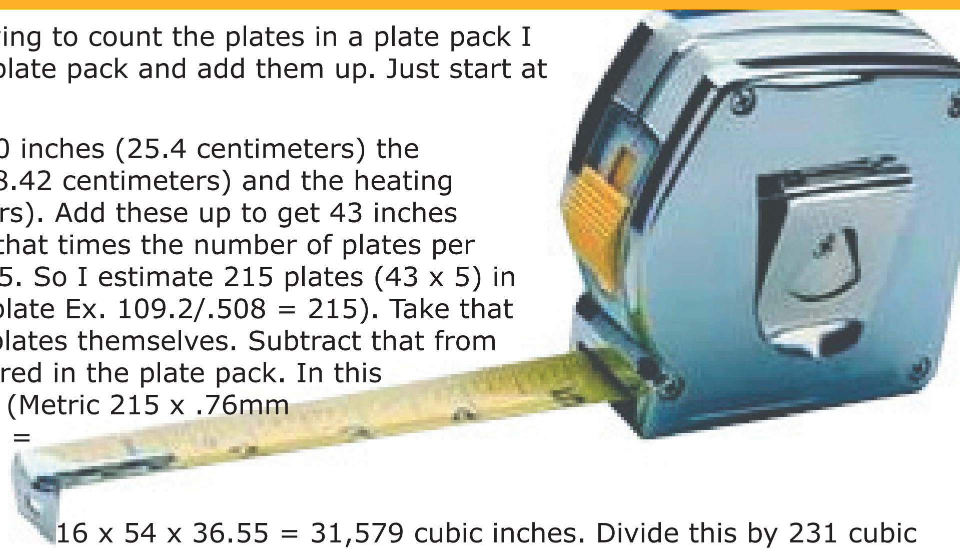
2nd - Measuring the Plate Pack

Now comes the hard part. Measure the size of the plates in the plate pack. This means the height top to bottom of the plates, remember the gasket is inside the outer edge so the actual product surface is smaller than the actual plate measurement. Now get the width of the plates. This can be tricky. Sometimes it is easier to measure the end plate then subtract the difference in from the edges. Now you have the length times width part of the equation. Write this down.

Now measure the number of plates per inch. Just hold the tape measure up to the plate pack and count how many plates there are per inch. It can vary anywhere from 4 to 6 plates per inch. (Sorry about that for the metric people, but you can just measure the distance from plate to plate in millimeters. Divide that into the total centimeters of plates measured to get the number of plates). Suppose I measure a pasteurizer and find the plates to be 54 inches (137.2 cm) in height and 16 inches (40.6 cm) in width. There are 5 plates per inch in this plate pack. (.508 cm per plate) We need to account for the plates themselves because they take up space as well. I find .03 -.05 inches (.76 mm) works. It depends on the thickness of the metal plates. Higher plates counts per inch tend to have thinner plates.

Here is where I cheat. Instead of trying to count the plates in a plate pack I measure the number of inches in a plate pack and add them up. Just start at one side and go to the other.



For example the cooling section is 10 inches (25.4 centimeters) the regeneration section is 23 inches (58.42 centimeters) and the heating section is 10 inches (25.4 centimeters). Add these up to get 43 inches (109.2 centimeters) of plates. Take that times the number of plates per inch. In this example that would be 5. So I estimate 215 plates (43 x 5) in this example. (Or divide by cm per plate Ex. 109.2/.508 = 215). Take that times .03 to get 6.45 inches of the plates themselves. Subtract that from the total inches of plates you measured in the plate pack. In this case 43 minus 6.45 = 36.55 inches. (Metric 215 x .76mm or .076 cm = 15.7 cm. 109.2 – 15.7 = 93.5 cm). Now it becomes a simple matter of length times height times width. In this example 16 x 54 x 36.55 = 31,579 cubic inches. Divide this by 231 cubic inches per gallon and we have 136.7 gallons. Add this volume to the balance tank volume. In our example that would be 70.5 gallons and we get an estimated pasteurizer volume of 207 gallons. If we wanted the volume in liters that would be 787.7 liters. (Just do all the measurements in metric. 40.6 centimeters x 137.2 centimeters x 92.84 centimeters = 517,148.5 cubic centimeters or 517 liters plus the balance tank volume of 266.4 liters and we get a total volume of 783.57 liters.

Some people will argue only half of the cooling plates and heating section plates have solution in them and they are correct. But what I have found is this volume is usually about equal to the volume of the holding tube so it ends up being a wash. This eliminates having to measure the holding tube.

Exceptions to the Rule:
Be careful to check to see if there is extra piping included with the pasteurizer during the wash. Some older, smaller plants will wash the pasteurized lines circuit with the pasteurizer. You will need to estimate the number of feet in these lines and add them to the total. Another exception is plants like condensed milk plants that will have a very extended holding time to denature the proteins in the milk. Some of these may be as long as ten minutes, so you are looking at a very long piece of pipe to fill and clean. You will need to either measure or estimate the number of feet in this piping. Use the following table to calculate the volume in extended piping.

measure INCH" meter measure foot' centimeter

Volume per foot of pipe (gallons)	
1 inch	.031
1 ½ inch	.077
2 inch	.143
2 ½ inch	.229
3 inch	.336
4 inch	.600

Just multiply the number of feet by the number that corresponds to the diameter of the pipe you are measuring.

The other thing to remember to add is the volume of the separator if one is included in the circuit. A typical separator is around 5 gallons, but a large separator can hold 7 gallons.

Once you get the hang of this it takes about 5-10 minutes to do the measurements and a couple minutes to do the math. Remember this is just an estimate, but I have found it to be close enough most of the time. You can be off 20-30 gallons one way or the other, but even if you are off 50 gallons on the high side, you are only looking at adding an additional gallon of caustic if you are targeting a 2% solution. Not bad for an estimate to get started.

Another tried and true method of calculating the volume of any circuit is back calculating from the caustic concentration.

If you know for sure the amount of caustic added to a wash circuit and know none of it is lost during the addition, you can titrate the solution and determine the volume of the system.

Example:
You added 7 gallons of caustic to the balance tank of a pasteurizer and tested 17 drops or 2.06% caustic.
(17 time the test kit factor .121 = 2.06%).

There are a couple methods to back calculate the volume.
I will show two ways.

Method II: Back Titrating from the Caustic Wash Method

We know 1.4 gallons of caustic added to 100 gallons of water gives a 1% solution of caustic. (1.4 liters caustic per 100 liters) In our example take 7 gallons divided by 1.4 gallons per 100 gallons = 500 gallons of a 1% solution. Now because we tested a 2.06% solution we need to divide 500 by 2.06 to come up with a volume of 242.7 gallons.

The other way is to calculate the volume based on a weight to weight basis. 7 gallons of a built caustic has 5.9 pounds of caustic per gallon. (Straight 50% caustic has 6.3 pounds per gallon) 7 times 5.9 = 41.3 pounds of caustic. We know by the test kit this makes up 2.06% by weight of the solution. So we divide 41.3 by 2.06% or .0206 if using a calculator without a percent key. This yields a result of 1991.75. Now we divide this by 8.3 which is what water weighs per pound. That gives a result of 239.99 or 240 gallons. As you can see either method gives a similar result. Being old school I tend to use the weight-to-weight method because if I know what the percent caustic is in the product added to make up the wash solution I can calculate the volume. The 1.4 gallons per hundred only works with a build caustic like Resource or Spec Tak G. For example if our prospect was using 50% caustic in our solution the answer would be 258 gallons instead of 240 gallons.

One way to get the weight of dry caustic in a gallon of liquid caustic is to look at the MSDS sheet. Most of the time it will show the Specific Gravity. Water has a specific gravity of 1.0. So if for example the MSDS for the product we are looking at shows a specific gravity of 1.43 we would take that times 8.3 (the weight of water in pounds) and get a weight of 11.87 pounds. If we know it is a 50% caustic we would have 5.9 pounds of caustic per gallon.

The titration method can be used on any system using caustic like evaporators, dryers, etc.

Triple Tube Pasteurizers
You can measure the length of the tubes in a triple tube and calculate the volume, but it becomes much trickier because it all depends on the diameters of the tubes used to make the triple tube. It becomes too complicated to explain here. You will probably have to use the titration method to get a volume.

Formulas:
Here are the formulas in their basic form.
Measuring Method English Measurements
(All measurements in inches) PH x PW x (P-N x .03) = X
(Volume of the plate pack) X/231 = gallons
X/231 + Y = Total Estimated Volume of the Pasteurizer.

Measuring Method Metric
(All measurements in centimeters)
PH x PW x (P-N x .076) = X
(Volume of the plate pack)

Where:
PH = Plate Height
PW = Plate Width
P = Measurement total of the plates in the plate pack
N = Number of plates in the plate pack
X = Volume of the plate pack
Y = Volume of the balance tank

Titration methods:
Volume of caustic added divided by 1.4 times 100.
Divide this result by the percent caustic concentratio
tested with the test kit. Result is volume of the system.
Example: 7 divided by 1.4 X 100 = 500.
Test kit concentration: 2.06.
500 divided by 2.06 = 242.7 gallons

Metric Example: 25 liters divided by 1.4 X 100 = 1785.7.
Test kit concentration: 2.06
1785.7 divided by 2.06 = 866.85 liters

Weight to weight method
Volume of caustic multiplied by the pounds of caustic per gallon.
Divide by percent caustic determined by the test kit.
Divide this result by 8.3 to get gallons of solution.
Example: 7 gallons times 5.9 pounds per gallon divided by 2.06 (.0206) = 2004. 2004 divided by 8.3 = 241 gallons

Metric Example: 25 liters times .708 kilogram per liter = 17.7 kilograms of caustic. 17.7 divided by .0206 = 859.22 kilograms/liters of solution

Q x P)/C= W
W/8.3 = Volume of the pasteurizer in gallons
For metric you would divide
Q = Quantity of caustic in gallons (or liters) added
P = Pounds (or kilograms) of dry caustic per gallon (or liter) of liquid caustic
C = Test concentration in percent
W= Weight of the solution in pounds or kilograms.
(For metric this would be the liters of solution.
You don't need to divide by anything to find the volume as a liter of water weighs roughly one kilogram.)

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