Minnesota

Dairy Products Processor

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MORE OF THE SAME

In the last issue of the "Processor" we took a look at a statistical technique for keeping tabs on butter composition. With little variation the same technique can be applied to volume control in a fluid milk plant, assuming that you don't have accurate check-filling devices built into the filler. Or you could use it for weight control in a butter printing operation.

THE FIRST STEP

It is desirable to know the sensitivity of a filler before you attempt to exert control over a filling operation. This can be determined by setting up a "frequency chart." You will need a reasonably sensitive balance for making weighings. That's all. Then you merely weigh samples from the processing line and note the weight of overfill or underfill and record the results.

DETERMINE NET WEIGHT

Net weight of product is the value you'll need. Net weight can be determined in three ways:

1. Take the gross weight (container plus product), empty the container, clean it and dry it. Weigh the empty container.

Then: Net Weight = Gross Weight - Container Weight

2. Pre-weigh marked containers. Weigh these containers after filling. Net weight is calculated as in (1).

3. Weigh 200 to 300 containers from a random sampling of 3 to 5 lots. Determine the average weight. Note the range in weight, also. If the range is small, you can use the average weight of containers as your weight factor.

PREPARING A "FREQUENCY" CHART

Frequency charts may be prepared by determining the overfill and underfill on, for example, one hundred packages. Set up your charts as follows:

Weight (grams or ounces)	Frequency (1)	Frequency (2)
+3.00	I	
+2.75		
+2.50	II	
+2.25		
+2.00	III	
+1.75	I	
+1.50	III	
+1.25	IIII	
+1.00	~~IIII~~	
+0.72	~~IIII~~ IIII	~~IIII~~ ~~IIII~~
+0.50	~~IIII~~ ~~IIII~~ ~~IIII~~ II	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~
+0.25	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~
0.00	~~IIII~~ ~~IIII~~	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~
-0.25	~~IIII~~ ~~IIII~~	~~IIII~~
-0.50	~~IIII~~ III	
-0.75	IIII	
-1.00		
-1.25	II	
-1.50		
-1.75	I	

In frequency (1) you will note that 65 percent of the samples (65 tick marks) were overweight, 10 percent were the declared weight, 25 percent were underweight. This is a rather wide distribution. It would be desirable to know if the filler is capable of finer adjustment. Note frequency (2) as an example of an adjustment which resulted in tighter control of fill around the declared weight value i. e., 70 percent overfill, 25 percent at declared weight, 5 percent underweight.

DEVELOPING CONTROL CHARTS

Once the filler is adjusted control charts may be developed for day to day control. Because it is easier to use gross weight than net weight you should start by determining the variance in the weight of containers:

1. Take a random sampling of containers using groups of five.

2. Determine the average weight of each container.

3. Determine the range in each group (the difference between the highest and lowest weight.)

4. Determine the average range (add five range factors together and divide by five).

5. Divide the average range by 2.326. (This is a statistical factor used only with groups of five.)

The answer you get is called a "standard deviation." Statistically then you can be assured that 95 times out of 100 the weight of any given container will fall within ± two "standard deviations" of the average weight.

As an example, assume the average weight of containers to be 50 grams, the standard deviation to be 1.0 Two standard deviations would be 2 x 1 = 2. And ± two standard deviations would be 50 + 2 = 52 and 50 -2 = 48 or a range of 48 to 52 grams. Ninety-five times out of 100 one of these containers would be expected to weigh between 48 and 52 grams.

After you have calculate a standard deviation for containers you must determine a standard deviation on the filler. Do this by the same procedure outlined for containers; by lots of five. Note the weight of products and the range in weight for each group of five. This can be done as you develop the "frequency chart."

You now have two values, a standard deviation on the weight of containers and a similar value on fill weight. Now the two values must be integrated. If we assume the values to be 0.15 and 0.27 respectively then the formula becomes:

Standard deviation = $\sqrt{(0.15)^2 + (0.27)^2}$

This is the square root of the sum of the square of each value.

Then: $\sqrt{(0.15)^2 + (0.27)^2} = \sqrt{.0225 + .0729} =$

$\sqrt{.0954} = .308$ or, rounding off .31

WHAT THIS VALUE MEANS

You now have the information you need to establish a gross weight factor, including container and product weight, for which you must aim in order to be assured of correct fill. The value you have calculated is another standard deviation.

Let us assume then that the fill you desire is 32.0 ounces, and the average weight of container is 1.9 ounces. Then 32.0 + 1.9 = 33.9 ounces, gross weight. If you aimed at 33.9 ounces as your target weight, many samples would go out underfilled because of the variations in container weight and filler capability. But if your target fill is set at two standard deviations above 33.9 than 95 out of 100 samples should be at correct fill or above.

Then, 33.9 + (2 x .31) = 33.9 + .61 = 34.51 ounces. This is the weight to shoot for.

CONTROL CHARTS

Control charts may be set up in the manner described in the last issue of this newsletter. We'll try to discuss this and show you some examples in the spring edition of the "Processor."

Reference: Much of this information was taken from a paper by F. R. Smith, Pet Milk Company, presented at the Dairy Products Institute, University of Minnesota, September 12, 1962.

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Dairy Products Processor

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