APEC
Automated Process Equipment Corporation

LIQUID ADDITION SYSTEMS SCALE V.S. METER

Introduction
- Accurate measurement saves money

General Considerations
- Ingredient Characteristics
  - Ingredient Flow Rate
  - Ingredient Temp, Viscosity, Density

Accuracy
- Scale Accuracy
- Meter Accuracy

Location
- Into the Batch Mixer
  - Scale Advantages
    - Very Accurate
    - Easily Checked for Accuracy
    - Easy to Calibrate
    - Cost Effective for Multiple Liquids
    - Can Batch Ahead and Hold
  - Scale Disadvantages
    - Can Have Problems with Compatibility of Liquids
    - Liquids Must Be Sequentially Batched
    - Scale Must Be Thermally Conditioned
    - Alarm Level Indicators Need To Be Used to Prevent Overflow Due to Valve Failure
    - Can Be Messy

  - Meter Advantages (coreolis meter)
    - Very Accurate
    - Easily Checked for Accuracy
    - No Moving Parts in Meter
    - Completely Enclosed So Mess Is Avoided
    - Hold Calibration Very Well
    - Multiple Liquids Can Be Metered At The Same Time
    - No Possibility For Cross Contamination of Ingredients
    - Typically Take Up Less Space

Meter Disadvantages

- Quite Costly
- Usually Requires A Special Instrument To Do Calibration
- Mounting and Placement Critical, follow mfg. recommendations

Post Pellet

Scale Advantages

- Very Accurate
- Easily Checked for Accuracy
- Easy to Calibrate

Scale Disadvantages

- Made More For Batch Applications
- Pelleting Systems Are Continuous Flow
- Requires A Large Amount Of Headroom
- Can Create More Stopping and Starting of Flow

Meter Advantages (coreolis meter)

- Very Accurate
- Easily Checked for Accuracy
- No Moving Parts in Meter
- Completely Enclosed So Mess Is Avoided
- Hold Calibration Very Well
- Multiple Liquids Can Be Metered At The Same Time
- No Possibility For Cross Contamination of Ingredients
- Typically Take Up Less Space

Meter Disadvantages

- Quite Costly
- Usually Requires A Special Instrument To Do Calibration
- Mounting and Placement Critical, follow mfg. recommendations

LIQUID ADDITION SYSTEMS: SCALE VS METER

Introduction:
There are a variety of ways that liquid additives can be introduced into a feed formulation. I will be covering the pros and cons of weighing vs metering of these additives. Volumetric methods for adding liquids to a feed formulation do not compare well with weighing of the liquid. These volumetric meters include oscillating piston meters, nutating disk meters, magnetic meters, and vortex shedding meters. These meters measure the volume of flow of the liquid. This is accomplished by either counting the number of times that a cavity is filled and emptied, or by indirect flow measurement such as measurement of the conductivity of the liquid, or measurement of turbulence that an obstruction in the line creates. Theses types of meters range in accuracy from +- .5% to 1%. This is of course based on the idea that the viscosity and the density of the liquid do not change. Changes in both viscosity (and temperature since it effects viscosity) and density will greatly effect the accuracy of these types of meters since they are only sensing the volume of flow.   There is a common misconception that if an ingredient is cheap, you can use a cheap method for measuring the ingredient because it doesn't cost much. If the ingredient is expensive, or if you use a large quantity of the ingredient, it can be shown that the more accurate methods of metering pay back quickly. For example if the volumetric meter that you are using has an accuracy of +- 1% that means that in order to insure that enough of the ingredient goes into the feed, you could be over formulating by 1%. It could also be true that a change in supplier or a change in the lot of ingredient that you have been using, or a change in the temperature, has caused a 1% error in the measurement that you are using, because the density of the product has changed, and you did not realize it. Lets suppose that you have a pelleting line running at 60tph and you are applying 3% fat to the pellets. The amount that you are applying is off by +1% of the desired flow. 120,000 x .03= 3600lbs x .01error = 36lbs/hr x 16hrs per day x 300 days = 172800lbs per year x .08 for eight cents a lb= $13,824.00 per year. A coriolis meter that is .1% accurate will cost about $ 5,000.00 so the meter has paid for itself in less then a year. Because of this I am going to concentrate on the metering technology that most closely resembles weighing.

General considerations:

When using ingredients in any process it is necessary to examine the characteristics of the ingredient to insure that the method of controlling and metering the ingredient is appropriate. These characteristics include density, viscosity, pH, percent needed to apply, desired accuracy, and optimal temperature. A chart can be created so that the various vendors

	Maximum	Minimum	Nominal	Density
Dry Flow Rate	________	________	_______	_______
Dry Material Particle Size	________			
Dry Material Angle of Repose	________			
Desired Accuracy	________			

	Maximum	Minimum	Nominal	Density
Liquid Flow Rate	________	________	_______	_______
Liquid Operating Temperature	________			
Liquid Viscosity at Operating Temperature	________			
Liquid PH	________			
Desired Accuracy	________			

. For example it is undesirable for copper or copper alloys to come into contact with animal fat. Tallow has a tendency to solidify at higher temperatures so it is desirable to heat trace equipment used in the application of this ingredient. Feeders and pumps should be sized for the appropriate flow for the desired percentage of ingredient being applied. When liquids are being applied at the pellet mill die, it is best if the cooler is a counter flow cooler, since this type of cooler does not have pans with perforations that can clog. If the cooler is a horizontal cooler , then if there is a way to gain some retention time to the liquid coated feed before it enters the cooler, it will greatly reduce the amount of build up in the cooler and air system. This can be nothing more then a short length of mixing conveyor that will give the liquid more time to absorb before entry into the cooler. When the ingredients are being applied after the cooling process, the application system should be placed as close as possible to the packaging or load out system, in order to minimize the build up of liquid ingredients on material handling equipment.

Scale Accuracy

When load cells are specified make sure that you get cells that are calibrated for 10,000 div.
A legal for trade scale is set up to match the load cells resolution of 1 part in 10,000
Scale resolution is one part in 10,000 of the scale rated full load capacity
This means that if a scale is rated for 20,000 lbs the resolution will be 2lbs
If the scale is rated for 100lbs the resolution will be .01
Resolution does not equal accuracy, for example if you wanted to weigh .1lbs you would not want to weigh this amount in a 100 lb scale because if you are off by 1 increment of the scale, then you are off by 10%. For most applications a variation of 10% would be unacceptable. So if you wanted to weigh .1lbs and you wanted to be within 1%, the maximum size scale that you could use is a 10 lb scale. 10/10,000= .001 x 100= .1
Other factors effecting accuracy include the feeding equipment into the scale. Is the automation system capable of stopping the feeding device in a timely fashion ?
Environmental, is the vibration in the area excessive ? Are there air currents that can effect the accuracy of the scale?

Meter Accuracy (coriolis)
A coriolis meter is based on the idea that a fluid will impart force on a tube when the flow changes direction. The coriolis meter is comprised of a u shaped tube, an electromagnetic drive coil, and two sensing coils. The u shaped tube is made to vibrate at a set frequency, usually around 80hz. This up and down vibration has a total movement of less then a tenth of an inch, and is stable when no fluid is flowing through the tube. When fluid flows through the tube, the direction of the fluid flow resists the up and down motion of the u shaped tube. As the fluid flows around the bend of the tube, the other side of the u shaped tube also resists the up and down motion of the tube. This resistance causes a twist in the tube and the sensing coils on either side of the tube pick up the difference between the two sides of the tube, and translate this into the degree of twist in the tube, which is directly proportional to the mass flowing through the tube.
Coriolis meters have an accuracy range from .1% to .2% of the flow, within the meters rated flow capacity. This means if the flow rate that is called for is 10lbs per min. the flow out of the meter will be between 9.99 and 10.01 lbs per min. These meters are setup from the factory to be spanned for the flow capacity that you will be running. It is important when ordering this type of meter to give the representative or factory as much information as you can about the characteristics of the liquid. These meters are very stable so once the meter has been calibrated, they rarely go out of calibration. There are some guidelines that have to be followed in the installation of these meters. The meters should be mounted so that they are being supported by the pipe that is supplying the fluid

to be measured. If the meter is ridgidly mounted on its own surface, separate from the pipe, then when the pipes move during expansion or contraction, the meter can be subjected to force that could damage the meter. If the weight of the meter causes the pipe to sag, then the pipe on either side of the meter should be supported. If the meter is to be located in an area where excessive vibration is present, then vibration dampening mounting adapters are available from most manufacturers. The vibration dampening is to protect the internal sensing elements, which could be damaged from long term exposure to excessive vibration. If a fluid such as tallow is being used, and the lines need to be heat traced, most manufacturers have trace kits that allow the meter to be electrically or steam heated. In many applications the lines into and out of the meter will be traced, and the residual heat is enough to keep the meter warm. In any case, the maximum temperature rating for the meter should not be exceeded (this is around 250 degrees F for the actual fluid temperature, with much higher temperatures available when specified). Most applications will have the sensing element mounted horizontally with the inlet and discharge pipes also running horizontally. If it is necessary to mount the meter vertically you need to make sure that the direction of flow is up through the meter, not down through the meter. The meter should always be kept full, so it is a good idea to have a short vertical run after the meter, rather then discharging out of the end of a horizontal pipe.

Scale vs Meter at the Batch Mixer

The first place that liquids are added to the feed is at the batch mixer. The amount of dry product is known because the batching system has weighed the product up before it went into the batch mixer. We will look at weighing and metering a liquid into the batch mixer. An 10,000 lb batch requires 3%fat. That means that the dry matter weight will be 9,700lbs and the fat addition will be 300lbs. The fat is weighed in a 500 lb liquid scale and we stop the flow within 2 scale increments so the final weight was 300.1 lbs. The accuracy of the scale is 1 part in 10,000 so the most error has occurred in the over draft in the scale which is .1, which equates to .04% We take the same amount of fat and add it to the mixer and it takes 1min. The rate is 240lbs per min. and the coriolis meter is accurate to +- .1% of flow, so 300lbs x .001= .3 lbs, which equates to .1%. This of course assumes that we can stop the flow through the meter instantly. A good control system could compensate the time it takes to shut off the flow of liquid in both cases, so overall the scale is a slightly more accurate way to add ingredients to the mixer. There are some other considerations regarding the scale. The scales themselves require inlet ball valves and discharge valves and also alarm level detectors in case the inlet valve fails to close. It is difficult to totally seal a scale hopper, since it should be vented in order to fill and discharge properly.   If the scale system valves malfunction, then you could have the scale, or the scale surge over flow, which is messy. The meter on the other hand is totally enclosed and if the shut off valve leaks, the meter should detect the flow, and sound an alarm, if the leaky valve is not detected, the fat runs into the mixer and not on the floor.

Scale vs Meter Post Pelleting

Scale

Since pelleting systems are continuous flow operations, it is difficult to batch weigh the product. This means that if we want to weigh the product in a post pelleting application, we have to have a way to surge the flow of material coming in, while the weighing process is taking place. This type of system is a loss-in-weight system and requires a garner hopper to hold the product while the weighing process is taking place, or it requires a duplex scale arrangement, so that one scale if discharging while one scale is filling. Continuous liquid application systems work best when you minimize the starting and stopping of the flow, and minimize the possibility of the dry and liquid products not being timed properly as they arrive at the liquid applicator. In order to maintain a continuous flow into the application machine while operating in a loss in weight mode, the system can be made to go into a weight exception mode during the refill cycle. When this happens, the system maintains the discharge rate that it was set at before the refill cycle began. After the refill cycle is complete, the system returns to a loss in weight discharge mode for the measurement of the liquid and dry flow.

Meter

The continuous flow of pellets into the liquid application equipment, when using mass flow technology is usually monitored with a device that takes density changes into account. This device can be a weigh belt, impact scale, or centriflow meter. This flow is then used as the master flow of material, and all other additions are slaved to this rate. The flow of liquid is controlled by a modulating valve or VFD on the pump. In this case the liquid flow is fed back to the controller from a coriolis meter. If the dry flow of product slows down or speeds up, the flow of liquid is adjusted accordingly.