

Application Note

# Material Feed Management by Weight

## How it can Increase Your Productivity

### Who is this application note for?

Process Control Engineers, Automation Engineers, Systems Integrators, OEM's or anyone who intends to design, install, commission, support, purchase or offer process weighing solutions for the purpose of manufacturing or processing product.

### What is discussed?

Material feed management by weight. It does not really matter what material you are working with, weighing provides accurate and repeatable material feed management result. In this application note we will address the following questions and topics:

- What is a Material Feed?
- What is Material Feed Management?
- Why is good Material Feed Management essential to production?
- Where are the challenges?
- What measurement & control techniques can I use to address these challenges?
- When should I use these techniques?
- How do Hardy's material feed management solutions deploy these techniques?
- Types of material feeds
- Other useful facts about material feed management



### WHAT IS A MATERIAL FEED?

During a material feed, raw material or finished product is moved from one location to another. Material feeds are used to execute and control the movement of many types of raw or finished products: liquids; slurries; powders; granules; solids; even gasses. Material feed management is used in Batch, Filling and Dispensing manufacturing operations.

In Filling and Dispensing ONE feed of a raw material or finished product takes place MULTIPLE times during a production run.

In Batch operations MULTIPLE feeds of different raw materials and quantities take place in EACH batch that is completed during a production run.

### WHAT IS MATERIAL FEED MANAGEMENT?

Managing the feed usually includes at least 5 stages in a material feed:

1. Ensuring the right conditions are met to start the feed
2. Starting the feed
3. Measuring and comparing the change in weight to a set point during the feed
4. Stopping of the feed when the set point is reached
5. Reporting feed data (target weight, feed weight, etc.)

### WHY IS GOOD MATERIAL FEED MANAGEMENT ESSENTIAL TO PRODUCTION?

Good material feed management has a positive impact on productivity. Here are some of the ways good material feed management impacts production:

1. Reduces raw material waste (less cost)
2. Increases batch and filling cycle times ( greater line capacity)
3. Increases quality ( more effective products)
4. Reduces reworks of finished product (less cost)
5. Reduces finished product loss (less give away)
6. Reduces customer dissatisfaction (fewer complaints of under filled product)



### WHERE ARE THE CHALLENGES?

There are at least 3 challenges that need to be considered to successfully managing a material feed.

- a) In the real world process conditions do not stay constant from one feed to the next feed – flow rates vary due: levels in vessels; material consistency; flow characteristics of materials, pump conditions etc.
- b) Secondly, communication timing (data transfer update rates) between a distributed field instrument and a PLC or DCS is usually not very

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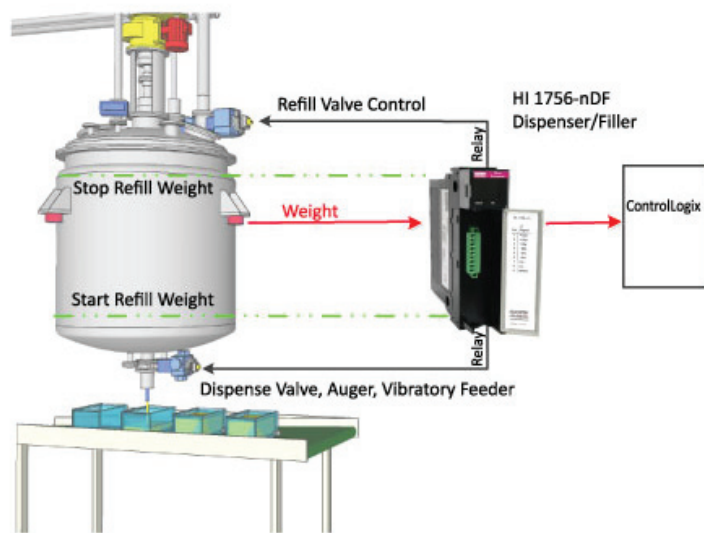
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deterministic – the time between one read cycle and the next read cycle can vary for many reasons. For example: because of variations in: the length of time it takes to send, update or collect data from buffers; the number of programming loops that have to be processed in one program cycle can change from one cycle to the next. These timing problems exist whether data is being used to compare real time weight against a set point OR whether an output is being used to open or close valve, start or stop a conveyor or vibratory feeder.

c) Lastly, during Loss-In-Weight feeds we have the problem of refill cycles to consider. That is how we manage feeds while we are in the middle of a feed and an alarm warns us that we need to refill the dispensing vessel.

One other point to note is that the higher the feed rate, the more likely the process change will affect the outcome of the feed result, even if the change is a percent in feed rate or a few milliseconds communications time, an error will be introduced if the feed control is not set up to take care of it. This usually results in an impact on quality by over or underfeeding feeding raw materials or finished product.



repeatability) plays a big part in delivering a successful material feed result. Moving the set point comparison out of the PLC or DSC into a dedicated scale instrument enables the opportunity for a more deterministic comparison that is close to the process. Remember milliseconds or microseconds = pounds, kgs, grams, or ozs of material. The higher the flow rate the higher the potential error.

3. Use historical data from the last feed and also slow down the flow rate close to the set point (this technique addresses challenge (a) above) - This is called “adaptive multi-speed feed control”. Until recent times this has been the most common method of addressing the problems. The process flow rate is constrained by brute force, so that any change in flow rate is reduced to a minute amount, thus reducing any potential error in the feed. The set point weight and preact values are sent to the controller and then the preact value is adjusted using the error from the first few feeds to adjust itself to the best preact value. The problem here has always been the cost to install extra pipework, valves and/or pumps to get control. Secondly there is a cost to manufacturing operations as well, because during every feed we have to slow the feed rate down and this affects and lengthens the batch cycle time. This eats in operational line efficiencies on every shift, every day, every week, every quarter and every year. It all adds up.

## WHAT MEASUREMENT & CONTROL TECHNIQUES CAN I USE TO ADDRESS THESE CHALLENGES?

Following are 7 techniques that can be deployed to address and solve the above challenges:

1. Stabilize the flow rate – (this technique addresses challenge (a) above). Using this technique usually only possible in liquid or slurry applications. Such as in color kitchens for example. Color Kitchens are used to mix up batches of different dyes for fabrics. In this case each of the raw material vessels is pressurized to a constant pressure to negate the effect of gravity and maintain a constant flow rate no matter what the level (height) of the liquid is in the vessel. The controller is sent a set point and after that as long as the pressure remains constant it never has to change. Unfortunately this is a very costly solution, and one as said that only applies to some materials.

2. Move the set point comparison as close to the process and measured weight as possible (this technique addresses challenge (b) above) – A deterministic set point comparator (speed and

4. Adapt for the flow variation in real time during every feed (this technique addresses challenge (a) above) - This method is called “adaptive predictive control”. Firstly an algorithm is used to adapt the pre-act value based on the last feed error, and a second algorithm is used to predict the change needed to the preact in the current feed based on real time flow rate changes monitored during the feed. Depending on how smart the algorithms used are, less severe multi-speed feed control might be able to be used (speeding up feed times). And in some cases, single-speed (on/off) feed control can even be used to deliver exceptionally accurate feed results and at the same time deliver optimized material feed and batch cycle times.

5. Move the field instrument into the PLC chassis (this technique addresses challenge (b) above) – This technique takes care of the simplifying or shortening the “communication chain” that the data has to travel to be sent to, or read from the PLC or DCS. This technique increases determinism and helps to simplify integration time.

6. Use a controller that has physical set point outputs (this technique

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addresses challenge (b) above) – This techniques offers the fastest method for delivering the STOP signal to the PLC or DSC input. Again increasing determinism and simplifying integration time.

7. Use a controller that has an in-built refill cycle manager (this technique addresses challenge (c) above) – This technique offer the best method of managing this problem at the local controller level.

## WHEN SHOULD I USE THESE TECHNIQUES?

Like they say – it depends! It depends on a combination of the following:

- the feed accuracy you are trying to achieve
- the feed rate you are trying to reach
- the batch cycle time operations requires
- the cost of the material you are feeding
- the number of feed done per batch, shift, year
- the material you are feeding
- how the material is being fed
- whether you are doing GIW or LIW feeds
- the PLC and communications you have to use

These are all questions that need to be considered and/or answered. What is worth thinking about is that the more demanding your application is, the more likely you need to use multiple techniques to optimize the material feed management operation/results.

## HOW DO HARDY'S MATERIAL FEED MANAGEMENT SOLUTIONS DEPLOY THESE TECHNIQUES?

Hardy offers instruments that deploy various combinations of the above mentioned techniques. These instruments when coupled with Hardy's load cell solutions offer differing mix of performance, capability, and cost.

### Value Class Instrument (HI 3010)

- Moves the set point comparison as close to the process and measured weight as possible

### Performance Class Instrument (HI 1756WS & 2WS)

- Moves the field instrument into the PLC chassis

### Performance Class Instrument (HI 4050)

- Moves the set point comparison as close to the process and measured weight as possible
- Uses historical data from the last feed and also slow down the flow rate close to the set point
- Uses a controller that has set point outputs on it



### Advantage Class Instrument (HI 1756nDF)

- Moves the set point comparison as close to the process and measured weight as possible
- Uses historical data from the last feed and also slow down the flow rate close to the set point
- Adapts for the flow variation in real time during every feed
- The 1756nDF can be used in one of 2 modes of operation, it can either be configured to use a real time externally calculated cut off (preact) value, or a real time internally calculated cut off value
- Moves the field instrument into the PLC chassis
- Uses a controller that has set point outputs on it
- Uses a controller that has an in-built refill cycle manager



## TYPES OF MATERIAL FEEDS

There are 2 types of material feeds:

### Filling/Gain-In-Weight:

In Gain-In-Weight (GIW) operations the scale is located on the vessel or container the material is being moved to. GIW feeds are used in Filling processes and Batch processes (usually when batch cycle time is not critical to operations and it is OK to feed material feeds sequentially into a mixing vessel). Gain-in-weight systems use load points (load cells and mounting hardware) or platform scales to weigh the material being received into a container. An empty container is placed on the scale and its weight is tarred, so that only the net weight of the material going into the container is displayed. Hardy controllers open and close the discharge gates while weighing the addition of the ingredients. Conveyors are often used to move receiving containers through the process.

### Dispensing/Loss-of-Weight:

In Loss-In-Weight (LIW) operations the scale is installed on the vessel or container the material is being moved from. LIW feeds are used in Dispensing processes and Batch (when multiple material feeds need to be done into a mixing vessel simultaneously) processes. Supply bins in loss-of-weight applications are suspended by load points to weigh the material being dispensed into receiving containers. Feeders are put on load points or platform scales to weigh the material as it is dispensed. Hardy controllers open and close the discharge gates or control the rate-of-flow of material from the feeder (see our Rate Application Brochure) while weighing the loss of the ingredients. Relays in a Hardy controller are set to automatically refill the supply bin or feeder when a programmed weight is reached. Conveyors are often used to move the receiving containers through the process.

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## OTHER USEFUL FACTS ABOUT MATERIAL FEED MANAGEMENT

### Hardy Instrumentation and Controls:

Hardy's instrumentation for filling and dispensing includes weight and rate controllers. They can be standalone systems or connected to host computers or programmable logic controllers (PLCs). Total net weight can be tracked with Hardy's totalizer feature, which keeps track of the total amount of net weight that has been filled or dispensed. Bar graphs give a visualization of the amount being filled, dispensed or totalized. In addition to filling and dispensing, Hardy controllers can also be used to control or monitor the rate of flow of material and batch ingredients (not discussed in the application note).



### Accuracy:

High resolution, fast update rates, plus the adaptive and predictive capabilities offered in Hardy's controllers allow for precise cut-offs required in filling and dispensing processes. Example: if one hundred pound bags of flour are to be filled to a quarter of a pound, the scale needs to be able to be read in tenth of pound increments. The scale must update faster than the rate material is entering or leaving it. Hardy controllers also have the ability to account and adapt for the in-flight material that is not yet on the scale when the valve or gate is closed (preact). A user-selectable preact can stop the filling or dispensing process earlier in order to compensate for the in-flight material, so it doesn't over shoot the final desired weight. If the final weight falls under the desired amount, Hardy's "jog" feature slightly opens the gate or valve for a short period of time to bring the weight into tolerance.

### Speed:

Filling and dispensing is increased using single (adaptive/predictive)

and dual speed (adaptive) capabilities of Hardy's controllers. A fast or bulk speed is used for the majority of the process cycle, where valves or gates are wide open to allow maximum flow, and a slow or dribble speed is used for a short duration at the end of a cycle, where the valves or gates are nearly closed. The slow or dribble speed allows for a higher accuracy of hitting the final desired weight without under or over shooting it. As with a gas station pump, most of the material is dispensed quickly and the last is dribbled in to allow the controller to accurately cut off the flow.

### Alarms/Tolerance Checks:

Alarms of various types can be set to notify operators. For example, if the controller energizes the feed output and the gate doesn't open or there is no more material available, an alarm will sound. Alarms are also set to notify the operator if the material falls over or under the weight tolerance range. The filling or dispensing process can be configured to stop when an alarm goes off.

Would you like to improve your Material Feed Management?

To find out more about our solutions or to ask for a quote, please contact Hardy at 1-800-821-5831 or visit [www.hardysolutions.com](http://www.hardysolutions.com)

