THAYER SOLIDS FLOW CONTROL®

BUILT *SMART*
BUILT TO *SURVIVE*

Scale Disturbance Control ("SDC")
For Loss-In-Weight Feeders

THAYER Loss-In-Weight feeders incorporate special proprietary software algorithms to deal with various disturbances that may periodically or randomly be experienced during normal operation. Unlike weigh belt feeders, Loss-In-Weight feeders are particularly vulnerable to external disturbances for two fundamental reasons.
All machine elements (i.e., hopper, feeder, drive components, and scale weighing surfaces) are being "weighed" and hence are physically exposed to the effects of disturbances. On a weigh belt feeder, a length of belting is all that is weighed and this is usually done in an enclosure.

The measurement sensitivity requirements of a Loss-In-Weight feeder are literally thousands of times greater than that of a weigh belt feeder. This is due to the fact that the measurement of flow rate is accomplished by continually evaluating tiny increments of weight lost at time intervals of less than 1/10th of a second on a scale that is supporting enough material to supply the needs of an hour or more of running time at minimum flow rates, (i.e., 10 minutes between refills at max. rate, 100 minutes between refills at min. rate, for a 10:1 turndown).

Thayer Scale's Loss-In-Weight controller has a unique disturbance protection control (SDC) that can be set up a number of different ways to address various disturbance concerns. Personnel in the area may inadvertently bump into the scale or drop something on it while working around it. Doors may occasionally be opened that create short duration drafts that disturb the scale. A bin discharger might cycle on or off at certain times. A fork lift truck might be driven past the feeder.

These disturbances are characterized as being "sporadic" and of "strong intensity", meaning that a substantial disturbance is encountered now and then, but is not present all the time. One particular type of sporadic disturbance occurs in installations whereby operators randomly re-fill the feeder hopper as opposed to using an automatic refill system. Other disturbances may not be sporadic in nature, but persist over longer periods of time and exhibit various levels of intensities. Floor vibration and un-shielded air currents are noteworthy examples. Unfortunately, these lower intensity, persistent disturbances, are never fully distinguishable from the normal machine-generated disturbances of the weigh feeder and agitation equipment itself.

Measurement Limiting is a mechanism for protecting the closed loop Loss-In-Weight Feeding control process from persistent background disturbances. Disturbance protection is necessary for successful Loss-In-Weight feeding because of the requirement for sensitivity and high resolution of the weight signal. Every sixteenth of a second the new weight reading is compared to the last weight reading to see if the correct amount of weight was lost to conform to the feed rate set point. If this difference calculation indicates a deviation from the set point, correction to the speed signal of the feeder is made. This difference is so small that the control is very vulnerable to disturbances.

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For example, if a Loss-In-Weight feeder normally operates at a rate so that it needs refilling every 20 minutes, the difference between successive weight readings should be only 0.005% of the working material load. The difference will be even less if expressed as a percentage of the range of the weight transducer, which must accommodate a heel of material before refilling and allow for some headroom. If the rate is to be controlled to an accuracy of 1% the sensitivity must be 100 times finer, and if the feeder must operate over a turndown of 10:1, the sensitivity must be finer by another factor of 10.

This example should make it easy to see that the control is very susceptible to mechanical vibrations, air drafts and any other disturbances. Filtering and averaging of the weight signal help, but too much of that makes the feeder unresponsive to changes in material density, rate set point or other real variables in the process.

One way to keep the control calculations from causing violent fluctuations in the signal to the drive and retain responsiveness is to limit unreasonably large differences in the weight measurements, called Measurement Limiting. If a decrease of 0.005% represents delivery at full rate, a relatively minor disturbance causing an increase or decrease of 0.1% in the next reading has a large effect. It calculates into a negative or positive instantaneous delivery rate of 20 times full rate, an impossible feat for a feeder. Rather than try to correct for this artificially great feed rate error, just clip its out-of-range amplitude and do not let the control equation see it. This measurement limiting technique quiets the effects of disturbances without excessive damping but does not hide real rate errors due to such factors as density changes that are in range and need to be corrected.

"ML1" Measurement Limiting: is the measurement limiting parameter that affects the closed loop control. ML1 is expressed as a percentage of design rate and has an upper boundary of 125%. ML1 defines a maximum band around the set point encompassing the operating range, regardless of where the set point is. Reasonable errors should be within the band and will influence the control normally, but large disturbance errors will be clipped to the band edges in order not to overwhelm the controller. Reducing this parameter tightens the band to further smooth control.

"ML2" Measurement Limiting: is the measurement limiting parameter that provides disturbance protection for the rate display and other rate functions not involved with the control feedback loop.

***"SOR"* Signal Out of Range:** is a higher level "sporadic" disturbance protection mechanism that is triggered in a manner similar to Measurement Limiting. The SOR Limit is programmable from 125% thru 999% with a default value of 250%. When a disturbance of sufficient magnitude is detected so as to trigger SOR, the feeder switches to a "pseudo-gravimetric" control mode, whereby an alternate rate signal, generated as the product of the instantaneous volumetric "speed" measurement and the most recently learned material "density" measurement, replaces the normal gravimetric measurement in the control loop. Thus, unlike a locked-speed mode, the feeder remains in an active control mode, always sensitive to changes in set point and/or drive "loading". Once SOR conditions subside, the feeder returns to normal gravimetric feeding.

Note: SOR can be used as a means of "protecting" the feeder during an unannounced refill, such as when hand refills are used. Once the disturbance of material being added to the hopper is detected, SOR immediately switches its mode of control. As soon as the SOR mechanism detects that no more material is being added to the feeder, SOR will return back to gravimetric control.

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