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APPLICATION NOTES AND PRINCIPAL OF OPERATION
FOREMOST CRAMMER FEEDER

The Foremost Series of Crammer Feeders are force feeding devices that are designed to compact fluffy materials at the extruder screw to provide a uniform density and relatively consistent head pressure. The normal mode of operation is "constant torque" in which the operator selects the torque (pressure) value to operate at as a percent of available torque. This value depends, to some extent, on application specific operating conditions such as:

* The amount of fluffy material being fed (typically 5% to 50% by weight)
* The bulk, uncompressed density of the fluffy material (typically 5 to 15 lbs/cu.ft.)
* The desired head pressure or degree of compaction at the extruder screw feed section.

Regardless of these conditions, in the vast majority of applications **the normal torque setting has proven to be between 20% and 40% of full output.** We recommend that all new users set the initial value of the crammer somewhere in this range (30% nominal). We also recommend that all changes to this setting be done in small increments (5% or less) with enough time between changes for the process to stabilize and the effect of the change to be measured.

As previously mentioned, when operating in "constant torque" mode, the crammer feeder will attempt to keep constant pressure on the material at the extruder screw. This means that the following conditions will exit during operation.

1. The material in the crammer at the extruder throat will be compressed to a uniform density relative to the torque setting of the crammer and the compressibility of the material.

2. The crammer will attempt to maintain the constant pressure on the material. If the extruder speeds up the crammer auger will follow the extruder in an attempt to maintain this pressure. If the extruder slows down, the crammer will again follow the extruder

3. If the extruder stops, the crammer will also stop while maintaining set pressure. Because of the drive design, this condition can be maintained indefinitely and the crammer will start again as soon as the extruder resumes. However **it is recommended that if the extruder is shut down for any lengthy period of time (hours) the crammer should also be shut down**. This is desirable for a few reasons, but eh most significant are:

- The material compressed at the extruder throat contains fluffy plastic. If there is not adequate cooling provided at the extruder throat during a shut down the fluff could partially plasticize in the throat with time, causing a blockage.

- The crammer drive is designed to allow a dead stall for extended periods of time; however this is partially dependent on ambient conditions. The motor is cooled by an external blower which must be running continuously during stall conditions. Also, if ambient temperatures are excessive, the blower cooling may not be adequate and a temperature sensor built into the crammer motor will trip the motor overloads to protect the motor, required a reset.

4. A substantial variation in material level in the crammer feeder hopper or a substantial variation in the percentage and/or density of fluffy material in the crammer hopper will produce a difference in head pressure at the extruder. This may also require a change to the torque setting of the crammer (especially true with large crammer feeder hoppers.)

   This occurs because a portion of the torque being generated by the crammer feeder drive is normally used to agitate the material in the crammer feeder hopper. If the material level in the crammer fluctuates substantially, this causes a coincident fluctuation in the amount of torque available at the extruder throat for compression. The effect is obviously more pronounced when the material in the crammer hopper is at a relatively high density (such as when the amount of fluff in the mixture is low.)

   An unusual but related situation occurs when:

   > A relatively large crammer feeder hopper is filled to a high level with dense material (mostly pellets with little fluff) and the torque setting is relatively low (below 20-25%)

   With this combination of conditions the material in the crammer will not flow freely around the crammer screw because of the small quantity of film in the mixture and the torque required to **agitate** the material in the crammer hopper is relatively large relative to the torque required to **compact** the fluffy material in the mixture at the extruder screw. As a result, the "breakaway torque" required for the agitator to begin turning at a full hopper condition is greater than the torque setting on the crammer. The hopper fills, the extruder screw removes compacted material but the torque setting is not high enough for the crammer to react and the extruder starves. The immediate appearance is that the crammer ahs bridged from some sort of over cramming. In fact, the opposite condition exists and the solution is **to increase the rammer torque setting** beyond the "breakaway" torque value.

RECOMMENDED METHOD OF OPERATION
FOREMOST CRAMMER FEEDERS

In general, the crammer should be run as follows:

I. The torque setting should be set between 20% and 40%

II. The material in the crammer should be kept at a relatively constant level. If the crammer auger is not turning often enough to keep the material leveled out, reduce the torque setting from the current value in small increments (no greater than 5% each change) until the crammer screw is turning at 2 to 6 revolutions per minute (one revolution every 10 to 30 seconds.

III. If the extruder is stopper for any length of time, shut down the crammer feeder as a matter of good practice.

IV. Run the crammer with enough fluffy material (10% by weight or more) to allow the crammer to function as intended, with most of the torque used to compact a light mixture rather than agitate a heavy mixture.

COMPARATIVE FEATURES AND BENEFITS
FOREMOST CRAMMER FEEDERS

TRUE CRAMMING ACTION

In "constant torque" mode of operation, the crammer feeders provide relatively constant head pressure throughout the range of normal extruder speeds. This is accomplished through the use of a highly sophisticated, state-of-the art vector drive and motor combined with rugged gearbox and force feeding auger. The auger closely fits the throat opening of the extruder and penetrates the feed throat ending near the extruder screw.

CONSISTANT MATERIAL DENSIFICATION AT THE FEED THROAT

Unlike our Cone-in-Cone and others fluff feeders, the crammer densifies fluffy materials at the feed throat to a uniform density as much as three to five times its starting value. For example, if a mixture of 30% fluff from 2 mil thick HDPE with a ground bulk density of 4lbs/cu.ft. is introduced to a crammer with the 80% pellets in the mix at 35lbs/cu.ft. the average bulk density will be .7(35) + .3(4) – 25.7 lbs/cu.ft. At the extruder throat, the fluff is compacted to four times its density or 16lbs/cu.ft. The average bulk density then becomes .7(25) + .3(16) – 29.3 lb/cu.ft. More importantly, the average bulk density remains relatively consistent even with changes in the percentage of fluff being introduced. Consider the following table and the attached graphs:

	Average Bulk Density of Mixture	
Fluff/Pellet Ratio	**Uncompacted**	**Compacted 4X**
1:10 (10% fluff)	.9(35)+.1(4)=31.9	.9(35)+.1(16)=33.1
2:10 (20%)	.8(35)+.2(4)=28.0	.8(35)+.2(16)=31.2
3:10 (30%)	.7(35)+.3(4)=25.7	.7(35)+.3(16)=29.3
4:10 (40%)	.6(35)+.4(4)=22.6	.6(35)+.4(16)=27.4
5:10 (50%)	.5(35)+.5(4)=19.5	.5(35)+.5(16)=25.5
6:10 (60%)	.4(35)+.6(4)=16.4	.4(35)+.6(16)=23.6
7:10 (70%)	.3(35)+.7(4)=13.3	.3(35)+.7(16)=21.7
8:10 (80%)	.2(35)+.8(4)=10.2	.2(35)+.8(16)=19.8

At higher compaction rates, the VARIENCE in average bulk density over a range of percentage fluff contents in the mixture is less than a lower compaction rates. This means that at higher levels of cramming, the percentage of fluff in the mixture can be varied rather broadly without the extrusion process experiencing a significant change in the AVERAGE density of the material being fed. This in turn makes the process more stable and less in need of adjustment if the percentage of film fluff in the mixture abruptly changes from say 10% to 40% or vice versa, a situation typical when roll stock is added or removed from edge trim and bleed recycling.

In general, cramming with a constant force feeder produces the benefits of:

* HIGHER LEVELS OF FLUFF IN THE MATERIAL MIXTURE

* LARGER VARIATIONS OF FLUFF IN THE MIXTURE WITH NO DENSITY EFFECT ON THE EXTRUSION PROCESS

* “SET-IT-AND-LEAVE-IT” OPERATION FROM EXTRUDER STOP TO FULL SPEED OPERATION

The trade-off for these benefits over a Cone-in-Cone, speed controlled fluff feeder is that more equipment (regrind to pellet blending) is required in a typical system at a coincident higher cost. This is because a typical crammer feeder does not proportion required fluff to virgin while feeding it to the extruder. A crammer feeder is designed for the singular purpose of feeding the extruder. A Cone-in-Cone fluff feeder is designed to be a multi-purpose device, both proportioning and feeding, albeit doing neither job as well as discrete devices doing both jobs independently.

Notwithstanding this point, a Crammer Blender does exist in the Foremost product line. This device is essentially Cone-in-Cone Fluff Feeder utilizing a constant torque crammer drive and auger. Functionally it combines the utility of both devices but only in a narrowly defined range of mixture percentages. It s most applicable where the fluff regrind comes exclusively from edge trim and bleeds in substantial amounts (15-15% of total) and with little variation over time. This device then allows the constant regrind feed to be reclaimed without the need for fluff to pellet blending equipment while maintaining a relatively constant head pressure over the range of extruder speed.