



PVC RIGID POWDER COMPOUND

Handling Characteristics

Powder compound is dustier than cubes or pellets. It will require more, finer dust bags to protect bulk handling equipment. Usually, one can use the same handling equipment to convey powder, cubes or pellets from a gaylord box to an extruder hopper. But, to convey over longer distances (e.g., from silo to extruder) more conveying air will be needed for cubes and pellets. One needs to consult with equipment manufacturers for exact details.

With both powder and cubes, handling equipment will need to be grounded to code. Both materials contribute to the generation of static electricity as they are air conveyed. This is especially true in the cold winter months. When statically charged, powder may become fluffy and look wet. The apparent bulk density of cubes and pellets as well as powder is low and flow time high. The selection of a good bulk handling system can help resolve these problems.

EQUIPMENT CONSIDERATIONS

Powder, cubes or pellets can be run on three types of extruders:

1. Single-screw gravity feed
2. Single-screw cram feed
3. Multi-screw gravity feed

SINGLE-SCREW GRAVITY FEED

PVC cubes or pellets run best on a single-screw gravity feed extruder, which has been designed to handle the apparent bulk density of this product. The extruder must have a configuration to give the correct amount of work to fuse PVC correctly. If powder is run on this equipment, configured for cubes or pellets, incorrect fuse or work and very low motor amperage

go into the powder. This is true at all but very low production rates.

SINGLE-SCREW CRAM FEED

The single-screw crammed extruder helps eliminate certain problems encountered when using powder in the gravity feed extruder. The crammer forces the powder into the main feed screw causing more amperage and better fusion. With the addition of the crammer, the single-screw extruder can handle powder at moderate production rates with good fusion. Cubes and pellets can also be run on this equipment. The RPM of the crammer will be lower than with powder. Because of the high apparent bulk density of the cubes and pellets vs. powder, a lower crammer RPM helps to avoid overloading the extruder motor.

MULTI-SCREW GRAVITY FEED

Multi-screw or twin-screw extruders were designed to extrude powder by gravity feed. They normally have smaller horsepower motors, but are able to achieve higher production rates than an equivalent size single-screw extruder. The recipe should be designed to allow the powder to run flood feed. This takes advantage of the multi-screw extruder's constant pump machine and achieves better dimensional control of the finished parts. If one is running starve feed on the multi-screw extruder, the screws are not full. This causes small amounts of surging, and changes the dimensions of the part. Starve feeding also causes more wear because of metal-to-metal contact

To run cubes or pellets on a multi-screw extruder, one must starve feed the material. If this is not done, the higher Apparent Bulk Density (ABD)

of cubes/pellets vs. powder overloads the extruder motor. Running starved feed causes loss of dimensional control and improper fusion of the compound. It can be done, but it is more difficult.

A good rule of thumb is that powder should be flood fed on all types of extruders. Cubes or pellets are flood fed on single-screw and starve fed on multi-screw extruders.

WEAR

Both single and twin screw extruders experience wear of both the barrel and screw as they extrude PVC. There are several factors that can cause this:

1. Abrasive ingredients
 - a. High amounts of calcium carbonate or titanium dioxide
 - b. High amounts of fiberglass
2. High screw RPM
3. High head or back pressure
4. Type of metal composition in barrels and screws
5. Particle size of filler
6. Coating on filler
7. Amount of through put of material.
8. Starve feeding the extruder

We have seen cases where single screw extruders needed barrel and screw replacement every six to seven weeks. This occurred when running 40+% loading of calcium carbonate, non-coated and large particle size. We also have heard of single screw extruders lasting seven or eight years.

At one time, multi-screw machines were believed to exhibit more wear than single screws. This was true in the pipe industry, where machines were run at full speed,

twenty four hours a day, seven days a week. When the machines' manufacturers changed from nitrated barrels and screws to bimetallic barrels and molybdenum flighted screws, wear was considerably improved. Single-screw manufacturers also improved wear by changing metals in later years.

Today both types of extruders can and will achieve three to five years of use before replacement is necessary. Life span can be better estimated by the amount of material going through the extruder. Assuming normal abrasion, one should be able to achieve between 7 million pounds and about 18 million pounds of product through the extruder with the typical around 12 million pounds. By using poundage through the extruder, production rate or RPM, both types of extruders show approximately equal wear characteristics.

DIES AND SIZING

The differences in sizing methods and dies used for single and multi-screw extruders are primarily due to their initial usage and the time period of their introduction to the industry. Single screws were the first extruders used in the different dies, air cooling and jigs, and finger sizing. As longer runs and higher rates were needed, streamline dies, air cooled and jigs, and finger sizing were introduced.

Today, powder compound on multi-screw extruders uses the latest technology of streamline dies, vacuum sizing and water cooling. But, there are some people running powder with flat plate dies, air cooling and jigs, and finger sizing using multi-screw extruders. The same can be said about cubes using single-screw extruders. There are people running streamlined dies, vacuum sizing and water cooling.

In summary, both single or multi-screw extruders are capable of running profiles on any type of die, sizing system, or cooling method. It depends on what you have, want and need on your type of profile.

DIMENSIONAL CONTROL

One benefit of multi-screw extruders is dimensional control. The reason for this advantage is that the multi-screw extruder is a constant pump machine whereas the

single-screw machine is not. This allows the multi-screw to give better dimensional control on any given die or sizing system. In some cases, high molecular weight resin is used on single screw machines to try to make the melt stiffer through the die. This may or may not work. If the higher molecular weight results in higher melt temperature, the viscosity through the die may be the same or lower instead of higher, depending on compound recipe and frictional heat from the extruder.

PRODUCTION RATES

In general, for profile extrusion, the multi-screw machine achieves higher rates, usually due to differences in technology of die and sizing. However, with the same types of die and sizing, production rates will be very close for single and multi-screw extruders. The multi-screw may be able to run longer on a give profile, but data are not conclusive. Single screw extruders are generally run between 100-300 lbs./hr. and multi-screw between 100-400 lbs./hr. The type and size of profile influences production rates.

THERMAL STABILITY

It is said that powder compound has more heat stability than cubes or pellets. However, studies show no difference in heat stability. Powder and cubes/pellets have also been exposed to weathering, and no differences have been found. Recipe and stock temperatures have a big effect on both heat stability and weathering, not the physical form of the PVC compound.

REGRIND

Both single and multi-screw extruders can run on regrind of 1/8 to 1/4 inch. Because of the higher horsepower motors and the ability to run high ABD compound, single screw extruders have a much easier time with regrind. The multi-screw extruder does an excellent job running regrind pulverized to around 300 microns. This is how the pipe and siding industries run their off-spec material regrind on the multi-screw extruder; the screw flights cannot be flood fed. The flights will be 1/4 to 1/2 full depending on ABD of the regrind. The regrind can be mixed with virgin powder or cubes/pellets and run into production parts. This is usually done at about 10-25% regrind.

STOCK TEMPERATURE

Cubes/pellets or powder are run anywhere between 350°F to 410°F. Single screw extruders primarily melt PVC from frictional heat by action of the screw and secondarily by inductance heat from the electrical heaters on the barrel. Multi-screws do the opposite. The main heating is done by inductance heat from the barrel and screw oil temperature and secondarily heating by frictional heat of the screws. It must be remembered that one needs both frictional and inductive heat to melt PVC and build proper physical properties in the extruded parts.

Melt temperature (stock temperature) is and can be affected by compounding. This can be done with lubricants and process aids. Process aids increase or decrease PVC melt viscosity and temperature to achieve the desired physical properties and die flow. This affect is the same no matter what the physical form of the PVC compound or type of extruder used.

CONCLUSION

Most (over 90%) powder compound is extruded on multiscrew (twin) extruders. Cubes and pellets are usually extruded on a single screw extruder. Either physical form of PVC compound can be extruded on both single or multi-screw extruders. Powder and multi-screw extruders are typically used for bigger profiles and long production runs, but technically don't need to be.

One should look at end products, number of product shifts and capital cost to determine the right equipment for an operation.

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