

Powder and Bulk Engineering

VOLUME 14 NUMBER 10

OCTOBER 2000 \$10.00

- Can a toll processor improve your bottom line?
- Case history: Recycling filters saves money, reduces waste

DUST COLLECTION

Can toll processing improve your bottom line?

Rick Ritter, Bill Mitchell, Dan Bopp, and Dennis Sarno WEDCO

Perhaps you've been in a situation where you find that a new product can be made from your existing stock of raw materials, but you don't have the necessary equipment, capital, or manufacturing capacity to do so. Many bulk materials manufacturers in this situation contract a toll processor. A toll processor can perform several manufacturing services for you, allowing you to expand your operations without having to expand your plant. This article discusses several services toll processors offer, including size reduction, blending, classification, compounding, testing services, and others.

Toll processing — also known as *custom processing* and *contract processing* — is performing a manufacturing service for a manufacturer for a fee. For example, a bulk solids manufacturer wants to blend product A with product B at a 5 percent level by weight but doesn't have the proper equipment in-house to perform the blending operation. The manufacturer then contracts with a toll processor to perform the blending operation. The manufacturer may send the raw materials to the toll processor, or the toll processor may procure them. The toll processor blends the raw materials together to produce the finished product. The toll processor then sends the finished product back to the manufacturer, who prepares it for market distribution.

There are many benefits to having your materials processed by a toll processor. For example, you can make

a product for a specific market for years and then find that a new market exists for the same product if it's ground finer, dried, blended with another product, or packaged differently. However, you may not have the necessary capital or manufacturing capacity to produce the new product. A toll processor can provide the required processing method or manufacturing capacity to make your new product quickly and cost-effectively.

Consider these toll processing benefits when deciding whether to use a toll processor:

- You won't have capital investment in or depreciation of new equipment.
- You won't have extended lead times for equipment delivery and installation.
- You won't have in-house engineering requirements.
- You won't have maintenance or spare parts requirements.
- You won't have additional personnel or floor space requirements.
- You won't need new permits for dust collection discharge.
- You will have predictable manufacturing costs.
- You will have quick turnaround times.

In addition, you can make use of the toll processor's processing expertise. Typically, the processor has experience in processing several materials under many conditions. This experience can help you establish the best manufacturing methods and procedures to ensure that you meet your product's processing specifications, such as particle size distribution and moisture content.

Toll processing services

A toll processor can provide some or all of the following services:

- Size reduction
- Blending
- Classification
- Compounding
- Packaging
- Procurement
- Warehousing
- Testing services
- Analytical services

Of these, size reduction is the service most frequently used because of the high capital, operating, and maintenance costs of in-house size reduction operations.

Size reduction

A size reduction machine uses one of several methods — cutting, pulverizing, crushing, impacting, or impingement grinding — to reduce a material's particle size. Most toll processors operate several types of size reduction equipment because no universal size reduction machine exists that can do it all. When determining which size reduction equipment to use, a toll processor looks at the properties of the material to be reduced. These include material hardness (typically classified according to the Mohs' hardness scale), heat sensitivity, moisture sensitivity, abrasiveness, friability, explosiveness, and the initial and desired particle size. Depending on the size reduction equipment used, materials can be reduced to specific particle sizes ranging from coarse to colloid grades, as shown in Table I.

Shredding. A shredder reduces nonfriable, bulky materials such as plastics, rubbers, and wood scraps to 2- to 6-inch chunks. The shredder relies on low-speed, high-torque rotating shafts powered by electric or diesel motors. The shafts drive a series of intermeshed cutting discs and spacers that rip, tear, and shear materials into coarse and medium-coarse pieces. The shredder is typically used in recycling operations and is often the precursor to further size reduction.

Rotary knife cutting. Rotary knife cutters include precision cutters, granulators, blow-through cutters, pelletizers, and guillotine cutters. A rotary knife cutter reduces large thin pieces or small thick pieces of nonfriable materials such as paper, plastics, and rubbers to medium-coarse (½- to 1-inch) pieces. The rotary knife cutter typically uses a shaft with a mounted knife (or knives) that rotates toward a stationary bed knife (or knives) to cut and shear materials between the blades. A perforated metal screen, located

below the knives, retains oversized material until it's processed to the proper size. Various screen mesh sizes allow particles to be reduced to multiple size ranges.

The number of rotating knives and fixed knives depends on the machine's size and function. The rotary knife cutter is available in several sizes (listed as knife-tip-to-tip length by shaft length) ranging from small laboratory equipment up to large production machines and can be powered by a motor ranging from 2 up to hundreds of horsepower. The rotary knife cutter can be used in applications as varied as recycling thin plastic film and reducing full bales of rubber.

High-speed impact milling. High-speed impact mills include hammermills, pin mills, counter-rotating pin mills, cage mills, turbo mills, and universal mills. A high-speed impact mill reduces nonfriable and friable materials such as wood waste, sheet pulp, plastics, coal, chemicals, limestone, and fertilizer to medium-fine and fine (10- to 200-mesh) pieces. The material to be reduced enters the mill's housing and is impacted by a rotating assembly of hammers, pins, or cages. As it rotates, the assembly throws the material centrifugally outward where the hammers, pins, or cages grind it against a perforated screen for further size reduction. The final product's size is controlled by the assembly's rotating speed and the perforated screen at the discharge port. A high-speed impact mill is available in several sizes ranging from small laboratory equipment up to large production machines.

Air-classifying milling. An air-classifying mill reduces friable materials such as polyesters, epoxies, acrylics, and sugar to fine and superfine (150- to 400-mesh) pieces. The material to be reduced first enters the mill's high-speed impact grind-

Table I
Size reduction grades^a

Size reduction grade	Particle size		
	Micron	Millimeter	Mesh (approximate)
Coarse	>100,000	>100	—
Medium coarse	10,000	10	2
Medium fine	1,000	1	18
Fine	100	0.1	150
Superfine	25	0.025	500
Ultrafine	10	0.010	1,250
Colloid	5	0.005	2,500

^a Note: Information is from the American Institute of Chemical Engineers, copyright 1992 AIChE.

ing chamber where a fixed-speed, rotating grinding plate with fixed hammers reduces it. Air moving through the mill then carries the particles to the classifying chamber where the classifier wheel rejects oversized particles and directs them back to the grinding chamber for further size reduction. The material circulates through this closed-loop environment until it's been reduced to the appropriate particle size. The classifier wheel's speed and the mill's airflow rate are adjustable to allow for a wide range of particle sizes. Heated or chilled air can enhance an air-classifying mill's performance.

Attrition milling. An attrition mill, also called a *disc mill*, reduces friable materials such as grains, thermoplastics, and metal powders to medium-fine and fine (15- to 200-mesh) pieces using discs with grinding surfaces such as machined teeth. An attrition mill can be one of two types: single runner or double runner. The single-runner mill is more common and has one stationary disc and one rotating disc, while the double-runner mill has two rotating discs. The material to be reduced enters the mill's grinding chamber through a chute near the discs' centers and is ground to the desired particle size between the discs as they rub against each other. The finished product exits through a discharge port, which may be covered with a perforated screen, at the chamber's periphery.

Three factors that determine the product's final particle size are the discs' grinding surfaces, including the number, depth, and shape of the grinding teeth; the distance between the discs during grinding; and, if used, the perforated screen's mesh size at the discharge port, which also recycles oversized particles. Both single-runner and double-runner mills are available in sizes ranging from small laboratory equipment up to large production machines.

Jet milling. Jet mills include fluidized-bed mills, opposed-nozzle mills, and multiple-port mills. A jet mill reduces friable, abrasive, and heat-sensitive materials such as metal oxides, graphite, rubbers, and soft waxes to fine and colloid (150- to 2,500-mesh) pieces. The jet mill uses high-velocity streams of pressurized elastic fluid — compressed air, another gas, or super-heated steam introduced through specially designed nozzles — and centrifugal force to simultaneously grind and classify particles by accelerating the material in the grinding chamber, causing high-speed particle-on-particle collisions. Some jet mills use a variable-speed classifying wheel to control particle size. As the elastic fluid expands in the grinding chamber, a cooling effect takes place, allowing heat-sensitive material to be processed without degradation. A jet mill is available in several sizes ranging from small laboratory equipment up to large production machines.

Cryogenic grinding. Cryogenic grinding technology can be adapted to most size reduction equipment. It's most commonly used with high-speed impact mills and attrition mills. Cryogenic grinding reduces heat-sensitive and nonfriable materials such as spices, plastics, organic dyes, and rubbers to

medium-fine and fine (20- to 200-mesh) pieces. When reducing a heat-sensitive, nonfriable material, a toll processor either mixes cryogenic fluid directly with the material in the grinding chamber during grinding or embrittles the material by exposing it to a cryogenic fluid prior to grinding. The most commonly used cryogenic fluids (called *cryogenics*) are liquid nitrogen and liquid carbon dioxide. A cryogen can lower material and grinding temperatures to -300°F, which increases the machine's particle size reduction capabilities by making a nonfriable material friable and minimizing the heat generated during grinding. Cryogenic grinding technology is also used in size reduction operations requiring inert atmospheres, such as those handling explosive or flammable materials.

Blending

You may want to supply your product that contains several materials recombined and repackaged as a new product. However, to manufacture the product you would need new mixing and blending equipment that you can't afford or don't want to invest in. A toll processor offers you an affordable alternative to installing costly mixing and blending equipment that you will only use intermittently.

The type of equipment used in mixing and blending operations depends on the materials to be combined. Certain blenders cause more degradation or generate more fines than is acceptable in a particular application, while others generate friction that can be detrimental to heat-sensitive materials. That's why a toll processor generally has several types of mixing and blending equipment available. For most powder blending applications a toll processor uses either *mechanical agitation blenders* or *rotating vessel blenders*.

A mechanical agitation blender uses motor-driven agitators to agitate the materials in its stationary vessel until they are mixed together. Examples are ribbon blenders and conical-screw blenders, which both can operate in continuous mode and handle cohesive materials, such as plastics, pharmaceuticals, and spices.

A rotating vessel blender has a rotating vessel that spins until the materials are mixed together. Examples are double-cone mixers (also called *V-mixers*) and drum tumblers, which both typically operate in batch mode and handle materials such as chemical powder blends, fertilizers, and plastic compound preblends.

Classification

The demand for materials with finer and sharper particle size distributions is becoming the norm in many bulk solids processing industries. But often the only way plants like yours can afford to accomplish these types of particle size distributions is to use a toll processor. Depending on your application's requirements, a toll processor can achieve particle classification by one of two methods.

The simplest method uses sieves, which are primarily for coarse through fine grades of material. Sieves use screens with a specified mesh size to separate the particles, and vibration or air fluidization is applied to the sieves to maintain particle flow through the screens. The toll processor can stack the sieves to classify a range of particle sizes greater than 100 microns.

The second classification method is air classification. An air classification machine uses air velocity to separate materials based on particle weight and size. It classifies particles ranging from 1 to 100 microns. Many air classifiers use a vaned wheel to control the particle size distribution.

Compounding

Compounding is the process of melt-mixing thermoplastic resins, natural and synthetic rubbers, or thermoset resins to enhance a polymer's final properties. Natural and synthetic rubbers are routinely compounded with other additives or added to plastics to enhance the finished product's characteristics.

You can avoid large capital investments in compounding equipment by having your specific formulations compounded by a toll processor. This is especially helpful during your product's development phase when the end market demand for the product is uncertain. The toll processor offers a range of equipment that is suitable for both your trial and full-production runs. This range of primary and auxiliary equipment also gives the toll processor the flexibility to reconfigure its lines to run a variety of materials. The processor normally compounds simple formulations with a Banbury mixer or single-screw extruder and uses more sophisticated equipment, such as a continuous mixer or twin-screw extruder, for compounding complex formulations.

Packaging

Customers are becoming more demanding about the types of packages they receive products in. Many toll processors can custom-package your product to suit your customer's needs. The processors can also receive and ship materials in bulk railcars, bulk trucks, international shipping containers, gaylord boxes, drums, bulk bags, 50-pound bags, and smaller packages. The processor can also custom-label the package to meet your customer's requirements.

Procurement

A toll processor can procure your raw materials for you by purchasing them directly from suppliers. Often, the toll processor can purchase a greater volume of raw materials at a smaller cost per unit than you can because the toll processor buys for many customers, placing larger and more frequent orders, and thus acquiring greater buying leverage than you can. Once the processing is done, you're

charged for both the raw materials and the processing. This arrangement is especially advantageous if your company is small, your cash flow is limited, and your orders are relatively small.

Warehousing

Since a toll processor deals with a large number of customers, it needs to have adequate storage facilities to hold both the raw materials to be processed and the finished products after they're manufactured. Often, the toll processor will offer additional warehouse and storage space to you so that you don't have to transport the finished product back to your plant or a centralized warehouse. This reduces your freight costs because the finished products can be shipped directly from the toll processor to your customer.

Testing services

A toll processor is likely to have pilot-testing equipment in its plant. Pilot-testing equipment is scaled-down production equipment that allows the toll processor to process small quantities of your raw materials for evaluation prior to starting full-scale production. By running these tests, the toll processor can evaluate each raw material in a controlled environment and can often predict how it will behave when it goes into full-scale production. With this information, the processor can modify equipment, define processing parameters, and give you pertinent data — such as expected throughput rates and estimated processing costs — to help you determine the finished product's cost.

Analytical services

For the toll processor, quality assurance is an integral part of doing business. Because the toll processor deals with many raw materials and performs several processing operations, it must be able to analyze the finished product to verify that it meets your requirements. To do this, the processor must have a fully equipped analytical laboratory with instruments such as sieves and laser diffraction equipment for both wet and dry particle analyses, along with other types of specialty analysis equipment. The processor's properly equipped analytical laboratory ensures that the finished product will always meet your quality assurance standards.

Selecting a toll processor

Selecting a toll processor isn't as simple as choosing the one that's the closest or cheapest. You should consider your toll processor an extension of your company and your partner in quality, because it will most likely be the final sentry between product defects and your customers.

Once you find a toll processor that can handle your specific processing needs, it's critical to review the processor's quality assurance and quality control procedures,

because the potential for problems in any process is great whether it's done outside or in-house. Only the most experienced and diligent toll processor will be able to avoid contamination, off-spec material, over- or under-weight packages, late shipments, and other problems. This is why many toll processors will trace your material from its arrival at the processor's plant through its departure.

When possible, it's a good idea to visit the toll processor's plant. This should give you a clear picture of what your material will be exposed to and how it will be processed.

Often, the toll processor will require a feasibility test before furnishing you with pricing for large batches or con-

tinuous runs. To speed up testing, give the processor detailed specifications on maximum particle size, particle size distribution, moisture content, bulk density, temperature limitations, and other finished product requirements.

The final decision to contract your bulk solids processing operation, as well as your choice of toll processor, should be based on whether the processor will make your life easier, reduce your capital investment risk, and give you a competitive advantage while adding to your bottom line.

PBE

Bill Mitchell is manager of engineering, and Dennis Sarno is regional sales manager at the company.

Corporate Office:

ICO Polymers North America
5333 Westheimer, Suite 600
Houston, TX 77056
(713) 351-4100
Charlie Busceme

ICO Polymers North America
4404 Euclid Avenue
East Chicago, IN 46312
(219) 392-3375
Barry Aubrey

ICO Polymers North America
16646 Old Nome Road
China, TX 77613
(409) 752-5330
Dennis Sarno

ICO Polymers North America
Route 173, 2 Vliet Farm Road
Asbury, NJ 08802
(908) 479-4181
Mike Bohon

ICO Polymers North America
10820 Hemlock Ave
Fontana, CA 92337
(909) 356-8091
Gerry Coplin

ICO Polymers North America
706 W. Madison Street
Grand Junction, TN 38039
(901) 764-2164
Joel Porter