MorehouseCowles

MorehouseCowles Product Selection Guide: The right tool for the job

Formulators don't have an infinite number of tools with which to process their products – just an unlimited number of ways to use them. How do they make the right choices?

In the coatings industry, market and product success often have as much to do with processing strategy as with chemistry. Just ask the leading makers of wood sealants, car coatings, and ink-jet printer ink. Materials simply would not be penetrating enough, hard enough or fine enough without the correct processing strategy. That's why many coatings manufacturers regard materials processing just as they do their chemical formulas – as trade secrets. In fact, chemical discovery, and materials processing discovery have a lot in common. Both often involve concentrated amounts of trial and error using known principles that were arrived at through years of experience. Researchers usually start with what worked in the past and then go from there. Yet there is one thing that is significantly different. In chemical research, the experimenter has virtually an unlimited number of raw materials with which to work, starting with the 109 elements in the periodic table.

However, in material processing, there are only seven equipment types from which almost every synthetic material ever created can be manufactured. Differences occur not just in the choice of equipment type, but also in the processing time, media used, temperature, processing speed and several other key variables (although, again, the total number of variables is very small, compared to the number of potential compounds that could be involved). What makes the discovery process complex is not the number of tools or processing variables so much as the variety of ways tools and processing variables can be combined to create unique processes. Fortunately (or unfortunately), the guidelines for making these choices are fairly limited in number.

The table below illustrates that most of the products in the coating industry can be made using only a few types of processing equipment: dissolvers, multishift dissolvers, vertical media mills, colloid mills, horizontal media mills, ball mills, and high-shear fluid processors. Under each product category in the table, asterisk symbols indicate how useful (in general) that type of equipment is for processing each type of product – one asterisk indicating low usefulness and four asterisks indicating extremely high usefulness. High-shear fluid processors, for example, are rated as the most useful for making digital ink used in computer ink-jet printers – which reflects the extreme particle size reduction and strict uniformity required to produce ink capable of being propelled through the tiny holes of an ink-jet printer. These same processors, however, are rarely used in the manufacture of ordinary house paint, where extreme size reduction is unimportant, although very high flow rate (combined with moderate size reduction) is – qualities that make horizontal media mills shine in this product category.

Where chemical researchers typically are in search of a formula, process researchers are looking for a scenario – a combination of one or more equipment types, set up in various configurations, and employed through a sequence of processing steps that will result in the hoped for final product.

To arrive at a scenario, formulators have to consider a number of process variables in light of the process objectives, including the following:

- Equipment type or types to be used
- Process parameters (e.g., temperature, pressure, flow rate, viscosity, etc.) for each
- Whether the process is batch or continuous
- Equipment configuration (e.g., blade types, media types, number of blades, etc.)
- Equipment capacities

Business objectives to consider include the following:

- Process objectives (e.g., size reduction, deagglomeration, dissolving)
- Performance objectives (e.g., particle/droplet size, shelf life)
- Cost objectives (e.g., will market support a high-cost process?)
- Product quality objectives (e.g., size uniformity, color uniformity, purity)
- Product quantity objectives

Following is a discussion of each of the seven major equipment categories, with reference both to the process variables and process objectives. One point that quickly becomes clear is that certain types of equipment either are or are not typically used with certain other types. For example, dissolvers are often used as a necessary pre-processor to all the other types of equipment to "wet" materials prior to more aggressive mixing, blending, or size reduction. Multi-shaft dissolvers, on the other hand, can be used alone. That's because: 1) they accomplish their own wetting, so a pre-processor isn't needed; 2) they would be "overkill" as a pre-process for other equipment; and 3) they have already been selected as the method of choice for mixing the more viscous products, so no other equipment is involved.

VISCOMAX™ MULTI-SHAFT MIXER: A multi-shaft dissolver is ideal for highly viscous products. The addition of wall scrapers on the sides and bottom of the anchor shaft ensures complete mixing. A third shaft is usually fitted with a screw-type auger, a tuning-fork-shaped gate blade or an axial flow-inducing turbine to minimize stratification and dead spots.

V-SERIES SINGLE SHAFT HIGH-SPEED DISSOLVER, V-25-10: V-series standard designs deliver the ultimate dispersion, de-agglomeration and dissolving technology. The reliable, versatile, and economical design is built for decades of dependable operation. With standard safety features, these dissolvers are designed to help prevent injury without sacrificing performance and reliability. These dissolvers will process solid-liquid, liquid-liquid and gas-liquid products, either synthetic, organic or inorganic.

Product Matrix

	MFIC Division:	MorehouseCowles				
	Generic Equipment Description:	Dissolvers/ Dispersers	Multi-Shaft Dissolvers	Vertical Media Mills	Horizonal Media Mills	Colloid Mills
Industries:	Trade Names:	Original COWLES	ViscoMAX™	Sand Mills	Zinger™	Stone Mills
Paints & Coatings:						
Architectural Paint (Trade Sales)		****	**	***	*	*
Automotive - Non Top Coat		****		***	****	
Automotive - Top Coat		****		*	****	
Resins		****	**	**	**	
Extenders		****	*	**	**	
Additives		****	*		**	
Fillers		****	*		**	
Conductive Coatings		****	***	**	****	
Automotive Elastomers		**	****	***	****	
Industrial		****	**	***	***	
Marine Paint		****	*	***	***	
Wood Finishes		****	**	***	***	
Gel Coats (polyester)		***	****	***	***	
Dye Stuffs		****	*	***	***	
Colorants		***		***	***	
Inks:						
General Printing		****		**	****	
Offset Inks		****	**	**	****	
High End/Specialty Inks		****	**	*	****	
Digital Inks		****	**		***	
Conductive Inks		***	***		**	
Flexograpic		****		**	***	
Lithographic		****	***			
News Ink		****	**	**	**	
UV Curable		***		**	**	
Gravure		***		***	***	
Adhesives		**	***			
Hot Melts (adhesives)		**	****			
Sealents		***	****			

TABLE KEY: under each product category in the table asterisks (*) indicate usefulness of equipment type for processing different products.
e.g. * = low usefulness. **** = extremely high usefulness

VERTICAL MEDIA MILL, 5-5A: Our vertical media mill is a workhorse for continuous wet milling of aqueous and solvent slurries in a variety of viscosities. Its simple, reliable, and easy to maintain design efficiently and uniformly mills product to the required particle or agglomerate size. The smaller and more uniform particle sizes produced by the vertical media mill enables smoother product consistency for better quality, enhanced performance and longer shelf life.

Product Matrix Continued

	MFIC Division:	MorehouseCowles				
	Generic Equipment Description:	**Dissolvers/ Dispersers**	**Multi-Shaft Dissolvers**	**Vertical Media Mills**	**Horizonal Media Mills**	**Colloid Mills**
Industries:	**Trade Names:**	**Original COWLES**	**ViscoMAX™**	**Sand Mills**	**Zinger™**	**Stone Mills**
Pharmaceutical:	Injectable Drugs					
	Emulsions	***	**			
	Dispersions	****		**		
	Cell Disruption			*	**	
	Liposomes					
Cosmetics:	Creams & Lotions	**	**			
	Lipstick	***	***	*		
	Nail Polish	***	*	**		
	Liposomes					
	Foundations					
	Oil & Essences					
Food Products:	Food Grinding	**		**	***	***
	Flavor Additives	**		**	**	**
	Colorants	**		**	**	**
	Chocolate & Confections	**		**	**	**
	Fat Substitues	**			*	
Bio-Tech/Cell Disruption:						
E-Coli		**				
Yeast		**			**	
Mammalian		**				
Algae		**			**	
Ag-Chem		****		***	****	
Magnetic/Iron Oxides		***		**	**	
Ceramics		***		**	***	
Minerals		****		***	****	**
Recycling		*				
Paper Coatings		****		***	***	
Paper Fillers		***		***	***	
Solder Masks		*	****	***	***	
Solder Flux (liquid)		****				
Solder Flux (paste)		*	****			
Foundry Cast Coatings & Slips		***				

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DISSOLVERS

As shown in the table, dissolvers are the universal appliance when it comes to processing almost any kind of coatings materials – either alone or as a preprocessor to other equipment types: vertical media mills, colloid mills, horizontal media mills, ball mills, and high shear fluid processors. In their solo role, they are effective for materials such as exterior house paint – products that:

- Are produced by mixing liquids in liquids, and solids in liquids (deagglomeration), and
- Require almost no particle or droplet breakup.

In their supporting role as preprocessors, dissolvers typically are employed as the first stage in a two- or three-stage process, where the next stage is a vertical or horizontal media mill and the third stage (if required) is a high-shear fluid processor. (There are also applications in which the formulation calls for the product to move directly from the dissolver to the high shear fluid processor.) The purpose of the dissolver in these scenarios is to create a premix so that particles and/or droplets are well distributed in the carrier liquid – a prerequisite for effective milling or fluidizing. Lumpy dry solids especially are difficult to process in these higher-end machines.

Among the most important decisions involving dissolvers are the impeller speed and which impeller to use. In general, the faster the speed of the impeller without spilling product from the tank, the better. That's because higher speed imparts more shear on the product, resulting in more efficient deagglomeration and more thorough mixing in less time. A variable speed dissolver allows the user to most closely match impeller speed to the application, as well to employ the same machine for a number of applications.

Two variables to consider when selecting an impeller are shape and composition. Most applications call for stainless steel, although that may not be appropriate when mixing highly abrasive solids (like sand) that can wear off the steel (which is then incorporated into the mix). That's why MorehouseCowles makes available a Polypeller™ blade – it's not only made from high-molecular-weight polyethylene plastic, it's also thicker than the stainless steel blade (1-inch vs. 1/8th-inch).

As for shape, key factors include the viscosity and mixing difficulty. A saw tooth disk, for example, is preferred in low-viscosity applications with high mixing difficulty – i.e., where particle/droplet size reduction requires more energy. In applications with higher viscosity and/or easier mixing, a bow-tie blade would be better, running at a much lower speed. The bow tie is more efficient at moving product, but is less efficient at breaking up particles and droplets than the saw-tooth disk. Impellers come in other shapes that blend the characteristics of these impeller types, allowing formulators to accommodate a mix of product requirements. When no single blade can meet all product requirements at once, it is time to consider a multi-shaft dissolver.

V-SERIES SINGLE SHAFT HIGH-SPEED DISSOLVER, V-25-10: V-series standard designs deliver the ultimate dispersion, deagglomeration and dissolving technology. The reliable, versatile, and economical design is built for decades of dependable operation. With standard safety features, these dissolvers are designed to help prevent injury without sacrificing performance and reliability. These dissolvers will process solid-liquid, liquid-liquid and gas-liquid products, either synthetic, organic or inorganic.

MULTI-SHAFT DISSOLVERS

Typically, a single shaft dissolver is used in easily flowing products with viscosities no greater than 50,000 cPs. Once higher viscosities are achieved, or if a product is extremely thixotropic (i.e., viscosity decreases with shear), complete mixing or dispersing may not be achieved because product at the tank walls may not be drawn into the high shear zone.

This problem is solved by adding an "anchor" type sweep or "bow-tie" type low-speed agitator often with risers and wall scrapers. The low-speed anchor shaft is located in the center of the mix tank, and the high-shear shaft is offset to one side. The anchor impeller is designed to both clean the tank walls and to move the viscous product around to the high-shear impeller. The addition of wall scrapers on the sides and bottom of the anchor ensures complete mixing and enables effective heat transfer if the tank is jacketed for heating or cooling. For heat sensitive products, or products with even higher viscosities, up to 3 or 4 million cPs, the addition of an intermediate speed third shaft is recommended. The third shaft is usually fitted with a screw type "auger," a tuning fork shaped "gate blade," or an axial flow inducing turbine. Operated at the proper RPM, this third shaft imparts a vigorous vertical pumping action to the mix and minimizes stratification and "dead spots" in the batch. Many three-shaft customers substitute a second intermediate speed blade (on the third shaft) in lieu of the high-shear dissolver, particularly when the product cannot tolerate high shear, or at the extremely high viscosity ranges where high shear is not needed.

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STONE MILL, 830 SERIES: Since 1925, MorehouseCowles stone mills have proven to be the most reliable and efficient way to process hundreds of different materials from food, cosmetics, and ceramics to paints, inks, and grease. Our stone mills break down a product or mixture to very small particle sizes. They offer grinding technology for dry to liquid processing where 100% of the material passes through the milling surfaces for superior consistency and performance.

MILLS: VERTICAL, COLLOIDAL, HORIZONTAL, BALL

Formulators use mills when they need a better "grind" (particle/droplet size reduction) than can be achieved with a dissolver. Almost always, the choice is between a vertical or horizontal media mill, and seldom would a formulator use more than one kind of mill on the same product. Ball mills and colloidal mills are for "special cases." Ball mills use relatively large media and achieve a size reduction in the 400µ size range. They are typically used following materials extraction (e.g., mining pigments from the earth) to obtain a product suitable for shipment to paint makers and other manufactures – and where it will be processed further in a mill and/or high-shear fluid processor.

Colloidal mills (also known as stone mills) operate on the same principle as a mill used to grind wheat into flour. Product flows through an opening in the center of a grinding stone rotating above a second stone. Product flowing out from the center is ground between the two stones. Colloidal mills are most often used in paint plants to salvage a batch "gone bad" from shock, or seed formation. Hot latex, industrial house paint, and industrial paint are among the products that do well in colloidal mills, as well as mineral processing, and true colloidal generation such as grease manufacturing.

In many other milling scenarios the choice is between a vertical media mill and a horizontal media mill. Of the two, the vertical mill is less expensive to own and operate, uses less media, and requires less operator intervention. The horizontal mill produces greater shear, achieves a better grind in less time with less media contamination of the product, and is easier to clean. Originally called sand mills, vertical mills once used a type of silica media called Ottawa sand (although today a variety of media ranging in size from sand to marble size). As the name implies, in vertical mills the mixing chamber stands on end with the media at the bottom. Besides media, the chamber contains a series of parallel agitator disks mounted on a high-speed shaft. As the shaft turns, energy is transferred from the agitator disks to the media. When product is introduced into the chamber, the motion of the disks and grinding media produces impact and shear forces that efficiently and uniformly deagglomerate particles to any specified size distribution. Product moves through the chamber under pressure from an integral, variable-flow diaphragm pump. Product enters the chamber at the bottom, is ground by the media as it rises through the chamber, and exits through a screen at the top. Particle size reduction depends on the size and type of media and the flow rate.

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In a horizontal media mill, premixed product is continuously pumped through a horizontal chamber. Media is aggressively accelerated through the chamber (and the product slurry) under the force of impeller blades. In the Zinger™ horizontal mill those forces also direct the slurry/media outward toward the chamber walls where specifically shaped projections reduce media acceleration, causing media to return to the center and be repeatedly accelerated all over again. (Horizontal mills that lack this patented technology require larger media and more energy, thereby reducing milling efficiency and increasing thermal buildup.)

The mill's horizontal orientation means the chamber can be 90-95% media filled vs. 65-70% for the vertical mill, thereby achieving more intensive interaction with the product and faster size reduction. (If a vertical mill is filled more than that, the media can bind the shaft up to where the mill cannot be started.) However, the fact that the horizontal mill has more media also means that the operator has to be more careful to run the mill at the correct speed. Running the mill too fast will cause the media to pack at one end of the chamber; running it too slow will cause the media to start eating away at the seal. These issues are often counterbalanced by the sheer productivity of the process. Users often report doing batches in a third to a quarter of the time it would have taken them using a vertical mill.

ZINGER™ HORIZONTAL MEDIA MILL: The zinger is a horizontal media mill that creates extra shear through diverters located along the mill's inside container wall, the effect of which is to enhance the acceleration of media and product as they come off the mill's impeller blade.

YOUR DECISION

Knowing which of these process paths to take ultimately boils down to what you want to achieve as an end-result, the materials you have to start with, and how much money the marketplace will let you spend. The biggest mistake formulators make is assuming that they should just repeat what has worked for them in the past – perhaps years in the past. They should know they have a range of solutions – based upon these seven basic processor types – and that different solutions, and combinations of solutions may get them where they want to go faster, for less money, and with fewer mistakes along the way.

Made in the USA

For more information, visit **morehousecowles.com** or contact MorehouseCowles experts today at **sales@morehousecowles.com** or **+1 (909) 627 7222.**

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