SIMPSON® TECHNOLOGIES

HOW TO CHOOSE THE BEST MIXER FOR YOUR WETTED SOLIDS APPLICATION

While conventional mixing is usually adequate for the blending of easy to handle solids, only more intensive forms of mixing can produce total uniformity in a mix of materials having disproportionate mass, particle size, liquidity, viscosity or density. This report has been prepared to assist you in reviewing wetted solids mixing options. Also provided in this report are examples of how manufacturers of differing products have solved shortcomings in their wetted solids mixing operations.

Evaluating Wetted Solids Mixers

Mixing is certainly an integral part of material processing. In determining which mixer is best for your particular application, it is important to review what you want to accomplish and to develop a set of criteria prior to selection of any mixing method. Consider several factors when selecting a type of mixer: the number and type of ingredients you will be processing, the quantity of end product you need to produce, the mixing time required to properly prepare the material, efficiency of the mixer, initial cost, and continuing operational costs.

Number and type of ingredients. Virtually all materials are composed of aggregates or other groupings of dissimilar particles. Obtaining even dispersion or mixing is a difficult task. This is further complicated when several materials are to be mixed. Add to this the introduction of liquid(s) to be dispersed into the mass and you have created a tremendous task for any mixer.

When conventional mixing is used (i.e. blender type mixers), it can appear on the surface that the product is being processed well. However, visual product inspection and even random sampling are not always accurate at determining if a mixture is properly prepared. In normal operation, of course, it is not practical to expect that detailed sampling can be taken on a regular basis. A mixer must be chosen through test work that has strong repeatability on the product(s) you want to prepare. Unless your mix is uniform and consistent throughout, the materials may not always exhibit the desired properties you need.

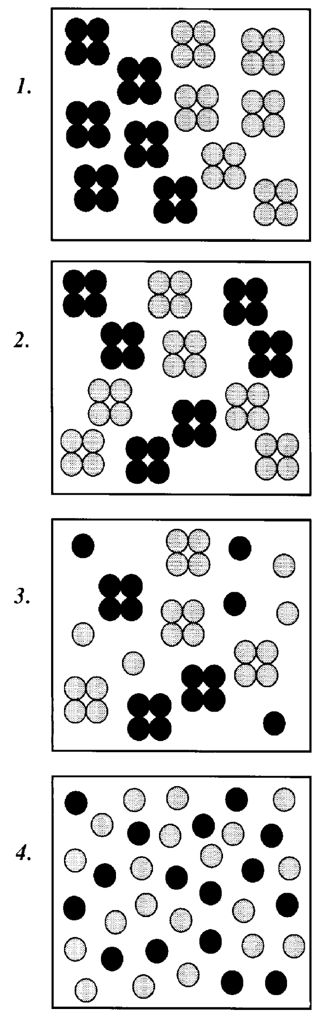


Figure 1. *Mixing of Ingredients*

(1) When materials are initially combined in a mixer, the "mix" is a jumbled mass of aggregates. (2) conventional blending may result in a uniform dispersion of the aggregates or (3) a mass of aggregates and individual particles. (4) But intensive mixing is required to produce thorough distribution of individual particles throughout the mix.

Amount of product required. Typically plant operations and market conditions will dictate the amount of product that will need to be produced. In order to assure that your mixer and mixing system can keep up with that demand, it is critical to properly size the mixer into your operation. Important criteria in determining the size of the mixer include: bulk and net densities of dry materials, particle size, viscosity and weight of liquids, and the chemical properties of materials such as corrosiveness or hydroscopic tendencies.

Mixing time and efficiency required. In testing different mixer types, it is critical to review time required for mix preparation and kilowatt consumption of the process in order to properly size the system required. The actual time required to prepare different products can vary greatly depending on the type of mixer that is being used. Most people knowledgeable in the field of mixing stress the importance of running mixing tests to best determine the ability of any mixer to properly prepare your product. Through test work (under controlled conditions) it is possible to determine the optimum mix time of your product to assure good product development in a reasonable period of time and with efficient use of energy. This mixing time data can then be compiled with the material specifications to assist in the sizing and selection of the right wetted solids mixer.

Initial and operational costs. Once the correct type and sizing of the mixer has taken place, it is possible to evaluate the initial cost of a mixer or mixers. In addition to the initial cost, other cost considerations must be considered such as; cost per kilowatt hour of operation, maintenance costs (hourly labor and material costs per kilogram or ton of product produced), dust collection or emission control costs, installation costs, and control integration with other facets of the plant.

Other factors. Other application dependent factors will effect your choice of mixer, such as heating or cooling requirements, vacuum operation, system automation of material handling devices to and from the mixer, the sequence and method of addition of your ingredients, and batch versus continuous mixing.

Determining which type of mixer to use is a complex procedure, but should never require you to make trade offs of one benefit for another. Through careful planning of mix criteria and proper evaluation of the various types of mixers in a controlled test program, it is possible to choose the right style of mixer for your wetted solids application. The only way to be assured of the results is to perform the tests.

Intensive Mixing Using The Muller Method

The muller type mixer (Figure 2) provides additional mixing forces over that of more conventional mixers to assure that the total mixture prepared is of uniform consistency. Unlike conventional mixing, mulling provides forces that incorporate kneading, shearing, smearing, and blending of materials for total uniform consistency. This process produces just enough pressure to move, intermingle and push particles into place without crushing, grinding, or distorting the ingredients. The result is a final mixture of truly uniform consistency in both physical and chemical structure.

Figure 2. Muller Mixer

Mulling is an extension of mixing resulting from the intensification of work forces (Figure 3). The work forces are applied via the tread of weighted mulling wheels. The weight, and thereby the mixing efficiency, is controlled through a spring suspension arrangement on the wheel that is fully adjustable and allows the user to increase or decrease the amount of work that is applied to the mixture via the mulling wheel. This extension of mixing has proven to be a successful method in a wide range of applications.

In order to provide some technical basis for this argument, let's look at a few applications where mulling has replaced more common methods of mixing. In all these cases, mulling has provided the user with significant advantages over the previous method of mixing.

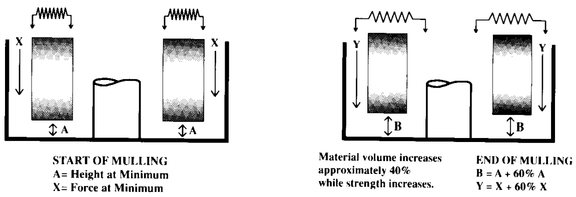


Figure 3. Mulling Pressure

Proper mulling pressure is always assured by the spring mechanism on the muller wheels. Before the mix begins to develop, less pressure is exerted on the mix (left). As the mix strengthens, mulling pressure is increased (right).

A comparison to Sigma Blade mixing. While sigma blade mixers (Figure 4) are used quite extensively in the preparation of pharmaceuticals and foodstuffs, several companies that have revaluated their mixing process have found that muller mixing has proven more successful. This section discusses the conversion from sigma blade mixers to muller mixing in the preparation of pharmaceutical tablets.

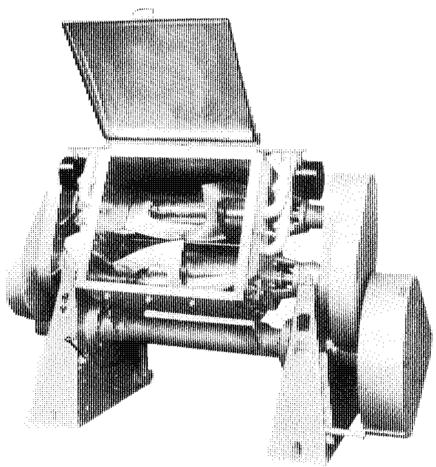


Figure 4. Sigma Blade Mixer

In a single pharmaceutical operation, testing proved that one muller mixer of twelve cubic foot capacity could replace twelve sigma blade mixers of three cubic foot capacity. In this application, the muller is outfitted with a special cooling jacket to control product temperature development. The muller wheels have been designed with a wheel lifting device that lifts the wheels at the end of the mixing cycle to allow for complete discharge of material. Additionally, a liquid spray arrangement has been integrated in the muller to assure proper clean-out of the machine.

Of course, these special features enhance performance of the machine, however it was the ability of the muller mixer to prepare the material more quickly and to exacting specifications that reinforced the decision to replace the sigma blade mixers. The material to be tableted is a granulated calcium carbonate that is processed by wet mixing, drying, and then tableting. In the original operation it was necessary to use twelve three cubic foot capacity sigma blades to process this work. Since it took 12 operators to produce a minimal amount of material, the system was labor and operationally intensive. It took each mixer an average of one hour to produce a batch. The raw material has a diamond hardness of 3 to 5 and created several mechanical problems for the sigma blade mixers.

The company embarked on a test program to evaluate new mixers. They decided it would be best if they could design an automated batching system for their plant. In laboratory test work performed, they were able to reduce the batch time from one hour to fifteen minutes using muller mixing. To automate the process, they incorporated a quick charge and discharge system. The raw materials are first dry mixed and flash loaded into the muller and the addition of water is made at the beginning of the mixing cycle. By replacing their twelve sigma blade mixers with one muller mixer this company increased their productivity by twenty times.

A comparison to ribbon blending. A manufacturer of feedstuffs for livestock and poultry needed to find a better solution to their mixing problems. Their current use of ribbon blenders (Figure 5) to prepare their material was a slow and maintenance heavy process. Since muller mixers had not been used very extensively in this application, there was a need for an experimental evaluation of the muller's suitability to the process. A study of the ability of this mixer to produce uniform mixtures of such material was done.

Recent advances in nutrition have shown the importance of small amounts of certain substances in the diet of animals. The need to distribute small amounts of such materials uniformly in a large quantity of other substances emphasizes the importance of the mixing problem.

The specific objectives of the study were: (1) To determine the effectiveness of mixing feedstuffs with the muller mixer; (2) To determine the time required by the muller mixer to produce a uniform mixture of feeds such as (a) minerals, (b) poultry, (c) dairy; (3) To evaluate the tendency of a given mixture to separate during handling; and (4) To compare the results produced by the muller mixer with those obtained when the same materials were mixed in a ribbon blender.

The method of evaluating the uniformity of the mixing in the case of the mineral feed consisted of the determination of iodide. In the case of dairy and poultry feeds, the determination of chlorides was the method employed. The batch was considered uniform and the mixing complete when a series of samples obtained from several locations were uniform in composition and the results were within specified control limits of the actual amount initially added.

The following conclusions were drawn from the extensive testing that was done:

1. On mineral mixtures the results showed that the muller mixer consistently obtained shorter mixing cycle times.

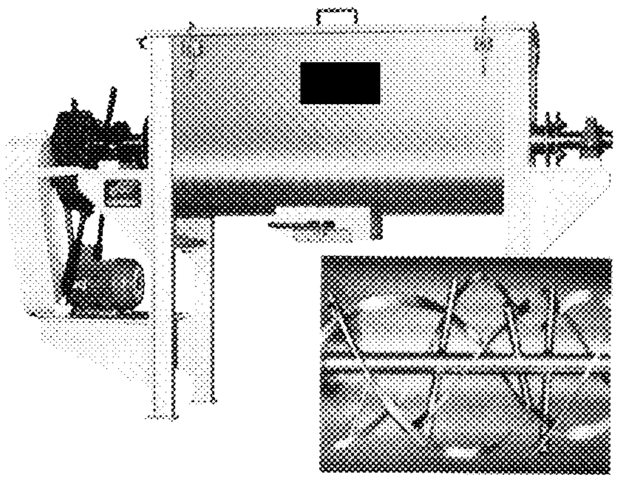


Figure 5. Ribbon Blender

2. On dairy feed the results showed that the muller could obtain the desired results after one minute of operation and that it is doubtful that uniformity is reached in the ribbon blender even after six minutes.

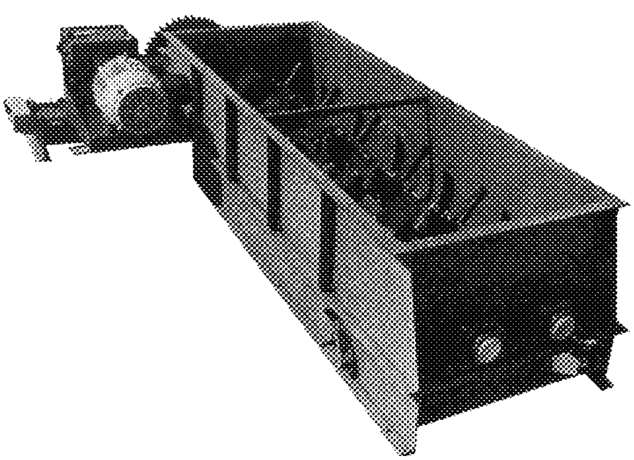


Figure 6. Paddle Mixer

3. On poultry feed the results showed that the muller could process in one and a half minutes what it took the other mixer six minutes to do.

4. An advantage of muller mixing is that all areas of the batch are active and put in motion, whereas in the ribbon blender there were inactive zones near the sides of the mixer that were particularly noticeable during the mineral feed tests.

5. It is possible to reduce the use of binders such as molasses by as much as thirty percent (30%) by using mulling. Since the wheels apply force to the mixture, the binder was more accurately distributed throughout the mass as compared with the analysis of feeds using binders that were processed in a ribbon blender.

Finally, the results indicated that there is a considerably greater tendency for the feed mixed in the ribbon blender to separate during handling and transportation, causing a significant change in the nutritional level of the feedstuffs.

TABLE I

COMPARISON OF DAIRY AND POULTRY FEED MIXES

RUN NUMBER	CHARGE (lbs)	% TRACER INGREDIENT	MIXING TIME
Muller 4	190	.10% NaCl	1 minute
Ribbon 4	100 A	.10% NaCl	5 minutes B
Muller 5	175	.10% NaCl; 5% Binder	1.5 minutes
Ribbon 5	100 A	.10% NaCl; 5% Binder	6 minutes B
Muller 6	200	.10% NaCl	2 minutes
Ribbon 6	100 A	.10% NaCl	6 minutes B

A - Batch in ribbon blender is less due to available capacity
B - Did not meet acceptable parameters even after two hours

TABLE II

COMPARISON OF MINER FEED MIXES

RUN NUMBER	CHARGE (lbs)	% TRACER INGREDIENT	MIXING TIME
Muller 1	500	.09% Kl	1.5 minutes
Ribbon 1	400 A	.09% Kl	Indefinite B
Muller 2	500	.09% Kl	2 minutes
Ribbon 2	400 A	.09% Kl	Indefinite B
Muller 3	500	.09% Kl; 8% Molasses	1 minutes
Ribbon 3	400 A	.09% Kl; 8% Molasses	Indefinite B

A - Batch in ribbon blender is less due to available capacity
B - Did no meet acceptable parameters even after two hours

A comparison to pug and paddle mixing. In the briquetting, pelletizing, and agglomeration fields the muller type mixer has been able to replace pug mills and paddle mixers (Figure 6) and has proven itself through laboratory testing and actual production operation. Heavy construction makes the mullers suitable for these high wear, high demand type of operations.

A producer of iron ore concentrate was having difficulties with the formation of pellets that are produced so that the product can be easily handled and transported. The usage of bentonite binder had been quite large in proportion to the amount of material that was being processed. Additionally, the pug mills and paddle mixers being used to process the material had a high incidence of failure during operation causing a tremendous amount of downtime in the plant. A better solution had to be found.

Previous studies had demonstrated the strong dependence of pellet strength on the degree of mixing of the iron ore concentrate and bentonite binder. The degree of mixing was also directly linked with the uniformity of ball and pellet properties. These findings pointed to a need for more thorough bentonite-concentrate mixing than is normally employed in conventional blending operations.

In the early stages of the test program, they evaluated other types of mixing, but found that the best balling properties could be attained only when subjecting the concentrate-bentonite-water mixture to the compressive forces found in the muller type of mixer. Plant tests verified laboratory findings that mulling provided a substantial savings in bentonite binder with no apparent decrease in ball or pellet quality.

The savings in bentonite binder were estimated by comparing a curve of ball strength versus bentonite contraction for one minute of mulling time against the equivalent mixing time in the company's other mixers. It was found that to make balls of acceptable strength and quality the muller mixer required only about half as much bentonite as the other mixers. Bentonite savings were based on six months of field test work. These tests provided the data on which to evaluate the economics of mulling.

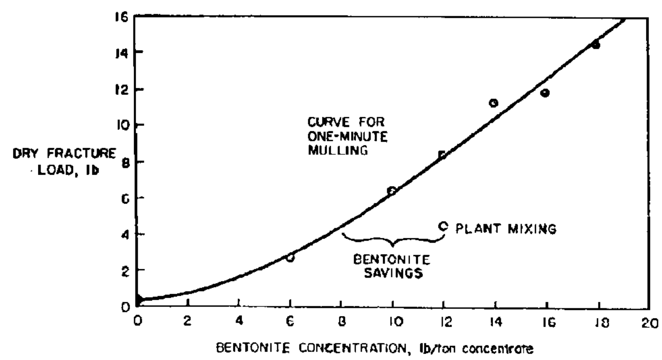
Maintenance costs for the muller type mixer versus the paddle and pug mill types were significantly less. In a typical twelve month period the muller had averaged only ten hours of downtime and the cost of maintenance (including parts and labor) was estimated at $0.037 per ton of product produced. (1)

Conclusion

The information supplied here presents a technical alternative to the more common mixing practices found today. In the evaluation of any mixing system it is critical that a detailed technical evaluation be made. This includes laboratory and field analysis of different mixing alternatives. No one mixer can accommodate all processes, so it is imperative to give close consideration to what you want to do, develop a detailed agenda to execute your plans, and seek out possible alternatives to current methods.

For more information on **Simpson Technologies Corporation,** our products, or our **Performance Laboratory** please call or write to us. We are happy to work with you to develop a test program that will help you evaluate mixing equipment and find what is right for your process.

References



Bentonite savings; 1-min mulling curve vs. plant mixing for Cornwall balls (laboratory balling).

(1) "Muller Mixing of Bentonite and Iron Ore Concentrate at Cornwall", Trans. SME/AIME, Vol. 252, 1972.