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625 Commerce Center Drive
Fairfield, OH 45011
P: 513.863.4758
F: 513.863.3846

innovation@westernstates.com
www.westernstates.com

Tips and Tricks for Operating Batch Type Centrifuges

By Edward D. Dunsmuir

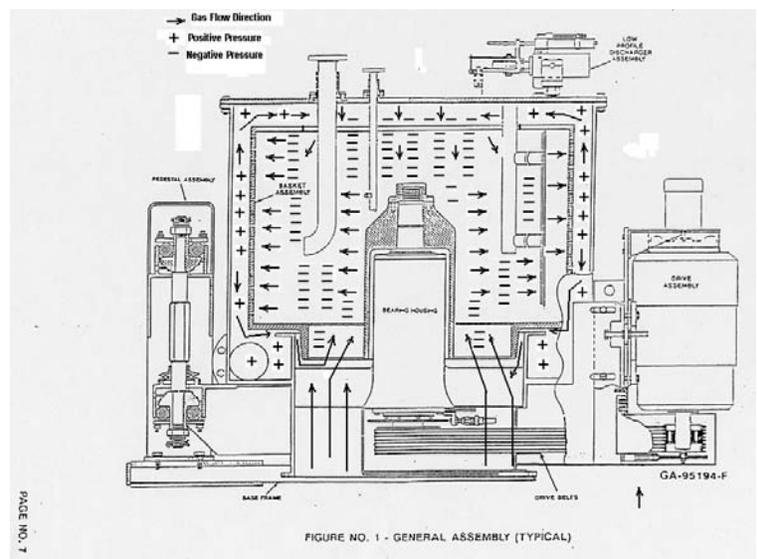
Gas flow and product contamination factors, inside a batch centrifuge

The general gas flow through a WSMC centrifuge(s), Fig.1, also indicated, at various locations, is the gas pressure, shown as a depression or a positive quantity in the wetted areas inside the curb. As one can see, there is a circular flow of gas and atomized liquid inside the basket, through the cake and basket side sheet, and then up and down the area behind the basket side sheet. Some of it then returns back into the center of the basket where a depression has been created by the pumping effect. Not shown is a large volume of gas exiting the curb via the effluent pipe. This exiting volume amount, only happens as long as the effluent and associated piping has not been “short circuited”, IE, blanking off or reduced in cross sectional area, thus rendering it unable to handle the total quantity of air and liquid being generated. A good re-circulating system promotes or enhances liquid drainage and air circulation.

Gas volume leaving the centrifuge, obviously upsets the pressure and volume equilibrium in the system and has to be replaced to maintain equilibrium. This replacement gas can and will flow from anywhere within the whole wetted system, from the path of least resistance, IE connected piping, tanks, vents etc. It will always take the path(s) of least resistance; usually this will be from discharger chute, the curb top vent, discharge chute or from the effluent outlet.

By providing a bye pass pipe from a tee added to the effluent outlet and connected to the curb top vent, the replacement gas source can be controlled, the exiting mother liquor (ML) continues out and down to the ML tank and the gas returns to the center of the of the basket.

During normal processing, liquid and gas that has passed through the product and the basket wall perforations, as mentioned above, exits the curb via the effluent pipe, but some of it is carried up the curb wall and across the underside of the curb top. This phenomenon is caused due to the cyclonic effect being generated inside the curb by the rotating basket that produces a pressure build up between the curb wall and the basket O.D. This flow eventually migrates back into the center of the basket back into the area of depression as shown in fig 1.





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A portion of it travels back through the cake; the balance wets any internal protrusion plus the underside of the curb top, the mechanical protrusions can be the discharger shaft and blade, the feed and wash pipe etc. This liquid can drip down into the wet cake bin and contaminate the finished product.

If the centrifuge effluent pipe terminates into the mother liquor tank through a “stack pipe” that it’s is end is under the level of liquid in the tank; this liquid can backup back into the curb gutter area, when the centrifuge basket stops rotating. This is due to the gas pumping effect of the rotating basket being removed.

To get the best performance out of your centrifuging system, whether it is a good draining or a poor draining product, the following suggestions should be considered.

1. When installing the centrifuge, ensure that the support base i.e. the centrifuge proper, is level both in the “X” and “Y” directions. Also make sure that the pedestal feet are fully supported on the support structure.
2. If possible, mount the feed and wash control valves, as close to the centrifuge curb top as the system design allows. If this cannot be done, consider installing an additional valve downstream of the control valve(s), and connect an appropriate gas supply; this is used to purge out the residual liquid left in the feed and or wash pipe(s), after feeding and or washing is complete.
3. Do not reduce the effluent pipe size between the centrifuge outlet and the ML receiver tank; this also applies to the curb top purge line. It is extremely important to have a good transfer of gas from inside the basket, through the cake and basket perforations into the area behind the basket and then out of the curb, this circulation promotes good liquid drainage through the cake bed. One must of course replace this exiting gas volume by either re-circulating the exiting gas or from some other source.
4. Set the radial orientation of the feed and wash pipe as tangential as possible, approximately 45° from perpendicular to the basket wall in the clockwise or trailing direction.



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Process Evaluation

Before running any process in a centrifuge, it is prudent to get a feel for how it is going to perform. The best way to gather this information is to run tests on a representative slurry sample, in a lab or pilot plant setting etc. The following are some of the characteristics that are helpful in making a decision on how to run the product, and if a batch type centrifuge should be use:

1. Mean particle size, this helps determines if a batch type centrifuge is suitable or not. Rule of thumb dictates that the particles should be at least 10 microns or above, this to allow sufficient drainage through them. As stated, this is a rule of thumb, but many operations with particles less than this can be processed successfully. The percent of “fines”, small particles in the slurry, also affects the drainage rate, these fines lodge in between the larger particles and progressively render the cake bed impervious. Good homogeneity of the feed slurry helps reduce stratification of the particles thus maintaining draining consistency throughout the slurry batch. If stratification is allowed to happen, i.e. the fine particles migrating to the top of the tank and cause the drain rate through the cake bed to drop off as the slurry tank drops in level. This situation can cause undesirable vibration leading to possible equipment failure.
2. One of the best ways to determine the drain rate of a product is to perform a “Buchner” funnel test, see attached procedure. From this test, you can extrapolate how well the mother liquor and the wash media will flow through the cake bed. Not only can you determine the flow rate but also if it is linear due to increased cake bed thickness. The rule of thumb for minimum drainage in a batch type centrifuge is no less than 1/2 gal./ ft.2/minute (0.03ml/cm2/minute). Again, many operations with drain rates less than this are processed successfully.
3. The feed and or wash rate should be delivered slightly above the drain rate flow through the cake. A hydraulic layer (load) on top of the cake, approximately 1/2” thick is always preferred, this helps drive the liquid through the cake and also stops the cake from cracking.
4. Processing temperature needs to be considered, it is usually desirable to process the slurry at the highest temperature possible, this lowers the mother liquor viscosity and thus enhances the drainability of the mother liquor. The same is true for the wash media.
5. Sometimes it is beneficial to purchase your centrifuge fitted with curb insulation, this helps to reduce the cooling effect of the rotating basket and helps to maintain the operating temperature inside the curb.



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Troubleshooting Process Problems

Usually any problems that occur in the centrifuge during processing can be due to one of the following:

1. A product related unbalanced load. This can be caused by one of the following:
 - a. Loading the basket at too low a RPM; this can cause the cake to assume a parabolic uneven shape, see attached sheet, “The Care and Feeding of Batch Centrifugals”.
 - b. Loading the basket at too high a RPM. This usually causes the cake to assume a “pot bellied” uneven shape. What happens here is, that because of the higher gravities, being generated by the higher RPM, the mother liquor is driven out of slurry and out of the basket prematurely thus the particles lose their lubrication and the ability to disperse evenly around the basket wall and are left stuck where the feed pipe delivery impacts the basket wall.
 - c. Product feed pipe; there is no one feed pipe fits all. All products require a specific type of feed pipe that suits the peculiarities of the product. The development of the feed delivery system is usually done during initial testing.
 - d. If the filter screen(s) is improperly fitted at the top and or bottom of the basket wall, this can allow liquid and solids to get past the screens. What happens here is “rat” holes form, i.e. areas void of solids, leading to an imbalance situation.
 - e. Discharged product can sometimes stick to the area around the basket spokes and the underside of the basket bottom and or hub and because it usually doesn’t stick evenly, an unbalance situation develops.
 - f. The filter screen(s) is blinded off or the process particles are too small. This situation causes inhibition of the mother liquor purging through the cake bed and or screen(s), and allows an excessive liquid layer to build up on top of the cake and due to the gas cyclonic effect inside the basket, i.e. windage, a liquid wave can develop thus creating an imbalance situation.

2. A mechanical related unbalanced centrifuge can be caused by one of the following:
 - a. Worn or damaged main or drive motor bearings.
 - b. An unbalanced or out of round basket.
 - c. The main curb suspension system is not operating optimally.
 - d. Connection(s) to the centrifuge, e.g. the effluent pipe, feed pipe etc, or some other impinging structure is impeding movement of centrifuge.



The Care and Feeding of Batch Centrifugals

The illustration in Figure VII indicates improper feeding of the batch unit. The configuration may be caused by:

- a) too high a feed outlet location position in reference to the basket wall;
 - b) too high a speed of the basket during feed;
 - c) too low a feed input rate;
 - d) leaks at the bottom periphery filter media seals;
- or
- e) any combination of a), b), or c).

The usual solution to this type of cake configuration would be to either:

- a) lower the feed pipe;
 - b) reduce the speed of the basket;
- or
- c) increase the input of feed.

Usually, when a cake of the configuration shown in Figure VII is formed, it indicates that the slurry is draining very rapidly and does not have the opportunity to flow evenly before dewatering. It is important that the slurry remain in a viscous state, to create an even wall before dewatering. A good rule of thumb is “. . . the feed rate should be slightly higher than the drain rate.”

If, perchance, the feed rate cannot be increased, the operator has the alternatives of lowering the feed pipe and/or reducing the speed of the basket. If these modifications do not solve the problem, then the obvious step would be to select an alternative feed-pipe design, such as shown in Figure II.

The load configuration illustrated by Figure VIII indicates that the same problem exists as in Figure VII, except that, in this case, the feed pipe outlet is too low. The solutions are, therefore, also similar to those in Figure VII, except that the feed pipe should be raised instead of lowered.

Figure IX indicates the possibility of two distinct, but not necessarily related, problems. Obviously, the feed pipe portion appears to be correctly located, but the “fade-out” of the cake at the top and bottom peripheries indicates one of several things. Various, one may assume that:

- a) the single-outlet style of feed device is not correct;
- b) the feed material is draining rapidly and not permitting the material to flow evenly; or

- c) serious leaks or “washouts” are occurring at the top and bottom peripheries.

In seeking solutions to the problems presented by this configuration, the operator should:

- a) check the top and bottom peripheries for leaks;
 - b) increase the feed rate;
 - c) reduce the speed of the basket;
- or

- d) replace the single-outlet feed pipe with a multiple-style unit.

Such recommendations as noted above are, of course, an attempt to cover, in a primary fashion, the problems and solutions usually experienced in this aspect of centrifuge operation. There have been no references to filter media, liquid load and the like, since these are different, although related, facets of endeavor.

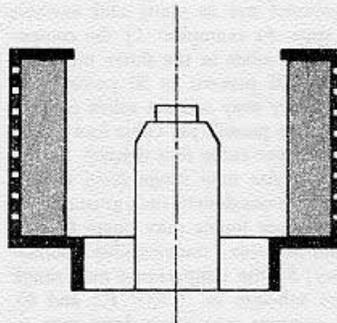


Figure VI

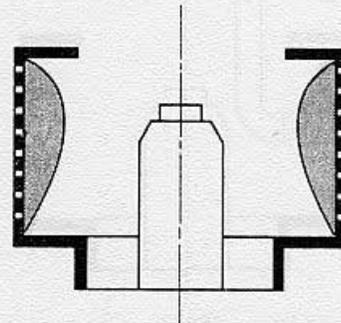


Figure IX

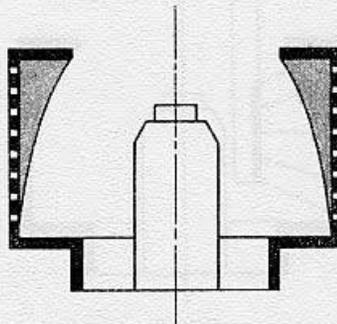


Figure VII

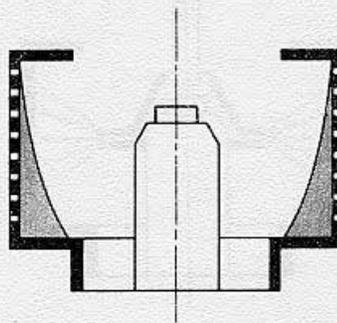


Figure VIII



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