An Introduction to Basic Hydrocyclone Operation

What is a Cyclone ?

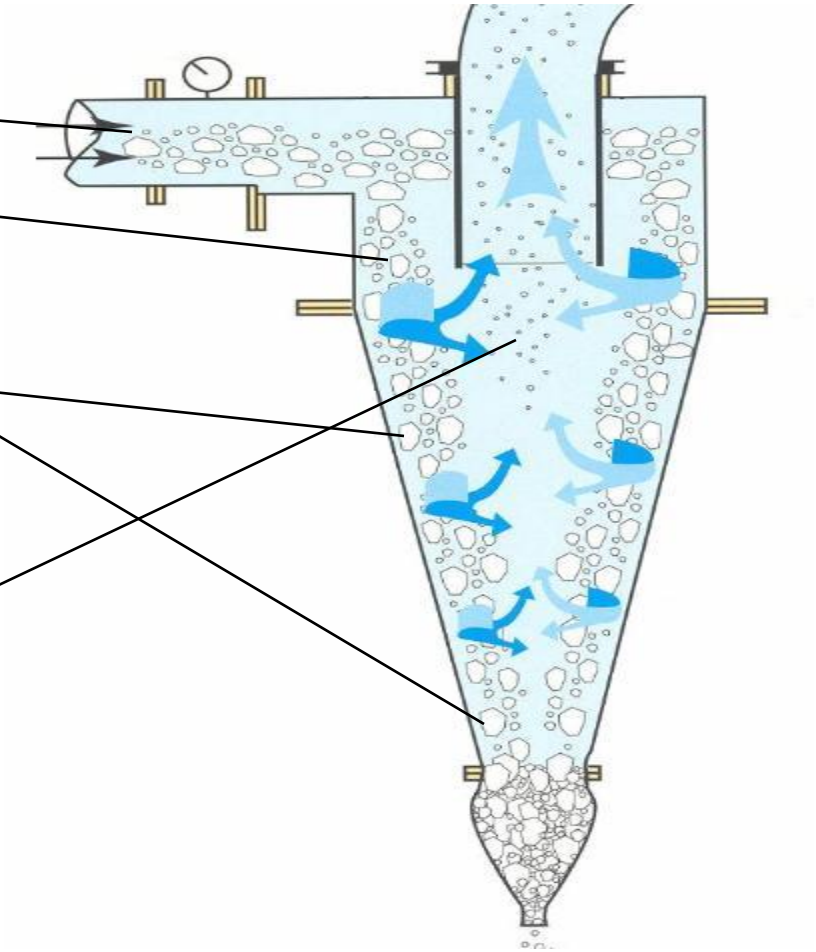
- A cyclone is a piece of process equipment capable of handling large volumes of slurry and classifying it based on differences in size and/or specific gravity.
- Based on these differences a cyclone will then produce two products – an underflow and an overflow.

What is a Cyclone - continued

- A cyclone uses centrifugal force that is generated by a slurry entering the feed chamber under pressure to make the separations. This centrifugal force causes the larger particles to be ‘slung’ to the cone wall while the finer material is kept closer to the center. The vortex finder draws the water and fine material to the overflow while the coarser material makes its way out the apex.

Internal Workings of a Cyclone/MDS

- Slurry enters through the feed inlet.
- Cycloning starts to take place in the feed chamber.
- Heavier particles move to the outer walls and move toward the apex.
- Lighter particles stay near the center of the cone and are carried away by the vortex finder.



What is the difference between a Cyclone and a Maximum Density Separator?

- A cyclone has the overflow and underflow ‘vented’ to the atmosphere.
- An MDS is closed to the atmosphere by the underflow regulator and an o/f waterplug.

Differences - continued

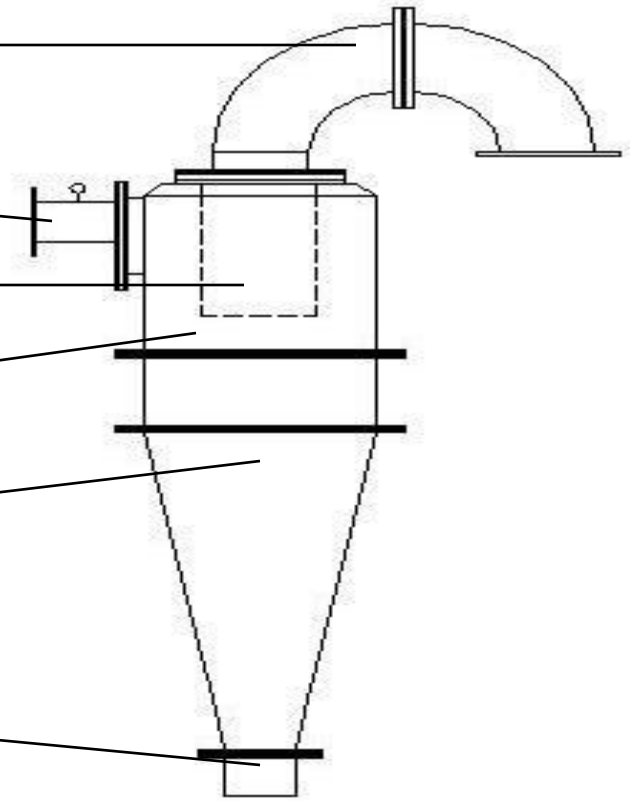
- The o/f of a cyclone will stop after the 180 degree return.
- The o/f of an MDS will have a ‘down leg’ of piping at least 6’ – 8’ below the bottom of the u/f regulator to create a siphon inside of the separator.
- This siphon is what draws the water and fines out of the u/f product.

Differences - continued

- By being open or vented, a cyclone will make a volumetric split. For every gallon that is delivered to it, a certain portion will go to the o/f and a certain portion to the u/f, with or without solids.
- By being closed, an MDS can control the volume to the u/f, forcing the majority of water and fines to the o/f. With water only, the MDS should have a nearly dry u/f.

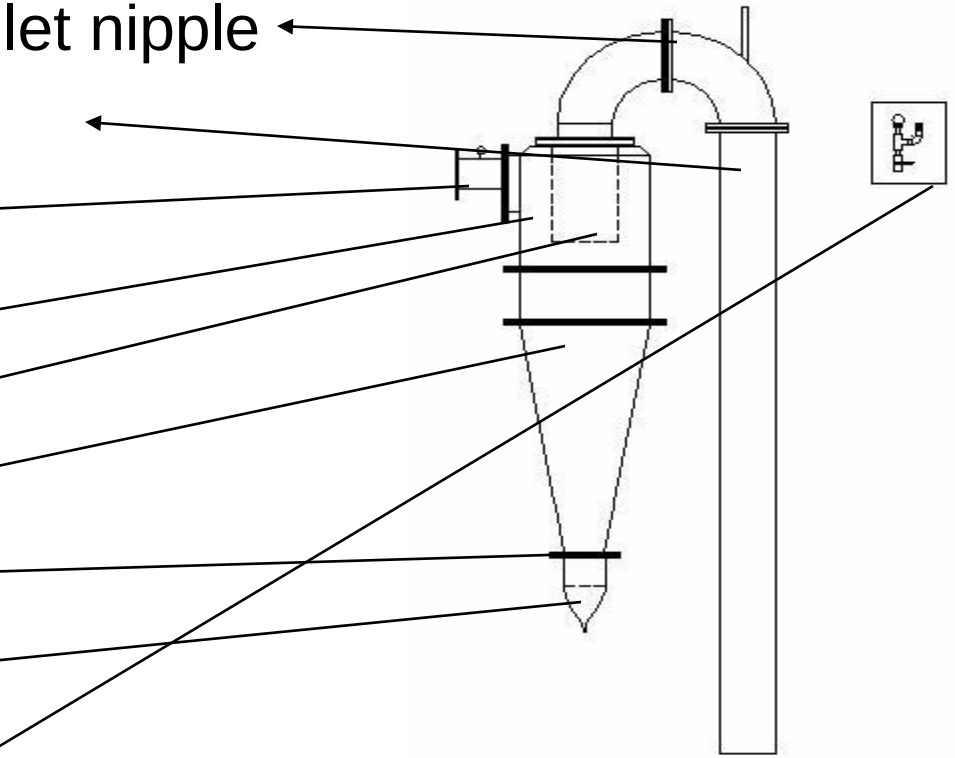
Parts of a Cyclone

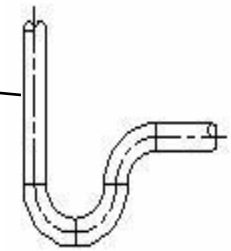
- Overflow return
- Inlet adapter
- Vortex finder
- Feed Chamber
- Cone body
- Apex

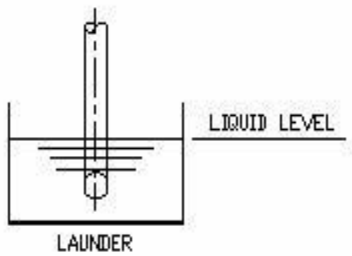


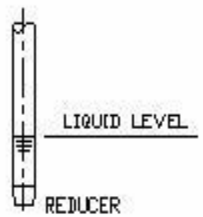
Parts of an MDS

- Overflow return w/air inlet nipple
- Overflow down piping
- Inlet adapter
- Feed Chamber
- Vortex finder
- Cone body
- Apex
- Underflow regulator
- Vacuum control plate
- Water plug









What Affects the Operation of a Separator?

- 1) Inlet pressure.
  - In dewatering only, a minimum of 10 PSI is usually required for separation of coarse solids and water. Less than this will result in a wet and inconsistent u/f.
  - In classification, 15 – 20 PSI is needed to separate solids by size or specific gravity.

Affects - continued…

- 2) Apex sizing
  - The apex is sized according to the amount of slurry (TPH product and water) that is needed to go through the apex.
  - If the apex is too large, the u/f will be wet and ‘fine’
  - If the apex is too small, the u/f will be dry but the unit may plug or reject wanted material.

Affects - continued…

- 3) Vortex Finder
  - The vortex finder is sized based on the GPM needed to go through it.
  - If the vortex finder is too small, more slurry will be forced through the apex and efficient cycloning will be hindered.
  - If the vortex finder is too large, it can ‘drag’ material to the o/f that should report to the u/f.

Affects - continued…

- 4) Percent Solids
  - Cycloning is most efficient between 5% and 25% solids.

Affects - continued…

- 5) Gradation of Feed
  - Feed gradations must be known before a separator can be sized properly.
  - When gradations are known, u/f and o/f products can be predicted.

Examples of Feed Gradations

Sample 1					
Mesh	Wt (g)	Cum wt (g)	% Ret	Cum % Ret	% Pass
35	0	0.00	0.00	0	100
50	0	0.00	0.00	0	100
70	0	0.00	0.00	0	100
100	20	20.00	2.92	3	97
140	50	70.00	7.30	10	90
170	125	195.00	18.25	28	72
200	100	295.00	14.60	43	57
270	70	365.00	10.22	53	47
325	100	465.00	14.60	68	32
pan	220	685.00	32.12	100	0
Total	685				

Sample 4					
Mesh	Wt (g)	Cum wt (g)	% Ret	Cum % Ret	% Pass
35	86	86.00	28.67	28.67	71.33
50	65	151.00	21.67	50.33	49.67
70	52	203.00	17.33	67.67	32.33
100	42	245.00	14.00	81.67	18.33
140	31	276.00	10.33	92.00	8.00
170	13	289.00	4.33	96.33	3.67
200	4	293.00	1.33	97.67	2.33
270	2	295.00	0.67	98.33	1.67
325	5	300.00	1.67	100.00	0.00
pan	0	300.00	0.00	100.00	0.00
Total	300				

Affects - continued…

- 6) Air
  - Because a separator is closed to any outside atmosphere, any air that enters the unit (especially through pump cavitation) will disrupt it's operation and cause erratic u/f results.
  - The only air the separator should see is what is introduced through the o/f siphon control valve.

Available Linings

- Standard lining for most applications is urethane.
- For high wear applications, rubber and ceramic liners are available.
- Separators can be lined with one material entirely, or using a combination. Urethane in the feed chamber and upper cone, ceramics in lower cone and apex, for example.

Linings Continued

- Advantages of urethane are cost, availability and ease of replacing parts.
- Advantages of rubber is wear life for certain materials (manufactured sand).
- Advantages of ceramic is wear life.
- Disadvantages of ceramic are difficulty in replacing worn parts, and ceramic is fragile.

Linings Continued

- When building cyclones new or when replacing worn cone segments, joints must be made smooth and interruption free to minimize losses and maximize efficiency.

Trouble Shooting

Underflow is too wet

1) Apex is too large
2) Vacuum control valve is open too far
3) Inlet pressure is too low
4) Pump is cavitating

Trouble Shooting Continued

Underflow is too dry (cone is plugging)

1) Apex is too small.
2) Vacuum control valve is closed too far.
3) Percent solids is too high.

Trouble Shooting Continued

Too many fines in the underflow

1) Close the vacuum control valve slightly.
2) Install a smaller apex.
3) No coarse material in the feed.

Trouble Shooting Continued

Underflow is too coarse

1) Open the vacuum control valve slightly.
2) Install a larger apex.
3) No fine material in the feed.