Efficiencies of Centrifugal Separators

Custom designed based upon liquid load, flow path and particulate removal

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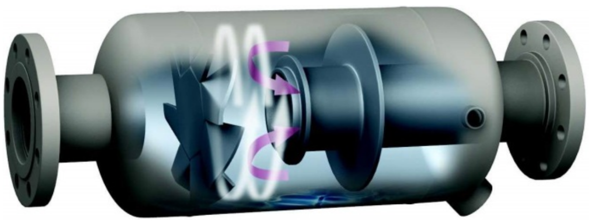
Centrifugal or "vortex" separators remove particulate and entrained droplets larger than 10 microns from air, steam or other gaseous applications. To learn about the design concept of centrifugal separators refer to our article: "Design and Capabilities of Gas/Liquid Separators". The following provides a better understanding of the options available for your application.

In its simplest form, the "L" Series separator consists of a cylindrical body horizontally in-line with the pipeline to which it is installed. Gas flows into the separator body encountering a vaned impingement, forcing the gas to pass through the circumference of the vessel at an angle thus creating a vortex on the other side. Droplets either directly impinge onto this vane or are propelled to the circumference where only the finest navigate through the angled vane openings. The droplets and particles accumulate and coalesce at the bottom of the centrifugal separator, running to a drain port.



Due to angular momentum the fine droplets that passed through the vane are unable to "navigate" towards the low velocity center of the vessel where the outlet nozzle pipe is located and they subsequently impinge onto the vessel body or the vortex containment plate mounted to the internal exit nozzle pipe.

The "L" Series can handle a liquid load equivalent to 5% of the maximum rated weight flow for a given size vessel.

A centrifugal separator "size" is not necessarily the same as the "size" of the inlet and outlet connections; it often is, but doesn't have to be. The mathematical calculations used for sizing a centrifugal separator relate to the vessel ID, vessel length and the total area of internal vane or separator element within. If the liquid load is high, options include using a slightly more complex configuration (minimizing the vessel size) or using a larger vessel and attaching smaller size connections to match the existing pipeline.

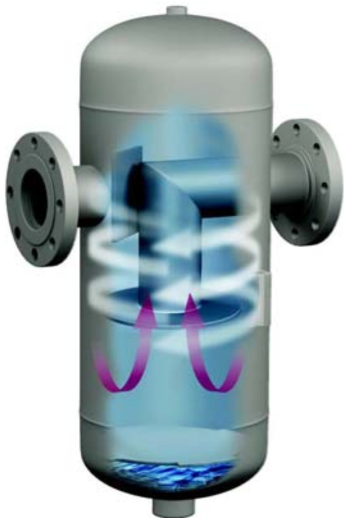
The simplest modification to a Type L is the addition of a sump, which we refer to as an "LS". The sump increases the liquid removal capacity to the equivalent of 20% of its maximum rated weight flow. The sump simply provides extra space for liquid to flow into without chance of being re-entrained.

The "L" Series can be further customized to have different size connection nozzles, have a horizontal inlet and vertical outlet or vice-versa and they all have that same 20% liquid removal capacity with the exception being if installed vertically with the flow path from bottom to top; the liquid removal capacity would then be equivalent to 10% of its maximum weight flow capacity.

If the liquid load is greater than 20% or if occasional "slugs" of liquid need to be removed it requires a slightly more complex design.

The "T" style operates on the same principles with the vessel body oriented 90° to the horizontal pipeline to which it is installed. This design utilizes an angled deflector plate to create the centrifugal vortex and due to the location of the outlet nozzle pipe, gravity assists with the removal rate. The lower portion of the vessel is also a built-in sump with a vortex containment plate preventing re-entrainment of the separated liquid. Only droplets finer than 10 microns can be drawn out through the low velocity area of the vortex where the outlet nozzle pipe is located.

The Type "T" will remove a liquid volume equivalent to 40% of its maximum weight flow capacity.



If we elongate the body of a Type "T" by approximately 25% it becomes what we refer to as a Type "TS" and is now capable of a liquid removal rate equivalent to 60% of its maximum weight flow capacity.

Applications having a very high liquid load, or more commonly an upset condition resulting in a large "slug" of liquid may require the "Receiver" style centrifugal separator, simply referred to as a Type "R".

The complexity of the Type R is slightly more than the Type T due to the addition of a secondary vortex. Instead of the gas exiting through the low velocity (center) of the initial centrifugal vortex, the gas travels to the topside of the vessel and must pass through angled vanes; the outlet nozzle pipe is located in the low velocity (center) of this secondary vortex. The Type "R" centrifugal separator has a liquid removal capacity equivalent to 90% of its maximum weight flow capacity.

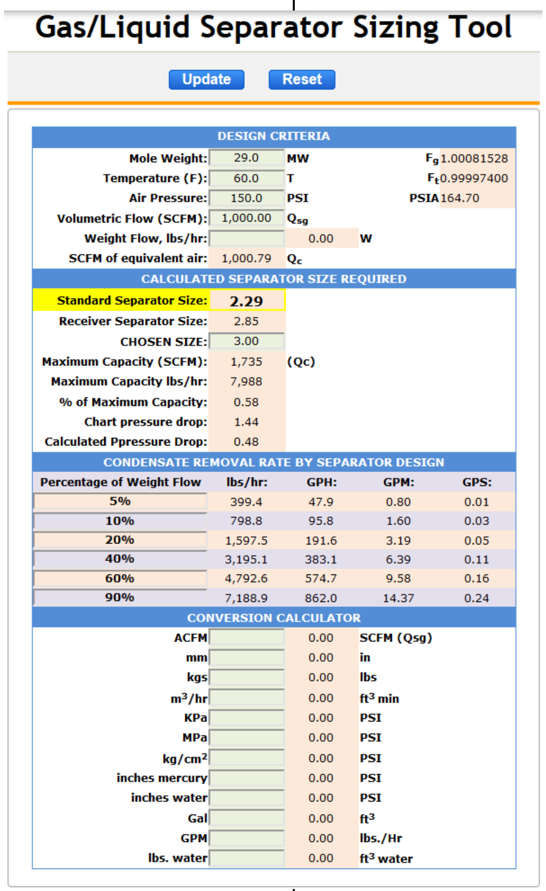
All of the aforementioned centrifugal separators maintain 99% efficiency for removal of droplets and particulate greater than 10 microns without any moving or serviceable components. They are considered self-cleaning due to the constant centrifugal vortex forces.

We accommodate applications requiring removal of droplets as fine as 4 microns by adding a coalescing section prior to the centrifugal vortex stage.

Removing droplets as fine as 0.3 microns requires a "polishing stage" after the centrifugal vortex. We use specially designed borosilicate microglass filter cartridges to channel these fine droplets to a coalescing drain point.

The addition of a coalescing or polishing stage increases the vessel complexity periodically the internal elements require cleaning or replacement.

How to you select the "best" centrifugal separator design for your application?



We have created the only known publically available, Internet based centrifugal separator sizing tool and its designed to help you compare your options.

After inputting just (4) design criteria the "separator size" is calculated; we show two different values, one for the Type "R" (receiver style) and the highlighted size applicable to all of the other "standard" separator designs.

To simplify the selection process, "size" is referring to the minimum inlet connection ID as relates to the vessel diameter and length. This is a nuanced delineation that I will explain further with our example.

Our example application therefore would require a 2.5" centrifugal separator or a 3" receiver style separator as both 2.5" and 3" are standard pipeline sizes.

Inputting "3" for the size calculates the maximum capacity (volumetric and weight flow), the differential pressure and chart of maximum liquid removal rates.

Additional factors that affect sizing include the liquid load to be removed and differential pressure.

If the calculated differential pressure is too high for your application, increase the size of the separator until it meets your requirement.

Likewise use the liquid removal capacity chart to determine which separator design is required; this is where things can get interesting.

If keeping the vessel size to a minimum is critical, moving up the chart to the 90% (receiver style) might make sense, however if you have "extra space" it might be less expensive to use a larger size "L" or "T" style because they are not as complex to manufacture.

Size Matters!

You cannot "oversize" a separator; the 99% efficiency will be retained, however you can certainly "undersize" a separator. Technically what happens when a centrifugal separator is undersized is that the velocity around the outlet nozzle pipe is high enough to prevent the droplets from impinging to the vessel walls where coalescing and gravity take-over. So we can easily "oversize" a centrifugal separator and attach to it smaller inlet and outlet connections to match your piping to handle your liquid load or differential pressure requirements. Remember the "minimum size" of 2.29" in our example is also related to the minimal internal diameter and length of the vessel, so anything larger increases the separation efficiency.

It is not recommended to install a separator having an inlet size smaller than the pipeline it will be attached to, even if the design criteria indicates a smaller size would be sufficient. The thought behind this is that there is likely an engineering reason for the existing pipeline size and it's usually not a good idea to unnecessarily restrict it.

The sizing tools are available to assist you with a better understanding of your options. We typically prompt you for the applicable design criteria and an overview of your application to provide a proposal, however you can use these tools for approximate the physical dimensions and have a better feel for the performance vs. pressure drop as compared to vane and mesh pad style separators which typically are physically larger (expensive) and have higher pressure drops (not to mention require periodic maintenance and lose efficiency at low flow rate conditions).

Visit us at http://www.fdpp.com and let us know how we can assist you with your gas/liquid separation application!

Chris Pasquali has provided sales and engineering support for the Wright-Austin product line since 2001, trained by both Hayward and Eaton.