



Graver Technologies

Application Brief

LIQUID PROCESS FILTERS GRAVER TECHNOLOGIES 1-888-353-0303

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Vent Filtration Basics **Elements of System Sizing**

Tanks are commonly used for storing a variety of liquids. To protect the liquid contents from microbial or particulate contaminant, it is customary to install a vent filter on the tank. When liquid is added or removed from a tank, air must move in or out of the tank to fill the changing airspace above the liquid. A tank vent filter allows air to flow in both directions and prevents possible damage to the tank that could result if air is compressed during tank filling or a vacuum is created during tank emptying. It is critical, therefore, to size for proper air flow under both normal operating conditions as well as potential CIP or steam conditions, taking into consideration the pressure and vacuum ratings of the vessel.

Factors Affecting Life

Vent filters tend to have significant life spans, often being in service from 3 months to 1 year. The life will depend upon a number of factors including environmental conditions, the operating temperature of the system as well as the choice of media.

- a.) Like any other filtration application, filter life will depend upon the volume of particles the filter is exposed to. Because the filter operates in both directions, there is some natural cleaning of the filter that occurs as the tank fills and forces air in the reverse directions. Obviously life span will be shorter in a dusty environment compared to the life span in a pharmaceutical clean room.
- b.) In general, high temperatures will have a negative impact on filter life. In critical applications, steam cycles are common to prevent microbial contamination. Steam will cause expansion and contraction of the filter (as it heats and cools) which may ultimately damage the structural integrity of the filter. In those operations that use a steam jacketed filter housings or heat tracing on the filter housing, the constant high temperature, which may range from 65°C to 120°C, results in oxidation of the polypropylene components and may lead to failure.
- c.) For a vent filter to function properly, the media must remain dry, so avoid contact with either the contents in the tank or environmental conditions. A wetted filter is impermeable to the bulk flow of air until the pressure reaches a point where the liquid in the pores is displaced (bubble point!). Since tank venting is done at essentially atmospheric pressure, this pressure is not achieved and may be higher than the vacuum or pressure rating on the tank. As such, it is best practice to choose a hydrophobic material for the application, with PTFE membrane being the optimal choice.



System Sizing

To maintain proper air flow in the tank, system sizing becomes a very critical process. While failure to properly size a liquid application may lead to the inconvenience of longer filtration times, failure to properly size a tank vent may result in catastrophic collapse of the tank. Inevitably, not all of the information to correctly size the system is readily available, so it is best to err on the side of caution. Some of the critical factors:

- a.) The design working vacuum of the tank.
- b.) The desired flow rate of air into the tank or maximum discharge rate of liquid out of the tank.
- c.) The air flow rate of the filter media at atmospheric conditions
- d.) The maximum temperature of the system - i.e. is it steamed or used for hot air injection?



Typically, the crush strength of the tank is readily available. If not, the manufacturer will be able to provide the information by the serial number of the tank or by researching the original purchase. However, the crush strength may not be the limiting factor as a rupture disk (recommended) or a vacuum gauge with an electrical cutoff could reduce the working vacuum available.

The air flow rate into the tank must be provided or can be calculated based upon maximum flow rates required in the operation. The flow rate of air into or out of the tank will correspond to the rate that the tank is drained or filled. Using the conversion rate of 7.48 gallons per minute (gpm) equaling 1.0 cubic feet per minute (cfm) of air flow, it is then possible to determine the actual cubic feet of air flow.

Hydrophobic filters that are intended for use as a vent filter, such as those composed of PTFE membrane, will typically have air flow rate data available at atmospheric (vent) conditions. Using this flow value, which is published as standard cubic feet per minute, it is possible to then calculate the number of ten inch filter increments that are required to meet the maximum flow demand of the system being designed. This then leads to selection of the appropriate size of filter cartridge housing.

One factor that will significantly alter the sizing is the maximum temperature that the filters will be exposed to. Using the Ideal Gas laws, it is understood that volume of gas expands as it is heated and contracts as it cools. This can result in significant variations in the actual volume of air filtered. The most critical consideration is when the system goes through a steam cycle. As the air cools from steam temperature, the volume may rapidly be reduced which results in a significant inflow into the vessel. It is essential to take into account this critical demand.

To summarize the steps needed to size a vent filter housing and determine the number of cartridges needed:

1. Identify the cartridge type, usually TefTEC, and micron rating to be used
2. Identify the air flow rate into and out of the tank. If it is not available, it can be determined by using the liquid flow rate (gpm) with the conversion factor of 7.48 gal. = 1 cfm. Use the largest value from either flow out of or into the tank.
3. Identify the operating temperature of the system, particularly noting the temperature if steaming is being conducted.
4. Identify the maximum vacuum allowed in the tank (in psid).

With these values, it is then possible to develop a recommendation. This recommendation will include a typical safety factor of 3X to in order to minimize risk to equipment.

Because of the critical nature of vent filter sizing, Graver recommends you consult with us to assist in this exercise.