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Liquid Supply Considerations for Sentinel® 5855 atomizing systems

The Sentinel atomizing system disperses liquids as a plume of tiny droplets (a fog). It is useful for many applications including sanitation, disinfection, odor control, insect control, asbestos abatement, humidifying, inhalation inoculation, mold remediation and disaster restoration.

The proprietary nozzle uses low pressure air to atomize water-based or oil-based liquids, or even light suspensions. The nozzle has no tiny orifices and plugging is generally not a problem. Therefore, Sentinel systems are well suited to outdoor or dusty locations such as landfills, composting facilities and waste transfer stations.

This paper outlines the factors to consider when choosing liquid supply equipment for a fogging application, or indeed for any chemical application. There's no single best layout; the right choice depends upon your circumstances, your site, and your preferences.

We start with general information – uses, safety and corrosion – then drill down to selecting materials, equipment options and piping layout for a successful project.

Fog ... ***Plusses and Minuses***	A "fog" is a dispersion of small liquid droplets in air. Droplets in the 5-50 micron range are generally considered fogs. [For comparison, the diameter of the human hair is 25-50 microns.] Small droplets have significant advantages for some purposes. They mix readily with air and are highly effective for vapor phase applications such as controlling odors. Also, small droplets are relatively insensitive to gravity. They can penetrate cracks and crevices, and reach the undersides of foliage or equipment. This makes them useful in pest control, sanitizing, disinfection, mold remediation and similar applications. Third, small droplets evaporate quickly. Fogging water is an efficient way to increase humidity in office buildings, winery barrel rooms, construction sites (concrete curing), guitar factories and industrial buildings. Water fogs are also used to cool restaurant patios and sidewalks in hot dry climates. Lastly fogs use relatively little liquid, with benefits of lower chemical cost, smaller pumps and equipment, reduced energy consumption and often shorter application time. On the other hand, fog droplets are hard to control. They may drift away from the target. Also, their tendency to evaporate quickly can be a disadvantage for some applications, but increasing the humidity helps to extend droplet life.

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Chemical Safety	Safety is important for all chemical applications, but doubly so when fogging because small droplets can be almost impossible to see. First, personal safety – primarily exposure through inhalation, but also contact with nasal membranes and eyes. Wear appropriate protective equipment, and keep other people from the treatment area. When possible, set up fogging equipment to operate unattended. Next, consider the potential for fire or explosion. A liquid dispersed as tiny droplets will burn much faster than in an open container. Do not fog a flammable liquid in an area where it could be ignited by a spark or flame. Third, chemical that moves away your target site could cause harm elsewhere. Be aware of drift and its potential impact downstream. When possible, apply fog in a confined space (closed room, warehouse, lift station, etc) to keep it on target. Fourth, know your chemical and its particular hazards. Start with the label. The label should have instructions on how to use the product safely and effectively. If you have questions, ask your supplier for help, or call the manufacturer. The Material Safety Data Sheet (MSDS) is another source of information. Prepared by the manufacturer, the MSDS provides a great deal of data about a product's physical and chemical properties, but is usually less explicit on safety. MSDS sheets are not widely distributed in printed form, but you can always find an electronic copy by searching. And many companies maintain a file of MSDSs for the chemicals used in their operations. Lastly, if a product is registered as a pesticide with the EPA, its label will have explicit instructions for use. You may not apply a pesticide in a manner that is inconsistent with its label. A pesticide label applies *only to that specific product* (manufacturer, trade name, formulation, etc); another product, even one with the same ingredients, could have different label wording, different uses and/or different instructions. The only way to know is "Read The Label."

Corrosion	Corrosion takes many forms – dissolving, etching, pitting, softening, swelling, cracking and so forth. Corrosion determines the metals, plastics, ceramics and elastomers suitable for the pumps, piping, seals and other liquid handling components in contact with your chemicals, and can severely limit your options. The *rate* of corrosion depends on many factors, including the target material, the chemical being used, its concentration, temperature, pressure and turbulence among others. Higher temperature, pressure or turbulence increases the rate of attack; higher concentration usually increases corrosion, but there are some exceptions. The internet has a wealth of corrosion data but you will have to consult several sources to get a balanced view. Since corrosion measurements depend greatly on test conditions, results are usually given as a qualitative grade: 1-4; A-D; or Good, Fair, Poor and Not Recommended, plus Unknown. These data will point out the materials to avoid when selecting equipment, and help you build a list of those appropriate for the chemicals you are using, or may use in the future. Pumps and other equipment should be made of compatible materials. Equipment brochures usually have a section called "Materials of Construction" or "Wetted Materials." Some manufacturers offer custom options, especially for seals, O-rings and gaskets. Of course, materials with superior chemical resistance tend to be more costly, and you'll have to judge the trade-offs for your circumstances and budget. In this, you're on your own; when it comes to corrosion, there are no guarantees.
Liquid supply requirements of Sentinel systems	The liquid supply requirements of the Sentinel atomizing system are modest: • Temperature: 50-125°F [10-50°C]; • Pressure: 5-10 psi [0.3 - 0.7 bar]; • Flow (per nozzle): 2-8 oz/min [60-250 cc/min, 1-4 gph]. Therefore, almost any type of pump can be used. Or you may not even need a pump – a hose bib to city water is sufficient for humidification work. And a hose bib plus a proportional injector can be used to dilute a concentrated chemical in line. Proportional injectors are recommended only for pure liquids, not suspensions. Finally, you may be able to feed a Sentinel system from an elevated reservoir, using only hydrostatic pressure.

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You Control ...
Time
Flow Rate
Concentration

After selecting the active ingredients to use, your next decision will be *how much* to use. The goal, of course, is to dispense enough to be effective, but not so much to be wasteful.

Three factors are under your control:

- ***When*** you fog (what days, times and cycle lengths);
- ***How much*** you apply (liquid flow rate);
- ***The strength*** of your chemical (concentration).

The amount of active ingredient you apply is calculated by:

Amt (gms) = Time (mins) * Flow (cc/min) * Concentration (gm/cc)

You can usually purchase chemicals in various strengths, from ready-to-apply dilutions to concentrates. There are advantages and limitations for each.

Ready-to-apply products need no additional dilution, saving labor and minimizing the possibility of calculation errors. On the other hand, ready-to-use products have higher freight costs and generate more containers for disposal.

Flow Rate is Doubly Important

Concentrates usually must be diluted on-site — by hand mixing; with an auto-dilute system; or (for water dilution of pure liquids only) in-line with a proportional injector.

The liquid flow rate in the nozzle has another importance for the Sentinel atomizing system — ***the flow rate sets the droplet size:***

- Larger liquid flow rate ➜ Larger droplets, and
- Smaller liquid flow rate ➜ Smaller droplets.

Choose the droplet size appropriate for your purposes. A low rate (say 50-100 cc/min [1-2 gph]) will generate a fine, dry fog. That's OK for odor control; you want fine droplets to mix freely with the air.

However, a fine droplet would not be suitable for mold control. Here you would prefer somewhat larger droplets that will settle out to treat and protect surfaces.

Pump types	Pumps can be grouped into two broad categories: positive displacement (PD) types, and centrifugal (non-PD) ones. The centrifugal pump uses a spinning impeller to sling liquid out the discharge port. It has internal slippage; if the outlet is restricted, the discharge pressure rises and the flow rate falls, but the impeller continues to spin, even if the discharge should be closed completely. A PD pump, on the other hand, has no internal slippage. It delivers a fixed volume of liquid for each pump cycle, stroke, or revolution, pretty much independent of system pressure. The only way to alter the flow rate of a PD pump is to change its motor speed. If the outlet of a PD pump is restricted, the discharge pressure rises quickly as liquid forces its way out. If the discharge is closed too tightly, the pump will be "dead headed," possibly stalling the motor, breaking the pump or bursting the piping. For this reason, a piping design for a PD pump usually includes a pressure relief valve or burst plate as a safety feature. Some PD pumps have an *internal* pressure relief mechanism. If the discharge is restricted, rising pressure activates the bypass, shunting output flow back to the inlet section. The internal bypass is a safety feature only. It should not be used to regulate normal system operating pressure, for two reasons. First, the bypass pressure is usually pre-set and not available to you for control. Second, heat buildup from excessive bypass could break down your chemical or induce damaging cavitation. Regardless of pump type, it's a good idea to put a bypass pressure regulator in the discharge piping. This lets you control system pressure independently by routing any excess flow to a return line and back into the reservoir.

Controlling liquid flow	For best efficiency, the size of a pump should be only as large as needed for the application – that is, for your treatment and for hydraulic agitation, if any. Installing a larger pump just means a greater investment, higher operating cost, more liquid to be recycled to the reservoir, and perhaps foaming problems as well. The best way to control the output of a pump is to change its motor speed. For a PD pump, it is the only way. It's easy to adjust the output of a pump with electronic control and variable speed motor. It is less convenient to adjust the flow of a pump with a mechanical linkage (changing the cam or gear ratio), but not difficult. A pump with electronic speed control *and* a feedback signal input can respond to process conditions automatically. For example, it could increase delivery of odor control chemical to a lift station to meet a spike in H_2S level, and cut back flow upon a return to acceptable levels. Since a PD pump and constant speed motor has a fixed output, your only way to control process flow is with a bypass regulator. It sets the system pressure (for your application and the agitation loop, if any) and dumps the excess flow back to the reservoir. To summarize, after selecting a pump, you have three ways to *reduce* process flow. They are, in order of preference: 1) reduce pump speed; 2) open the bypass regulator (that is, reduce system pressure); and 3) throttle the valve controlling flow to process equipment. To *increase* process flow, reverse the sequence: 1) open the valve controlling flow to process equipment; 2) tighten the bypass valve to increase system pressure; and 3) increase pump speed.

Pumps 101 ***Suction lift*** ***Priming*** ***Run dry***	Your piping and equipment layout limits your equipment options. For example, you could not use a "flooded suction" pump unless you can put it lower than the reservoir. Similarly, a pump above the *base* of the reservoir must have a suction lift greater than the height difference. Air should be excluded from all liquid lines, but especially on the inlet (suction) side of the pump. A newly installed pump must be "primed" to purge air and replace it with liquid. Once the suction line is filled, the pump will operate normally, without intervention. However, a piping leak (on either the suction or discharge side of the pump) may let air back in and break prime. The internal slippage of a non-PD pump may let liquid drain back into the reservoir when the pump is not running, breaking prime. An inlet check valve will solve this problem. The design of a PD pump generally prevents "drain back" but a check valve is often installed anyway. Most pumps need liquid for lubrication, cooling and sealing check valves. They will be damaged if run dry for more than a short time. Take care that the liquid reservoir is not emptied and that prime is not lost. Some piping designs add an alert to signal a low tank, and perhaps a cutoff switch to shut down operations if there's a danger of running out. A self-priming pump is able to operate dry, at least for a short time, to expel air and lift liquid from the reservoir to the pump head. Pump specifications will include data on self-priming lift. Priming is most easily done at zero discharge pressure. You may want to include a poppet valve in the discharge piping to relieve head pressure when priming. Centrifugal pumps generally have a priming vent in the volute.
Agitation ***Mechanical*** ***Hydraulic***	You may need agitation to keep your liquid well mixed and uniform. Suspensions (solids mixed with liquid) tend to settle out. Emulsions can break into two liquid layers. And even a pure solution – crystal clear, with no hint of cloudiness – can precipitate solids if the temperature drops. Mechanical agitation uses a mixing paddle or blender. Hydraulic agitation uses a jet of recycled liquid to stir the tank. And air agitation uses a stream of air bubbles to induce vertical mixing. Hydraulic is usually easiest to implement; just install a larger pump with enough capacity for the agitation return stream, and the valves and pressure regulators to manage it. How much agitation? Only testing (at both high and low reservoir levels) can tell you.

Reservoir	The liquid reservoir holds your feed chemical – either a pre-diluted liquid at ready-to-apply strength, or a concentrate to be diluted in-line using a proportional injector. The reservoir can be a permanent tank, refilled as needed. Or it could be a shipping container hooked up to the feed piping, and swapped out when empty. Small reservoirs need less agitation and present a lower hazard from a spill or tank break, but require more frequent handling and refilling.
Freezing solutions	"Baby, it's cold outside." If you sing this tune, you'll probably want to protect your equipment against freezing. The small diameter tubing used in the Sentinel system has enough stretch to tolerate freezing, but the glass flowmeter tubes are definitely vulnerable. There are several ways to deal with freeze risks: 1. Winterize. If fogging is not required during cold months, drain liquid from internal lines before storing your equipment. 2. Heated enclosure. Waste heat from the atomizing air blower can help warm an enclosure, and a thermostat-controlled heat strip will deliver supplemental heat when the blower is not running, 3. Keep liquid moving. Flowing liquids are less likely to freeze than static ones. 4. Install equipment to auto-purge liquid lines between fogging cycles.

The exhibit on the next page summarizes the main types of Liquid Supply equipment.

Liquid Supply Components for Sentinel® 5855 atomizing systems

Liquid Mover	PD Type?	Comments	***H***elpful / ***E***ssential Control Components			
			Gauge	Bypass Regulator	Needle Valve	Flowmeter (c)
Piston Pump	Yes	Requires pressure relief/bypass return line to reservoir. (a) Not for use with solids.	***H***	***E***	***E***	***H***
Diaphragm Pump	Yes	Requires pressure relief/bypass return line to reservoir. Some models have internal bypass and can operate deadheaded. (a)	***H*** (b)	***E*** (b)	***E*** (b)	***H***
Peristaltic Pump	Yes	May require pressure relief/bypass return line, depending on pump size. (a)	***H*** (b)	***E*** (b)	***E*** (b)	***H***
Centrifugal Pump	No	Bypass return recommended but optional (pump can operate deadheaded).	Optional	***H***	***E***	***H***
House water system	No	For humidification, or for use with a proportional injector to inject chemical (pure liquids only, no solids) into the line feeding the atomizing system.	Optional	–	***E***	***H***
Gravity feed (siphon)	No	Max liquid flow limited by static head (height difference between chemical supply tank and the nozzle). Submit details of proposed installation for factory review. Siphon installation (negative pressure) not recommended.	Optional	–	***E***	***H***

(a) If hydraulic (jet) agitation is used to keep suspended solids from settling, the pump must be sized for the total flow required (for atomization *and* agitation). The piping design should allow independent flow/pressure control of the agitation branch. Experiments are needed to determine agitation requirements.

(b) Gauge, pressure regulator and needle valve not necessary if flow is managed by a variable speed pump.

(c) Flow meters come in many size ranges. To ensure proper sized meters are used in your Sentinel system, inform factory of projected flow rate or the model pump you plan to use.