# Solvent Loss Control Technical Guidance

With the resurgence of vapor degreasing as a viable method of cleaning in both the electronics and precision cleaning industries, a primary concern of customers is solvent loss control. ChemLogic prides itself on well over 30 years of combined vapor degreasing experience and has provided a set of user guidelines and diagrams that will allow the user to control solvent losses, minimize solvent use and achieve optimal cleaning consistency. The techniques discussed in this bulletin will improve safety, protect the environment and save money by reducing solvent consumption.

Vapor degreasing solvents are used in degreasing and defluxing equipment that may be configured in a variety of ways. Most equipment configurations are based on a fundamental concept: a simple two-sump, open-top unit. However, the same concepts that relate to small degreasers can be applied to larger, automated machines. Methods for reducing and minimizing solvent loss are based on this type of equipment as well as the following concepts:

- Equipment must be properly designed and maintained.
- Appropriate work practices must be applied.
- Solvent should be reclaimed and reused.

## Equipment Design and Maintenance

Three major sources of solvent loss are emissions, dragout and leaks. Proper equipment design and maintenance may control emissive losses. Diffusional losses may be significantly decreased or eliminated by items such as freeboard height adjustment, properly fitted cover and the effective use of freeboard cooling or dehumidification coils. Dragout can be reduced by properly orienting parts to allow for complete drainage of the solvent from the parts. Using a sufficiently long dwell time in the vapor blanket so that parts reach equilibrium with the blanket temperature will also decrease solvent loss. A superheated vapor blanket is especially effective in eliminating dragout when properly used. Faulty equipment connections and poor maintenance allow solvents to leak or escape the system.

### *Emissions – Diffusion Losses*

Heat Input:

In a vapor degreaser, solvent vapor must be generated to produce a vapor blanket. This is accomplished by heating the solvent with electricity, steam, hot water or hot refrigerant gas. In addition to the heat input required to produce the vapor blanket, additional heat is needed to warm the workload to the temperature of the vapor in order to dry, for solvent distillation and to replace radiation and convection heat loses (see Figure 1).


**8503 El Rey Blvd • Austin, Texas, 78737 • USA**
**www.chemlogic.us 512-426-5728**
**www.vapordegreasing.info**

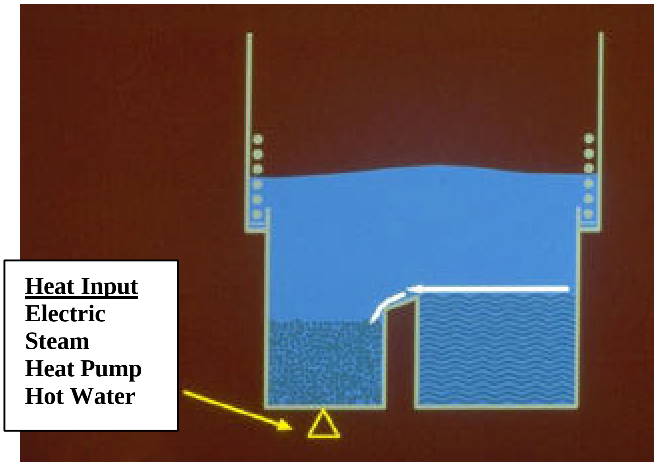


**Figure 1**

Work Shock:

If sufficient heat is not provided or if the workload is too massive, the vapor blanket will collapse when the workload is introduced, and air will enter the degreaser in a process called "work shock". As the vapor blanket is restored to its proper position, the vapor-laden air will be pushed out of the degreaser and high emission losses will occur. Work baskets should not be any heavier or massive than necessary to help minimize work shock. Do not waste "cleaning energy" on cleaning the basket versus the parts since the degreaser can not distinguish between the basket and the parts being cleaned. It is important to design a system with adequate heat input for the anticipated workload. Likewise, it is equally important not to introduce a workload more massive than the degreaser was designed to clean (see Figure 2).

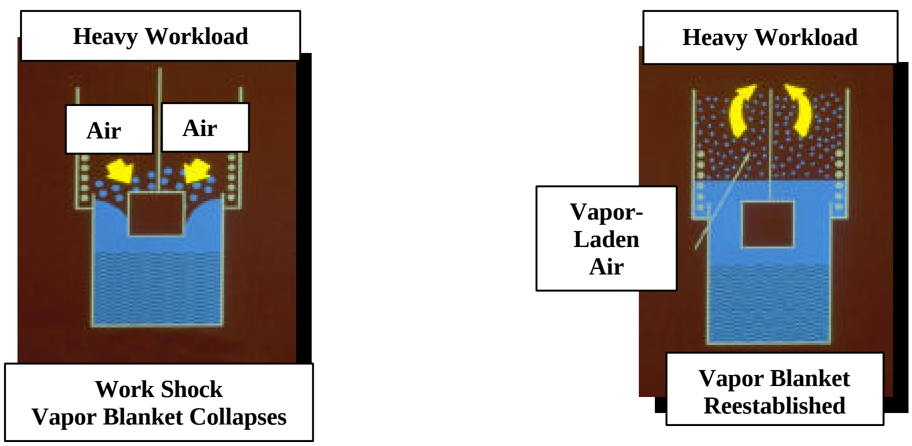


**Figure 2**

Condenser Temperature – Primary Condenser Coils:

Diffusional losses are directly related to condenser temperature. Heat input must *never* exceed cooling capacity. The primary condensers should be designed to operate at the lowest practical temperature, but above freezing. An attempt should be made to balance the vapor blanket on the center coil of the condensers. If the vapor blanket is higher, this means that there is either insufficient cooling or too much heat. If the vapor blanket is lower than the center coil, it is possible the system has insufficient heat and this can cause an unstable vapor blanket. Too much cooling can cause excessive water to be introduced into the system due to the dehumidification of the air above the vapor blanket (see Figure 3).

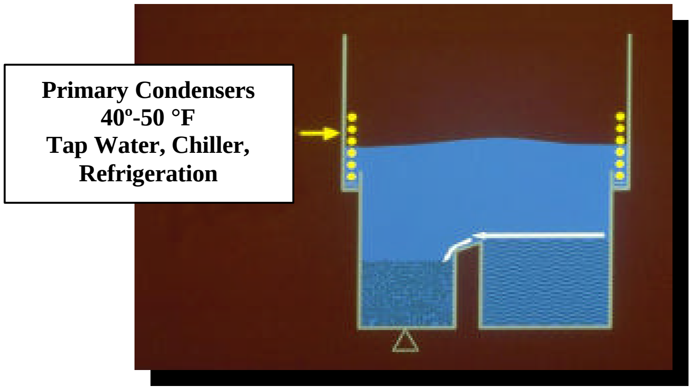


**Figure 3**

Condenser Temperature – Freeboard Chiller/Dehumidification Coils:

Freeboard condensers should *not* be necessary to control the position of the vapor blanket if the primary condensers are designed and operated properly. They *are* most effective, though, in combination with a condensate trough to dehumidify the air and help control the introduction of water into the degreaser. The freeboard condensers will also help reduce diffusional losses by lowering the solubility of the solvent in the air above the vapor blanket. The temperature of these coils can range between 35ºF to –20ºF and usually depends on the equipment manufacturer's design. The lower the temperature and humidity of the air above the vapor blanket, the lower the solubility of the organic solvent in that air. If freeboard condensers are used, it is important to remember that if the temperature of these coils approaches 32ºF (0ºC) or lower, they will ice up, and will need to be defrosted. When defrosting these coils, it is highly recommended that the resulting water be directed to a water separator that is dedicated to these coils. If the water is directed to the water separator or desiccant that is used with the primary condenser coils, the purpose of the dehumidification coils is defeated. The dehumidification coils are intended to dehumidify the air above the vapor blanket *before* that humidity or water is condensed on the primary condenser coils and mixed with the condensed solvent (see Figure 4).

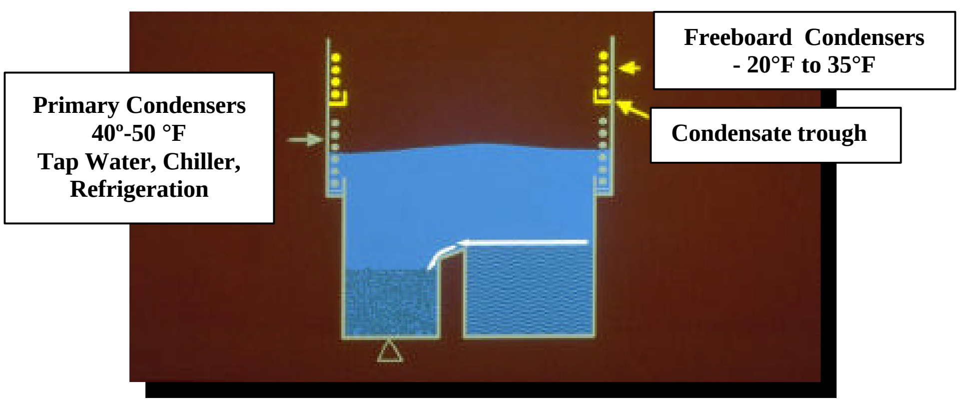


**Figure 4**

Vapor Depth:

It is important for the vapor blanket over the rinse or condensate sump to be deep enough to hold the largest workload that can be immersed in that sump. If *any* portion of the workload is removed from the vapor blanket prior to either equilibration in temperature or drying, dragout losses will be increased (see Figure 5). In an attempt to lower the height of their vapor degreasers, equipment manufacturers have been known to reduce the depth of either the vapor and/or the freeboard zones. Ultimately, this design violation will result in an increase in solvent emissions and consumption.

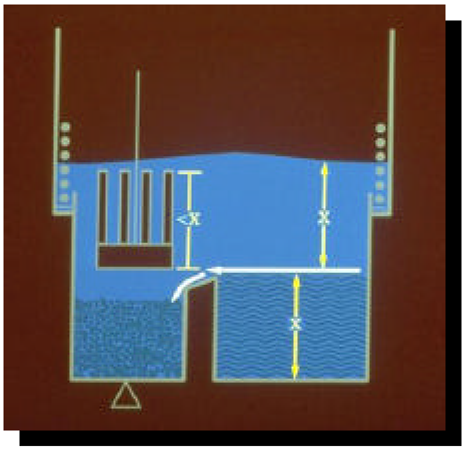


**Figure 5**

Freeboard Height:

Diffusional losses are inversely proportional to freeboard height. To minimize these losses, the freeboard should be at least 100%, but preferably 150%, of the smallest horizontal tank dimension, which is usually the width of the machine (see Figure 6).

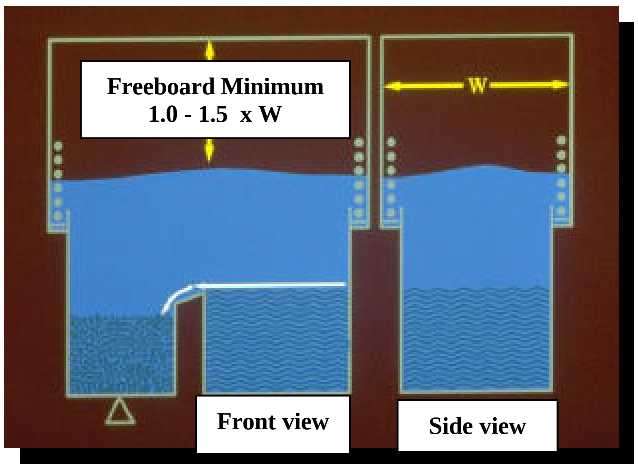


**Figure 6**

Vapor/Air Interface:

Diffusional losses are also directly proportional to vapor/air interface. If all sumps of the degreaser are not in use, or when possible, the vapor/air interface should be minimized. This practice is sometimes referred to as an “offset” boil sump or vapor generator (see Figure 7). Conveyorized and automated systems should be designed so that the vapor/air interface is minimized or only big enough to get the workload into and out of the unit's inlet and exit tunnels (see Figures 8, 9, and 10).

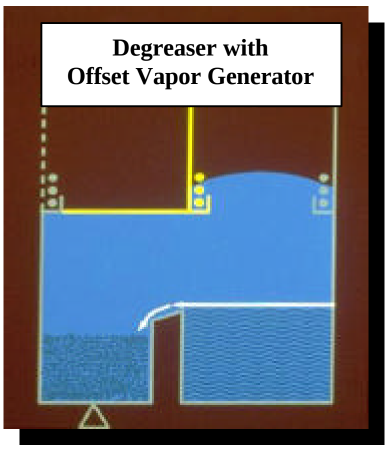


**Figure 7**

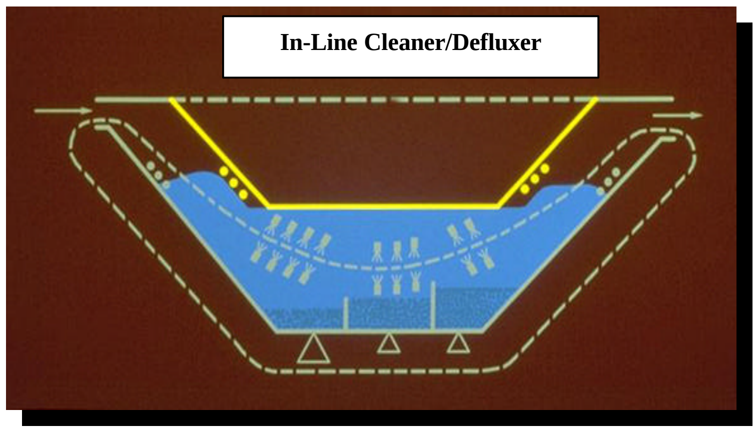


**Figure 8**

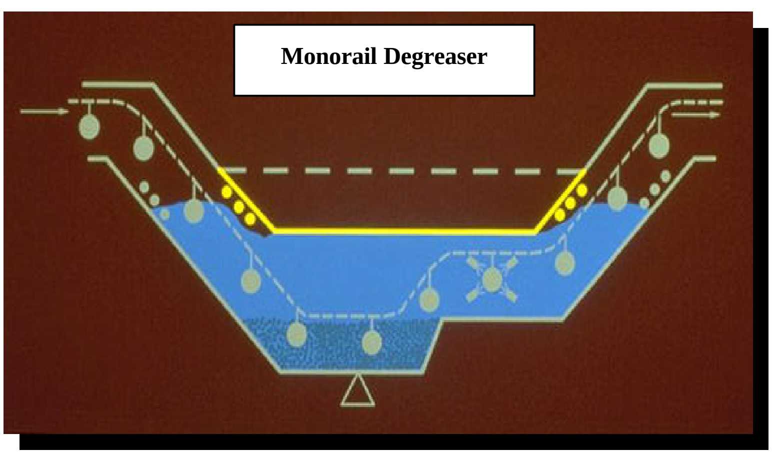


**Figure 9**

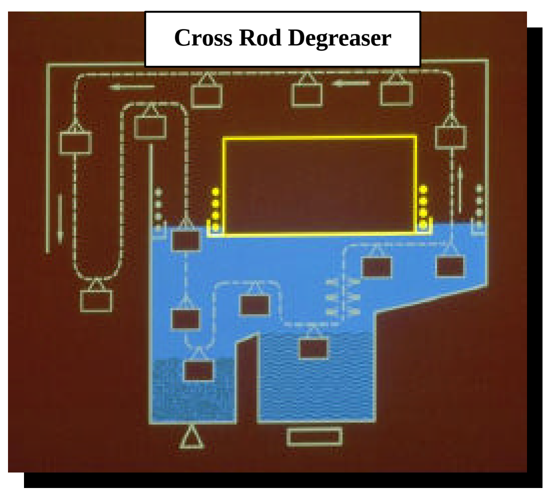


**Figure 10**

Covers:

Covers can also be used to minimize diffusional losses during idling periods, or when the equipment is shut down. The covers should be designed so they can be opened or closed with minimal disturbance to the vapor/air interface. One of the most important concepts in solvent conservation in a vapor degreaser is to protect the vapor blanket. The more the vapor blanket is disturbed or moves up and down, the more solvent is consumed. Covers should *never* be hinged; a sliding or rolling cover is preferable. (see Figure 11).

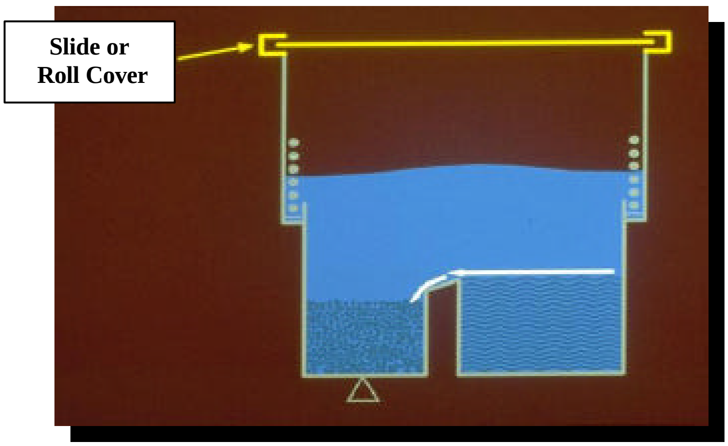


**Figure 11**

Cool Down Coils:

A liquid's evaporation rate is a function of vapor pressure, and in turn, a direct function of temperature. Cooling the solvent liquid as well as the air above the sumps during equipment downtime can minimize evaporation and diffusional losses. Cool-down coils are desirable, especially in large cleaning systems (see Figure 12). On small vapor degreasers where cool down coils are not practical, allowing the primary condensers and freeboard coils to operate while the boil sump heaters are off can accomplish a similar effect (check with the equipment manufacturer).

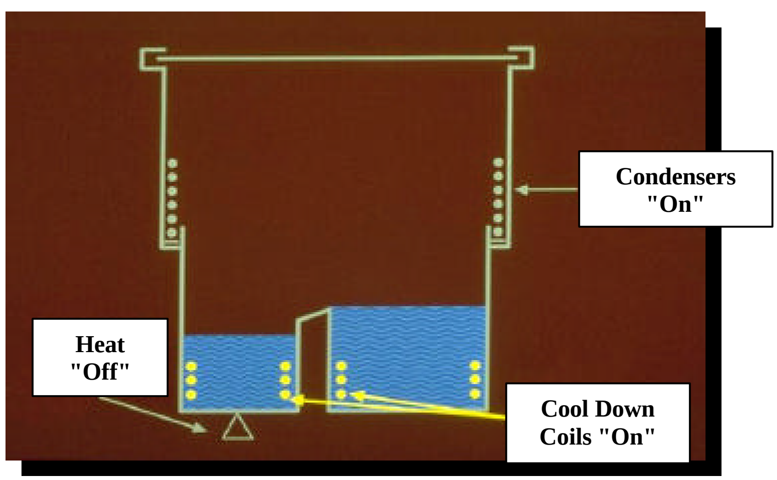


**Figure 12**

Automation and Work Enclosures:

The "human factor" is probably the greatest contributor to solvent loss versus any other factor in the vapor degreasing process. Automated or programmable work transports can help minimize solvent losses by eliminating the "human factor". Automation can provide consistent introduction and withdrawal of workload from the cleaning unit, while allowing the appropriate time for drying and at a rate (<10 feet/minute) that will minimize vapor/air turbulence (see Figure 13). Work transports with hood enclosures will further reduce solvent consumption and emissions by eliminating vapor/air disturbances caused by outside air currents (see Figure 14). Remember, any movement of the vapor blanket caused by operators or external influences will increase solvent consumption.

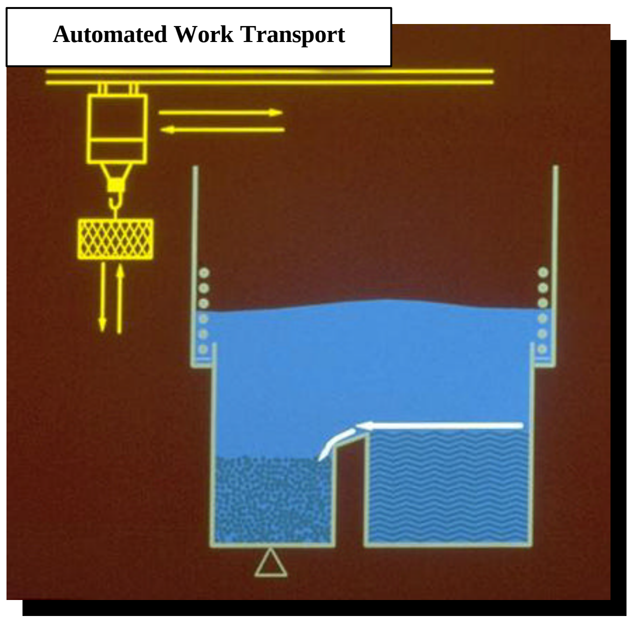


**Figure 13**

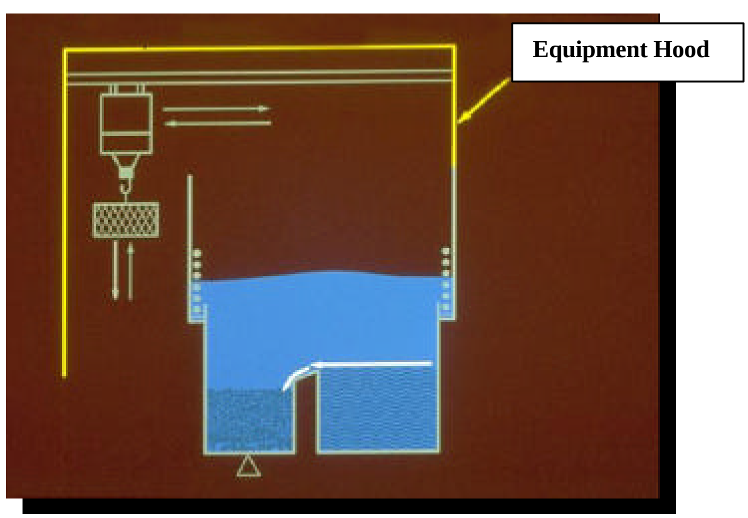


**Figure 14**

Ventilation /Carbon Adsorption:
Vapor degreasers designed according to prudent guidelines (and using the options presented here) will emit only minimal solvent when properly operated and maintained, thus eliminating the need for ventilation under normal conditions. Lip ventilation (see Figure 15) should be avoided when possible since it can dramatically increase solvent consumption by disrupting the air above the vapor blanket. Once the air above the vapor blanket becomes saturated with diffused solvent vapor, depending on temperature and humidity, it can hold no more solvent. If the "saturated" air above the vapor blanket is continually replaced with new air due to improper ventilation, solvent will continue to diffuse until it is saturated again. Ventilation, when necessary, should be designed in a manner to minimize vapor blanket/freeboard air disruption. All organic solvents are heavier than air and tend to "drift" or flow downward. Lip ventilation (see Figure 15) and vent "hoods" tend to increase solvent losses and consumption. Place vents *lower* than the top edge of the degreaser in order to allow the *heavy* vapors to flow down into the vent.

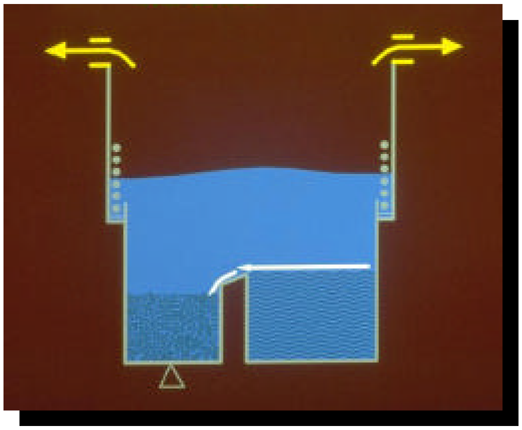

**Figure 15**

However, there *may* be some cases where a particular cleaning application may justify the use of lip vents when connected to an auxiliary carbon adsorption system. In these applications the lip vents will direct the organic solvent vapors to the carbon adsorption beds that will collect and recover emissions that *cannot be suitably minimized by other means*. Carbon adsorption should be the last resort since there are efficiency, solvent consumption, utility and maintenance limitations (see Figure 16).

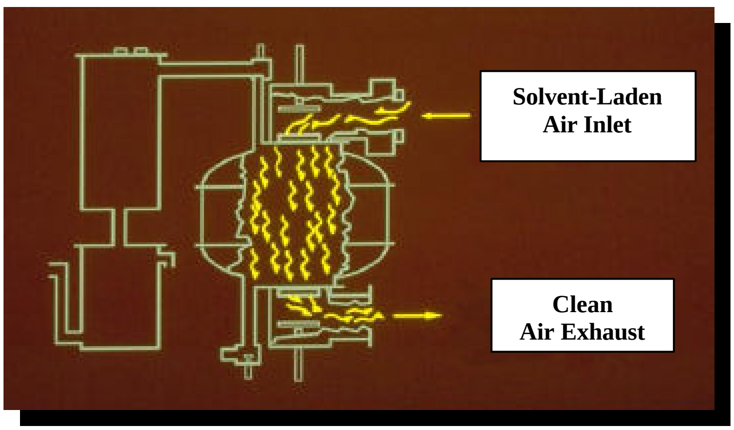


**Figure 16**