Designing a Solvent Recovery System, Part II

By Mabbett, Capaccio & Associates Inc.

Part I of this article, which appeared in the January issue of ***PC Fab,*** addressed the benefits of solvent recovery systems and detailed a number of solvent recovery techniques. This segment of the article will examine the process of designing and installing such a system.

The most important factor in the design of the recovery system is the amount of solvent in the uncontrolled exhaust stream relative to the quality of the emissions required to meet current air pollution control regulations. The greater the reductions in solvent emissions necessary, the more sophisticated and expensive the recovery system. The following is a partial listing of important factors that must be considered when designing solvent recovery systems.

CHARACTERIZING THE EXHAUST STREAM

The initial step in the design of a recovery system is to fully characterize the waste stream. This analysis must first take into account the properties of the carrier gas. The most important characteristics of the carrier gas are composition, temperature, pressure, and humidity.

The composition of the carrier gas is important because some gases, such as sulfur dioxide or chlorine-containing solvents, can corrode the metal parts of a recovery system.

The temperature of the carrier gas is important because it affects exhaust volume, the construction materials, and the type of sorbent that can be used. Pressure becomes important if it is above or below atmospheric pressure because the system must then be tightly sealed to prevent leaks. Humidity can limit the efficiency of some types of sorbents and other collection systems. Under certain circumstances, special precautions must also be taken for carrier gases that are reactive, combustible, or highly toxic.

Critical information needed for the design of a recovery system is the flow rate of the carrier gas and the extent of variations in the flow rate under extreme conditions. The most important properties of the solvent include quantity, composition, volubility, and sorbability.

The quantity and flow rate of the solvent to be recovered determine the size of equipment needed. The composition of the solvent stream directly affects the quality and value of the solvent that can be recovered. In addition, the end use and the degree of chemical purity required (95% chemical purity for recycling stream) impact design considerations.

The exhaust stream's volubility influences the ease of solvent removal, and the design must frequently be modified accordingly. The efficiency of an absorption or adsorption technique depends on the sorbability of the solvent intended for recovery. Care must be taken during the design phase to correctly match the right removal technique with the right solvent." However, some flexibility for final adjustment of the system at the time of actual operation should be built into the design.

In summary, certain engineering data must be accurately determined before the actual design phase can be initiated. These are the flow rate (cfm), temperature (degrees Farenheit), pressure in the duct work (inches of mercury) and moisture content (percentage of water by volume) of the exhaust stream.

DETERMINING THE REGULATORY CONTROL LEVEL

The identity and quantity of each solvent and other contaminants present in the waste stream should be determined through testing of the current exhaust system. Once the compounds are known, state and federal regulations must be reviewed to determine acceptable emission levels, These limits may be established in terms of total volatile organic compounds (VOCs) that can be emitted at a type of facility (20 tons per year), or the regulations may specify an ambient concentration level for a particular chemical that cannot be exceeded (allowable ambient level for 1,1,1 -trichloroethane is 190.48 parts per billion (ppb) in Massachusetts),

Once the regulatory requirements have been unequivocally determined, the designer of the solvent recovery system must plan for future regulatory changes because the trend is toward increasingly strict air pollution regulations. The system should be designed so that additional control components can be added if the air pollution control requirements become more stringent.

FEASIBLE CONTROL TECHNOLOGIES

Information on solvent recovery system requirements (in terms of engineering and regulatory needs) is used to evaluate the control alternatives that could achieve the desired level of solvent recovery and emission control. Specific data concerning system efficiency, engineering specification, capital costs, operating and maintenance costs, and energy consumption should be collected relative to each viable alternative. These data are evaluated and compared, and the most feasible alternative is chosen.

SELECTING THE BEST CONTROL TECHNOLOGY

The control alternatives should be compared in terms of effective removal as well as economic, energy, and environmental impact. A useful way to measure the cost-effectiveness of a system is to calculate the number of dollars spent to achieve one ton of solvent removal. The required expenditure for the control system includes the following factors:

- Capital cost (equipment)
- Energy required to operate the system
- Installation cost
- Maintenance and replacement of parts
- Cost of regulatory permitting
- Upgrading of the local exhaust ventilation system, if necessary.

All these costs should be considered in determining short- and long-term economics. However, the value of the recovered solvents or increased production capacity due to emission reduction can easily offset these costs.

The most important criterion in choosing a solvent recovery system is meeting the engineering and regulatory requirements in an economically feasible fashion. However, the least expensive system is not necessarily the most appropriate or effective one. Decisions based entirely on cost usually require further expenditures for future modifications and additions,

INSTALLATION

There are many factors to be considered when installing a solvent recovery system.

Selecting a Vendor. Once the technical specifications of the solvent recovery system have been prepared, a proposal should be sent to prospective vendors. Vendors should be encouraged to submit a confidential bid for the project. Every bid should be evaluated carefully on an equal basis of performance and efficiency of solvent control. A policy of automatically accepting the lowest bid is not recommended. Very low bids frequently result in substandard installations and subsequent additional costs as well as potential regulatory enforcement liability.

Obtaining Required Permits. Once selected, the vendor should be instructed to turn in professional-quality layout and design drawings and other technical materials needed to apply for installation and operation permits for the system with state or federal authorities.

The permits required for solvent recovery systems are often complicated, and the approval process can take many months. Approval is necessary before operation and startup, and in most states serious fines can result if either installation or operation is initiated without proper approval. Therefore, significant resources should be set aside for permitting and sufficient time allowed for the approval process.

Before system construction begins, the contractor should provide detailed shop drawings. These should be carefully reviewed and work started only after full approval has been given.

Adjusting the system performance. When installation is completed, the operating parameters should be carefully adjusted to optimize performance. The equipment vendor should be able to provide some advice, but hands-on experience with air pollution control units is also very helpful.

After the system is installed, a comprehensive stack emissions testing program may be required to demonstrate compliance with the permit limitations. If emission levels are too high, the system should be readjusted and retested.

Establishing good operating and maintenance procedures. The final step, which is very critical in the long run, is to establish good operating and maintenance procedures. These should be recorded in detail in a maintenance or an operating log.

PUBLIC RELATIONS

Now that all this time and money have been expended to control air contaminants, consider potential public relations benefits and take advantage of them as appropriate. Your clients will appreciate knowing they do business with an environmentally-conscious firm that is in compliance with the applicable air pollution control regulations.

SUMMARY

Solvent recovery systems will play a vital role in helping to bring various facilities into compliance with more stringent environmental regulations. The discussion of issues related to solvent recovery as well as the more technical background presented in this article are intended as a starting point for the evaluation of solvent recovery system utilization at many different types of facilities. The next step is to examine the facility's individual needs and specific engineering requirements facility and relate them to the overall strategy presented in this article. ■

BIBLIOGRAPHY

Calvert, S., and H. Englund. ***Handbook of Air Pollution Technology. New*** York: John Wiley & Sons, 1984.

Chlorinated Solvents in the Environrnent, Halogenated Solvents Industry Alliance (HSIA), 1989.

EPA. ***Air Pollution Engineering Manual,*** Publication No. AP40, 1973.

Neale, M. "Stringent VOC Standard Contrls Pollution in Southern California." ***Modern Paint and Coatings.*** April 1989.

Nell, K.E. and J.N. Sarlis. "Adsorption Characteristics of Activated Carbon and XAD4 Resin for the Removal of Hazardous Organic Solvents." ***JAPCA 38:1512-1517, 1988.***

Parmele, C. S., W.L. O'Connell, and H.S. Basdekis. "Vapor-Phase Adsorption Cuts Pollution, Recovers Solvents," ***Chemical Engineering,*** December 31, 1979.

Stern, A.C. ***Air Pollution,*** third edition, Vol. IV, New York, NY: Academic Press, 1977.

Mabbett, Capaccio & Associates, Inc., provides environmental pollution control, occupational safety and health, and process facilities consulting and engineering design services to the printed circuit and electronics industries on a national basis. MCA can be contacted at 5 Alfred Circle, Bedford, MA 01730, **61 7/275-6050.**