Is Your Quest For Substitute Solvents Preventing You From Evaluating Other Options?

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Many firms search for "nontoxic" solvents and cleaning agents only to find that they have unwanted side effects after the switch has occurred. A more informed approach to solvent cleaning use reduction and/or elimination is required.

PARTS CLEANING IS a common process operation utilized by industries involved in the repair, maintenance, or manufacture of a wide variety of different equipment. This operation is typically a preparatory step that is performed prior to assembly, application of paints and conversion coatings, or plating. Often halogenated solvents are utilized for parts cleaning.[1,2]

The "descriptive approach"[3,4] involves the use of process flow diagrams and materials use accounting to determine the functionality of the cleaning operation. It helps identify opportunities for pollution prevention without the use of "prescriptive" checklists, questionnaires, and worksheets developed by regulatory agencies in an attempt to facilitate the implementation of pollution prevention by industry. This column will focus on reducing the use of toxic cleaning solvents as a primary opportunity to minimize waste and prevent pollution.

The Evaluation Process

It is important that the pollution team prepares a detailed *process flow diagram* of the cleaning operation and conducts careful materials accounting around each of the steps. To completely understand the "functionality" of the cleaning operation, the following components of the process must be identified:

- The substance to be *removed*, i.e., the "soil";
- The substrate upon which the soil is adhered to; and
- The mechanism by which the solvent removes the soil.

Some detailed characterization of each of these components may be necessary to define functionality.

The next logical step is to *determine if solvent cleaning is necessary*. For example:

- Can the soil be eliminated, reduced or changed by consolidating operations, reviewing handling/packaging steps, or improving housekeeping?
- Can the substrate be altered prior to soiling to reduce or eliminate the soil or to allow a

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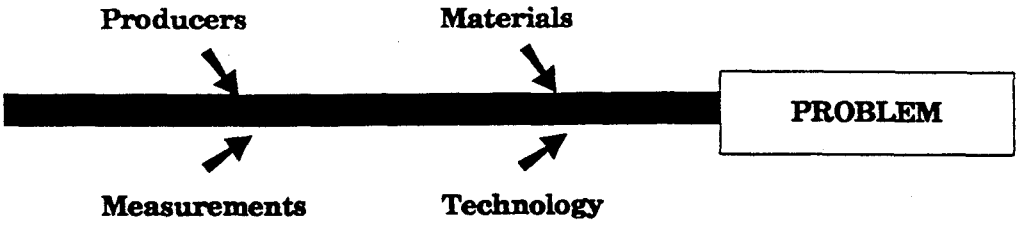
Figure 1. Cause and Effect Diagram



different means for removing the soil?

- What other means can be used to remove the soil? For example, does the soil need to be dissolved or can it be removed by mechanical means?

Once information about the cleaning operation has been gathered and the process flow diagrams have been prepared, it is necessary to verify these diagrams by observing the cleaning operation directly.

Once information about the cleaning operation has been gathered and the process flow diagrams have been prepared, it is necessary to verify these diagrams by *observing* the cleaning operation directly. Some cleaning operations involve the insertion and removal of a part from a tank containing solvent, followed by the rinsing of the part. Solvent loss can be reduced by extending the life of the cleaning solution (i.e., reducing soil drag-in, reducing drag-out, avoiding solvent decontamination or volatilization, and removing impurities from the solvent via in-process recycling). Precise protocols and tests used to determine the condition of the solvents can identify when a solvent should be changed, helping to extend the usage of the solvent. For example, used antifreeze can be filtered and blended with new antifreeze to meet the required viscosity as measured on a viscometer.

Equipment design may also play a major role in limiting solvent loss and controlling solvent consumption. By extending the freeboard on the tank and installing cooling coils along these walls, a blanket of air is created above the surface of the solvent which reduces evaporative losses.

The pollution prevention team should conduct a *brainstorming* exercise involving those who are involved in the cleaning operation. It may also be useful to prepare a "cause and effect" diagram (See **Figure 1**).[5] In this case the group examines what can be done to change procedure, materials, measurements, and technology to get a clean part. Procedural changes may focus on solvent conservation, precleaning of the parts without solvent, keeping the soil off the part, and so on. Materials changes will include substitute solvents and easier to remove soils. These changes can also involve the substrate itself. For example, a different material would not need an oily covering to protect it from corrosion. Measurement would focus on "how clean" and other measures of the losses. Instead of discarding solvent on a fixed schedule (e.g., once a shift), a simple measure such as viscosity or color is utilized to allow for variations in the amount of soil and production schedules. Finally, technology may help obviate the need for a solvent. Appropriate alternatives for cleaning might include a laser beam, infrared radiation, microwaves, electron beams, light pulsing, solid CO_2, abrasives or

Table 1. Minnesota Technical Assistance Program Generator Checklists for Identifying Waste Reduction Opportunities: Cleaning

Waste Reduction Option	Yes	No	N/A	Tried in Past	Further Evaluation Required	Comments
Solvent Cleaning General: Are your cleaning units installed and operated as per manufacturer's instructions?						
Are cleaning needs and the efficiency of the cleaning system routinely evaluated?						
Is the loss of the solvent's cleaning ability monitored prior to replacing the solvent?						
Is cross-contamination of the solvents avoided?						
Is water contamination of the solvent avoided?						
Is sludge from the cleaning tanks removed on a routine basis?						
Has your company investigated the use of an on-site distillation unit for solvent recovery and reuse?						
Has your company investigated the use of aqueous based cleaning as an alternative to solvent cleaning?						
Has your company considered using non-chlorinated solvents in place of chlorinated solvents where possible (note non-chlorinated solvents can be more flammable than chlorinated solvents)?						
Has your company investigated using plastic media blasting of a water based material for paint stripping in place of a solvent based stripper?						
Solvent Cleaning Vapor Degreasers: Do your employees cover all cleaning tanks when they are not in use to prevent vapor loss (note units should be covered with a material impervious to the solvent vapors)?						
Do your degreasers contain a refrigerated freeboard which will condense the solvent vapors within the unit and return the condensate to the bottom of the tank?						
Are the degreasing units placed in an area of the shop where drafts will not enter them and push out vapors?						
Has your company considered adding cooling jackets to the outside walls of the degreasing units in conjunction with the interior cooling coils to prevent vapors from escaping along the unit's wall?						

Table 1. Minnesota Technical Assistance Program Generator Checklists (continued)

Waste Reduction Option	Yes	No	N/A	Tried in Past	Further Evaluation Required	Comments
Solvent Cleaning Vapor Degreasers (continued): Are parts of racks placed in the degreaser in a way in which excessive amounts of vapors are pushed out of the unit?						
Is work removal rate set at a speed low enough to prevent vapor dragout?						
Solvent Cold Cleaning: Has your company considered centralizing and consolidating cold cleaning operations to minimize vapor losses?						
Are you using counter current cleaning methods where possible (i.e. using dirty solvent for initial cleaning and clean solvent for final cleaning)?						
Are parts allowed to hang above tanks for solutions to drain back into the tanks and reduce dragout?						
Alkaline/Acid Cleaning: Are cleaning units installed and operated as per manufacturer's instructions?						
Has your company considered increasing drain times for parts before/after washing to reduce dragout?						
Do personnel avoid cross-contaminating the cleaners?						
Are dropped parts removed from the cleaning tank on a routine bases?						
Is sludge from the cleaning tank removed on a routine basis?						
Has your company considered reusing cleaners by filtering and rejuvenating them?						

other mechanical means.[6]

Information should be gathered on each of the options and additional analysis can be conducted until the pollution prevention team is sure that it is working with a full menu of options. A handy checklist of cleaning options has been prepared by the Minnesota Technical Assistance Program (See **Table 1**).

A *feasibility study* can be conducted to examine technical, economic, and institutional issues involved in selecting the most suitable option. Because pollution prevention is like total quality management, the concept of continuous improvement is most welcome in the feasibility study. In other words, a "low tech" solution that can be inexpensively implemented (e.g., evaporation controls to conserve volatile solvent losses) may suffice until more data can be collected on a more expensive or difficult to implement choice such as changing the substrate itself.

Each step should lead to greater pollution prevention. No possibility should be entirely eliminated. Rationale for not considering an option should be documented in case the team wishes to revisit it at a future date. It is easy to see that a restrictive approach to finding substitute solvents may be quite short-sighted in the long run. Information and technology are always changing and the team must keep abreast of these changes.

More To Come

This is an example of how the descriptive approach to pollution prevention can be applied to a specific industrial operation. Look for more problem-solving ideas and approaches in upcoming issues. If you want us to consider a particular problem that you are facing at work (e.g., coating techniques, wave solder, reducing lead using in electronic equipment, CFC elimination, and so on), please send a description of your operation complete with a process flow diagram and materials accounting to *Pollution Prevention Review*. We will address your problem in a future column.◆

Notes

1. U.S. Environmental Protection Agency, *Waste Minimization in Metal Parts Cleaning*, EPA/530-SW-89-049, Washington, DC, August 1989.

2..Oregon Department of Environmental Quality, *Guidelines for Waste Reduction and Recycling of Solvents*, Portland, Oregon, August 1989.

3. R.B. Pojasek and L.J. Cali, "Contrasting Approaches to Pollution Prevention Auditing," *Pollution Prevention Review* (Summer 1991), 225-35.

4. R.B. Pojasek, "Waste Reduction Audits", in Eric B. Rothenberg and Dean J. Telego (eds.), *Environmental Risk Management: A Desk Reference* (RTM Communications, 1991).

5. K. Ishikaua, *Guide to Quality Control* (White Plains, New York: Quality Resources, 1990).

6. Other alternative cleaning methods are given in EPA's publication *Waste Minimization in Metal Parts Cleaning* (cited in note 1).