cleaningtimes

The Semi-Aqueous Process

The theme of this issue is finishing for automotive components. The requirements of some cleaning work in this area are generally not strict. But some requirements in automotive manufacture and repair do approach, and are met, by articles cleaned in cleanrooms.

For the most part, the cleaning technology practiced in automotive businesses is conventional aqueous technology. In this column I am going to cover/introduce a cleaning technology that can meet most any requirements for article cleanliness.

It is the semi-aqueous process—which is not commonly used in the automotive industry. (Perhaps it should be?)

INTRODUCTION

Developed in the late 1980s, the semi-aqueous process was organized to use low-cost solvents (terpenes and refined hydrocarbons) with water, in order to replace the cleaning performance of CFC-113 (Freon) and 1,1,1-trichloroethane (TCA).

The semi-aqueous process has a substantial strength and a debilitating weakness. The former is the ability to clean high-value products, such as printed wire boards (PWBs) or printed circuit boards and optic components. The latter of that operation is often overly complex.

A PROCESS CONSTRUCTED AROUND WATER

The semi-aqueous cleaning process is truly well-named. It's constructed around use of water. Safety, health, and environmental (SHE) concerns about solvents in general are one principal reason why the semi-aqueous process was developed using water as one of the two components.

In addition to water, there are required contributions from detergents and solvents, pressurized sprays, and especially management of temperature variations. These are the three basic actions that are found in any cleaning process.

It's a co-solvent process, meaning that there is more than one solvent involved. It's one of many such cleaning processes. One solvent is used for cleaning. The second solvent is used for rinsing.

THE FALSE APPEARANCE OF SIMPLICITY

Like most co-solvent processes, the semi-aqueous process is not as simple as a single-solvent process—though the cleaning steps alone can make it appear so. They are shown in Figure 1.

But it's not the cleaning steps which add complexity. It's three other factors that foster complexity:

- **There are multiple or multi-component solvents and multiple needs to separate and reconstitute them for reuse,**
- **The key separation is done gravimetrically, based on immiscibility and a difference in fluid density, so that the effectiveness of separation is strongly dependent on temperature and composition (soil type and loading), and**
- **The number of process control set points has grown from one or none in a vapor degreaser, or two or three in an aqueous cleaning process, to perhaps at least a half-dozen (or more).**

In other words, a semi-aqueous cleaning system is not forgiving of change. It's probably less forgiving of change than a standard aqueous cleaning process. And nearly all of the complexity is not associated with removal of soil from parts; it is associated with the separation steps.

That complexity may be why the semi-aqueous cleaning process hasn't been extensively used in the automotive industry.

GENERAL SEMI-AQUEOUS COMPLEXITY

There are many semi-aqueous processes, each sponsored by a firm with commercial interest in solving a specific problem.

A simplified version of a general continuous semi-aqueous process is shown in Figure 2. Compare to Figure 1 to see that the complexity is not within the cleaning baths.

The general semi-aqueous process:

1.) Uses a mixture of solvents which are miscible with water at an elevated temperature such as 140°F to 160°F, and immiscible at reduced temperature such as 100 to 110°F.

2.) Uses cleaning agents (solvating agents, or SAs) in the cleaning bath that are mostly water.

Concentrations of the total solvent mixture in water are probably less than 10 weight percent. The reason for this is that the solvents are

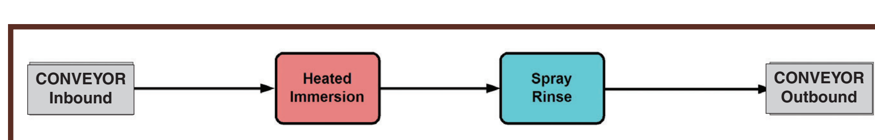

Figure 1. Single solvent semi-aqueous process.

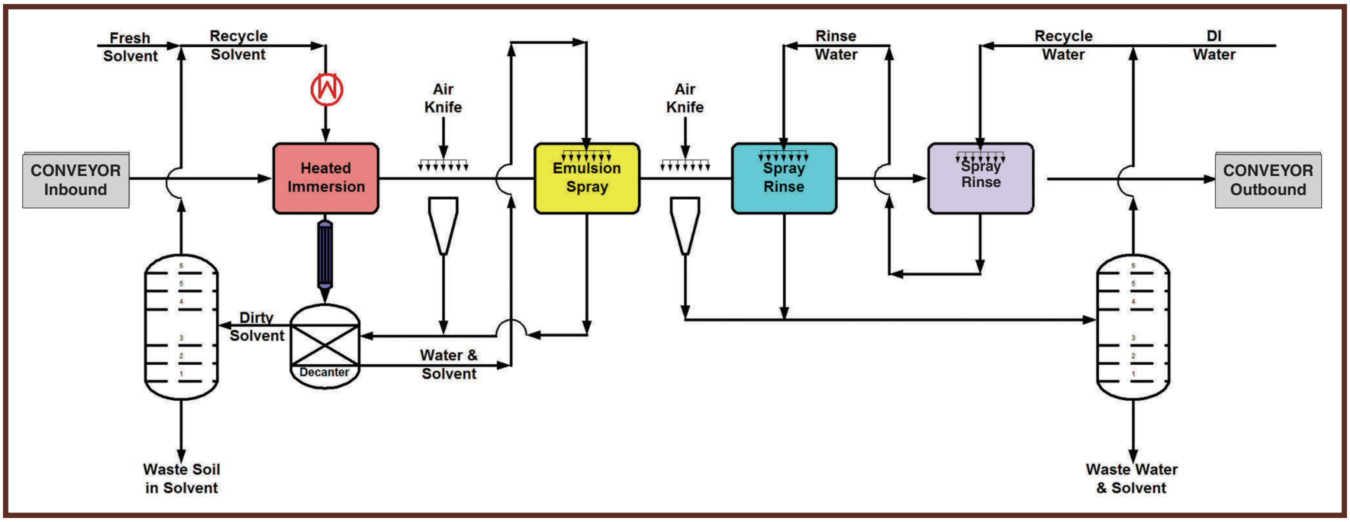

Figure 2. Simplified version of a general continuous semi-aqueous process.

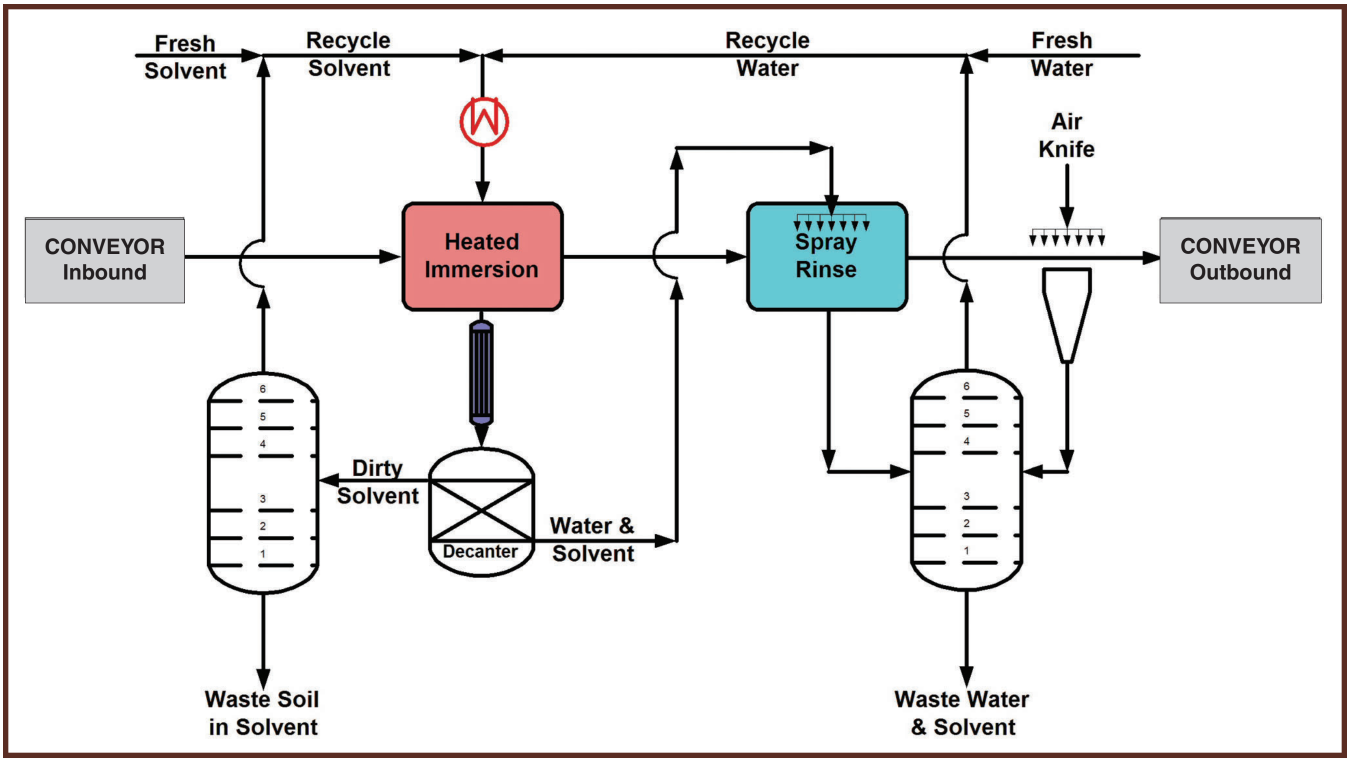

Figure 3. Version of the semi-aqueous process used to clean printed wire boards (PWBs).

expensive and do perform adequately at these concentrations.

Remember, the solvent mixture dissolved in water is the dragout material left on parts as they leave the cleaning bath. That expensive product is both lost when diluted in the rinse water, and left on the parts as residue.

3.) Does cleaning by immersion (or occasionally spray cleaning) in any vessel where the solvent mixture and water are miscible.

Contact times between parts and the water/solvent mixture can be as little as 30 seconds but is more commonly 5 minutes or more. Often incorporated is agitation by under-immersion or in-air fluid spray.

4.) Cools the soil-laden water/solvent-mixture brew, then feeds it to a decanter such as that shown in Figure 2, which allows it to phase-separate. The heavier water phase, by at least 0.15 to 0.2 g/cc, usually contains soluble solvent components, but little soil. The lighter solvent mixture phase contains solvent, little water, and hopefully all the soil.

DESIGN DETAILS

Fluid holdup time in the decanter is not short. It may be 5 to 30 minutes—probably closer to the latter. The decanter is a simple tank, likely with cove corners (to avoid fluid retention), and certainly without agitation (to avoid mixing the phases together).

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