Treatment Alternatives for Liquid Penetrant Rinse Waters

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Rinse waters containing residues from the penetrant inspection process are generated from all but Method C (solvent removal). The rinse water contains penetrants (Method A), or penetrants and emulsifier (Methods B and D), which contain oils and surfactants. The water may also contain suspended solids (e.g. from powder developers). Although generally considered to be of low toxicity, these wastes can pose problems if sewered without treatment. A number of treatment options are available.

All municipal sewer authorities or POTW's (publicly owned treatment works) restrict the concentration of certain contaminants that industrial users can discharge into the sewer system. Although there is a large variation in these limits, most POTW's place limits on fats, oils and grease (FOG), color, and turbidity (suspended solids). Most also limit BOD and COD (biological and chemical oxygen demand).

Most of these limits are established to reflect the added cost burden that untreated contaminants place on the POTW. The dyes present in penetrant rinses pose a unique problem, however. POTW's rely on micro-organisms to break down domestic waste and organic material. The micro-organisms require ultra-violet radiation from sunlight to survive and reproduce. Penetrant dyes, both fluorescent and visible (red), absorb the UV rays from sunlight, resulting in a kill-off of the micro-organisms. Further, because of their distinctive color, penetrant rinses are easily observed and can be tracked back to their source.

There are several options available to generators of penetrant rinses. Each has advantages and disadvantages.

Off-Site Disposal - Sending penetrant rinses off-site is an option that requires no capital investment and no maintenance. However, the economics of shipping waste that is usually 99 percent water is not very cost-efficient. Care should be exercised to ensure that the waste hauler is processing the waste correctly. The courts have repeatedly ruled that the ultimate responsibility for protecting the environment rests with the generator of the waste.

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Oil Skimmers/Coalescers - These simple mechanical devices remove free-floating oils and non-emulsified oil and grease. They are more effective with post emulsifiable penetrants than with water washable, especially with the pre-rinse water. Many penetrants contain surfactants and other additives that can register as high FOG levels and are not removed with the oils. These treatment devices are relatively inexpensive and are often used for pre-treatment to remove oil prior to other treatment methods.

Carbon Filtration - Filters containing activated carbon can effectively adsorb and retain the dyes in penetrant rinses. Unfortunately, oils and suspended solids can coat and plug the carbon, reducing its effectiveness. Carbon usage can be high when surfactants and other additives are adsorbed along with the dyes since carbon is expended in direct proportion to the concentration of dissolved contaminants. And, carbon costs twice: first when it's purchased and again when it's properly disposed of or regenerated. Carbon is often used for dye removal following a different treatment method to remove the other contaminants.

Membrane Filtration - Membrane filtration is capable of removing any or all of the contaminants from penetrant rinse water, depending upon the specific membrane selected. As the choice of membranes gets progressively tighter, or more restrictive, the water that passes through the membrane contains fewer and fewer contaminants. Membrane types range from micro-filtration that can remove suspended solids, to ultra-filtration for removing emulsified oils, to nano-filtration that can remove everything including even the dyes and surfactants. The choice depends on the quality of discharge water desired.

The membranes can be assembled in different configurations depending on how the membrane elements are constructed. The most common types are tubular, hollow fiber and spiral wound. Tubular membranes are used primarily when the waste has a high level of suspended particles that cannot be removed by other methods. Hollow fiber systems are often used for removal of oils and solids, but are not restrictive enough to remove the dyes and surfactants. For this reason they are often combined with activated carbon filters or ozone generators. Spiral wound systems are capable of removing all the contaminants in a single operation when the membrane chosen is a nano-filtration one. Spiral membranes have a useful life of 12 to 18 months, which makes them extremely cost effective.

Ozone Generators - Ozone is very effective at color removal because of the ability of ozone to oxidize the dye component. It is much less cost effective at reducing BOD and COD because of the slow rate of oxidation. It is even less effective at reducing oil and suspended solids in the rinses. As with carbon, ozone is sometimes effectively used to remove color after another method has reduced the other contaminants.

The following chart shows the advantages and disadvantages of each option:

	Off-Site Disposal	Skimmer/ Coalescer	Activated Carbon	Membrane (hollow)	Membrane (Nano)	Ozone
Capital Costs	none	low-med	medium	high	high	high
ContinuingCosts	high	low	high	low	low	high
Removal of:						
Oil	n/a	moderate	fouls	excellent	excellent	poor
Susp. Solids	n/a	poor	fouls	excellent	excellent	poor
Dye	n/a	poor	excellent	poor	excellent	excellent
BOD	n/a	poor	excellent	poor	excellent	moderate
COD	n/a	poor	excellent	poor	excellent	moderate
Metals	n/a	poor	med-good	poor	good-exc.	poor

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