Air Stripping
Industrial Wastewater

Industrial wastewater can be quickly, efficiently and economically treated using air strippers.

by Bruce Lamarre and Don Shearouse

Air stripping removes a range of volatile and semi-volatile contaminants from water. And the performance of various types and sizes of tray-type air strippers for treating contaminated water now is highly predictable because of laboratory studies.

Air stripping can be a fast, efficient and economical approach to treating industrial wastewater. However, since every industrial wastewater stream is unique, each must be evaluated to determine its constituents, its potentially adverse effects on treatability, and any pretreatment steps necessary to ensure desired results.

How air strippers work
The general principles of air stripping are simple. In an air stripper, the surface area of a film of contaminated water is maximized while air is directed across it. Contaminants at the air/water interface volatilize and are discharged to the atmosphere or to an off-gas treatment system. The two main types of air strippers are packed towers and low profile, tray-type strippers.

In a packed tower air stripping system, water trickling over a packing media creates a water film. As water flows downward, it spreads thinner, creating more surface area. These thin films of water are met by a counterflow of air blown in from the bottom of the tower. This is the oldest — and still a widely used — form of air stripping.

Low-profile air strippers have gained increasing acceptance in the past five years and now are widely used at new remediation sites. The most common style of low-profile air stripper used is the tray-type unit, in which a shallow layer of water flows along one or more trays. Air is blown through hundreds of holes in the bottom of the trays to generate a froth of bubbles — a large mass transfer surface area where the contaminants are volatilized. In the tray-type low-profile system, the air simultaneously creates the surface area and volatilizes the strippable constituents.

Low-profile air strippers can operate at very high air-to-water ratios for high treatment efficiencies required for the more difficult-to-strip compounds, such as acetone and ammonia. They can be operated over a wide range of flow rates, so there is substantial turndown flexibility. They are
designed for easy access to and rapid removal of scale and other types of fouling that may occur frequently in industrial applications.

The amount of contamination that can be stripped from water depends on many factors, including:
- the strippability of the compound(s);
- flow rate of the influent;
- residence time in the system;
- air flow;
- water temperature;
- air temperature; and
- the effects of solids, minerals and other chemicals in the water.

The air stripper is a powerful tool because most of these variables can be controlled to obtain an optimized, site-specific solution for contaminant removal.

Air stripping is effective in removing contaminants found in a wide cross section of industrial waste streams, including:
- food processing (ammonia);
- electronics manufacturing (chlorinated solvents);
- petroleum products (BTEX and MTBE);
- laundries (chlorinated solvents);
- printing plants (solvents);
- plating solutions (solvents);
- synthetic fiber processing (acetone); and
- plastics processing (styrene).

Is the target contaminant strippable? Four classes of volatile organic compounds (VOCs) are candidates for removal from water by air stripping. If any are present in an industrial waste stream, air stripping could be a cost-effective method for their removal.

**Readily strippable VOCs.** Strippability of a compound is a function of its volatility and solubility. The easiest compounds to strip are highly volatile and only slightly soluble, for example, BTEX (benzene, toluene, ethylbenzene and xylenes). The volatiles readily flash from the liquid phase to the vapor phase. With these compounds, air stripping provides excellent cost/performance benefits.

**Water soluble VOCs.** These chemicals, such as acetone and MEK, are both volatile and water soluble, and this can cause strippability problems, which are difficult to predict. Treatability or pilot studies are an essential part of an air stripper evaluation for these compounds.

**Extractable VOCs.** With extractables, such as diesel and jet fuels and fuel oil, low volatility makes the strippability of these compounds difficult to predict. Again, treatability and/or pilot studies often are a prerequisite.

**Ionized VOCs.** When volatile compounds, such as ammonia and hydrogen sulfide, dissolve in water, they ionize and resist stripping. Strippability can be improved by adjusting pH levels, heating the water, and/or increasing residence time in the stripper. These measures need to be confirmed by treatability and pilot studies.

**What else is in the water?** Once it has been determined that the contaminants are strippable, it is necessary to determine what else is in the waste stream, what effect these substances may have on air stripper performance, and how any negative effects may be mitigated. The following characteristics of waste streams should be considered for their effect on air stripper performance:

**Suspended solids.** Materials that float or settle are considered suspended solids. These include fibers, sand or grit, and sticky materials, such as oil and grease. To prevent the air stripper from plugging, suspended solids typically are removed upstream by filtration, flocculation or flotation.

**Dissolved solids.** These include iron and manganese minerals, chloride, sulfate and carbonate salts, and calcium and magnesium-bearing minerals. Precipitation is a problem with dissolved solids because it causes fouling. There also may be material compatibility problems. Chlorides, for example, may corrode stainless steel. Plating waste is an example of a waste stream in which stripping is complicated by the presence of a number of dissolved solids. For dissolved solids, a lab test is used for the pretreatment selection of a sequestering agent, pH adjustment and solid/liquid separation requirements.

**Total solids.** The complete solids content of a waste stream, suspended and dissolved, can be determined by a total solids test. This test often provides values different from those produced by adding the suspended and dissolved contents.

**Heavy metals.** Because they may not precipitate, the presence of salts of heavy metals such as lead, copper, zinc and mercury does not directly affect air stripper performance.

**Biological oxygen demand (BOD).** This measurement indicates how much oxygen is used by bacteria in degrading organic materials, providing an indirect calibration of how much organic material is present in the waste stream. Unfortunately, BOD is of little use in predicting air stripper performance because it does not tell how much of the organic content is strippable. However, reduc-
For large systems, it may be prudent to set up an on-site pilot system that can be scaled up to final treatment needs.

Other considerations
Other important considerations include air quality standards, upstream and downstream equipment, and confidence in analytical support.

Air quality standards. In some areas, off-gas treatment is required. This process adds to the costs of equipment, maintenance and operation.

Upstream and downstream equipment. Water delivered from upstream equipment should be in a treatable condition; water discharged downstream should not have characteristics that negatively affect subsequent processes. Frequently, air stripping is the final treatment process before wastewater discharge. Occasionally, there are reasons to alter this sequence. For example, it might be necessary to remove VOCs from sludge before it is dewatered so it is not classified as a hazardous waste. In this case, rough stripping may precede dewatering. Subsequently, water would be polished in a secondary stripping operation to remove residual VOCs.

Confidence in analytical support. The more familiar the analytical lab is with the operating conditions of a particular waste stream, the greater likelihood that the test results will provide useful design data necessary for a specific air stripping system for a site.

Treatability/pilot studies
Some treatment issues may be resolved by performing simple lab tests. These involve making chemical adjustments to small batches of stream samples to remove solids, such as iron, or to help determine other pretreatment needs.

Applicable waste streams
Air stripping should be evaluated as the removal method for any waste stream containing volatile contaminants that are readily strippable, water soluble, extractable or ionic. Most often, air stripping is the method of choice for removing readily strippable VOCs. Other categories of volatile contaminants frequently are difficult to remove, no matter what the method. For these, air stripping can be cost-effective.

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