

# The Science of Solvents

## Solvents and their Industrial Uses

Solvents are liquids or gases that can dissolve or extract other substances. They are used to dissolve grease, oil, and paint; to thin or mix pigments, paint, glue, pesticides, and epoxy resins; to clean electronics, automotive parts, tools, and engines; and to make other chemicals.<sup>1</sup>

Solvents are incredibly useful in a variety of industries today including:

- Coatings and paint
- Printing and ink
- Automotive
- Transportation/ asphalt
- Furniture and wood manufacturing
- Aerospace and marine
- Pharmaceuticals
- Oil and gas
- Electrical
- Metal finishing
- and many more

Solvents can range anywhere from \$50-\$2000 per 55 gallon drum, which can very quickly add up even for companies that use small volumes of solvent. They are generally purchased and delivered to various companies for use. But what do companies do with their used solvent?

## Solvent Classifications

There are two main categories that solvents are divided into – polar and non-polar solvents. Polar solvents dissolve in other polar solvents, while non-polar solvents dissolve in other non-polar solvents (like dissolves like). When like solvents dissolve within one another, they are said to be “miscible solvents”. However, polar solvents will not dissolve in non-polar solvents and vice-versa. When chemicals do not dissolve within one another they are said to be “immiscible solvents”.

Whether two solvents are miscible or immiscible depends on the bonding and arrangement that is present within the chemicals themselves. In order to dissolve, one chemical must successfully form a chemical bond with another, which will only occur with “like” polarities (ie. mixture of salt water). If the solvents are not “alike”, a solution may exhibit distinct layers when mixed (ie. mixture of oil and water). These layers will form and order themselves according to their respective densities. The chemical that has a higher density will remain on the bottom, while chemicals with lower densities will float on top.

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1. “Solvents.” National Library of Medicine – National Institute of Health. Accessed July 20, 2015.

## Impurities and Chemical Separation Methods

Impurities are small traces of chemicals that are present within a given solvent. They can be removed in most cases to yield the desired pure chemical mixture. There are a variety of different methods that can be used to remove unwanted chemicals from a desired solvent including:

- **Evaporation** – separates mixtures by heating the unwanted chemical into its vapor form, leaving the desired solvent behind in its liquid form
- **Simple distillation** – similar to evaporation, except the heated vapors are cooled back into their liquid form using a condenser
- **Steam distillation** – the same process as simple distillation, but is generally used for temperature sensitive compounds that may decompose at high temperatures
- **Fractional distillation** – often used with miscible liquids with varying boiling points
- **Extraction** – generally better for mixtures that do not dissolve with one another. For example, a mixture of polar and non-polar chemicals (like oil and water)
- **Paper chromatography** – often used in the food industry
- **Filtration** – useful to separate solids from liquids
- **Magnetism** – used when one chemical possesses magnetic properties
- **Separating funnel** – ideal for mixtures that do not dissolve within one another (immiscible mixtures).

## Boiling Points and Distillation

The boiling point of a chemical is the temperature at which a liquid evaporates into its vapor form. This point is reached by heating the chemical, and is an essential characteristic of distillation. Distillation is the process that separates a chemical mixture into its individual components. It does this by first feeding the waste mixture into the distillation vessel. As the distillation vessel gets warmer and warmer, the mixture will evaporate chemical by chemical. As each chemical is evaporated, it will travel to a condenser, which cools it back into its liquid form. The process of distillation has been around since the time of the ancient Greeks and has been proven to be effective in both laboratory and industrial settings.

## Solvent Disposal and Recycling Options

The main options available for companies who use chemical solvents are:

- Shipping chemical waste to an off-site facility to be recycled and recovered
- Shipping chemical waste to an off-site facility to be properly disposed of

- Organizing mobile visits from a recycling facility to do on-site recycling using their recycling units
- Purchasing or renting an on-site solvent recovery unit to recycle solvents in your own facility

Different methods will suit different companies depending on their recycling needs. Generally, companies that produce little waste or are using solvents for a short period of time will generally prefer to use off-site recycling services. This is beneficial because they will pay minimal disposal costs for shipping and removing very small amounts of solvent. However, those that use large volumes of solvent, or plan on using solvent over a longer period of time would benefit from on-site recycling units. These units generally pay for themselves within 6-12 months, and will provide the company with independence. These units can be used whenever waste solvent is produced – companies no longer have to store their waste until shipping it out. This is a convenient environmentally friendly solution for companies that produce a reasonably large amount of solvent.

### The Benefits of On-Site Solvent Recycling

- **Economically feasible** – on-site solvent recycling units have a return on investment (ROI) of 6-12 months, depending on the volume of solvent recycled. Companies save money through two major ways:
  - Reduced disposal costs, as the recycled solvent is re-used
  - Reduced inventory costs, companies will not have to purchase as much virgin solvent, and will save money in storing, shipping, and handling associated with purchasing new solvent
- **Environmentally friendly** – recycling on site reduces the overall waste disposal volumes and emissions, as the same solvent can be used over and over instead of being shipped out and disposed of.
- **Time and energy conserving** – most recycling units are designed with the environment in mind and therefore use little energy and produce very low emissions. Users can also save large amounts of time by just loading and unloading the machine, instead of scheduling and storing waste solvents to be disposed of.

### Deciding Between Off-site and On-Site Recycling Options

Solvent recycling will vary depending on the chemicals present and volume of the waste mixture. The easiest way to determine the correct method is to assess the chemicals and volumes you currently consume, and then assess the viable options available. It is

usually best to speak with company representatives to properly assess and fulfill your solvent recycling needs.

**Some questions you may want to ask yourself include:**

- What solvent am I looking to recover?
- What contaminants may be present in the waste drum?
- How much solvent do I use per month?
- What is the cost of purchasing new virgin solvent?
- Do I prefer automatic or manual recycling methods?
- Optional: What are the boiling points of the chemicals in the waste stream?

**Some questions you may want to ask company representatives include:**

- How much money will I save by recycling/ disposing my waste solvent off-site?
- How much money will I save by recycling/ re-using my waste on-site?
- What payment options are available?
- Do you offer support services for your recycling equipment?