SOLVENT/WATER SEPARATION

SEPARATING THE SOLVENT

WHAT IS SOLVENT/WATER SEPARATION, AND WHY IS IT NECESSARY?

Garments absorb moisture from the surrounding air when exposed to humidity. During the wash cycle, this moisture is transferred to the cleaning solvent. Later, during distillation and drying, the solvent and water vaporize together and then condense back into a liquid mixture. Before reusing the solvent, the water must be removed. This process is known as **solvent/water separation**.

Fortunately, solvent and water are **immiscible**, meaning they do not dissolve into one another. When two immiscible liquids are allowed to stand undisturbed, the lighter liquid floats on top of the heavier liquid. Most modern hydrocarbon and other alternative dry-cleaning solvents are lighter than water and therefore float on its surface. **PERC**, however, is heavier than water and sinks to the bottom.

Using gravity to separate either type of solvent from water is known as **gravity separation**.

THE EFFICIENCY OF GRAVITY SEPARATION DEPENDS ON SEVERAL FACTORS:

1. **Difference in specific gravity** — The greater the difference in density between the solvent and water, the faster and more completely they separate. PERC has a specific gravity of approximately 1.6, compared with 1.0 for water. This large difference makes separation relatively easy and usually requires only a single separation stage. Lighter-than-water solvents typically have specific gravities around 0.9, making them much closer to water in density. As a result, they separate more slowly and generally require multiple separation stages.
2. **Separator volume** — Larger separators provide more space for the liquids to separate, improving separation efficiency.
3. **Turbulence** — Separation is most effective when the liquid inside the separator is calm. Excessive turbulence mixes the solvent and water, slowing separation.
4. **Separation time** — The longer the solvent and water remain undisturbed, the more complete the separation becomes.
5. **Liquid temperature** — Within practical limits, cooler liquids generally separate more effectively than warmer liquids.

PERC VS. LIGHTER-THAN-WATER SOLVENTS

Separation systems used with **PERC** are relatively simple and differ little from one manufacturer to another. The condensed solvent/water mixture enters a separator and is allowed to remain undisturbed. Because PERC is heavier than water, it settles to the bottom of the separator while the water remains on top. The separated PERC is returned to the solvent storage system, and the water is discharged for disposal.

Separation systems used with **LIGHTER-THAN-WATER SOLVENTS** are considerably more complex. Because these solvents float on water and have a density much closer to that of water, they require more elaborate separation methods to achieve acceptable efficiency.

Different manufacturers use a variety of separator designs, making it impractical to describe every variation. Instead, this discussion focuses on the most common separation system used with lighter-than-water dry-cleaning solvents.

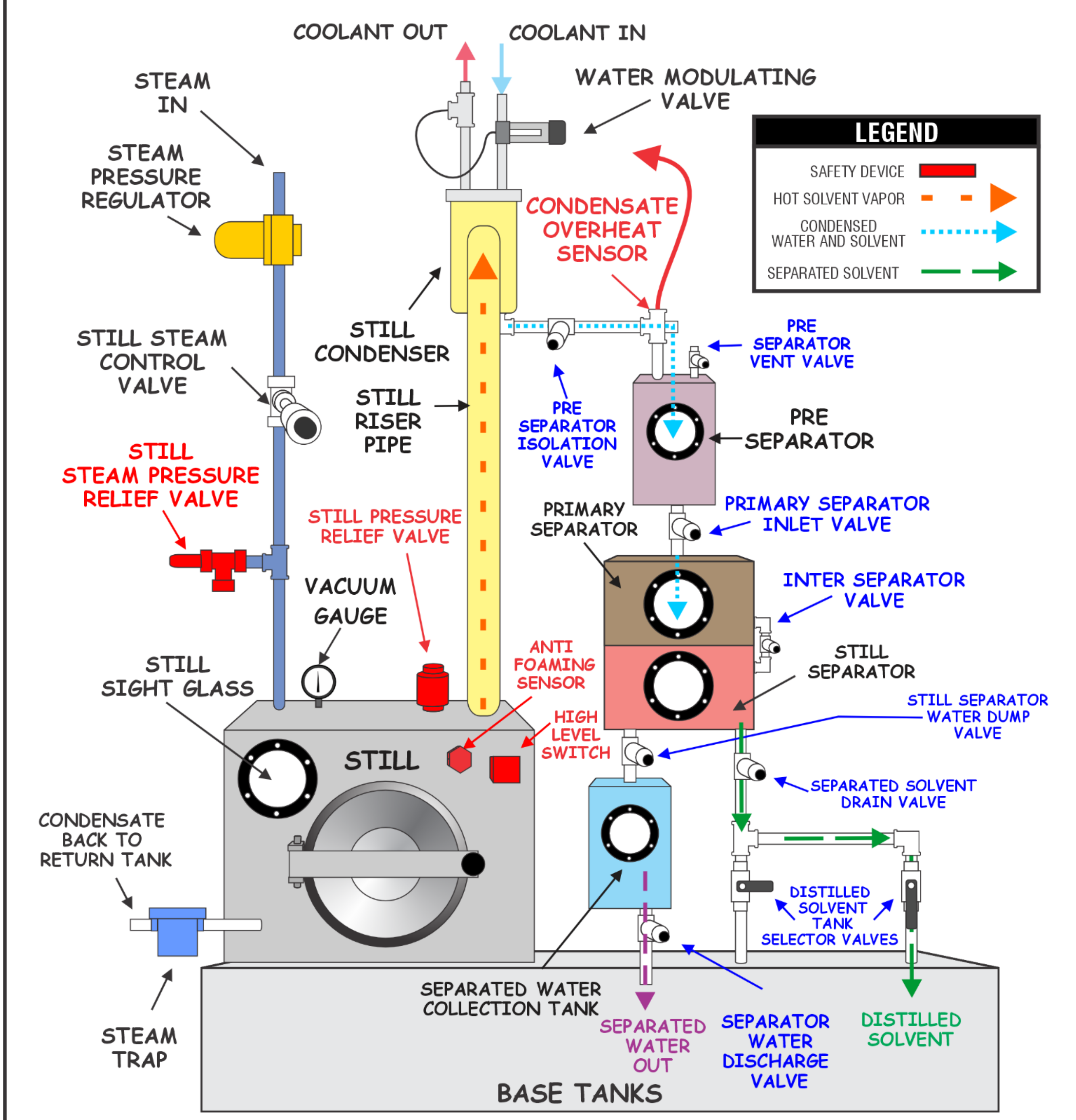
As discussed earlier, the relatively small difference between the specific gravities of water and lighter-than-water solvents requires a larger separation volume to allow the two liquids to separate by gravity. This additional volume is typically provided by using multiple separators.

Most lighter-than-water dry-cleaning solvents have a **flash point**, which is the lowest temperature at which they produce sufficient vapor to ignite in the presence of an ignition source. To reduce the fire hazard during distillation, the solvent is heated under a partial vacuum, which lowers its boiling point below its flash point.

Maintaining this partial vacuum throughout the distillation process requires **batch distillation**—distilling the solvent in measured quantities rather than continuously. Batch distillation, in turn, requires the coordinated operation of several valves.

TYPICAL DRY CLEANING MACHINE DISTILLATION SYSTEM FOR LIGHTER THAN WATER SOLVENTS

*This illustration is a composite of several machine brands and may not represent your machine's exact configuration



HERE'S THE SEQUENCE OF THIS TYPE OF DISTILLATION

1. HEATING AND CONDENSATION

A partial vacuum is drawn in the **STILL**. When the required vacuum level is reached, a vacuum switch actuates, opening the **STEAM CONTROL VALVE** and allowing steam to enter the **STILL STEAM JACKET** (not shown).

As the solvent reaches its reduced boiling point, it vaporizes and rises through the **STILL RISER PIPE** into the **STILL CONDENSER**. There, the solvent and water vapors contact a coolant-chilled SERPENTINE COIL (not shown), condense into a liquid mixture of solvent and water, and flow into the **PRE-SEPARATOR**.

2. TRANSFER TO THE MAIN SEPARATOR

The **PRE-SEPARATOR** contains a **FLOAT SWITCH** that monitors the liquid level. When the liquid reaches a predetermined level, the float switch actuates, closing the **PRE-SEPARATOR ISOLATION VALVE** and opening the **MAIN SEPARATOR INLET VALVE**.

This valve sequencing allows the condensed liquid to flow from the **PRE-SEPARATOR** into the **MAIN SEPARATOR**. When the liquid level in the **PRE-SEPARATOR** falls, the valve sequence reverses.

3. GRAVITY SEPARATION AND SOLVENT/WATER DISTRIBUTION

The transfer cycle described in Step 2 continues until the liquid level in the **MAIN SEPARATOR** reaches the operating point of its float switch. The float switch then signals the machine's control system to initiate the solvent and water discharge sequence.

Depending on the machine manufacturer, the piping arrangement, valve layout, and valve sequencing may vary. However, in the generic system described here, the separated solvent is directed through the **DISTILLED SOLVENT TANK SELECTOR VALVE** into the selected **BASE TANK**.

During this sequence, the separated water is discharged into the **SEPARATED WATER COLLECTION TANK**, which is periodically emptied through the **SEPARATOR WATER DISCHARGE VALVE**.

The valve sequencing described above, along with numerous internal venting operations, is automatically controlled by the machine's control system. These operations are designed to maintain the required partial vacuum in the **STILL** while permitting liquid transfers that require portions of the separation system to be vented to the atmosphere.