Vapor Compression Distillation vs Multiple Effect Distillation

The concept of producing Water for Injection (WFI) using compressed steam [Vapor Compression (VC)] dates back to the post World War II era. The idea is simple: use steam to produce a purified steam; then re-compress that steam to be used to create more purified steam; condensing the steam during that process into WFI. Much like a refrigerator continually cools.

the other common approach to producing WFI is to use multiple stages of distillation, known as "Multiple Effect." This process simply uses steam to produce purified steam; the resulting purified steam then passes to a second stage where the process is repeated up to 8 times. In the end, the MED process has similarities to an old "Ice Box" in that "fuel" (ice) must be constantly fed to the system.

Just like the refrigerator versus the ice-box analogy, the end result is VC is typically more energy efficient than MED.

There are other advantages as well:

- Because MED must operate the first stage at very high temperatures (135 - 176°C) in order to have enough energy to drive subsequent effects, there are several handicaps created. One is the materials are more exposed to damage by certain chemical attach (e.g. chloride); another is that the high temperatures can cause more precipitation as various feed water constituents reach their saturation point. The end result is that MED requires significantly greater pretreatment than VC. Generally, VC can be pretreated by softening an Activated Carbon whereas, an MED almost always requires an RO or -in some cases- Two-Pass RO.

- Also because of the greater heat input requirements, MED requires external cooling to re-condense the final steam product to WFI water. Just like the VC, the MED uses the feed water to extract the heat the the greatest extent possible. But, because of the heat input differences, the VC is able to re-condense the product completely using feedwater cooling, while the MED needs supplemental cooling…and, often significant quantities for the smaller units.

- Since the VC process re-condenses the steam into WFI as part of the process, the vapor compression technology can produce a cooler - or "ambient" - WFI product even less costly. In the case of MED, the reverse is true - the cost to produce an ambient product is actually greater because more cooling is necessary.

Summary

- VC is typically more energy efficient, a fact that may become more pronounced as electrical costs held in-check by wind, water, and nuclear power… all "green" technologies that help to stabilize the cost to generate electricity. Meanwhile, MED will always be driven by the cost to produce steam, directly creating a "carbon footprint."

- VC can create ambient WFI at the lowest over-all cost. The cost to create ambient WFI with an MED is actually higher than the already high cost to produce hot WFI via MED.

- Additional cooling creates a higher energy demand (less green) to re-condense the steam to WFI.

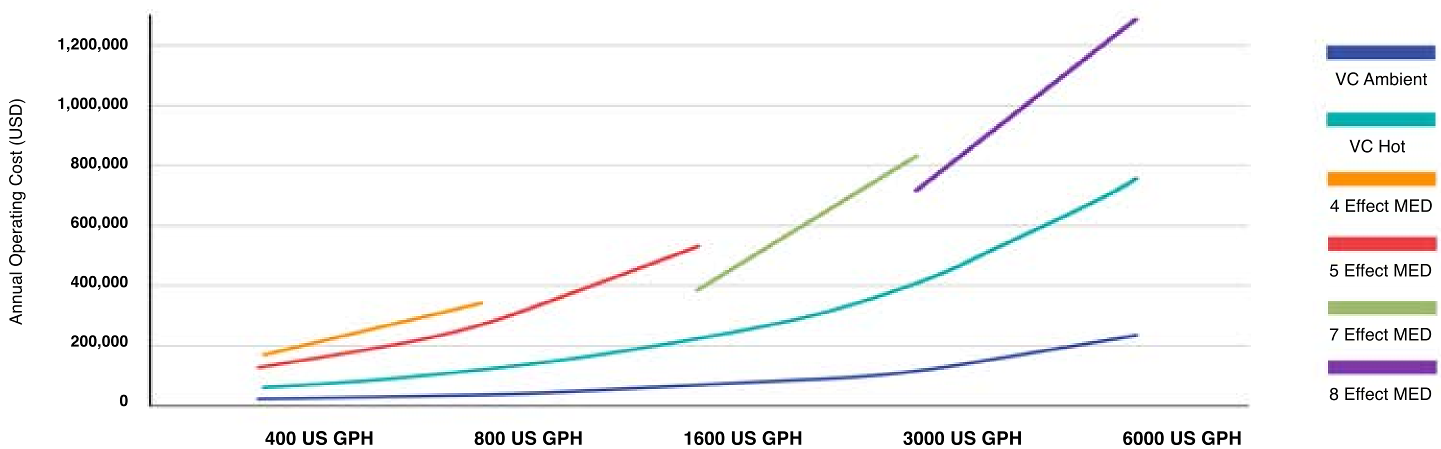
- Hardness and silica factors in feedwater will cause harm to the operation of any distillation process. Both VC and MED require the removal of hardness from the feedwater (typically by an ion-exchange softener). But, because a softener is unable to remove either chloride or silica, a more extensive pretreatment (usually RO) is necessary to meet the less than 1 ppm silica and low chloride requirements of a MED; meanwhile, a VC can tolerate up to 10 ppm of silica and always contain a certain amount of chloride, an RO will typically be required for a MED and a VC will not.

Energy Comparison

The chart below graphically describes the energy comparison of the VC versus the MED process. The operational cost figures are based on typical expenditures for electricity, steam, and water. Naturally, these figures become skewed one way or another for cases where these utility costs are not typical.

Base Costs

Electricity:	USD 0.10 per KwH
Steam:	USD 0.025 per pound of steam
Cooling:	USD 0.001 USD per 1000 BTU
Pretreatment (Δ):	USD 0.002 USD per US Gallon



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