Best Practices

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Bleed & Feed for Process Solution Control

Bleed & Feed is a very effective process solution control practice to control solution contaminant concentration as an alternative to the conventional practice of batch dumps. Below is a list of common terms and definitions that may be helpful to readers of this column.

Definition of terms

Best Practice - A best practice is a technique, method or process that produces a particular result more efficiently and effectively than any other technique, method or process.

Decant - Process solutions are periodically dumped to control contamination, and a new solution is made up to replace the contaminated solution. Alternatively, a partial dump or decant can be made to reduce contaminant concentrations. If the decant is 50%, then the new solution will be a 1:1 blend of old contaminated solution and new uncontaminated solution. If a contaminant was 12 oz/gal in the old solution, then the new blended solution will contain 6 oz/gal of that contaminant.

Bleed - A solution bleed is a small decant. Solution bleeds can be manual (beaker, bucket, etc.), but are normally made with small metering pumps.

Feed - A solution feed is a small make-up of solution chemistry to replace solution lost through drag-out or bleed. Solution feeds can be made manually or with small metering pumps.

Bleed & Feed - Bleed & feed is a technique which synchronizes solution bleeds with solution feeds to achieve steady-state operating conditions.

Process solution control

Efficient and effective process solution control is critical in wet surface finishing processes. Traditional solution control relies on periodic analysis and prescribed additions, continuous and/or batch treatments, and batch dumps of spent solutions. A solution becomes spent when contaminants which build up over time reach an upper control limit. See Figs. 1 and 2.

Solution contaminants include suspended solids, organics (oil and grease, brightener breakdown products, etc.) and dissolved solids (cationic and anionic). Contaminants are introduced to the solution from a variety of sources, including:

- Agitation air
- Anodes
- Cross contamination
- Drag-in
- Make-up air
- Make-up chemicals
- Make-up water
- Mists and aerosols
- Over-spray and drips
- Reaction by-products.
- Tank and bus bar corrosion

Common treatments to control solution contaminants include:

- Carbon treatment
- Crystallization
- Dummy plating
- Filtration
- High pH
- Oxidation/reduction
- Settling
- Skimming

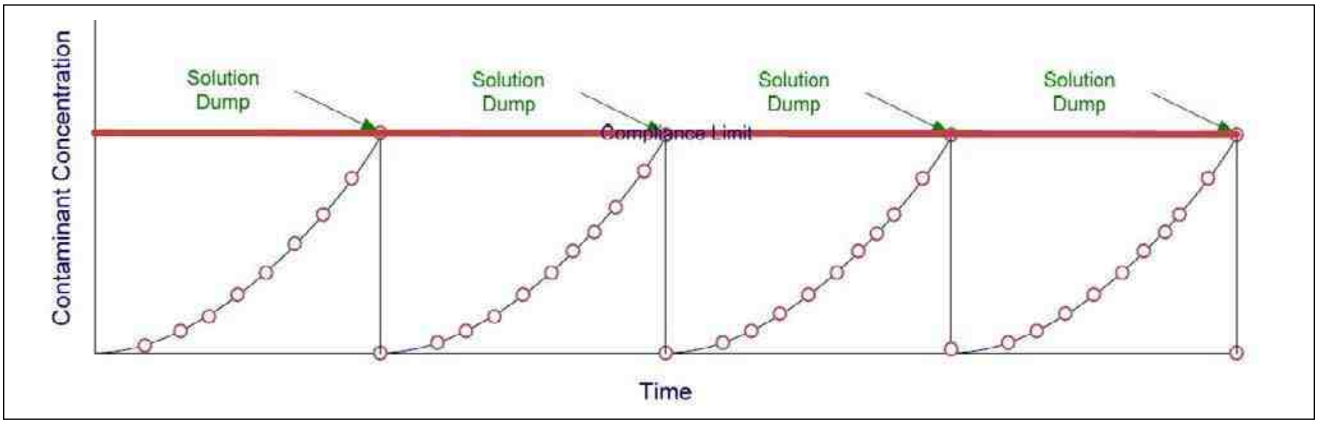

Figure 1—*Process contaminant concentration plotted over time.*

Less common treatments utilize advanced separation technologies, including:

- Acid sorption
- Diffusion dialysis
- Distillation
- Electrodialysis
- Ion exchange
- Microfiltration
- Nanofiltration
- Ultrafiltration

Contaminants are also purged through drag-out. When production rates are high or drag-out control is poor, drag-out, though wasteful, is often adequate to maintain solution purity and solution loss is made up with chemical additions.

Example 1:
A 200-gallon tank is operated five days/week for two (2) eight-hour shifts or 320 hours. The drag-out rate is 10 gallons/shift, 20 gallons/day (gpd), 1.25 gallon/hr (gph) or 0.021 gallon/min., and is roughly equivalent to dumping the solution every two (2) weeks. If the process solution is an HCl pickle, operated at 25 vol% and if iron is introduced as a byproduct of pickling at a rate of 10 oz/hr, and if the average concentration is eight (8) oz/gal, then the solution is at equilibrium. Drag-out removes iron at a rate of 10 oz/hr (8 oz/gal × 1.25 gph).

Bleed & feed

Bleed & feed works in much the same way, but the contaminant concentration equilibrium is controlled rather than coincidental. The bleed rate necessary to control solution is normally of the same order of magnitude as the drag-out rate, and the wastewater treatment concentration impact is relatively small. Steady-state process operating conditions (Fig. 3) provide many benefits, including:

- Predictable operating performance (time, etch rate, strip rate, smut formation, water break, etc.)
- Improved wastewater treatment performance due to steady-state loading
- Reduced operating costs compared to batch dump and make-up
- High operability and maintainability compared to advanced separation technologies.

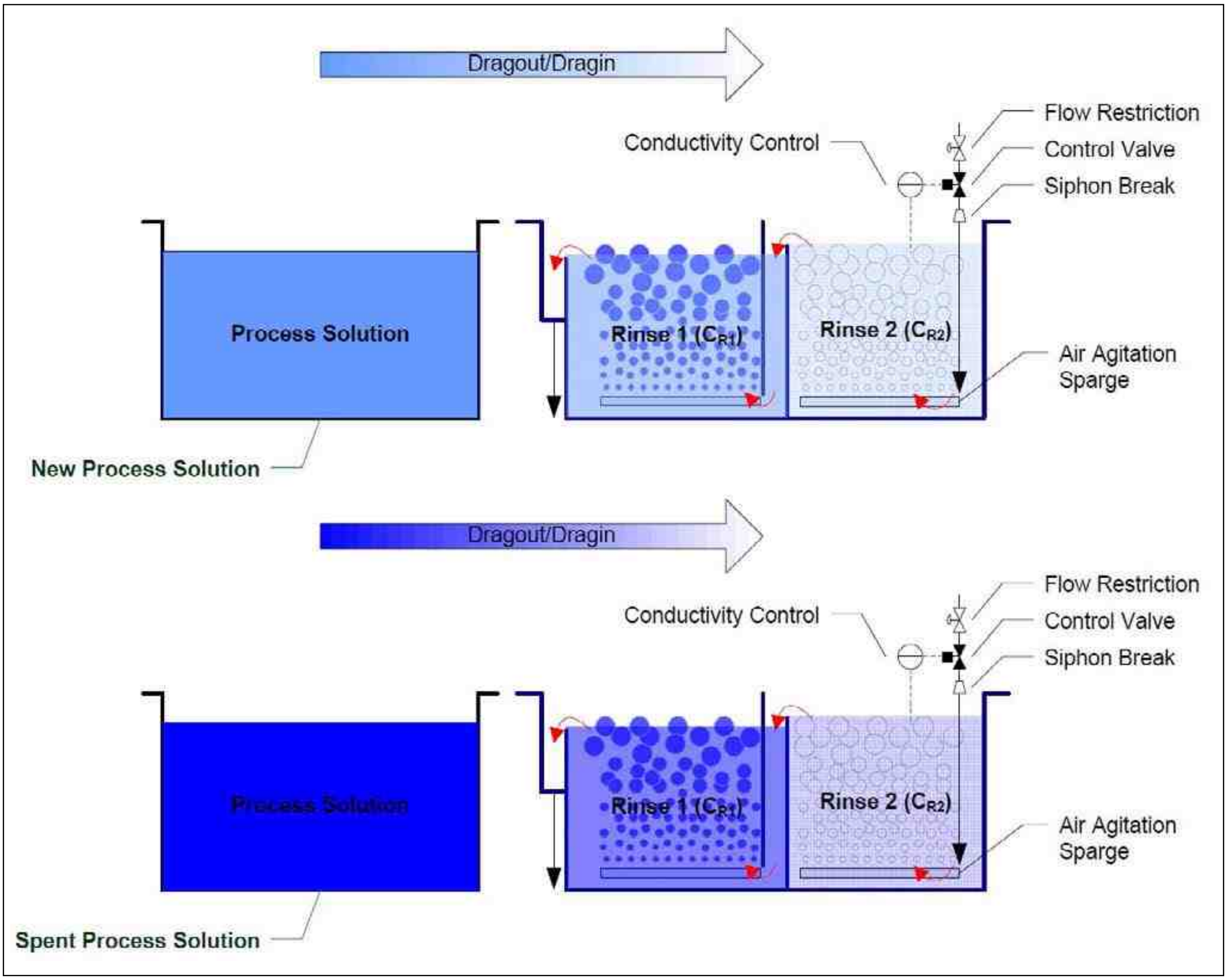

***Figure 2**—Illustration of new and spent process solutions.*

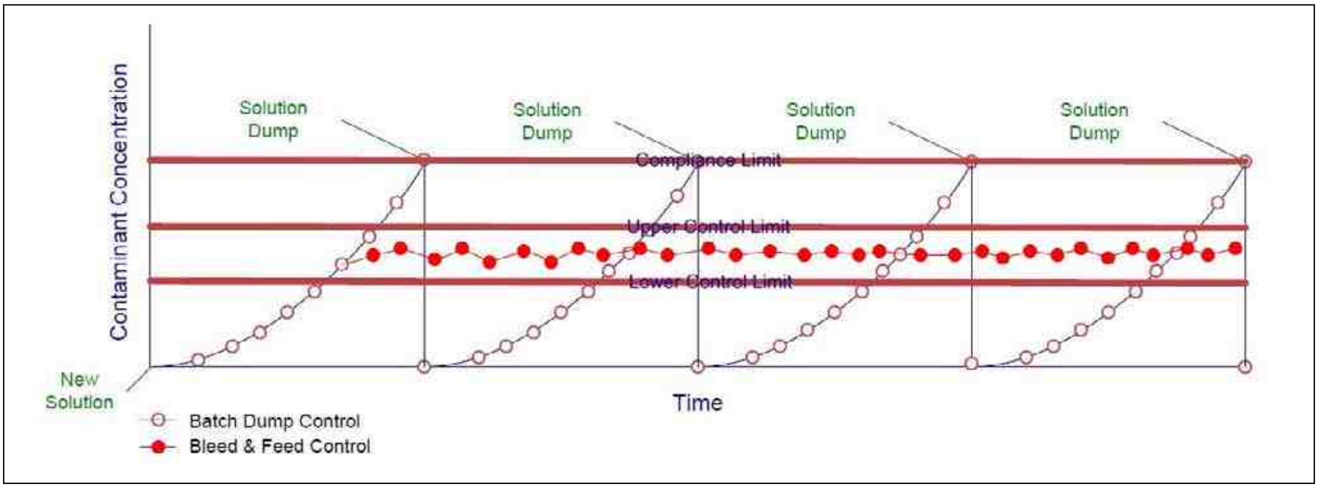

Figure 3—*Illustration of steady state control using bleed & feed.*

Example 2:
A 400-gallon tank is dumped every four (4) weeks. The tank is operated five days/week for two (2) eight-hour shifts or 320 hours. A bleed rate of 10 gallons/shift, 20 gallons/day, 1.25 gallon/hr, or 0.021 gallon/min is roughly equivalent to dumping the solution every four weeks. If the process solution is a soak cleaner, operated at eight (8) oz/gal or ½ lb/gal of XYZ cleaner, and drag-out is also 20 gallons/day, then the feed is equal to 40 gallons × ½ lb./gallon or 20 lbs of XYZ cleaner per day. The chemistry feed can be metered in as an equivalent solution or concentrated slurry, or the addition can be in the form of periodic additions of powder.

Bleed & feed can be operated as a manual, semi-automatic or fully automatic process. Figure 4 is an illustration of a semi-automatic bleed & feed system. An automatic system requires a real-time production input (amp-hrs/min, loads/hr, pounds/hr or ft^2/hr) and an algorithm to control the bleed & feed rates.

Summary

Bleed & feed is a best practice for process solution control because it is both extremely effective for controlling process solutions and efficient. It is an elegantly simple technique that is in practice at thousands of wet process facilities around the world. Bleed & feed, in combination with common treatment processes, is more cost effective for solution control than advanced separation technologies in 80 to 90% of cases and more cost effective than batch dumps in 99% plus cases. *P&SF*

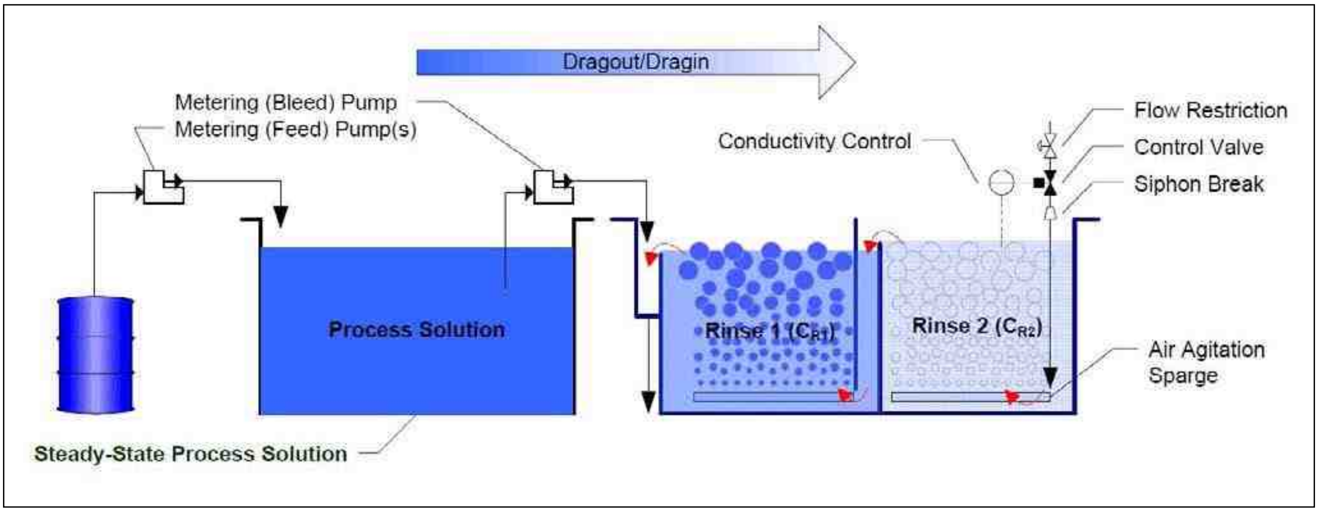

Figure 4—*Illustration of semi-automatic bleed & feed control.*