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Achieving full control over a binary blend feeding a liquid chromatography process

Inline Blending Solutions Built For You - Part 1

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Liquid chromatography processes typically require dilution or blending of constituents to achieve necessary mobile phase solutions. These solutions can be pre-blended – but inline blending is a more efficient solution and can be accomplished by implementing a few clever control schemes in an automated system.

The simplest configuration is two separate constituent streams blended and then driven through a diaphragm pump to the column; but in order to allow for the greatest control, each stream should be metered by a control valve with equal percentage trim. Equal percentage trim affords a superior resolution at the low end of valve travel. This sensitivity is ideal for any gradient – especially for gradients that have heavily lop-sided flow proportions – so that the low flow constituent can maintain acceptable accuracy. In a control valve arrangement, each of the two valves plays a separate, harmonizing role to maintain ideal control:

- The first valve is responsible for the diluent – either WFI or another fluid that accounts for a majority of the blend – and would normally have a larger CV value than the second valve. The control parameter is the blending pressure, measured where the two streams converge. This may seem counterintuitive; however, this allows the first valve to complement the position of the second valve regardless of any other influences.

- The second valve is responsible for the component that is getting diluted. This valve would normally account for a minority of the blend and have a comparatively smaller CV value. The control parameter is the blending parameter – flow proportion, conductivity, or another property used to define the desired blend. This valve will increase its open position to increase flow rate proportion or decrease its open position to decrease flow rate proportion (or conductivity for salt concentrates, etc.).

Once the second valve adjusts its position in pursuit of the desired blending parameter, the blending pressure is affected. In response, the first valve will adjust its position in the opposite direction. Thus, the two control valves are independently controlled, but they respond to one another. This is the first step toward achieving full control over a binary blend feeding a liquid chromatography process, the next step will be described in detail in our second piece addressing this topic.

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Questions?
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Achieving full control over a binary blend feeding a liquid chromatography process

Inline Blending Solutions Built For You - Part 2

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"The lobe pump, recirculating loop and backpressure regulating valve work together to maintain pressure.

Liquid chromatography processes typically require dilution or blending of constituents to achieve necessary mobile phase solutions. These solutions can be pre-blended – but inline blending is a more efficient solution and can be accomplished by implementing a few clever control schemes in an automated system.

After implementing the independently controlled equal percentage control valves – as described in the previous piece – the next step is to control the incoming process pressures of each of the valves. Processes might be fed by various sources, such as from a carboy/drum/bag, supply header, access point, utility transfer panel, etc. – and each of these sources can differ from one another in the pressure they supply to the chromatography equipment. More importantly, the pressure can vary over the course of a single batch and any kind of fluctuation can be detrimental to the automated blending system.

Fortunately, there is a solution to this problem – a booster module, added in front of each control valve, that can supply a specific and consistent pressure. While the addition of these modules will increase footprint, maintenance and the burden on automation, the trade-off is critical protection from outside disruption to help achieve reliable and repeatable operation.

Each booster module comprises three elements that work together to maintain pressure:

- Since they use a mechanical seal, lobe pumps must be primed prior to operation; but once primed, they are able to provide a consistent, high flow rate from a relatively small pump head.
- The second element is a recirculating loop. Fluid splits between the control valve and the recirculating loop after passing through the lobe pump, which must be operating at enough speed to ensure there is flow along two paths. Some of the flow will move through the valve to become part of the blend while the rest passes around the recirculating loop back into the suction side of the pump. This configuration ensures that the control valve receives a constant supply of process fluid.
- The third element is a backpressure regulating valve, situated in the recirculation loop – the flow heading back to the lobe pump's suction side passes through this regulator. Adjusting the set point controls the pressure entering the regulator, which is the same as the pressure discharged from the pump. It is also essentially the same as the pressure entering the control valve. Thus, the backpressure regulator allows control of the control valve's supply pressure. Any fluctuations in the supply line are absorbed by the booster module if the supply lines remain primed, and the pressure that enters the control valve is not only consistent but also controlled to a desired set point.

Uniting all three of these elements to produce booster modules will protect against disruption from disparities or fluctuations in fluid supply pressures. At the completion of this critical step, full control over the binary blend feeding into liquid chromatography process should be achieved.

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