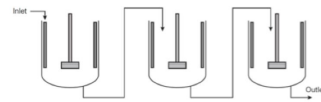


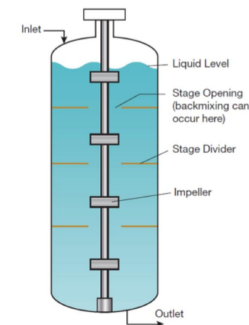
Continuous Flow Reactors

Ideal continuous flow reactors are generally considered to be either plug flow or backmixed. The closest physical embodiment of a plug flow reactor is a Static Mixer® unit in a pipe. However, the very high cost of such construction per unit of reactor volume makes its use cost-prohibitive for all but very short residence time applications.

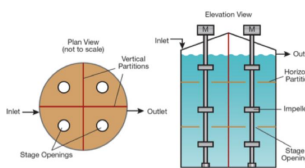
More commonly, a backmixed reactor is used. To reduce retention time required, and thus total reactor volume, usually there are multiple stages used. The simplest embodiment of a backmixed reactor is an agitated tank, and a multi-stage reactor can consist of agitated tanks in series:



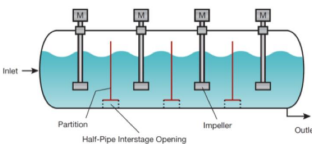
The above arrangement requires one agitator and one tank for each stage. It is possible to reduce capital and operating costs by compartmentalizing a single vessel, allowing the use of one agitator with multiple stirrers. This arrangement is often referred to as an agitated column:



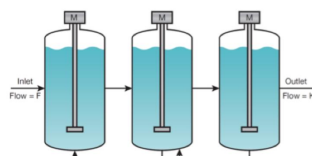
Very large tanks can be compartmentalized both horizontally and vertically:



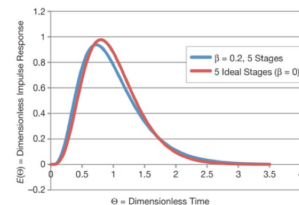
Horizontal tanks can be compartmentalized as well:



Many other configurations are possible. All reduce capital and operating costs compared to discrete tanks in series. However, all such arrangements permit a certain amount of backmixing between stages, which reduces stage efficiency. A key measure of backmixing is called the backmix ratio, β , which is the ratio of backmix flow to process feed flow. A good way to model a staged reactor with backmixing is to treat it as ideal backmixed reactors in series with recycle between stages:



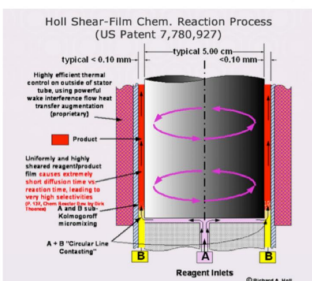
Backmixing affects residence time distribution (RTD) and reaction conversion. An illustration of the effect of backmixing on RTD is shown below, comparing 5 ideal stages to 5 stages with a backmix ratio (β) of 0.2:



Balancing the mixing and the backmixing in such designs is the key to success in continuous flow reactions. Beutect can help you with this.

The previous illustrations are courtesy of Chemical Engineering Progress, and were used in part in "Designing Multistage Agitated Reactors", G. Berra, Chemical Engineering Progress, January 2014, pp 30-34.

If your reaction is fast but is heat or mass transfer limited, or is selective, a novel reactor scheme should be considered. It consists of blending with a shear film in Couette flow. Reaction speed and conversion are very high compared to conventional reactor design for fast reactions. The basic elements are shown below.



Beutect is a representative of the manufacturer of the above equipment, Holl Partners, LLC. Contact us to see if your reaction would be a good candidate for such a system!