stamixco **Plug Flow Reactor Static Mixers**

This is a Temporary Brochure – Final Brochure in progress

Plug Flow Reactors for Viscous Materials

Tubular reactors filled with static mixing elements are often used as plug glow reactors for viscous materials.

Figure #1: GX static mixer used in plug flow reactors for viscous materials.

Figure #2: Typical layout of a skid-mounted small diameter long residence time static mixer plug flow reactor.

Principles of Operation

In the production of viscous polymeric materials, it is often desired to operate continuously in order to eliminate batch-to-batch variations and produce a consistent product at all times. There are many equipment techniques employed to achieve continuous operations such as with the use of extruders, cascades to stirred tanks, scraped surface reactors, etc.

The typical process goals of a continuous reactor are that the exiting product be homogeneous with regard to molecular weight, degree of reaction achieved, viscosity, temperature and other chemical and physical properties. For this to be achieved, all the material within the reactor must be well mixed and have the same residence time (plug flow).

A tubular reactor is a fundamentally simple continuous reactor where there are no moving parts other than pumps that deliver the reactants. Unfortunately, an empty tube is not suitable as a viscous material chemical reactor. However, the addition of GX static mixing elements inside the tube provides the ideal conditions of radial mixing and near plug flow necessary to perform chemical reactions.

Radial Mixing:
In an empty pipe, viscous material in laminar flow will exhibit no radial mixing (Figure #3-top) where material will exit the pipe in virtually the same position as where it was introduced into the pipe. Addition of GX mixing elements in the same pipe will create a high degree of radial mixing (Figure #3-bottom).

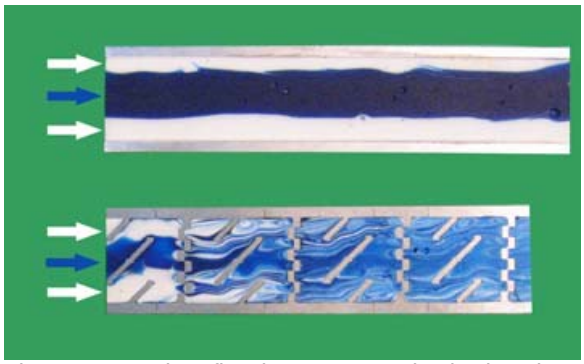

Figure #3: Laminar flow in an empty tube (top) and through a GX static mixer (bottom).

Plug Flow:
In addition to excellent mixing, continuous reactors require plug flow conditions which means that all the material processed through the reactor has the same residence time. An empty pipe is a poor continuous reactor because the material in the center of the pipe travels at twice the average velocity resulting in poor plug flow characteristics (Figure #4 and #5). Due to poor empty pipe plug flow characteristics, material in the center of the pipe will exit only partially reacted where the first material break-through is at 0.5 of the overall residence time (Figure #5) while material at the wall will still not have exited at 2.5 residence times (Figure #5). The addition of GX static mixing elements in a pipe dramatically improves plug flow characteristics (Figure #4 and #5).

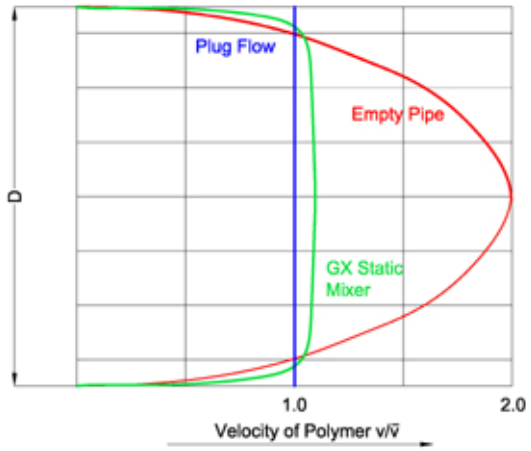

Figure #4: Velocity profile in an empty pipe (red), GX static mixer (green) and Ideal Plug Flow (blue)

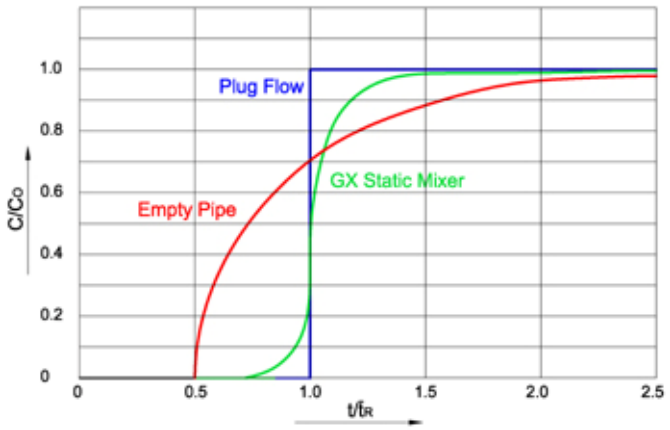

Figure #5: Step Response Curve for Ideal Plug Flow (blue), GX static mixer (green) and Empty Pipe (red).