

In-line Solids into Liquids Mixing: Capitalizing on Lean Manufacturing Concepts

The concept of Lean Manufacturing has been growing in popularity in the manufacturing world for the past several years. Driven by several factors including a slowing U.S. economy, rising costs of input materials, an increase in rationalization of production facilities, and the influx of inexpensive products from overseas, manufacturers are embracing the premise of Lean Thinking to ensure their own survival.

Liquid Processors have been especially susceptible to these external forces. Rising material costs coupled with cutbacks in engineering resources and overloaded work schedules have manufacturers turning to their equipment suppliers to help them develop and implement processes that take advantage of the benefits that can be derive from implementing the principles of Lean Manufacturing.

In this paper, we will review the concepts of Lean Manufacturing and some solutions that are readily available to help manufacturers achieve the benefits of this concept.

What is Lean Manufacturing?

Lean manufacturing is a generic process management philosophy derived mostly from the Toyota Production System (TPS). James Womack, in his book entitled *Lean Thinking*, identifies five basic principles of lean manufacturing¹

- Understanding Customer Value. Only what your customers perceive as value is important.
- Value Stream Analysis. Once you understand the value that you deliver to your customers, you need to analyze all the steps in your business processes to determine which ones actually add value.
- Flow. Instead of moving the product from one work center to the next in large batches, production should flow continuously from raw materials to finished goods in dedicated production cells.
- Pull. Rather than building goods to stock, customer demand pulls finished goods through the system. Work is not performed unless the part is required downstream.
- Perfection. Elimination of waste from the process and flow product continuously according to the demands of your customer reduces time, cost, space, mistakes, and effort.

The National Institute of Standards and Technology Manufacturing Extension Partnership's Lean Network summarizes the definition of Lean Manufacturing as:

“A systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection.”²

Process equipment manufacturers can help manufacturers realize the benefits of Lean Manufacturing by providing solutions that promote one or more of the five principles. Single pass, in-line mixing of powders into liquids is one such solution.

Traditional Mixing Methods

In traditional mixing methods, the addition of powders to a liquid process is generally directly to a vessel with some type or combination of mixing devices in the vessel. Addition is accomplished by 2 common methods:

- a. Manual bag dumping directly to the vessel. This method is a slow process requiring transport of bags to the top of the vessel, usually on pallets. This method creates several health and safety risks. First, the operator is exposed to vessel vapor head while dumping the powders into the tank. Secondly, the operator must lift and dump bags increasing the potential for injury. And finally, contamination of work area with powder during this process creates a risk for all working in the area.
- b. Conveying powders from some form of bulk storage (super sac, IBC, silo, etc) to the top of the vessel and adding the powders into the top of the vessel. Conveying methods could be a mechanical screw conveyor, or some form of pneumatic conveying. While this method offers a cleaner environment in the wet process area and safer environment for the operator, it does require additional equipment and the discharge area of conveyor to process vessel is prone to build-up, especially if the liquid process is hot (water vapor/steam)

While some of the issues with these methods can be mitigated through the use of various technologies, the major downside to traditional mixing can not. In traditional mixing, the addition of solids to the liquid surface creates inherent mixing problems

- a. floating powders
- b. formation of lumps
- c. air entrainment

This results in:

- o longer processing times
- o waste material from build up on walls
- o vessel cleaning requirements
- o filtering requirement downstream of batch

Single Pass, In-line Powder Dispensing into Liquids

Single pass, incorporation of powder capitalizes on the benefits of in-line processing. In-line processing is the introduction of the powder phase into the liquid phase at some point in the process piping². In-line mixing can be achieved by various methods: a device located in the pipeline between two vessels, in the water fill line leading to a batch tank, in a re-circulation loop with a tank, or simply part of a continuous processing line where there are no tanks.

Where single pass, in-line powders into liquids mixing excels is in its ability to control the introduction of powders and apply only the amount of shear necessary for the specific behaviour characteristics of the powders. This is accomplished without the need to set-up the powder dispersing device in a re-circulation loop with a tank. Many of the issues raised with in-tank mixing can effectively be prevented.

Example of Single Pass, In-line Powder Dispersion Quadro Ytron ZC Technology



Single Pass, In-line Powder Dispensing into Liquids yields several significant benefits and in doing addresses two of the principles of Lean Manufacturing – Flow and Perfection.

Flow

- Reduces batch times - no waiting for the wetting of floating powders. Powders can be introduced and dispersed into the liquid during the filling operation of the vessel
- Reduces equipment requirements in two ways. First, a single in-line device can be used to feed a number of batch tanks. There is no need to marry a high shear mixer to each and every process vessel. Second, the need to install expensive de-aerating devices is avoided no tank vortexing

- occurs. This results in significantly less air being entrained in the process fluid.
- Reduces energy requirements - the energy applied is focused on the task at hand – at generating uniform, lump free dispersions. No energy is wasted on trying to re-circulate multiple passes of fluid through an in tank dispersing mechanism.
 - Reduces downtime - Single pass, in-line processing eliminates build-up on the tank wall, mixer shaft, and baffles. This reduces tank-cleaning time, lowers the chance for cross contamination, and virtually eliminates ingredient waste.

Perfection

- Consistent product. Repeatable processing, batch-to-batch
- Elimination of over processing to remove lumps. Very important when dealing with heat or shear sensitive products
- Eliminate/reduce filtering. Poorly mixed products require filtering to remove inconsistencies from the product. By eliminating or reducing the need for filtering the final product is more uniform in nature ensuring the customer receives the same product on a continuous basis.

In summary, Lean Manufacturing can provide some real, tangible benefits to manufacturers today. Single pass, in-line processing can help manufacturers realize some tangible benefits in the form of savings through the elimination of waste, downtime, long batch times and excessive energy costs while producing a consistent product the first time. These savings, combined with the other principles of Lean Manufacturing, will help manufacturers compete in the global market and survive in these trying times.

¹ Womack, James P. and Daniel T. Jones, Lean Thinking, Simon and Schuster, New York, NY, 1996

² Stephen Russell-Hill, P.Eng., The Better Way to Mix Solids into Liquids, Chemical Engineering, November 2004