WHITE PAPER

Continuous Mixing vs. Batch Mixing: Payback Considerations

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INTRODUCTION

As continuous mixing and other automated mixing processes continue to gain favor in the United States and abroad, a growing number of bakery operators are trying to determine which mixing system is best suited for their specific operation.

Continuous mixing systems almost always have a higher initial cost than batch mixing. This is because the raw materials entering the continuous mixer must be metered, which requires ingredient feeders. On the other hand, cost of operation and ownership is almost always less expensive with continuous mixing. So, where does the payback occur? Continuous mixing payback opportunities come from a number of different sources including increased yield, increased throughput, increased consistency, reduced manpower, reduced downstream handling equipment, and reduced energy.

YIELD

Yield is defined as the pounds of product shipped per pound of flour purchased. While this seems to be a simplistic concept, one must consider the implications in more detail to understand the significance of knowing your yield. This is because yield takes into account all forms of waste from recipe error to loss of product due to downtime, to packaging inefficiencies, to raw materials specification. While one would choose to track all of the above sources of loss, yield is the ultimate scorecard. The second equally important measurement is efficiency, defined as average pounds of product produced per hour.

Yield is the best way to compare plant-to-plant, shift-to-shift, and day-to-day, yet many companies do not track it. Even a slight increase in yield can represent a significant savings. Imagine if you could generate just one-half percent more products without additional cost.

So, how does yield relate to continuous mixing? The single biggest payback opportunity for continuous mixing is increasing yield due to a more consistent process involving less human intervention and just-in-time mixing. The best way to demonstrate and quantify the savings is by determining before and after yield. Improvements of one percent to two percent are common, but improvements of five percent have also been seen.

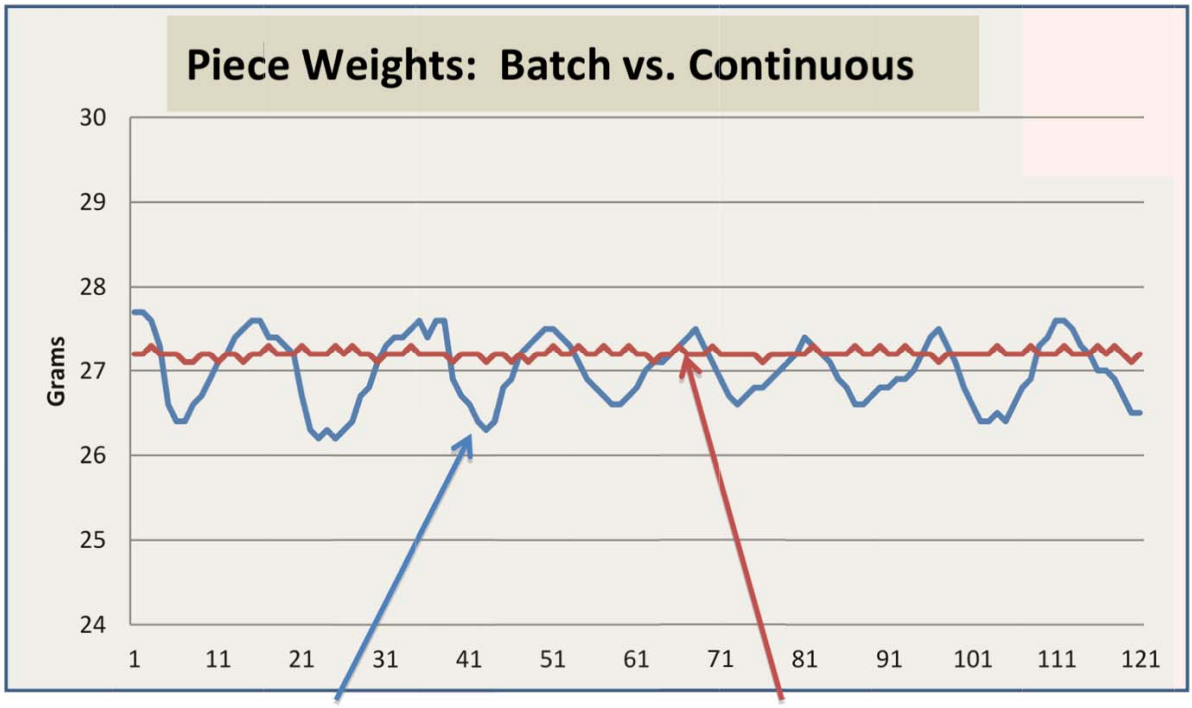
CONSISTENCY

While continuous mixing of dough is readily credited with operational and cost advantages, many bakery operators also select continuous mixing based on the promise of increased product consistency and quality.

A recent study looked at two side-by-side production lines -- the only difference between them was that one line was supplied by a continuous dough system, while the other line was supplied by a batch system. Both lines produced the same small snack products from low-pressure extruders. This arrangement allowed the dough consistency to be determined by measuring the piece weights.

Consistent dough would extrude consistently and make consistent piece weights, while inconsistent dough would vary the flow of the dough through the extruder die resulting in varying piece weights. The trial was conducted for one hour on each line. Each weight sample consisted of 20 pieces and a sample was taken every 30 seconds.

As the chart below indicates, the continuous dough production line delivered much more consistent dough. Worth noting is that the wave curve made by the batch mixing weights mirrored the frequency rate of the batch mixing itself.



Variations in Batch Mixing Weights ***Variations in Continuous Mixing Weights***

Note: 120 samples each taken over one hour.

This variation may seem slight when weighed at the individual piece level, but when this variation represents the variation across the width of the production baking band – and over time – it becomes clear that this can add up to large deviations for the rest of the equipment. In particular, the oven may not be able to maintain an even heat balance as it removes moisture from the product. This will impact not only the quantity of fuel used over time, but the product quality itself since the consistency of the heat transfer will impact the type of product characteristics most often measured by consumers.

Creating dough in discrete batches will always introduce slight variations from batch to batch. While these may seem manageable they will always lead to inconsistency over time. Trying to manage quality while chasing these variables will add to the already higher and ongoing labor cost of batch mixing. On top of the inherent variation introduced by the mixing process itself, batch mixing implies that the batch of dough will spend some amount of time waiting to be processed after being mixed. The dough will change over that period of time due to aging, environmental conditions, and the interactions of the

dough ingredients. The consistent frequency of the ‘peaks’ in the batch-mixing chart suggests when these times occurred.

Continuous mixers can represent a significantly higher initial capital investment, but over time they require much less labor to operate and clearly show a greater consistency even at significantly higher production rates.

THROUGHPUT

Throughput is also another important consideration for payback. This is because of the relation between equipment cost and throughput. In the case of batch mixing, there is a linear relationship between throughput and equipment cost. If you double the throughput requirement you will typically double the equipment cost.

On the other hand, when doubling the throughput requirements for a continuous mixing system the cost will typically increase in the range of 20 percent. This is because the feeding equipment remains almost the same cost no matter the rate. As a result, as throughput requirements increase continuous mixing becomes easier to justify versus batch mixing.

DOWNSTREAM EQUIPMENT REQUIREMENTS

It has been stated here that continuous mixing is more expensive than batch initially because additional upstream equipment is required to meter ingredients at a constant rate. It should also be noted that at least some of the cost is offset by the fact that generally less downstream equipment is required with a continuous mixing system.

This is an often-overlooked point for cost comparisons of batch to continuous mixing. The batch mixer makes large “batches” of dough. Because these large batches are not in a usable form, additional equipment must be purchased to resize the batches. In addition, the resizing of the dough can result in time delays in the use of the dough, additional shear due to added handling and unnecessary environmental exposure where contamination can occur. The result is additional risk, costs and variation to the product.

However, with continuous mixing the dough exits the mixer in small chunks (generally 15 to 50 pounds) depending on the mixer size. These loaves can easily be moved to the downstream equipment on a conveyor. This means no troughs, no transfer pumps and no chunkers. The elimination of the downstream handling equipment also significantly reduces the time required to clean such equipment. This is particularly important during an allergen wash down.

MANPOWER

Savings in manpower with continuous mixing is often a primary factor in justifying an equipment purchase. Generally, one operator can perform any and all tasks associated with a continuous mixer

regardless of the throughput. In addition, the operator can usually also be responsible for other tasks. It is reasonable to assume continuous mixing requires one-half man per operation.

The question that is more difficult to define is how many persons are involved in a batch mixing operation including handling of the dough after the mixer. Plant management will almost always underestimate this number due to the many tasks an operator must do in a batch operation that aren't required in a continuous operation. For a high-speed line it is not unusual to see three persons per shift, per mixer involved in the mixing operation.

ENERGY SAVINGS

Less energy is required with a continuous mixer for a number of reasons. Generally, an operation can expect to save $25,000 per year per 5000 pounds of dough an hour being mixed. By saving energy, you are also having a positive effect on the environment.

In a side-by-side comparison – mixing the same dough type in the same plant for the same time period – a continuous mixing system demonstrated far less energy consumption during production conditions.

Mixer Type:	Batch	Continuous
Production	Hamburger Bun Dough @ 8,000 lbs. / hr.	
Production Time	60 minutes	
Number of Samples	361 (every ten seconds)	
Highest Recorded Energy (95% percentile)	146,059 watts (139,600 watts)	64,240 watts (60,600 watts)
Average Energy Reading (μ)	75,685 watts	57,481 watts
Median Energy Reading	100,000 watts	57,400 watts
Approximate Energy Used	29,560,000 watts	20,867,400 watts

Mixer Energy Consumption Comparison

Please Note: The chart shows the exact readings measured at the mixers, but is arranged to represent typical production energy use over time.

Each mixer's energy consumption was sampled at ten second intervals over the course of an hour for a total of 361 data points. The continuous mixer recorded approximately 29 percent less energy used during production, but had the same product yield. The median energy reading was over 42 percent less for the continuous mixer.

PRODUCT ASSURANCE

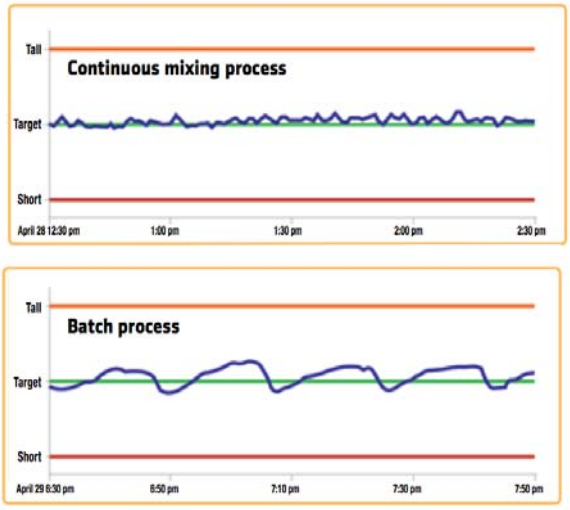
Product assurance is a soft cost that must be considered. How often is reworked dough added to the mixer? How often are products shipped when an error in recipe went undetected? How many raw materials are lost due to this? These are the soft costs and problems that are eliminated with continuous mixing.

Also consider the soft costs of variations in product quality. Batch processing can be inefficient and lead to variations in dough, which can impact quality. Continuous mixing solves these problems by providing a consistent, uniform dough stream to your production line at the same rate that it is being used.

The thorough mixing action of continuous mixing systems quickly develops strong bonds in gluten strands. Peak development and consistent delivery of dough at the optimum temperature is achieved through a precise combination of speeds in the mixing and developing sections of the system.

The results in the graphs below illustrate the improved consistency of bun color and height delivered by continuous mixing compared to batch mixing. Numerous additional variables were measured and all showed similar improvements.

Bun Height



Bun Color

CONCLUSIONS

It is not possible to offer an exact payback for a continuous mixing purchase without a full understanding of a company's operation and philosophy. Are high level, hard workers available in your area? What is the value of your product? What is the value of your ingredients? How robust is your product to process inconsistencies? But there is no question you will find continuous mixing better for higher quality products and the lower cost of operation and ownership option.

Jim Warren is vice president of Exact Mixing for Reading Bakery Systems. To learn more about the advantages of continuous mixing and decide if it is right for you, please call him at (01) 610.693.5816 or email at: jim.warren@readingbakery.com.

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