Automatic Yeast Pitching Control Using Cell Counting

By H.A. Teass, Jr.
McNab, Inc., Mount Vernon, NY, USA.
This poster was originally presented at the MBAA 112th Anniversary Convention, Keystone, Colorado, 1999.

ABSTRACT

Yeast pitching to start the fermentation in a mid size brewery is often a manual process involving assumptions of uniform distribution of yeast in the supply tank, as well as manual calculation of quantity of yeast required, and manual control of the transfer pump. In this work, a packaged/skid-mounted unit is used to transfer the correct number of cells for a given batch size.

Components of the skid include a McNab HSA4 in-pipe cell counter, a magnetic flow meter, and a controller (or logic) unit. The existing brewery pump and hardware are used. An accessory laboratory meter (CLB) may be used to verify accuracy.

The brewer enters the number of gallons of standard yeast required for the batch size, and the skid turns on the transfer pump, counts the number of cells transferred, makes continuous “on the fly” corrections in the calculation, and turns off the transfer pump when the target is reached.

In this installation, the skid replaces the former volumetric method of measurement, correcting for variations in yeast concentration. Measurement of actual cells/ml in the fermenter at the start of fermentation shows a substantial reduction of variation in cells/ml at initiation of fermentation.

Keywords: Yeast Pitching Control, Yeast Pitching System, Yeast Particle Counting, Automatic Yeast Dosing

SINTESIS

El proceso de arrojar la levadura para empezar la fermentación en una cervecería de mediano tamaño es frecuentemente un producto manual que involucra suposiciones de que la distribución de levadura es uniforme en el tanque de abastecimiento, así como el cálculo manual de la cantidad de levadura requerida y un control manual de la bomba para transferir. En este trabajo, una unidad skid/empacada es usada para transferir el número correcto de células para una remesa dada.

Los componentes del skid incluyen un contador de células McNab HSA4 en pipeta, un medidor de flujo magnético y una unidad controladora (o lógica). Se usan el equipo físico y la bomba existentes de la cervecería. Un medidor de laboratorio accesorio (CLB) se puede usar para verificar la precisión.

El cervecería marca el número de galones de levadura estándar requerida para el tamaño de la remesa y el skid prende la bomba para transferir, cuenta el número de células transferidas, hace correcciones continuas de la calculación durante el proceso y apaga la bomba para transferir cuando se alcanza la meta.

En esta instalación, el skid reemplaza el método volumétrico de medición anterior, corrigiendo las variaciones en la concentración de levadura. La medida de las células actuales/ml en el fermentador al inicio de la fermentación muestra una reducción sustancial de la variación de células/ml al inicio de la fermentación.

INTRODUCTION

The yeast delivering pump that was in place at the Alaskan Brewing Company operated based on the time that was necessary to deliver a pre-determined amount of gallons carrying a certain amount of cells/ml. The cells/ml in the slurry were measured in the laboratory and number of gallons of slurry that were needed to introduce the correct amount of yeast was calculated. After that was determined, the pump would run for the calculated period of time at a certain flow rate, theoretically moving the appropriate amount of slurry gallons into the wort stream, and then the fermenter. Adjustments were made for percentage of live cells.

The management at the brewery believed that if they could improve pitching accuracy by at least 500%, improvements in operational efficiencies and product quality would be easily attainable.
OBJECTIVES

The Alaskan Brewing Company established a goal to improve its yeast pitching accuracy to a ±500,000 cells/ml range of target 95% of the time, subsequently improving efficiencies and increasing brewery productivity. Reaching this goal was expected to:

1. Prevent the development of off-flavors caused by high diacetyl levels
2. Enhance product assurance by removing the variability of the pitched yeast
3. Provide greater batch-to-batch uniformity
4. Reduce blending-off re-work due to out-of-spec pitched beer
5. Lower operational expenses by significantly reducing laboratory costs associated with slurry and pitched yeast analysis

The Alaskan Brewing Company sought to reach these goals with a system that:

1. Would cause a minimal interruption in production for installation
2. Would allow for pitching-rate variation to accommodate different brews

OTHER REQUIREMENTS AND PRECONDITIONS

There were several requirements beyond the ones mentioned above. The yeast pitching skid had to be completely sanitary, require a minimal amount of floor space, and not allow the introduction of contaminants by avoiding open handling of the yeast slurry (Figure 1).

A high emphasis was placed on avoiding any extra personnel’s attention and/or increasing the time required for fermentation by brewery management as well.

It was determined that the conventional method of pitching was no longer adequate if their new requirements were to be met. Typical volumetric flow and tank-yeast-level-change measurements require laboratory dilution (in measurement of cell concentration) calculations. Subsequent adjustment by laboratory measurements was deemed too inexact and costly.

In discussions elsewhere, the suggestion arises that the laboratory practice of measuring the cells and dilution is more difficult in practice than in theory. This difficult laboratory task occurs in a production environment, where, unfortunately, there is more work than time available.

PARTICLE COUNTING

The HSA4 cell counter replaced laboratory hemocytometer hand-counting that provides instantaneous cell counts in a zero to 2 billion cells/ml range (Total or alternatively, live cells counted; but note, for necessary correction to live cell counts, continuous cell size correction is suggested [see Cahill']). We have found a high level of correlation between ASBC hemocytometer measurements and the HSA4 cell counter in previous works. The HSA4 cell counter employs advanced optics, modern electronics and proprietary algorithms to provide real-time measurements (Figure 2). Likewise, to improve volume accuracy, a flowmeter is used.

Upon pump start-up, the total number of cells being delivered to the wort stream are counted and tallied (Figure 3). When the predetermined delivery amount is attained, the pump automatically shuts off (slurry delivery may be independently adjusted to match wort flow).

As Figure 4 shows, the yeast slurry enters on the left-hand side and passes through a hose into the Skid. Within the Skid, volume is automatically determined and yeast concentration is measured and computer-totaled. It is then moved forward into the wort line using the yeast slurry pump.

The Skid can also perform the same action as yeast delivery systems that incorporate load cells on slurry tanks. With additional processing, the signal from the load cells (instead of flow) can be used to determine cell concentration. Both methods, tank or flowmeter, will provide similar improved results.

The slurry cell count may also be verified by the Model CLB laboratory cell counter (See Figures 6 and 7).

LIVE CELL ADJUSTMENT

The viability condition factor may be obtained by yeast staining with methylene blue and running a live cell ratio (not count). See ASBC Yeast - 3. This gives the user a (manual) percentage factor pitching rate adjustment.
**FIGURE 2**
HSA4 measurements vs. actual yeast cells/ml \( r^2 = 0.973 \)

**FIGURE 3**
Skid controlled yeast transfer.

**FIGURE 4**
Yeast pitching skid.
As a live cell adjustment: suppose we determined (as total cells) that 128 “standard” gallons is our pitching setpoint. Note that this assumes 100% yeast viability. Where cell viability condition is found to be less than 100% (by laboratory or history), we may adjust the yeast pitched (setpoint) for this viability condition. For example, if it is determined that the actual viability yeast condition is 93%, a new setpoint adjusted for viability condition can be calculated as follows:

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\text{Setpoint (@ X\% viability)} = \frac{\text{original total setpoint gallons}}{X/100}\times \frac{100}{X/100} = \frac{100}{93} \times 128 = 137 \text{ standard gallons}
\]

The unit was installed in January 1999 and, immediately upon installation, the brewery met its requirements for the new demands for yeast target accuracy (Figure 7). At the end of April, it was determined that the new Skid system had met all of its objectives. The variability of the pitch was immediately reduced, and laboratory analysis was continued in parallel with the automatic analysis for verification only. At high cell concentration, it has become our belief that the cell counter provides a more accurate count than the hemocytometer method. The results are as follows:

A. Diacetyl levels were brought into a lower constant level and, with this technique and other operations, a reduction to new acceptable levels of diacetyl was accomplished.

B. There was a significant improvement, in some cases as much as 12 to 1, of the variability in the pitching amount.

C. Predictably, the goal of having batch-to-batch uniformity was accomplished. Additionally, pitching target rates could be adjusted to suit the specific needs if necessary.

D. There was reduction in the rework effort to blend off-specification batches, which would follow from “C” above.

E. Laboratory pitch set-up time was reduced by 90%; from approximately 6 hours per week to less than 40 minutes (limited to occasionally verifying the Skid pitching rates by hand), lowering operational expenses.

F. Production interruption was minimal, as wet testing was performed at McNab prior to the skid shipment (i.e., factory commissioning). Thus, no welding or complex installation was required. As the skid is not mounted in the wort line, installation merely requires hooking up hoses, resulting in no interruption in brewery operations. Reliability has been proven to be better than 99.9%.
CONCLUSION

The project at the Alaskan Brewing Company illustrates that a small- to large-sized brewery can more accurately pitch its yeast to a very high standard. It is a cost-effective method of accomplishing pitching that, in effect, eliminates the uncertain and time-consuming laboratory analysis of manually counting yeast cells. This results in high quality beer, greater batch-to-batch uniformity and lower operating expenses.

SUMMARY

The newly installed Skid-mounted Yeast Pitching System at the Alaskan Brewing Company has enhanced brewery performance, simplified laboratory requirements, and increased pitching accuracy.

The results were immediate and remarkable. The installation of the Yeast Pitching Skid improved the variability and the concentration of pitched yeast by a factor of more than 10 to 1.

BIBLIOGRAPHY


ACKNOWLEDGMENTS

The authors wish to express their thanks and appreciation to the individuals within their respective organizations—the Alaskan Brewing Company and McNab, Incorporated—who assisted in the design and development of the yeast pitching system and for the thoroughness of their efforts with respect to data acquisition and analysis for the purpose of this poster.