APPLICATION OF IN-PIPE YEAST COUNTING ANALYZER IN MEDIUM TO SMALL BREWERIES

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Descriptors

Yeast Pitching, Particle Counting, Yeast Pitching Uniformity, Diacetyl.

Summary

With regard to accurate pitching levels, the following requirements apply, which typically have not been met. This automatic pitching increases the performance of the brewery, simplifies the laboratory's requirements and increases the efficiency of the pitch. The new pitching system at Alaskan Brewing Company meets these requirements. Through careful design, the variability and the concentration of pitched yeast was improved by a factor of better than 10:1. This results in improved diacetyl concentration levels.

INTRODUCTION

The Alaskan Brewing Company in Juneau, Alaska, had a requirement to improve the yeast pitching. In order to meet its needs the pitching accuracy had to be improved by a factor of approximately 500%.

OBJECTIVES

The brewery's goal was to improve the pitching so as to meet a new standard of ±500,000 cells/ml for 95% of the time in its pitching system. This is done for the following reasons:

1. Reduction of off flavors caused by high diacetyl levels.
2. Quality guarantee by removing the variability of the pitching amount.
3. The greater batch-to-batch uniformity.
4. Reduction of blending off rework by out of spec pitched beer.
5. Cost reduction by significantly reduced laboratory fees in the analysis of the slurry and pitched yeast.
6. Pitching rate may be easily varied.

REQUIREMENTS AND PRECONDITIONS

Alaskan Brewing Company had several concerns. The pitching SKID must be, of course, completely sanitary, and introduction of contaminants must be avoided (open handling of yeast slurry). The floor space required by the SKID must be minimal. In no way must this SKID introduce an additional burden into the brewery by requiring extra operational personnel's attention or by an increase in time delay in the fermentation process. No production interruption by the SKID installation into the brewery could be allowed.

In order to meet these requirements, the conventional method of pitching was deemed not adequate to meet new requirements. With the conventional volumetric flow or by the yeast concentration level change in the tank, pitching adjustment was made by the laboratory dilution factor (in measurement of cell concentration and calculations). This subsequent adjustment by laboratory measurements was inexact and too costly.

It was noted that the yeast measurement by particle counter will give lower instantaneous cell values. The brewery had in place a yeast slurry delivery pump and it was run based on the time required to deliver a certain amount of gallons carrying a certain amount of cells/ml. In practice the laboratory would go measure the cells/ml in the slurry, calculations were made of how many gallons it would take to meet target, that was converted to in-pump operating time and the pump was started, yeast was delivered into the wort stream, and then into the fermenter.

PARTICLE COUNTING

In place of the laboratory yeast slurry (hand counting with a hemocytometer), a HSA4 was installed in the yeast pipe that would read 0 - 2 billion cells/ml total cell (or alternatively, live cell summary, Figure 1 - HSA4 v Hemocytometer). Likewise, in order to improve the pitching, a flowmeter was installed. On command, the pump would be turned on, the total number of cells being delivered to the wort stream would be counted "on the fly" and tallied (See Figure 2) and, when the predetermined delivery had been accomplished, the pump would automatically be turned off (slurry delivery can be independently adjusted to match wort flow). You can see by the illustration how this is accomplished (see attached Fig. 3-Yeast Process Skid). Yeast comes in the left hand side and passes through a hose into the SKID, its volume is measured, its concentration is measured and, with a computer, totalized. Then, using the yeast slurry pump, it is moved forward into the wort line and then into the fermenter.

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For those yeast systems incorporating load cells on slurry tanks, the SKID could have the same effect. With additional processing, weight information could be used from the load cells' signal (in lieu of flow) in order to determine the volume delivered. Thus cell concentration can be determined. Either method (tank or flow meter) would arrive at the same improved result.

INSTALLATION

The unit was first installed in January 1999 (see photograph of the SKID in operation) and, as of the end of April, the new system has met its requirements for the new demands for yeast target accuracy (See Figure 4). In other discussions it is suggested that the laboratory practice of measuring the cells and dilution is a more difficult one than first imagined. This difficult laboratory task occurs in a production environment, where there is more work than time available.

RESULTS

Immediately upon hook-up, the brewery fully met its objectives. The variability of the pitch was immediately reduced (see Figure 4-Yeast Pitching Rates). Laboratory analysis was continued in parallel with the automatic analysis for verification only. We have now come to believe that the cell counter provides a more accurate count than the hemocytometer method. The results are as follows:

(A) Diacetyl levels were bought 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) Therefore, the next goal of having the batch-to-batch uniformity was accomplished. Pitching target rates could be adjusted to suit the specific needs as necessary.

(D) There was a reduction in the rework effort to blend off in these off specification situations which would follow from "C" above.

(E) Cost of production in laboratory hours was reduced from approximately 6 hours per week down to 1/10th of original (limited to occasionally verifying the Skid pitching rates by hand); so that, in effect, the production cost decreased as pitching did not consume the laboratory time (to set up pitching parameters).

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(F) What was not apparent [but resulted because of prior wet testing done at McNab on the system (e.g., checkout and commissioning done at McNab)], was that there was no welding, no complex installation (the installation of the Skid was ultra simple as it is not mounted in wort line and entails just hooking up hoses), resulting in no start up interruption in the operation of the brewery. The result of this design has been a continuous flow of beer and the pitching rate is now under control.

CONCLUSION:

This project demonstrates that a small to large size brewery can more accurately pitch its yeast to very high standard. It is a cost effective method in accomplishing pitching and that it, in effect, eliminated the uncertain and time-consuming laboratory analysis of manually counting yeast cells . This resulted in high quality beer.

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QUESTIONS:

Following are questions posed to Mr. Teass after his presentation:

1) Q: What about the cleaning? Is it included?

A: The system may be thought of as a twenty foot stainless steel tube and as such it's easy to clean; likewise, the sensors for the flow meter as well as for the optical cell counter. Sensors are CIP proof and, for that matter, steam proofed. So, fundamentally, the techniques used to sanitize the slurry feed pump are appropriate to the SKID.
See:

[1] "Hygienic equipment design criteria"

[2] "Hygienic pipe couplings," TRENDS IN FOOD SCIENCE & TECHNOLOGY

2) Q: Micro control to avoid contamination?

A: Crevices and the like are to follow strict sanitary requirements, avoiding o-rings and to include FDA gaskets and food finished stainless steel.

3) Q: Viscosity vs. Cells counts (cells/ml)?

A: Viscosity is not an optical quality (cell counting). Instruments used here are optically based so that viscosity does not act as an interference to cell counting. Other non-optical systems do have viscosity as an interference and make the performance less than what is desired.

4) Q: Please give a name or reference of breweries that are using the system?

A: As mentioned in the paper, Alaskan Brewing Company is a happy user of the SKID system.

5) Q: What is a small brewery? The maximum output is?

A: When you think about small breweries you think about the yeast slurry line being 1" or 1.5" or 2". That would define the size of the brewery and the maximum output.

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6) Q: Comment on live and dead cells.

A: Total cells are measured optically. Live cells are measured by a capacitance meter. As the total of cells and live cells often vary close one to another and track well with one another, a percentage factor can be cranked into the total cell system to give a good live cell value, particularly considering the fact that methylene blue (that technique used to assign a percentage of live cells and total cells) has questionable accuracy. See "The Use of Methylene Violet Staining Procedures To Determine Yeast Viability and Vitality," by Katherine A. Smart, Oxford Brookes University. The vitality issue may be more important in top fermenting yeast with the difficulty of separation of dead from live than from bottom fermenting. In any case, if the brewer records indicate that the percentage of live cells varies substantially, they ought to consider incorporating a live cell counter.

7) Q: Measuring particle size (count) on dark product.

A: The particle size for yeast is considered about five micron and protein 1/10 of that. In-line particle size analyzers are successful when the concentrations (either large or small particles) are very light and thin. So in a case such as Guinness Stout, with both high color and with high particle levels, conventional wisdom has it that particle sizing cannot be determined without independent dilution down to an appropriate level for the instrument. This may be done on line via an in-pipe sensor.

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