Troubleshooting the Plant Process

By Garth Whiddon and Steve Westra

A primary challenge facing ethanol plant managers is getting the most out of their facility. As a result, vendors are often called upon to assist in diagnosing problems and offering potential solutions.

Ethanol Technology uses a consultancy approach in partnering with operating facilities, as it allows us to thoroughly investigate sources of problems and offer real solutions. Troubleshooting all parts of the plant's processes is the key aspect of this approach. If the plant is not running consistently, the loss of ethanol—and ultimately profit—will result.

The continued growth of the ethanol industry presents an interesting dilemma, for as each new plant starts up, the amount of applicable technical experience is diminished throughout the industry, putting the burden of troubleshooting on outside influences. A partnership between select vendors and a production facility benefits both parties. To best enable representatives to perform this role, Ethanol Technology recruits experienced plant/process professionals. This allows the on-site technical representative to add true value and the facility need not rely on scheduling technical support from a corporate office. Being able to troubleshoot all areas of the plant is important, and applying that knowledge is key in solving the myriad issues that operating facilities see everyday.


Westra

Two types of issues are related to troubleshooting: transient and chronic episodes. Transient episodes relate to individual or short-term issues while chronic episodes relate to long-term issues that are identified through baseline trending analysis.

A primary function of a consultative relationship with a plant is troubleshooting performance and its effect on plant yield and optimization. Fermentation, the only area of the plant that produces ethanol, is a specific troubleshooting area. While other areas, such as the breakdown of the substrate to fermentable sugars and distillation are important, if fermentation is not optimized, yield will be affected and the profitability of the biorefinery will be impacted. Unused sugars and low ethanol levels result in increased downtime for cleaning and maintenance, and a plant whose water balance is out of control.

Fermentation troubleshooting, although a science, can be thought of in simple terms. Is the fermentation environment conducive to optimal ethanol production? Are proper food and nutrition available in the environment? What outside influences or stressors can be affecting fermentation?

The following is a simplified way of examining these issues.

Environment

The fermentation vessel contains yeast, a living organism, which makes ethanol distilleries different than typical chemical plants. Since a living organism is relied upon to produce the final product, plant operators need to ensure that the environment provided for the organism allows it to flourish.

Processing parameters such as pH and temperature need to be monitored so that the optimal substrate is available for fermentation. This usually takes place in the cooking system. For example, if the pH is too high or too low, the yeast will be forced to use valuable energy to balance its own internal pH


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within the environment. If the operating temperatures are too hot, the yeast will die. Without yeast, the sugars will not be converted into ethanol, and the potential for contamination grows as the sugar is available for other organisms. If the temperature is too low, the yeast may become sluggish or go into a state of stasis, resulting in yield loss.

Nutrition

Proper nutrition is the key for yeast to be able to survive. The ethanol process requires yeast to switch from an aerobic (requiring the presence of free oxygen) to an anaerobic (living in the absence of oxygen) environment. Yeast can readily absorb glucose and maltose and produce ethanol at increasingly higher levels given the right environment. The process requires them to do this with minimal production of non-commercially beneficial byproducts such as glycerol.

Similar to a highly trained athlete, the yeast cell needs proper nutrition and food sources to perform properly. Glucose needs to be provided at a level that is neither too high nor too low as either extreme can cause the yeast to suffer. Proper nutrition such as nitrogen, amino acids and small peptides will help maintain the proper vitality and stability needed for optimal ethanol production within a fermenter.

Outside Stress Factors

Yeast, since it is a living organism, can be affected by outside stressors. These may include high organic acids and sodium levels, and the recycle effect of distillation upsets. If these outside stressors are not controlled, competition for glucose with other wild yeast strains or bacteria can result in yield loss.

Going Deeper

How should troubleshooting be performed? To start, we ask when the issue started, where it appears to be coming from, and how to best address it. The first step is determining if the issue is transient or chronic, since the troubleshooting method differs for each. The second step is identifying the issue causing the problem within the plant.

Transient issues may be as simple as one fermenter having a higher organic acid (lactic, acetic or succinic) peak than the other fermenters, glucose levels at drop increase or ethanol concentrations drop by 0.5 percent over the past week.

Transient issues impact individual fermenters and aren't usually seen on a 30-day trend. They typically involve one or two fermenters and are the result of process upsets or changes. We need to look at the short-term focus and determine when the fermenter started filling, what occurred during the fill cycle and how its corrected before the fermenter drops and production is lost.

An example is a fermenter that never begins converting glucose to ethanol, or stops conversion mid-cycle. We can usually look back and diagnose the cause as improper cleaning, failure to follow the plant's standard operating procedures, or a process upset that affected how the fermenter was filled.

Proper documentation of operating conditions is essential to troubleshooting. Without properly documented log sheets and records, it is unlikely the culprit will ever be found.

Chronic issues may be as difficult as low yield, slow fermentation and high residual starches. They are of a continual nature and may affect one or more months of production. To investigate chronic issues, a longer term focus is needed, beginning with a review of monthly and weekly fermentation and plant production trends. Chronic issues are usually the result of yeast stressors or lack of nutrition.

For chronic issues, a longer term focus is needed to determine the problem, when it started and how to correct it. Proper documentation gives the troubleshooter valuable information on when or how the problem may have started or what changes were made prior to its start.

An example of a chronic issue is a fermenter that is continually infected, causing lower ethanol and higher organic acid levels compared to the other fermenters. Reviewing trends can help determine when the fermenter started having issues and what occurred at the time.

Next, we need to examine and establish where the infection may be coming from. Using a fluorescence microscopy can be a simple yet effective investigative method to determining the problem's source.

The "how" is the simple part of the troubleshooting equation, and once the source of the infection has been identified, proper methods for alleviation are suggested and implemented.

Troubleshooting is a critical function of plant operation. With all of the facility's equipment and processes, it is essential that proper focus and methods are available to deal with the issues. Troubleshooting problems is invaluable to maintaining process consistency—the more consistent the process, the more likely yield will be maintained.

Troubleshooting can be one of the most financially and functionally rewarding activities in which a plant can be involved. The cost of doing nothing is always greater than the time and resources invested in solving the issue. EP

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