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Leveraging High Performance CIP Processes to Reduce Water Usage in the Beverage Industry

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ABSTRACT

The beverage industry around the world has been water-intensive, traditionally involving significant water usage, resulting in conflict over the viability of water sourcing vis-à-vis the respective surrounding ecosystems. Much of the usage has been related to the cleaning and sanitizing of manufacturing lines. With the advent of "clean-in-place" systems (CIP), it is possible to clean these lines in one minute in an environmentally friendly manner. This article discusses the use of advanced CIP to improve the beverage production process through reduction of water consumption, and how continuous improvement will assist in solving a critical problem in food manufacture. The legal ramifications of treatment of water with a concentrated food cleaner will be discussed, as well as an investigation of attaining and exceeding established regulatory standards.

Keywords: *Clean-in-place; CIP; Hazard analysis and critical control points; HACCP; Sustainability; Corporate social responsibility; Regulation; Water*

By its very nature, the beverage manufacturing industry is a significant consumer of water; water is a primary component in numerous beverages, including milk, soft drinks, juices, and beer and liquor. The consumption of water extends throughout the manufacturing process, including the cleaning of production equipment.

This consumption of water throughout the process presents a challenge, that is, the burden this consumption places on an ecosystem. The Uganda Ministry of Water and Environment (2015) reported that 82% of the nation's 28.4 million population lives in rural area. These rural areas have a safe water coverage of 65%, up slightly from its 2013 report. This population competes for water with various beverage manufacturers: UG Facts lists nine beverage companies, in addition to breweries that are a part of AB Inbev (Nile Breweries Limited) and Diageo (Uganda Breweries Limited). There is a recognition that it is in the best interest of the breweries to reduce water consumption: Nile Breweries has posted on its website, http://nilebreweries.com/sustainable-development/, that it has reduced its water consumption from 8 hectoliters of water per hectoliter of beer produced in 2006 to a current level of less than 3.6 hectoliters per hectoliter produced. Uganda Breweries Limited posts the Diageo Water Blueprint (2015), enunciating goals of reduction of water use through a 50% improvement in water efficiency, and return of 100% of water waste from its operations safely to the environment. According to Healy, that target for water reduction has been met, and efforts for further improvement continue. Interestingly a further goal of replenishing water-stressed areas with an amount of water equivalent to that used in the final

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product, through reforestation and improved farming techniques, among other initiatives, according to both breweries' respective websites.

Clearly, the amount of water as a component of the end product is a fixed quantity. This paper's focus is on a means of achieving water reduction in the manufacturing process, specifically, cleaning and sanitizing of production equipment. Traditionally, cleaning of equipment involved dismantling of equipment for thorough cleaning of components, in a process known as cleaned-out-of-place (COP). Stier and Cramer (2005) note that COP processes are utilized for equipment and utensils that cannot be cleaned where they are used and require disassembly, and for complex, hard-to-clean equipment. Clean-in-place systems (CIP) can be used to clean interior surfaces of tanks and pipelines of liquid and semi-liquid food. Cleaning is accomplished by circulation of detergent via turbulence, by use of a spray ball or spray. Bacteria and chemical residues are removed by circulation of a chemical cleaning and sanitizing solution. This solution can be circulated back into a reservoir, so as to allow for reuse of the solution, where appropriate. CIP systems may be single-use, multiuse, or reuse systems, depending on how often the solution is utilized for cleaning and disinfecting.

The use of CIP and COP are directly related to Hazard Analysis and Critical Control Points, or HACCP. Developed by the United States Food and Drug Administration over four decades ago to establish guidelines to keep food safe for astronauts (Food Engineering, November 26, 2005), HACCP is now codified at 21 CFR 117.135, and is now applicable to all commercial food manufacturing in the United States. The seven principles of HACCP are:

1. Identify the potential consumer health hazards;
2. Identify the control points when the identified hazards may occur;
3. Establish critical limits for the potential hazards and safety measures;
4. Establish monitoring routines to ensure safety measures are working;
5. Establish appropriate responses if monitoring indicates a problem;
6. Establish an accurate and detailed recordkeeping system that documents problems and remediation steps taken;
7. Establish a verification system to ensure steps are being followed.

21 CFR 11.10 *et seq.* allows for electronic recordkeeping. The World Health Organization adopted the HACCP standards in 1993.

These principles were developed at a time when COP was the most common, and often only, process available. While the merits of COP are recognized, there are drawbacks to COP: labor costs in dismantling and reassembly of equipment, as well as cleaning; lack of availability of production equipment during the COP process, and a lack of feasibility in storage and reuse of cleaning solutions. Further, if there is a problem, remediation will require a further COP, and perhaps lack of direct knowledge as to exactly where the problem occurred. This can easily lead to redundancy of cleaning and remediation with potentially inflated costs of labor and material; lack of accurate knowledge of the location of the hazard will necessitate a complete cleaning,

An attractive aspect of CIP equipment is that it is scalable. AXEON Water Technologies CIP systems, for example, vary in size based on the number of vessels to be cleaned in parallel. These units can also be portable, with caster wheels available from the manufacturer.

Further, Jude and Lemaire (2013) report that software advances allow for dramatic reductions in troubleshooting time in the event of a problem, and reduction of cleaning time by up to 20%. The reduction of cleaning time means that equipment will have correspondingly less downtime. The software also allows for instantaneous

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assessment of cleaning time and cleaning solution concentration, as well as post-cleaning levels, providing more accurate records for the Food and Drug Administration, and allowing the producer to pinpoint potential problems in a specific area of the machinery, rather than necessitating a complete teardown and thorough recleaning of the entire system.

Reduction of energy, water and chemical consumption can be significant. In a test facility with three silos, twelve tankers and a cream separator, DeLaval documented annual water savings of over 1.1 million gallons of water, based on 313 CIP cycles, the equivalent of the annual number of COP cycles from the prior year.

Given the potential advantages of the CIP process, the authors suggest inclusion of an eighth principle to the HACCP:

Establish practices to enhance sustainability.

For purposes of this paper, "sustainability" refers specifically to water sustainability.

The seven promulgated principles go to identification and correction of issues compromising food safety and quality assurance. Adding the sustainability principle to the list moves the business from the level of detected food safety compromises, into the realm of environmental improvement. This is in keeping with the definition of sustainability from the first Earth Summit, as referenced by HEC Global Learning Center (2009):

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

In short, sustainability has a forward vision beyond mere compliance with current standards, to improve the future. With this focus on the future, we look again to the initiatives of Nile Breweries Limited and Uganda Breweries Limited. In those initiatives, one sees this focus in the planting of trees and improved farming techniques. This latter initiative in particular also addresses the first goal of sustainability, that is, meeting the needs of the present, by improving the lot of farmers vis-à-vis cultivating their crops.

The principle of sustainability further addresses corporate social responsibility. Reidenbach and Robin (1991) identified five levels of corporate moral development:

1. Amoral;
2. Legalistic;
3. Responsive;
4. Emerging ethical;
5. Ethical organization.

A corporation at the legalistic level is focused primarily on rules and regulation, while the responsive organization recognizes the balance of rules and following a moral compass. At the emerging ethical level, the organization actively seeks a balance between ethics and profits (Reidenbach and Robin, 1991). Even at the legalistic stage, the benefits of a CIP system are apparent. Jude and Lemaire (2013) recognize several consequences in the event of mistakes or faulty processes that lead to injury, illness, or fatality:

1. Human tragedy;
2. The expense of product recalls;

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3. Loss of confidence in a company's brand;
4. Loss of revenue.

To this list, the authors would add the factors of the potential for civil lawsuits, government fines, and the potential for criminal sanctions. These, of course, will be dependent on the government involved and the locus of the harm.

Moving to these higher levels indicates that the organization actively seeks to benefit not only itself, but others as well. The authors believe that a focus on sustainability keeps an organization cognizant of its responsibilities to various stakeholders, as discussed by Mason and Simmons (2014). The beverage manufacturing industry has numerous stakeholders from the organization itself and its owners, to the government(s), its consumers, suppliers, and those in its ecosystem, to name but a few. A focus on sustainability recognizes these stakeholders, both now and in the future.

The challenge lies in leading the organization to acceptance of this higher level. There is still considerable debate as to the social responsibility of a business. Friedman (1970) famously stated that "(t)he social responsibility of business is to increase its profits." There is increasingly the viewpoint that a business's responsibility goes beyond its owners and maximizing their return on investment; more commonly, the view is that the responsibility of a business is to stakeholders. The Mckinsey Survey of 300 Chief Financial Officers indicated that two-thirds of those surveyed embrace the notion that corporate social responsibility enhances shareholder value.

Hong and Liskovich (2014) identify three economic channels as reasons to explain why corporate social responsibility is regarded as a valuable asset; each involves improving corporate image: signaling product market quality, delegated giving, in which consumers purchase a product because of goodness in the production function, and the halo effect (Nisbett and Wilson (1977)), in which one's judgment of a person's character can be influenced by one's impression of that person, without actual knowledge of that individual. Hong and Liskovich found that more socially responsible firms pay 40% less than the median fine for violations of the Foreign Corrupt Practices Act. A corporation that has not reached the emerging ethical level, but is at the responsive or even legalistic level should be able to recognize the value of corporate social responsibility, if for no other reason than corporate image. At the emerging ethical and ethical levels, the principles of sustainability should in and of themselves be an inducement to act in a responsible manner.

Conclusions

Advances in CIP have allowed for greater efficiency in the cleaning process for the beverage industry, with reductions in labor and supply costs, reduced downtime, and more effective detection of hazards, through metering and constant electronic monitoring of the cleaning process. The ability to reuse cleaning solutions enables the manufacturer to reduce water consumption, and a decrease in the necessity of neutralizing a solution prior to discarding it. The addition of a principle of establishment of practices to enhance sustainability to the seven existing principles of HACCP, coupled with increased recognition of the importance of social responsibility to the image of a business, will make the beverage manufacturer aware of the immediate and long-term benefits of adoption of a CIP process as a component of the manufacturing process.

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