"The Water Audit as a Strategic Tool to Manage Operational Costs and Performance"

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Food and beverage plants focus strongly on two objectives:

- Drive toward producing high quality product in an efficient and well-run production facility.

- Achieve this, while reducing/controlling costs and maintaining effective investment planning. The later includes investment avoidance where it is the best strategy.

There is also an interrelationship between the various processing systems in most food plants. The same careful planning that goes into plant processing and water treatment must include the financial costs and implications that these operations will have on plant effluent. High wastewater surcharges, or the need to construct a wastewater treatment plant, can often be eliminated or reduced, based on:

1) changes in the type water treatment technology used,

2) modifications to equipment operation and sanitation procedures, or

3) in addressing minimization and recirculation techniques.

An immediate parameter to establish when planning an audit is that such changes must improve quality and performance.

An alternative addressed in this paper is the use of production facility audits to evaluate and quantify the impact that plant water treatment technologies, and water management practices have on the following critical functions in a food processing and packaging plant:

Product Quality and Processing System Performance. Are we truly safe from all organic and inorganic risks associated with the water supply. Foods must have the product stability to withstand storage environments and maintain excellent shelf life quality. Water treatment technology must in itself resist fouling and avoid microbiologic vulnerability. A good audit will strive toward a

multiple barrier protection system for product water … and often a total plant barrier where a pathogen such as Cryptosporidium is even a remote possibility.

Water Consumption and Sewer Surcharges. Many plants pay for the water they use twice. Once when they use it, then again when they dispose of it to the drain. The main cost in disposal is usually the organic load in the water ... so simply reducing the volume of water has minimal effect. An audit can address changes that significantly reduce sewer surcharges, or establish a pre-treatment alternative to reduce costs by 50 % or more.

Avoiding Construction of a Plant Wastewater Treatment Plant. Food plants are seldom disposing of a wastewater that contains serious contaminants. Plant operating practices can often be changed so that the wastewater volume and loading are far from being classified as a serious contributor to a municipal system.

Our focus today is on water. We will focus on case studies that are primarily related to water treatment technology, with secondary impact on wastewater treatment and water reclamation.

- **What is an "Operational Audit":**

There are a number of ways to look at an Audit. It can be cast in the same light as a survey or a study. It can be an accounting of operational facts or it can be an audit with an ulterior motive.

That's the Audit we are discussing today … the Audit with an ulterior motive. The motive can range from "are we OK?" to "are we missing an opportunity to do this job better?" The Audit measures how the facility operates and identifies alternatives that either improve quality and performance, or keeps the operation within regulatory compliance. The Audit can be a trouble-shooting tool, or can target cost savings, or investment avoidance.

An Audit should not be a checklist and the use of observations alone. It must be data based. Individuals or a team that has process system expertise should perform the audit. They should also have knowledge of the plant's products, production standards, operating guidelines and start-up – shutdown protocols. Where relevant, testing at the site should be performed including analytic and microbiologic parameters.

- **The mind-set needed to manage a successful "Operational Audit":**

For any operational audit, the first requirement is to understand why you require an audit and what you hope to see as a result. Secondly, who, or what team, will perform the audit.

The mindset must have an attitude that says when we identify alternatives such as in saving water, we must do so with an **improvement** in system performance … more efficient production, enhanced assurance in protecting product quality, better operational control.

The Audit team, must be free to **challenge** standards and guidelines … they must be encouraged to think outside the box of conventional wisdom …

Observations and checklists can be valuable especially when they represent a new set of eyes, but a high impact audit will require much more detail and data.

Operational Audits …

Must **improve** system performance, quality and safety ...

Must be free to **challenge** conventional wisdom ...

Observations and checklists are not sufficient ...

- **Typical "Audits" and the need for a plan:**

Audits are designed to address specific issues or to measure operating parameters. Typical operational audits address these common issues related to plant operation:

Regulatory Compliance
Water Conservation
Selection of Water treatment Technology
Wastewater Characterization and Biodegradability
Selection of Wastewater Treatment Technologies
Reduction of Plant Effluent Surcharges
Cost Reduction / Cost Avoidance
Efficiency Improvement
Plant Safety
Sanitation

- **Three "Audit" case studies:**

Our three case studies will focus on Audits related to water treatment, wastewater treatment, water reclamation and plant operations.

Case Study 1.

Audit Scope:

Large multi-beverage plant in Europe

Seven production lines

Coagulation and Membrane (RO) technology for product water

Cation exchangers for softening water to be used in heat exchange equipment and for rinsing operations

Combination aerobic / aerobic wastewater treatment technology

Three Issues:

1. Performance difficulties with wastewater treatment, BOD removal not at normal high level

2. Regulatory compliance at that site required a discharge BOD5 of 20 mg/l plus wastewater to meet many drinking water parameters. The chloride level in the discharge from the plant was borderline high and heading up.

3. Water treatment plant contained 4 carbon purifiers, one of which was giving periodic chlorine carrythrough, even when the charges were changed.

Audit impact:

- Plant had changed to a new line lubricant that impacted wastewater biodegradability. Tests confirmed and plant switched to a more degradable product. No negatives.

- BOD5 reduction returned to performance level at 99% however reducing chloride level required two alternative approaches.

    1. RO water was used where not needed. This increased both the volume of water to the WWT plant and the chloride level of the wastewater.

2. Correcting this plus alternating between softened water and the use of complexed phosphates for some rinse water applications resulted in compliance. For the future the plant would use RO water were needed and nanofiltration or UF where this was preferable.

- Chlorine carryover was traced to an error in Carbon purifier design where insufficient freeboard was allowed for proper backwashing of the carbon. The result was channeling of the carbon bed. Solution was to remove some carbon, creating the proper freeboard, and running the unit at a proper design flow of 1 GPM/ft3.

Case Study 2.

Audit Scope:

Large food plant in the United States

Four production lines

No Wastewater Treatment Equipment – BOD5 to drain 2000 mg/l+

Membrane (RO) technology and support systems for production water

Water softening for water used in heat exchange equipment

Three Issues:

1. Substantial sewer surcharges and compliance issues leading toward a need for a complete wastewater treatment facility. Space and zoning limitations … new site being considered. Plant targeted as significant "user".

2. Concerned with microbiologic issues surfacing periodically in water treatment system. Water quality meets all specifications but servicing of system getting more critical.

3. Concerned with how various plant operation conform to regulatory guidelines.

Audit impact:

- Municipal and plant data was confirmed relative to BOD/COD loading and volumes discharged. Clearly the plant was discharging a safe and easy to treat wastewater which posed little concern to a

municipal authority. Surcharges are weighed heavily toward strength of waste (BOD5) and an alternative was identified to pre-treat the wastewater for a 50% reduction in BOD5 before discharge. Other options include changing plant procedures for using heat exchange waters and disposing of solids.

- Stainless steel carbon purifiers were to replace existing units that would not allow steam vapor sanitizing/stripping, nor hot water sanitizing. It is critical that carbon towers be in a vessel that allows easy to perform steaming and hot water sanitizing so that an effective protocol can be developed to assure micro control and reduction of the buildup of organic contaminants.

- Plant was excellently managed and in compliance with the regulation identified. Changes were initiated but most were cosmetic and addressed storm water runoff.

Case Study 3.

Audit Scope:

Large Beverage plant in South America

Six production lines

Coagulation Water Treatment Technology

Anaerobic Wastewater Treatment

Extensive sugar treatment process

Water softening for water used in heat exchange equipment and for rinsing requirements

Six Issues:

1. Cost of water extremely high. Reduction in water consumption critical. In addition, surface water supply poses quality and safety threat to plant.

2. Volume of wastewater and loading to existing anaerobic wastewater plant too great. Multi-million dollar expansion of system will be required.

3. Concerned with quality and inconsistency of incoming water supply despite complete treatment plant for product water.

4. Needed verification on risk free status of sugar treatment effectiveness (hot carbon process) and that bottle-washing operation is delivering a clean and completely sanitary bottle.

5. Use of paper labels was fouling their bottle washing solutions requiring frequent dumping of their caustic baths. These caustic solutions were as high as 3.5 % Sodium Hydroxide, with additives added for chelating and sequestering purposes. Huge impact on operating costs, and a potential quality issue.

6. Dumping of caustic solutions was adversely effecting anaerobic wastewater treatment plant despite neutralization. Concerned with how operation conforms to regulatory guidelines in a number of areas.

Audit impact:

- Audit confirmed that plant efforts on minimizing unneeded water usage had been highly successful and most processing systems were operating as designed including a number of improvements contributed by the plant engineering and maintenance staffs.

- Major usage of water was in bottle washing and rinsing. This area accounted for better than 50 % of the plants water consumption. It was also the main flow into the anaerobic waste treatment plant. A water reclamation system was installed, fully in accordance with compliance guidelines. Water usage was reduced by 75%. More important the washing and rinsing operations were measurably improved in terms of bottle cleanliness. Micro data confirmed that all agreed to parameters had been achieved with a wide margin of safety.

- The water reclamation system cut the flow of wastewater to their anaerobic WWT plant in half but the BOD loading per day continued as before. Other measures were identified to reduced BOD loading via sugar treatment changes but these were largely unnecessary. The anaerobic WWT plant operated much better with the more concentrated and consistant wastewater.

- Label removal and caustic reclamation systems were identified that would accomplish two tasks:

    1. With high recirculation flows, rapid straining out of labels before they could be “pulped” in the caustic bath improved machine performance and gave a cleaner caustic solution.

2. Caustic reclamation extended caustic life 300% (as a minimum) saving considerable monies, as well improving machine performance. An automated neutralization system was installed to protect the WWT. Plant.

- Surface water supply was confirmed as at risk to waterborne organisms and a total plant barrier concept was introduced. All incoming water would be treated specifically to guard against pathogens of concern. Whether water was to use for gardening, cooling, general purposes or even fire control stand-by, the barrier would be in effect at the plant inlet. For production purposes the water would still be treated and subject to a multiple barrier system.

• Concluding Remarks

The key in each case study, and as a rule for an effective audit, is to go with an Audit that has an "attitude" … the Audit with an ulterior motive. Using normal approaches to restrict or reduce water usage often means an approach that gives away a margin of safety. In these days, the concerns faced by the food industry are very real and the food industry is determined to err on the side of the angels.

An audit should start with a specific objective … ready to address an opportunity.

An audit should be done by experienced personnel … always to include a most experienced plant engineer, operator or scientist.

Drawings (plant, plant site and function), operating data and laboratory results should be reviewed … before starting an audit.

In a serious water audit … always start by getting complete water analysis … organic and inorganic … before the audit begins.

Testing on site, particularly micro, is critical to most water audits.

Think big!

Recommended actions should always **improve** operation and plant performance.

Do not rule out **avoiding** a major investment in water or wastewater treatment systems as a result of a proactive audit.

With the pre-work described above done in advance an effective audit can usually be accomplished in two to three days … depends on the objectives.

Whether by audit, survey, study or experience, never buy or select water treatment technology without a thorough understanding of the following:

Water source … often sources

Water quality and volume needs of the various plant functions

The impact the technology selected will have on sewer surcharges and regulatory compliance

All investment and anticipated operating costs

Quick availability of support and services

Thank you.