Chemical Concerns for the Craft Brewer

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ABSTRACT

A sanitation program is as good as you make it. Adequate knowledge, forethought and preparation are essential prior to getting started. Never use cleaning chemicals without prior training in safe handling procedures. Never allow employees to become involved in using chemical cleaners and sanitizers without prior training. Your chemical supplier should be your partner in this endeavor. Choose your chemical supplier carefully. He or she can be a great help to you.

Keywords: safety, safety rules, effluent, sanitizers

INTRODUCTION

When introducing a sanitation program in a new or existing microbrewery or brewpub, there are certain principles and concerns that cannot be overlooked in the interest of personal safety, cleaning effectiveness and value. The tips provided in this paper can be used to get started in the right direction.

PERSONNEL

Safety for personnel is the highest priority in selecting the menu of detergents and sanitizers:

A sanitation program can achieve other objectives, but undue risk of harm or injury is not an acceptable tradeoff. Any gains from compromising personnel safety are quickly lost in the event of an accident.

There can be incremental costs for safer alternatives, and it can be tempting to seize the up-front savings. The value of safer alternatives lies in the cost of accidents that don't happen, which is difficult to quantify.
Ten basic safety rules for anyone handling chemicals:

1) Know the chemicals.
2) Know their applications.
3) Know the risks.
4) Never mix chemicals.
5) Use the right safety equipment.
6) Follow safe procedures.
7) Remedy hazardous conditions.
8) Know where the MSDS book is.
9) Know what the MSDS book is.
10) Know what to do in the case of.....

Employees have to be trained and willing to work safely. They are dealing with industrial-strength chemicals, yet if equipped with the proper understanding and respect, they need not be fearful.

Never mix chemicals. If the detergents or sanitizers are not achieving the desired effect, consult with your chemical company to choose one that will. The classic example is of what happens when a chlorinated product is mixed with an acid - chlorine gas is produced, and depending on quantities, can be anything between annoying and catastrophic.

Employees must wear proper protective apparatus - protective gloves, aprons, boots, wet suits (as the situation requires), and especially eye protection. Chemical burns to the skin, while unpleasant at the very least, will heal. Lost eyesight is irreversible.

OSHA requires that employees be informed of information regarding any chemicals they may be handling. Responsible chemical purveyors will provide Material Safety Data Sheets (MSDS); will identify hazardous components, physical and chemical information, fire, reactivity, health risks, handling and environmental risks; and emergency phone numbers. These MSDS sheets are of critical value to emergency personnel in time of need, and should be readily available to them.

Dispensing and proportioning chemicals:

Given the choice, liquids are preferable to powdered chemicals because dispensing can be automated, eliminating handling and exposure.

Dispensing (moving liquids from the shipper to a secondary container) can be accomplished several ways:

- gravity
- siphon
- pump
  a) manual on/off
  b) timed feed
  c) level controls

Likewise, proportioning (diluting the concentrate to use-strength) can be done several ways:

- slug method
- educators
- pump
  a) manual on/off
  b) timed feed
  c) conductivity controllers

The handling of concentrates should be done only by designated, trained personnel because of the higher level of risk as contrasted with the handling of use-dilutions.

Relative risks of various types of detergents and sanitizers:

Acids are defined:
- pH < 7.0
- electron-air acceptors
- yield H⁺ when dissolved in water

Acids are further categorized:
- mineral acids, for example:
  a) hydrofluoric
  b) hydrochloric
  c) sulfuric
  d) nitric
  e) phosphoric
- organic acids, for example:
  a) citric
  b) acetic
  c) propionic
  d) decanoic
  e) nonanoic

Generally, mineral acids are more aggressive than organic acids, representing greater risk in their handling. Phosphoric is the most innocuous of the mineral acids listed, and the one commonly used as a component of acid detergents for the beverage industry. Phosphoric/nitric blends derive benefit from the oxidizing characteristic of nitric, and are used for CIP and recirculation applications, not used for manual applications.

Organic acid formulations are gaining acceptance for acid washing of release tanks because of the greatly reduced turnover time as compared to caustic wash with hypochlorite sanitizing. The organic acid formulations provide detergency, biocidal activity, and can be used in a CO₂ atmosphere. The pH of the use-dilution is about the same as Coca-Cola.

Inordinate fear of acids is a common misconception, especially when contrasted with alkalines, and specifically caustics.

Alkalines are defined:
- pH > 7.0
- electron-pair donors
- yield OH⁻ ions when dissolved in water

Alkalines are further categorized:
- alkalis (other than NaOH & KOH), for example:
  a) silicates
  b) phosphates
  c) certain amines
- caustics
  a) NaOH (caustic soda)
  b) KOH (caustic potash)

Caustic solutions at 1% to 2% causticity, and at 140°F are used for recirculation cleaning of brew kettles and fermentation vessels; caustic solutions at 3.5% to 4.5% causticity, and 130°F to 140°F are used in bottle washers. The concentrates and hot caustic solutions can cause severe burns.

Effectiveness is the second priority in selecting the chemical menu:

Detergents and sanitizers have to perform to the desired intent in keeping with safety considerations. If chemicals don’t perform satisfactorily, it doesn’t matter how inexpensive they may be.
A CASE OF MISPLACED FOCUS

A food processing plant uses $30 to $35 per day of detergents and sanitizers. There are 16 people on the cleanup crew, 8 hours per day, at $15 per hour with benefits. Supervision has an incentive program; one of the objectives is to reduce chemical costs.

If all of the chemicals were eliminated, maximum savings would be $35 per day.

Labor cost is: 16 people x 8 hours x $15 per hour = $1920 per day. If the cleanup crew were reduced by 1 person, savings would be: 1 per 8 hours x $15 per hour = $120 per day.

To further complicate matters, production runs 21 hours per day; the cleanup crew has 3 hours to clean the plant. 16 people are used ineffectively for 5 hours, but assuming everyone is working productively during cleanup: 16 people x 8 hours = 48 man hours of actual cleanup time.

If the cleanup crew had 8 hours to clean the plant: 48 man hours ÷ 8 hours = 6 people.

Alternatively, 48 man hours ÷ 15 people = 3.2 hours to clean the plant.

The real problem is not one of chemical over-usage, but one of labor management and time allocation.

PRODUCT

Several controllable variables directly impact the quality of the product before it gets out into the trade.

The people who make your product:

The personal hygiene of anyone involved in the food and beverage processing industries has to meet high standards.
should be developed and implemented. Monitoring is required to assure that the procedures are being followed, and that the results are good (See Figure 2).

A cleaning procedure reduced to the lowest common denominator is shown below; more specific procedures can be developed by adding detail. Care should be taken not to add too much detail as to make the procedure cumbersome and thus unusable. Generally, procedures should comprise 5 to 10 steps, and be written on one side of one page. A simple procedure is 1) pre-rinse 2) wash 3) post-rinse 4) inspect 5) sanitize.

**ENVIRONMENT**

**Effluent discharge to a Publicly Owned Treatment Works:**

Of concern, both from an ethical and a monetary standpoint are BOD, COD, pH, and solids. Municipalities levy assessments for discharges exceeding certain limits in any of these categories:

- Biochemical Oxygen Demand (BOD) is the amount of oxygen required by bacteria while stabilizing decomposable organic matter to CO₂, H₂O, and NH₃ under aerobic conditions. The organic matter is a nutrient to the bacteria.
- Chemical Oxygen Demand (COD) is the total quantity of oxygen required for oxidation to CO₂ and H₂O, regardless of the biological decomposition.
- pH outside of a range of pH 4.0 to pH 8.5, typically.
- Solids.

When being monitored by a municipality, composite samples are always preferable to grab samples. Grab samples can reflect atypical spikes, resulting in unfair assessments.

**Direct discharge of treated effluent to the environment:**

Direct discharge requires the waste stream be treated to a higher standard before it is released to waterways.

- **aerobic treatment**
  a) easier to operate
  b) more forgiving
  c) more resilient biosystem
  d) off-line retention required
- **anaerobic treatment**
  a) smaller footprint
  b) possible co-generation
  c) very temperature and pH sensitive
  d) fragile biosystem
  e) on-line and off-line retention required
  f) requires constant monitoring and adjustment

**Evolution from caustics and soaps to syndets to environmentally-friendly syndets (synthetic detergents):**

Soaps are natural fats reacted with NaOH (or KOH) to form sodium (or potassium) salts of long chain carboxylic (fatty) acids. Soaps can solubilize organic materials not normally soluble in water. Soaps from natural fats are readily biodegradable.

Synthetic detergents evolved in the mid-60s, and had the advantage of hard-water tolerance, not forming scums in the presence of temporary hardness as soaps do. Early synthetics (alkylbenzene sulfonates) were not rapidly biodegradable due to being comprised of branched-chain linkages.

Newer developments in synthetics (alkane sulfonates) can be rapidly metabolized by naturally occurring bacteria due to being straight-chain linkages.

Nevertheless, detergents in sufficient amounts will have an impact on treatment systems. Good management, exercising intervention measures will minimize the impact:

- use biodegradable detergents.
- don’t use higher pH than necessary.
- control quantities used.
- divert high chemical discharges to retention:
  a) soaker dump
  b) bottleshop cleanup

**Sanitizers:**

Sanitizers are designed to provide 99.999% reduction of microbes in production areas, and therein lies a paradox. Depending on the type and quantity of sanitizer reaching a treatment system, a reduction of microbes may occur there, too, compromising the performance of the system.

- Quats are good sanitizers for non-product-contact applications since they have known residual characteristics, but their mode of action poses a problem to treatment systems. Quats are persistent biocides because they are surface-active to microorganisms, and are not consumed in that process.
- NaOCl is more friendly to treatment systems because its mode of action is that of an oxidizer, and it is used up stoichiometrically by the organics encountered in the waste stream.
- Cl₂ has the advantage that it is used up by organic load, and also does not break down into THMs or other chlorinated hydrocarbons.

**Is California right?**

While California has stringent requirements such as Proposition 65 and others, future generations may thank them for being forward-thinking and responsible with the limited resources we have on our planet.

Alternatives to chemicals that are problematic to the environment already exist. Until they are mandated, broad implementation is a matter of striking a balance of the cost-to-benefit ratio.

NaOCl, for example, is an extremely fast-acting, broad spectrum, and inexpensive sanitizer, but it has downsides, among them breakdown to THMs. The use of NaOCl may eventually be restricted.

Caustics are appropriate for heat-set and cooked-on soils, but are poor detergents without additives. The additives contribute significantly to the cost of the product. Once the cost advantage...
is gone, the synthetic detergents become attractive as safer and environmentally friendly.

Overview from a vendor’s perspective:

A range of management philosophies can be identified within the food and beverage processing industries:

- Major company “good citizen”
  The “big guys” have little choice but to be politically correct, which is not to question the underlying sincerity of their internal and public actions. Well-defined and documented policies exist.

- Mid-sized, cost-driven
  Often lacking in ethic, and given the choice, will take the alternative that represents short-term thinking. Operating for today, typically do not make any capital re-investment or do longer range planning. Tend to pay poorly, and experience a high rate of turnover. A serious risk to public health and the environment.

- Committed to ideals
  Smaller or startup companies; choose to take the high road in matters of operation, and always concerning the product. Experience a higher rate of failure through the pinch between cost of goods and what the market will bear. Sometimes fail due to lack of a comprehensive and realistic business plan. Can be extremely successful with an accurate assessment of their niche, and staying focused.

Roles of stakeholders:

Industry, vendors, and regulatory agencies share the same objectives – to provide a safe and wholesome food supply to the consumer (Figure 4):

- Within industry priorities overlap, but various operating groups will have parochial interests:

<table>
<thead>
<tr>
<th>area</th>
<th>priority</th>
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</thead>
<tbody>
<tr>
<td>a) brewhouse</td>
<td>product</td>
</tr>
<tr>
<td>b) bottleshop</td>
<td>throughput</td>
</tr>
<tr>
<td>c) QA</td>
<td>quality</td>
</tr>
<tr>
<td>d) sanitation</td>
<td>time, effort</td>
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<tr>
<td>e) purchasing</td>
<td>cost</td>
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<tr>
<td>f) maintenance</td>
<td>trouble-free</td>
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<tr>
<td>g) environmental</td>
<td>“save the planet”</td>
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- Vendors should be looked upon as a resource to industry, bringing new technologies and suggesting improved methods.

- Regulatory agencies are the ombudsman for the consumer, and should not be looked upon as the bad guys trying to put you out of business.

- The media rarely contributes in a positive manner.
  The media:
  a) may be uninformed.
  b) may be misinformed.
  c) can mislead the public.
  d) can causes hysteria.

Choosing a chemical supplier:

A vendor of sanitation chemicals and services should be:

- a sanitation consultant in addition to merely providing chemicals.
- contemporary in formulary, equipment, and technique.
- focused.
- full-line.
- linked to quality outsourcing of ancillary services.
- customer-driven, not shareholder driven.
- adequately staffed with capable front-line people.

CONCLUSION

This discussion has only scratched the surface relative to effective cleaning in your brewery. Your chemical supplier or professional organization are very good sources for further information on study materials, short courses and seminars in cleaning and sanitation.