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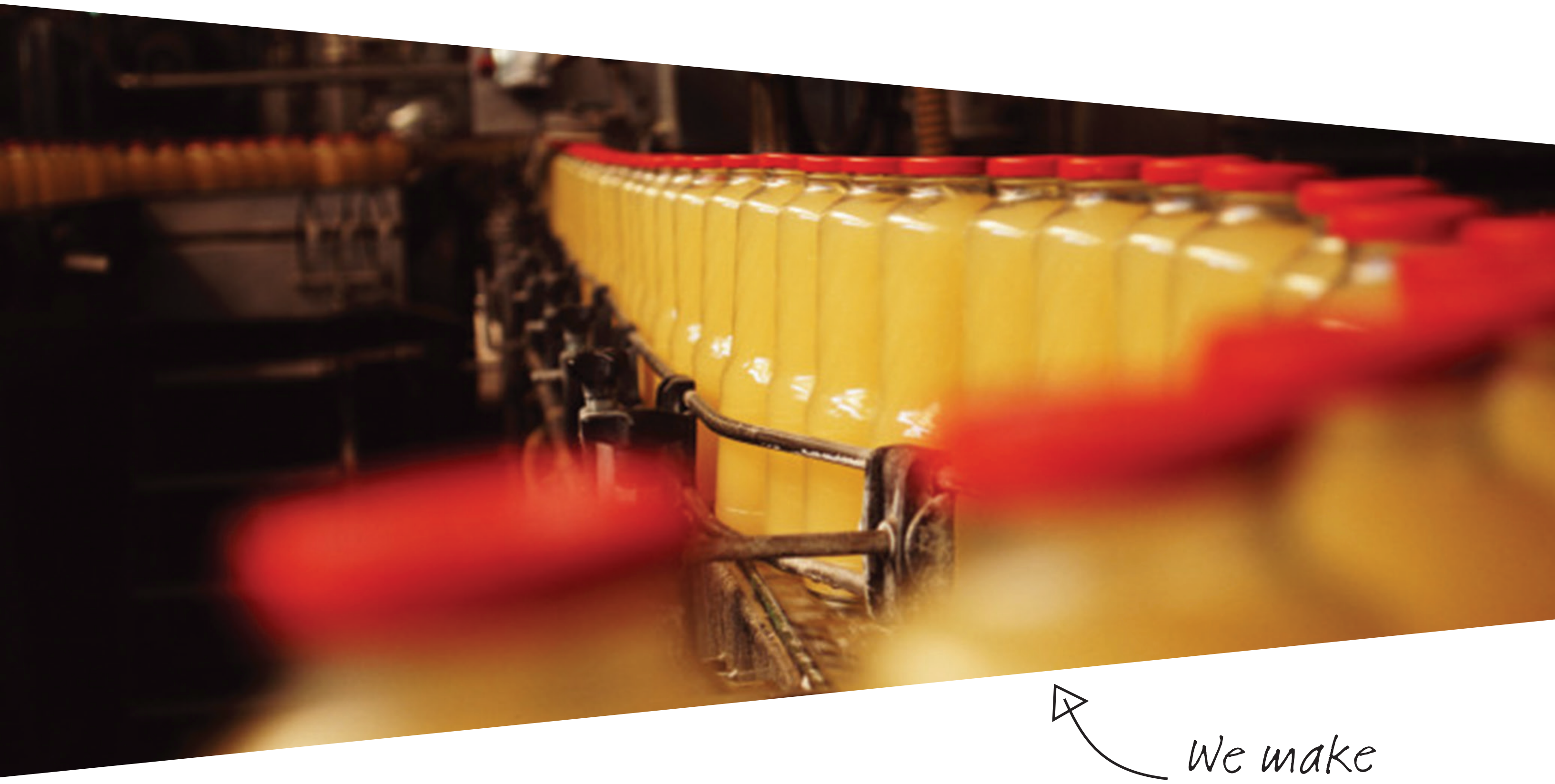

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WHITE PAPER

Preventing Contamination

A guide to material selection for food and beverage equipment

Author: Jerry Scherzinger

Cautionary Tales of Companies Failing to Maintain Proper Food Safety Standards

Topps Meat Shuts Down After Recall
"Topps Meat Company announced Friday that it is closing its entire operation effective immediately due to the financial impact of the recall of 21.7 million pounds of ground beef that were potentially contaminated by the E. coli bacteria." (Sahba, Marshall, & Rizzo, 2007)

Peanut Industry: Recall Price Tag $1 Billion
"The effects of the widespread peanut butter recall could cost rural America's peanut producers $1 billion in lost production and sales, according to testimony set to be heard Wednesday at a House subcommittee hearing." (Associated Press, 2009)

"According to the Centers for Disease Control (CDC) more than 200 known diseases are transmitted through food. In the U.S. alone an estimated 76 million cases of foodborne disease occur each year. Cases range from mild to severe and are the cause of approximately 5,000 deaths annually." (Mead et al., 1999)

"Worse yet, this is a growing problem for producers and processors. The combined effects of a more complex supply chain, expanding global markets and an ever-increasing population have seen the rate of food and beverage recalls grow from 240 in 2006 to 565 in 2008 and 925 in 2009." (Oehl, Floyd, & Fowler, 2010)

Figure 1: Food and Beverage Recalls, 2006-2009 (Oehl, Floyd, & Fowler 2010)

Introduction

Can your company afford the costs of a product recall? In the food industry, recalls due to contamination can be devastating, but typically can be completely avoided. All too often, simple steps in a food safety protocol are overlooked, the result of which can lead to an overwhelming financial strain and even the end of a business. Taking the initiative to ensure your company is not only aware of but effectively adheres to industry guidelines for food safety is of the utmost importance in maintaining a viable business.

Best practices for safety in the food processing industry can be broken down into two basic categories: selecting the optimal material and design components for your food processing equipment, and the cleaning and disinfection options and procedures for equipment surfaces.

Equipment materials must be chosen with the machine's ultimate function in mind. Some surface materials are better suited than others for food handling, such as stainless steel. Another factor in designing this equipment is that of the machine components and whether they are hydraulic, electric or pneumatic. There are advantages to each depending on the task, but most often pneumatic components are the best solution for food processing. This is due to the ease in which pneumatic components can be cleaned and their lower component cost.

Specific protocols exist for the maintenance and sanitation of equipment. A large part of keeping the equipment clean involves the identification of water impurities and food soils involved in the cleaning process. Stringent cleaning procedures, along with choosing the correct cleanser, must be in place in order to maintain hygienic equipment.

Keeping up with safety standards is crucial in the food processing industry. This paper will describe current guidelines and provide best practices for your business to take in order to avoid food contamination and maintain compliancy with industry standards.

Federal Guidelines

As expected in matters of public health, federal agencies such as the Food and Drug Administration (FDA) (www.fda.gov) and the U.S. Department of Agriculture (USDA) (www.usda.gov) play a prominent role in setting standards that must be followed.

For many years the most prominent and visible set of standards backed by the FDA has been a prevention based food safety system that identifies and monitors specific food safety hazards that can adversely affect the safety of food products. Referred to as HACCP (www.haccpalliance.org) the Hazardous Analysis and Critical Control Point program is a systematic preventive approach to food safety and pharmaceutical safety that addresses physical, chemical, and biological hazards as a means of prevention rather than finished product inspection.

> **HACCP was first used in the 1960s by the Pillsbury company to provide the safest and highest quality food for astronauts in the space program.**

More recently the FDA proposed the Food Safety Modernization Act (FSMA) that was signed into law by President Obama on January 4, 2011. It is considered the most sweeping reform of our food safety laws in more than 70 years.

For detailed information on the rules and standards created by the FSMA visit http://www.fda.gov/Food/GuidanceRegulation/FSMA

The USDA and the FDA bear the major responsibility for food safety programs at the federal level. However, federal food safety responsibilities are shared by at least a dozen separate agencies whose authority is derived from over 35 separate statutes. These wide ranging, and sometimes overlapping, responsibilities represent an impressive array of functions. For the purposes of this paper we will focus on common high level recommendations shared between the agencies.

In addition to the USDA and FDA, a third organization shapes many of the accepted best practices in food safety. Initially organized in the 1920s as a set of standards put forth by food industry suppliers and the milk producers, the 3-A standards movement was more formally organized in 2002 with the incorporation of 3-A Sanitary Standards Inc. (3-A SSI). The five Founding Members include the American Dairy Products Institute (ADPI), the International Association of Food Industry Suppliers (IAFIS), the International Association for Food Protection (IAFP), the International Dairy Foods Association (IDFA), and the 3-A Sanitary Standards Symbol Administrative Council. Along with the Founding Members, the leadership of 3-A SSI includes the Food & Drug Administration (FDA), the U.S. Department of Agriculture (USDA), and the 3-A Steering Committee. (3-A.org)

General Design Considerations

3-A Standards divide food processing equipment into two categories:

1. Food product contact surfaces
2. Non-product contact surfaces

The surfaces of food equipment are further subdivided into two categories:

1. Food product contact surfaces
2. Non-product contact surfaces

A food product contact surface is defined as a surface in "direct contact with food residue, or where food residue can drip, drain, diffuse, or be drawn." (FDA, 2004b) Because these surfaces can directly result in food product contamination, rigid sanitary design criteria must be met. Non-product contact surfaces are those that are part of the equipment (e.g. legs, supports, housings) that do not directly contact food. Since contamination of non-product contact surfaces can cause indirect contamination of food products, these surfaces cannot be ignored with regard to sanitary design.

Cleaning and Disinfection

The correct order of events for the proper cleaning and sanitation of food product contact surface areas is:

1. Rinse
2. Clean
3. Rinse
4. Sanitize

(Schmidt, 1997)

It is important to recognize that proper cleaning is not sufficient to maintain adequate hygienic levels, since cleaning alone does not necessarily destroy micro-bacterial organisms. It is only through sanitization and disinfection processes that microbial populations can be reduced to levels considered safe enough to avoid food contamination.

Water Chemistry and Quality

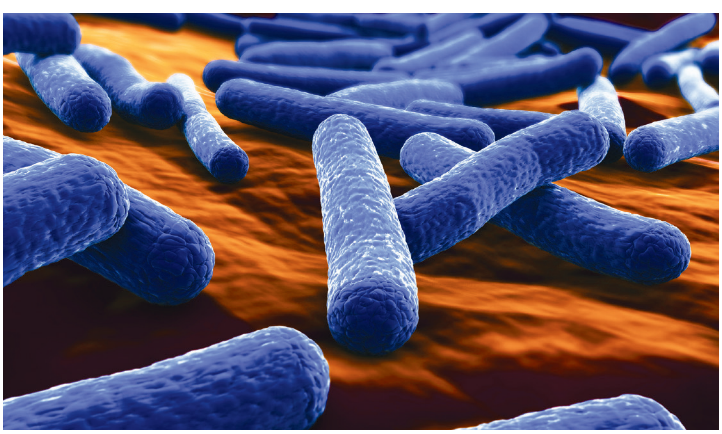
One often overlooked criteria for good cleaning practices is the quality of the water being used. Water comprises approximately 95%-99% of cleaning and sanitizing solutions. Water functions to:

> Carry the detergent of the sanitizer to the surface
> Carry soils or contamination away from the surface

Impurities in water can drastically alter the effectiveness of a detergent or sanitizer. Water hardness is the most important chemical property, having a direct effect on cleaning and sanitizing efficiency. Other impurities can affect the food contact surface, soil deposit properties or film formation.

Water pH generally ranges from a pH level of 5 to 8.5. This range is of no serious consequence to most detergents and sanitizers. However, highly alkaline or highly acidic water may require additional buffering agents.

Water can also contain significant numbers of microorganisms. Water used for cleaning and sanitizing must be potable and pathogen free. Treatments and sanitization of water may be required prior to cleaning regimens. Water impurities that affect cleaning functions are presented in the following table.



E.coli Microorganism

Water Impurities and Associated Problems

COMMON IMPURITIES	PROBLEM CAUSED
Oxygen	Corrosion
Carbon Dioxide	Corrosion
Bicarbonates (Sodium, Calcium, Magnesium)	5/16-18
Chlorides or Sulfates (Sodium, Calcium, Magnesium)	Scale
Silica	Scale and Corrosion
Suspended Solids	Scale
Unusually high pH (above 8.5)	Mediate Corrosion and Deposition; Alter Detergent Efficiency
Unusually low pH (below 5)	Mediate Corrosion and Deposition; Alter Detergent Efficiency

LESS COMMON IMPURITIES	PROBLEM CAUSED
Iron	Filming and Staining
Manganese	Corrosion
Copper	Filming and Staining

(Schmidt, 1997)

Food Soils

Food soil is generally described as unwanted matter on food contact surfaces. Soil can be visible or invisible. The primary source of soil is the food product being handled. However, minerals from water or cleaning compound residues also contribute to films left on surfaces.

Since soils vary widely in composition, no one detergent is capable of removing all types. It is essential that personnel involved understand the nature of the soil being removed before selecting a detergent or cleaning regime.

The rule of thumb is acidic cleaners dissolve alkaline soils (minerals) and alkaline cleaners dissolve acidic soils and food wastes. Improper use of detergents can actually “set” soils making them harder to remove.

> Soils may be classified as:
> Soluble in water (sugars, some starches, most salts)
> Soluble in acid (limestone, most mineral deposits)
> Soluble in alkali (protein, most fat emulsions)
> Soluble in water, alkali or acids

Food soils are generally complex in that they contain mixtures of several components. Refer to the table to the right for general soil classifications and removal characteristics.

Characteristics of Food Soils

SURFACE DEPOSIT	SOLUBILITY	EASE OF REMOVAL	HEAT INDUCED REACTIONS
Sugar	Water Soluble	Easy	Carmelization
Fat	Alkali Soluble	Difficult	Polymerization
Protein	Alkali Soluble	Very Difficult	Denaturation
Starch	Water and Alkali Soluble	Easy to Moderately Easy	Interactions with other constituents
Monovalent Salts	Water and Acid Soluble	Easy to Difficult	Generally not significant
Polyvalent Salts	Scale	Difficult	Interactions with other constituents

(Schmidt, 1997)

Once the type of soil that needs to be addressed is identified, it is important to understand the effects of different types of cleaners and their potential uses and hazards.

Types of Cleaning Compounds

TYPE	USES	HAZARDS	EXAMPLES
Strong Alkali	Destroys microbes, dissolves protein	Corrosive	Sodium Hydroxide (caustic soda)
Heavy-duty Alkali	Removes fats, mechanized systems	Slightly corrosive	Sodium carbonate
Mild Alkali	Lightly soiled areas, softens water	-	Sodium bicarbonate
Strong Acid	Dissolves surface mineral deposits	Corrosive to concrete, metals and fabric	Phosphoric and hydrofluoric acids
Mild Acid	Controls deposits, softens water	Slightly corrosive	Levulinic acetic, hydroxyacetic, and gluconic acids
Solvents	Dissolves grease and oil	-	-
Soaps and Detergents***	Emulsifies fats, oils and grease	-	-

*** Household cleaners have a pH of 8 to 9.5
(Cole-Parmer Technical Library)

Materials

Aggressive cleaning and disinfection solutions pose the greatest challenge for machine designers in the food equipment industry.

Many factors are taken into consideration when making surface material selections. Stainless steel is specified in many industry and regulatory standards as the preferred surface for food equipment. For example, 3-A Sanitary Standards identifies the 300 series stainless steel as the preferred surface for use in the milk industry. Other grades of stainless steel are appropriate for different purposes, such as handling high fat products or meats. For products containing high levels of acid, salt or other corrosive elements, corrosion-resistant materials like titanium may be required.

“Softer” metals like aluminum, brass, copper or mild steel are also used, however, these materials are generally less corrosion-resistant and care should be exercised in their cleaning.

Aluminum is readily attacked by acidic and highly alkaline cleaners, which can render the surface uncleanable due to corrosion. Plastics are subject to stress cracking and clouding from prolonged exposure to corrosive food materials or cleaning agents.

Why Choose Stainless Steel?

In addition to its excellent resistance to corrosive elements, stainless steel offers other attractive qualities that influence its popular usage across industries. These qualities include:

People
In terms of health and safety, stainless steel has no negative impact on individuals who handle the material throughout its production process, use or ultimate disposal. (International Stainless Steel Forum [ISSF], 2010)

Planet
The emissions footprint of stainless steel as related to carbon, water and air is minimal. Stainless steel is highly reusable and also recyclable. Its low maintenance costs and long life indicate stainless steel makes a low level of impact on the planet. (ISSF, 2010)

Profit
Industries that produce stainless steel show long-term sustainability and growth, provide excellent reliability and quality for their customers and ensure a solid and reliable supply-chain to the end consumer. (ISSF, 2010)

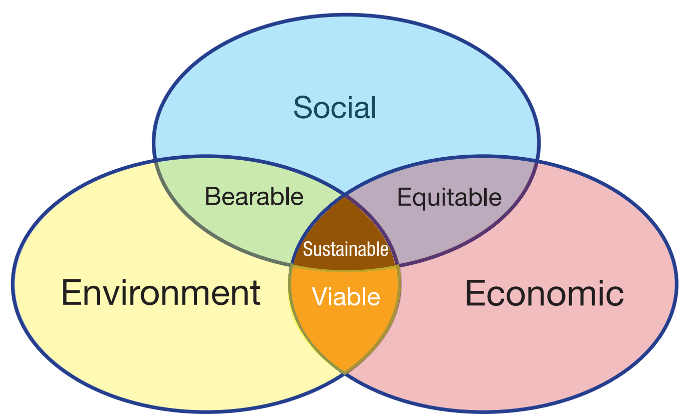


Figure 2: Ven diagram representing sustainability (Wikipedia.com)

Pneumatics in Wash Down Applications

Design engineers are faced with numerous decisions when designing equipment for use in wash down applications. One of the first decisions they make is the type of technology to utilize in order to provide the motion and “muscle” required to do the work.

Pneumatic, hydraulic and electrical components all provide unique advantages and disadvantages. Typically a combination of all three may be required for complex equipment. Most systems specifically require electric components as the use of motors, valves and switches provide the necessary control flexibility for today’s modern equipment.

Hydraulics are usually utilized in applications that require high pressure and force. For applications where only low to moderate force is required, pneumatics are preferable. Pneumatics possess a few distinct advantages over hydraulics, such as:

- Lower component cost
- Lighter weight
- Cleanliness of air versus hydraulic fluids
- Simplicity of design and control

When selecting pneumatic components such as actuators, valves and air preparation, consideration should first be given to the construction materials. As noted earlier, the use of stainless steel components should be considered whenever possible. Depending on the chemistry of the wash down solution, other non-corrosive metals may also be considered, as well as plastics such as acetyl resin. For example, pneumatic cylinders are usually designed with stainless steel bodies, end caps and piston rods. Properly designed components will also reduce the presence of small crevices in component geometries, which can foster growth of bacteria by trapping food product in hard to clean areas.

Other design features that make cylinders optimal for use in wash down applications include rod wipers, which limit the potential for external contamination during pressure spraying, and corrosion-resistant bearing and bushing materials such as PTFE (Polytetrafluoroethylene).

Audit Your Current Equipment and Processes

1. Familiarize yourself with local and federal guidelines that apply to your industry.
   a. FDA/HACCP
   b. USDA
   c. 3-A SSI
   d. Others
2. Review your equipment to ensure it has been designed to allow for efficient cleaning and disinfection.
   a. Food product contact surfaces
   b. Non-product contact surfaces
3. Develop and/or improve your current cleaning and disinfection protocol.
   a. Rinse/Clean/Rinse/Sanitize
   b. Identify water quality and chemistry
   c. Recognize food soils and contaminants that need to be addressed
   d. Select the proper detergents and disinfectants
4. Implement changes to design and cleaning protocols to ensure you are properly protected from the devastating effects of food contamination.

Food and beverage design engineers are under constant scrutiny to deliver machines that are both good for the bottom line and that protect the company from devastating product recalls. It is essential for engineers to select materials and components that both meet the functional requirements of the application as well as Federal Guidelines for safety and contamination prevention. It is also paramount that the proper protocols are followed for the maintenance and sanitation of equipment surfaces.

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Bimba
25150 S. Governors Hwy
University Park, IL 60484

Tel: +1 800 44 BIMBA
Fax: +1 708 235 2014
Email: cs@imi-precision.com
Website: www.bimba.com