

# Green Instrument Chemistries for Reprocessing of Reusable Medical Devices

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## Learning Objectives:

1. Define the “Green” technology concept
2. Discuss the importance of “green” cleaning agents and its effect on the environment
3. Review the 12 principles of “Green” Chemistry

## Introduction

Cleaning and decontamination are highly effective infection prevention measures for curtailing the spread of infection when re-processing reusable medical devices. Cleaning refers to the removal of all visible soil and other contaminants from surgical instruments. It is the most important step in the decontamination process. Decontamination is the removal or reducing of contamination by infectious organisms or other harmful substances rendering them safe for further handling and subsequent sterilization/disinfection.

Soiled surgical instruments and equipment provide an environment for the growth of microorganisms. Employee safety is a very important concern in the health care environment. Healthcare workers are constantly at risk for becoming infected with hazardous bloodborne pathogens including HBV, HCV, and HIV. Central Service Departments use a multi-step process of cleaning and rinsing of devices through manual and mechanical means. Thorough cleaning is essential prior to sterilization or disinfection of re-usable devices. Central service personnel may not know the origin of the contamination and must assume that every item received in the decontamination area can pose a risk.

Enzymes enhance detergent cleaning and have the ability to catalyze or speed up chemical reactions. A catalyst is a substance that accelerates a chemical reaction without being consumed by the reaction. Enzymes can be effective in very low concentrations and have the ability to avoid being consumed in the cleaning process. Thus, when used in concert with other cleaning agents, surfactants, enzymes speed up the cleaning process and enhance the effectiveness of the detergent to remove organic soil. Surfactants play a key role in soil removal including surface active agents with wetting, detergent and emulsifying properties. Surfactants with good wetting properties facilitate enzyme action. What is important is the combination of the right surfactant and multiple enzymes to attack and break down various organic soils and proteins so that they can be washed away.

There are many instrument chemistries available. Properly formulated pH neutral detergents are non-corrosive and does not attack metal surfaces. Alkaline detergents may be effective cleaners, but create pitting, discoloration or corrosion to the devices that are intended to clean, and if highly alkaline or acidic may be hazardous to the environment as well. Enzymatic cleaners for

decontamination of reusable devices allow for the use of pH neutral detergents as a substitute for caustic cleaners including alkaline detergents. The use of enzymatic cleaners facilitates the cleaning process, saves energy as lower water temperature is needed for processing, and reduces the time required for a thorough cleaning. Furthermore, enzymes are compatible with a larger number of delicate medical devices. In addition, pH neutral means corrosion resistant and safe for release in our waste water streams.

Green Chemistry is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. This approach to pollution prevention is the focus of the US Environmental Protection Agency's (EPA) Green Chemistry Program. The EPA has initiated a program which reviews products and processes for environmental safety and sustainability.

Worldwide industry is faced with the challenge to provide effective devices and products for surgical instrument cleaning and decontamination while recognizing the importance of sustainability and ecological compatibility. Sustainability has been defined as meeting the needs of the current generation without impacting the needs of future generations to meet their own needs. There is a social responsibility to protect the public from exposure to harm. As a result, all manufacturers need to anticipate and are obligated to design instrument chemistries to control measures which might lead to possible harm or uncertainty. The burden of proof that the suspected risk is not harmful falls on those taking action.

The concept of the precautionary principle includes an ethical responsibility toward maintaining the integrity of natural systems, a willingness to take action in advance of definitive scientific proof when a delay will prove ultimately most costly to society and nature as well as unfair and ultimately selfish to future generations.

Green Chemistry is often referred to as a form of molecular level pollution prevention. Green Chemistry relies on a set of 12 principles that can be used to design or re-design molecules, materials and chemical transformations to be safer for human health and the environment.

#### **The Twelve Principles of Green Chemistry:**

1. **Prevent Waste:** It is better to prevent waste than to treat or clean-up waste after it has been created.
2. **Atom Economy:** Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
3. **Less Hazardous Chemical Syntheses:** Whenever practical, synthetic methods should be designed to use and generate substances that possess little or no toxicity to humans or the environment.
4. **Designing Safer Chemicals:** Chemical products should be designed to affect their desired function while minimizing their toxicity.
5. **Use Catalysts:** Catalytic reagents such as enzymes are superior to stoichiometric reagents.

6. **Avoid Chemical Derivatives:** Unnecessary use of blocking groups or physical/chemical processes should be minimized or avoided as such steps require additional reagents and can generate waste.
7. **Use of Renewable Feed stocks:** A raw material or feedstock should be renewable rather than depleting whenever technically and economically practical.
8. **Use Safer Solvents and Reaction Conditions:** The use of auxiliary substances, solvents or separation agents should be made unnecessary whenever possible and innocuous when used.
9. **Increase Energy Efficiency:** Energy requirements should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.
10. **Design for Degradation:** Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.
11. **Analyze Attempts to Prevent Pollution:** Analytic methods need to be developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.
12. **Minimize the Potential for Accidents:** Substances used in a chemical process should be chosen to minimize the potential for accidents.

In summary, cleaning, decontamination and subsequent sterilization are essential steps in breaking the chain of infection. Cleaning is the most critical step in the decontamination process and requires the commitment from the manufacturer to follow, design and produce instrument chemistries with demonstrated efficacy and sustainability. Medical devices are critical for patient care and it is the responsibility of Central Service Personnel to provide a clean and sterile device. Caustic cleaners are unnecessary for instrument processing and present significant hazards to health and safety. We all have an ethical responsibility to maintaining the integrity of our natural systems. Enzymatic detergents save water and energy, and replace toxic chemicals that may harm our environment. Enzymes are in every living organism and play an important function in central sterile, at home and in the environment. Because they are pH neutral, biodegradable and readily break down, they are ideal for facilities considering green initiatives. As with all chemical compounds, instrument cleaners should be handled appropriately and staff should use proper personal protective equipment to ensure their safety.

**References:**

Aehle, Wolfgang. 2004. Wyley-VCH. *Enzymes in Industry*.

Environmental Protection Agency (EPA). *Green Chemistry*. <http://www.epa.gov/gcc/>

IAHCSMM Central Service Technical Manual, 7<sup>th</sup> edition. Chicago, Ill.

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