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Infection Control Concerns and Recycled Laundry Wastewater – *Fear or Fact?*

Kim Karch, EVP Global Sales and Marketing, AquaRecycle
Gene Dedick, VP Sales, AquaRecycle

Research studies, data and guidelines abound in relation to infection control issues in healthcare laundry environments. However the data focuses largely on various aspects of handling, processing, storing and transporting of soiled and processed linen.

The nation's predominant standard setting and accrediting body for healthcare is The Joint Commission for Accreditation of Healthcare Organizations (JCAHO). The organization has developed standards to evaluate safety and quality of patient care in healthcare organizations throughout the world. While standards are in place for handling and processing linens, research indicates that the organization has no current standards in place specifically related to the water used in the wash process. Likewise, The Center for Disease Control & Epidemiology (CDC) guidelines focuses primarily on the laundry environment and textile handling; there are currently no CDC guidelines specifically addressing the water used in the wash process.

Recycling of laundry wastewater is a relatively new phenomenon in the industry – a necessary result of rising utility costs, diminishing water supplies, increasing EPA restrictions. In addition the emphasis on environmentally conscious "Green Building" and increasing demands on municipal wastewater treatment plants that have long exceeded their capacity. Predictably, infection control questions regarding the safety of water recycling in healthcare laundries are being asked. Is there reason for concern?

Microbes And The Wash Process

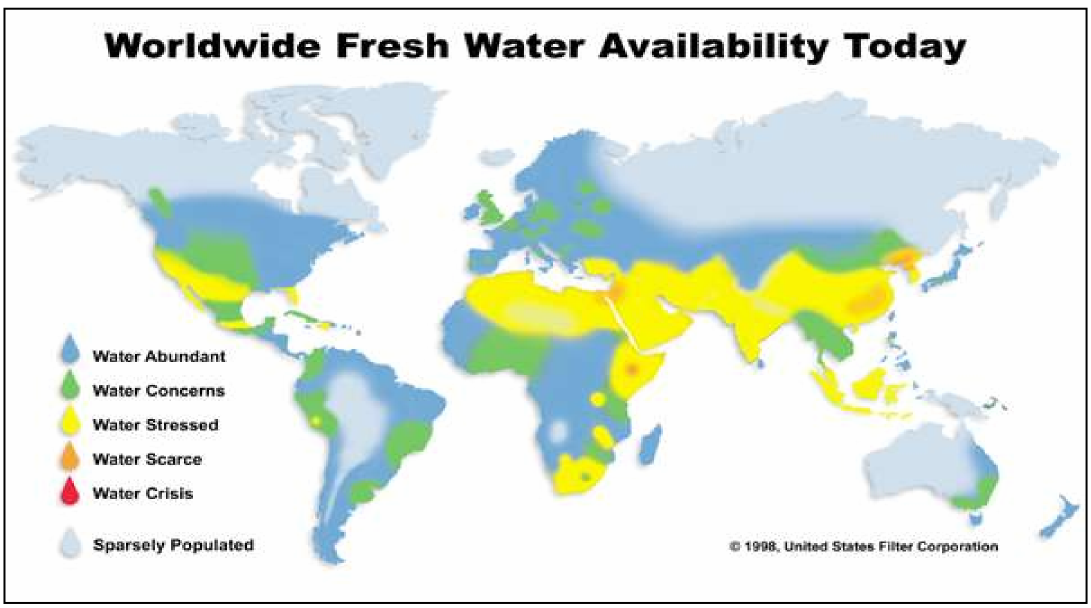
Let's begin with the wash process itself. The literature generally concurs that a variety of factors working in synergy contribute not only to the removal of soils, they also offer a significant degree of microbial control: (1) temperatures of 140 degrees or higher offer bactericidal protection, (2) agitation and detergents aid in the loosening and removal of soils while some chemicals may provide microbial activity, (3) chlorine effectively eliminates microorganisms, (4) alkali and sours create extremes in pH and an inhospitable environment for microorganisms, (5) high temperatures associated with drying and ironing kill bacteria and (6) the time of the wash and rinse process contributes to microbial control of textiles.

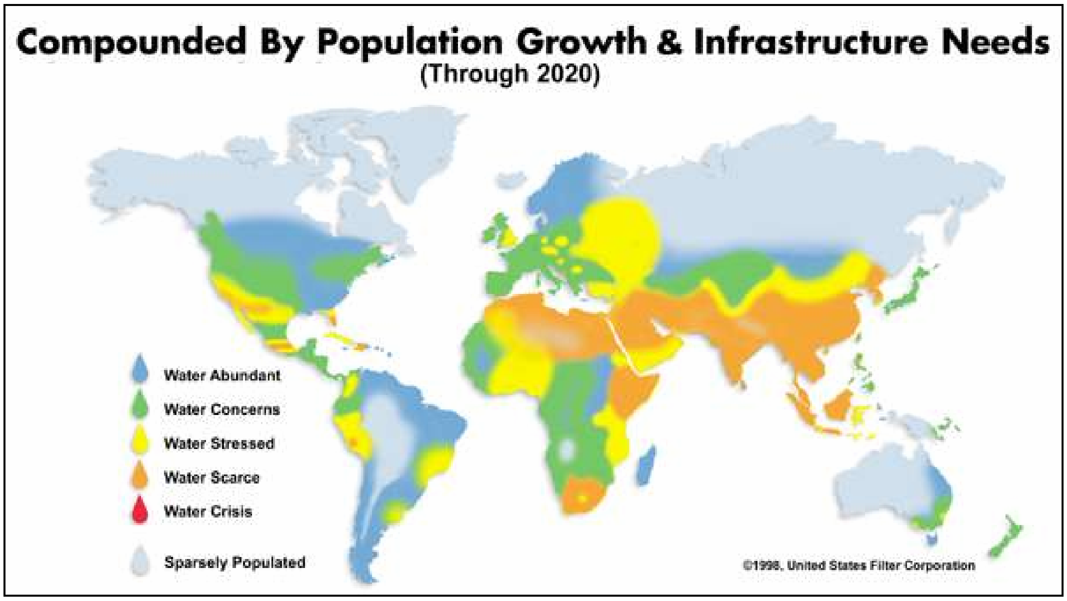
What about the water used in the laundry process? As environmental and economical pressures encourage laundries to consider recycling as a means to reduce water usage and utility costs many healthcare laundries question the infection control ramifications of using recycled water in the wash process. As with many fears, the lack of readily available information contributes to the perception that recycled water is "bacteria laden" and will pose infection control risks for the patient population. As water resources continue to diminish however we must all become more familiar not only with conservation, but also with our water resources in general – where does our water come from and what are the processes that insure safe water quality?

Water Everywhere. Not a Drop To Drink.

The fundamental factor that distinguishes our planet from others is the presence of water. Water covers about 70 percent of earth's surface and constitutes 75 percent of our bodies. Our life depends on it. Despite the perceived abundance of water on our planet, only 1 percent of Earth's water is available for drinking. 97 percent is the ocean; 2 percent is frozen in glaciers and icebergs. Of the 1 percent available for drinking, about 98 percent is used by industry; the remaining 2 percent is available for sustaining our life and our health. As modern demands pollute our waterways and industrial and population growth place increasing demands on this limited resource, we cannot continue to take our water for granted.

Historically, humans chose to populate in areas where fresh water supplies were abundant. Today however it seems that population growth abounds in areas where fresh water supplies are scarce, placing ecological strain upon those areas and their ability to support life. In 1970 there were three billion people on the planet. By 2050 it is projected that we will number over 9 billion. National Geographic Society's Gilbert S. Grosvenor stated in 1998, "We are at a crucial turning point. If we do not change the way we respect and manage our freshwater supplies within the next ten years, we might as well as write off civilization as we know it." From a global perspective, there are already water shortages in many regions of our world. The following charts illustrate the severity of the shortage anticipated in the next 20 years:





All water is recycled – even bottled water. Our earth's water supply is finite; we use and re-use the same water we have used throughout history; the same water that cave men drank. Water leaves the earth's surface through evaporation from lakes, rivers and oceans or through the transpiration of plants. Water vapor then forms clouds leading to precipitation on land and sea and the cycle begins again. Mother Nature's purification process below ground works well to restore water quality. When pollution, run off and increased demand of surface waters occur, municipal wastewater treatment plants prepare the water for human consumption.

Municipal water supplies all have treatment processes in place to treat water before it reaches our taps. The most basic function of wastewater treatment is to speed up the natural processes by which water is purified.

Water purification involves the removal of unwanted contaminants from raw well water or surface water to produce potable water that is acceptable for human consumption. Bacteria, algae, viruses, fungi, minerals, and man-made chemical pollutants are removed in the water puriifcation process. These unwanted contaminants are removed to improve the water's smell, taste, and appearance and to minimize the water's toxcity or presence of pathogens in the finished product. A small, controllable amount of residual disinfectant is usually maintained in the finished product to minimize the potential for distribution system contamination.

The two main options for ensuring sustainability with our current water resources are: (1) increase the production and quality of potable water at less cost, and (2) decrease the current consumption rate of the same water resources.

There are three main steps involved with the water purification process. These are:

1. **Primary treatment** – Collection, transport, pumping screening and storing raw well and surface waters.
2. **Secondary treatment** – Employing clarification, coagulation, flocculation, filtration, in order to remove total suspended solids, organics, and a host of contaminants.
3. **Tertiary treatment** – Removal of dissolved solids, soluble organics via polishing filters, pH adjustment, & carbon adsorption to remove taste and smells. Disinfection and proper retention time allow disinfecting agents to work before the finished product is allowed into the potable distribution system.

The most widely used technology for laundry water recycling incorporates the some of the same processes used by municipal water treatment facilities; suspended solids removal, adsorption filtration and disinfection.

How Are Contaminants Removed From Wastewater?

Anthony Mazzoni, of TIGG Corporation provides the following explanation of the role that carbon plays in the removal of contaminants in wastewater:

> The primary raw material used for activated carbon is any organic material with high carbon content (coal, wood, peat, coconut shells). Activated carbon has an incredibly large surface area per unit volume, and a network of submicroscopic pores where adsorption takes place. The walls of the pores provide the surface layer molecules essential for adsorption. Amazingly, one pound of carbon (a quart container) provides a surface area equivalent to six football fields.
>
> Physical adsorption is the primary means by which activated carbon works to remove contaminants from water. Carbon's highly porous nature provides a large surface area for contaminants (adsorbates) to collect. In simple terms, physical adsorption occurs because all molecules exert attractive forces, especially molecules at the surface of a solid (pore walls of carbon), and these surface molecules seek other molecules to adhere to. The large internal surface area of carbon has many attractive forces that work to attract other molecules. Thus, contaminants in water are adsorbed (or held) to the surface of carbon by surface attractive forces similar to gravitational forces. Adsorption from solution occurs as a result of differences in adsorbate concentration in the solution and in the carbon pores. The adsorbate migrates from the solution through the pore channels to reach the area where the strongest attractive forces are.
>
> Water contaminants adsorb because the attraction of the carbon surface for them is stronger than the attractive forces that keep them dissolved in solution. Besides physical adsorption, chemical reactions can occur on a carbon surface. One such reaction is chlorine removal from water involving the chemical reaction of chlorine with carbon to form chloride ions.

One of the benefits provided by the use of carbon filtration as used in the application of recycling laundry wastewater is the removal of chlorine from the recycled water. The chlorine is adsorbed by the carbon preventing the return of the chemical to the wash process while also providing positive ecological benefits by removing potentially damaging chlorine compounds from the waste stream.

The Fear Factor: Protection From Bacteria, Viruses and Spores

Bacteria and viruses literally exist everywhere around us and within us. The process of sterilization or the destruction of all microorganisms in a material or on the surface of an object can be a complex and expensive process; not necessary or practical for water treatment.

Disinfection is a process that reduces the number of viable microorganisms by deactivation, but does not completely eliminate microbial life. Disinfection processes used in the water treatment process are able to reduce the number of known pathogens to levels low enough to prevent the spread of disease and protect public health.

While chlorine disinfection is the most well known and widely used method in water treatment, two other widely used and effective methods include ultraviolet (UV) radiation and ozone disinfection.

Ultraviolet Light: Ultraviolet Light or UV as it is commonly referred to is a proven, economical method used for controlling microbiological activity in a variety of recycle water systems. Ultraviolet disinfection systems transfer electromagnetic energy from a mercury arc lamp to an organism's genetic material, (DNA & RNA). When UV radiation penetrates the cell wall of an organism it alters the genetic material of the cell and retards the cells ability to reproduce. When reproduction is inhibited, attrition takes over and the microbial population eventually dies out.

The main advantages of using UV for disinfection are that:

- UV is effective at inactivating most microbes, viruses, spores, and cysts
- UV is a non-chemical method of disinfection eliminating the need to handle or store toxic, hazardous or corrosive chemicals.
- UV creates no residual toxins that can concentrate and harm the ecosystems within the environment.

Ozone: Ozone is an allotropic form of oxygen, O_3. Ozone is generated at the point of use so no storage of hazardous chemicals or elaborate chemical feed systems are required for it to be applied at a given location. It can be generated by passing air through a set of electrodes or photo-chemically using ultraviolet light. Ozone controls bacteria growth by oxidizing or "burning" the cell membrane of these organisms. Once this is done the cell can no longer transport food, oxygen and respiration by-products in and out of the cell. Hence the cell expires.

Ozone has the desirable properties of:

- Being a strong oxidizer for superior disinfection
- Possessing a short half-life to ensure that no waterborne residuals are released or concentrated in the environment.

The use of ozone is a proven, economical, & effective oxidizing agent used for controlling microbiological activity in re-circulating laundry water recycle systems.

The combined use of UV and ozone is not only a highly effective method of microbiological control in municipal water treatment plants, but is incorporated in a widely used laundry water recycle system technology. Ultraviolet disinfection is a proven, dependable and effective method for controlling levels of microorganisms present in the water. Ozone is an effective method for microbial control and minimizing organics present in the water source.

A large centralized healthcare laundry located in Marietta, GA has been recycling their laundry wastewater for over five years, with over 110 million gallons recycled to date. The Support Services Healthcare Laundry has maintained the practice of monitoring bacterial growth on final processed linen as a routine component of their infection control program. Since the installation of the laundry water recycle system, there has been no documented increase in microbial growth on final processed linen. The following independent laboratory study supports this:

Bacteria Counts After UV Treatment:

ASI **ANALYTICAL SERVICES, INC.**

Environmental Monitoring & Laboratory Analysis
110 Technology Parkway Norcross, GA 30092
(770) 734-4200 FAX (770) 734-4201

Elaine
2 pages
1-800 774-75[illegible]

Laboratory Report

WellStar Health System Laundry
1011 Williams Drive
Marietta, GA 30066

Attention: Mr. Austin Ashley
Report No. **225887**

May 23, 2006

Sample Description
WellStar Health System Laundry
Laundry Monitors, March 2006

Analytical Method	Analyte	Result	Detection Limit	Units
	Linen Kit Testing			
	Bath Towels			
	Total Aerobic Plate Count	1	1	CFU/sqin
	Staphylococcus aureus (coagulase positive)	BDL	1	CFU/sqin
	IV Gowns			
	Total Aerobic Plate Count	1	1	CFU/sqin
	Staphylococcus aureus (coagulase positive)	BDL	1	CFU/sqin
	OR Towels			
	Total Aerobic Plate Count	1	1	CFU/sqin
	Staphylococcus aureus (coagulase positive)	BDL	1	CFU/sqin
	Spreads			
	Total Aerobic Plate Count	1	1	CFU/sqin
	Staphylococcus aureus (coagulase positive)	BDL	1	CFU/sqin
	Pillow Case			
	Total Aerobic Plate Count	1	1	CFU/sqin
	Staphylococcus aureus (coagulase positive)	BDL	1	CFU/sqin
	Sheet			
	Total Aerobic Plate Count	3	1	CFU/sqin
	Staphylococcus aureus (coagulase positive)	BDL	1	CFU/sqin

BDL - Below Detection Limit

Page 1 of 2

Report No. 225887

May 23, 2006

Sample Description
WellStar Health System Laundry
Laundry Monitors, March 2006

Analytical Method	Analyte	Result	Detection Limit	Units
	Bath Blanket			
	Total Aerobic Plate Count	2	1	CFU/sqin
	Staphylococcus aureus (coagulase positive)	BDL	1	CFU/sqin

Additionally, laboratory studies have been completed to document bacterial levels in recycled water before and after passing through the recycle system's ultraviolet radiation treatment. The following study documents the efficacy of the UV treatment in reducing the numbers of potential pathogens in the recycled water:

Bacteria Counts Before UV Treatment:

ASI ANALYTICAL SERVICES, INC.

Draft Report
Preliminary Results Only
All Results and Detection Limits are Subject to Change Pending Final Review

Draft Laboratory Report

E M I
450 Ridgewater Drive
Marietta, GA 30068

Attention: Mr. Jeff Lebedin
Report No. **173848-2**

April 10, 2003

DRAFT -- Sample Description -- DRAFT
E M I
Wastewater, Grab, Embassy Suites - Airport, Final Before UV, 04/07/2003, 14:10, received 04/07/2003

Analytical Method	Analyte	Draft Result	Detection Limit	Units
	Microbiology			
SM 9222 D	Fecal Coliform	2100	10	CFU/mL
	Staphylococcus aureus (coagulase positive)	not	1	CFU/mL

ASI ANALYTICAL SERVICES, INC.

Draft Report

Preliminary Results Only

All Results and Detection Limits are Subject to Change Pending Final Review

Draft Laboratory Report

E M I
450 Ridgewater Drive
Marietta, GA 30068

Attention: Mr. Jeff Lebedin
Report No. **173848-3**

April 10, 2003

DRAFT -- Sample Description -- DRAFT

E M I

Wastewater, Grab, Embassy Suites - Airport, Final After UV, 04/07/2003, 14:08, received 04/07/2003

Analytical Method	Analyte	Draft Result	Detection Limit	Units
	Microbiology			
SM 9222 D	Fecal Coliform	BDL	10	CFU/mL
	Staphylococcus aureus (coagulase positive)	not	1	CFU/mL

The Chlorine Dilemma

According to the EPA, Chlorine compounds are used to disinfect water in about 98 percent of the publicly supplied drinking water. Chlorine has proven to be a very effective method for disinfection but it has some drawbacks. Chlorine is a very strong oxidizer that is non-selective so whatever it comes in contact with, it will try to oxidize. Chlorine readily reacts with many organic compounds to form stable organic-chlorine compounds that can bio-accumulate and bio-magnify in the various food chains that exist in our ecosystem. An example of this is the bio-concentration of polychlorinated biphenyls (PCBs), in fish & birds in the Great Lakes Region. Another suspected organic-chlorine compound is the pesticide DDT that is thought to imitate the biochemical properties of the hormone estrogen and affect the reproductive ability of several species of birds.

The biggest issue with chlorine compounds is that they are stable and quite resistant to biodegradation. As such the concentration is increased in the environment and they are allowed the exposure time and concentration to affect the various ecosystems in an adverse manner.

The Federal EPA is currently in the process of developing a national strategy for substituting, reducing, or prohibiting the use of chlorine and chlorinated compounds.

This attempt to protect our environment by restricting the use and discharge of chlorine presents challenges to laundries that routinely utilize chlorine in the wash process for disinfection and whitening.

As mentioned, the activated carbon utilized in laundry water recycling removes chlorine from the wastewater, preventing the discharge of harmful chlorine compounds into the environment – yet another consideration in the decision to recycle.

Healthy Buildings

As we become more aware of the impact that our buildings have on our health and our environment, the practice of Green or sustainable building is gaining momentum in the marketplace. Healthcare institutions are embracing the practice as an effort to be socially responsible and to reduce operating costs.

Two leading organizations that provide resources and guidelines for environmental sustainability in healthcare include Hospitals for a Healthy Environment (H2E) and LEED (Leadership in Energy and Environmental Design).

H2E was jointly founded by the American Hospital Association, the U.S. Environmental Protection Agency, Health Care Without Harm and the American Nurses Association. The organization provides education and resources about best environmental practices in their efforts to improve the health of their communities.

The LEED United States Green Building Council's (USGBC) Rating System® is a voluntary, consensus-based national standard for developing high-performance, sustainable buildings. LEED certification recognizes the achievements of institutions in the areas of sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. Points are provided in each area providing the opportunity to achieve this increasingly coveted status.

LEED certification of water and energy projects requires achievement of at least 40 percent of the following core credits as determined by the USGBC LEED Steering Committee. The practice of laundry water recycling can contribute to LEED certification in the following categories:

- Sustainable Sites - (8 Credits / 14 Points)
  Storm water Management, Drift, Spills, Emission
- Water Efficiency – (3 Credits / 5 Points)
  Blowdown for Irrigation and Reduced Sewage Flow
- Indoor Environmental Quality - (8 Credits / 15 Points)
  Pollutant Source Control
- Innovation & Design (2 Credits / 5 Points)
  CIR approved for Non Chemical Treatment and Points Awarded
- Materials & Resources - (7 Credits / 13 Points)

It is projected that the federal government will in time require LEED certification for all new construction. An increasing number of building projects have achieved certification and are enjoying the benefits that come with LEED status.

An Understanding

In conclusion, fresh water supplies are limited today and will be in greater demand in the future. Many of these water sources have been or will be determined to have levels of contamination that will render them unfit for consumption. Water and energy costs are skyrocketing in the US and the world. Many if not all countries will accrue tremendous costs of maintaining and upgrading the current status of our water treatment infrastructure.

In the future the challenge to reduce water consumption and discharge will increase for industries that consume this resource. As such, the water treatment technologies that decontaminate, recycle, and reduce water consumption will become more prevalent.

Perhaps a more thorough understanding of the issues surrounding our challenge and the processes available to address our current and future water needs will help to alleviate some of the fears that exist today with regard to laundry water recycling.

Founded in 1998, AquaRecycle™ is a privately-held company based in Marietta, Georgia. Satisfied customers include major hotel chains, large commercial laundries, hospital laundries, coin laundries, and correctional facilities across the country. For additional information call toll-free 1-866-AQCYCLE (1-866-272-9253) or (770) 973-6207, or visit the AquaRecycle website at www.aquarecycle.com.