Engineering Data Sheet

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Process: Pathogens And Their Control

A **pathogen** or **infectious agent** is a biological agent that causes disease or illness to its host. The term is most often used for agents that disrupt the normal physiology of a multicellular animal or plant. However, pathogens can infect unicellular organisms from all of the biological kingdoms. The term *pathogen* is derived from the Greek παθογένεια, "birth of pain." There are several substrates and *pathways* whereby pathogens can invade a host; the principal pathways follow different episodic time frames, but soil contamination has the longest or most persistent potential for harboring a pathogen.

The human body has many natural defenses against some of common pathogens (such as *Pneumocystis*) in the form of the human immune system and by some "helpful" bacteria present in the human body's normal flora. However, if the immune system or "good" bacteria is damaged in any way (such as by chemotherapy, human immunodeficiency virus (HIV), or antibiotics being taken to kill other pathogens), pathogenic bacteria that were being held at bay can proliferate and cause harm to the host. Such cases are called opportunistic infections.

Some pathogens (such as the bacterium *Yersinia pestis*, which may have caused the Black Plague, and the *Variola* virus) have been found to be responsible for massive amounts of casualties and have had numerous effects on afflicted groups. Plague is carried by fleas. Of particular note in modern times is HIV, which is known to have infected several million humans globally, as well as Severe Acute Respiratory Syndrome (SARS). Today, while many medical advances have been made to safeguard against infection by pathogens through the use of vaccinations, antibiotics, and fungicides, pathogens still continue to threaten human life.

Types of pathogens

Below is a listing of different types of notable pathogens as categorized by their structural characteristics, and some of their known effects on infected hosts.

Pathogen	Examples	Typical effects
Bacteria	*Escherichia coli*	honeymoon cystitis or urinary tract infection (UTI), peritonitis, food poisoning
	Mycobacterium tuberculosis	tuberculosis
	Bacillus anthracis	anthrax
	Salmonella	food poisoning
	Staphylococcus aureus	toxic shock syndrome
	Streptococcus pneumoniae	pneumonia
	Streptococcus pyogenes	strep throat
	Helicobacter pylori	Stomach ulcers
	Francisella tularensis	tularemia
Viruses	*Hepatitis A, B, C, D and E*	liver disease
	Influenza virus	flu
	Herpes simplex virus	herpes
	Molluscum contagiosum	rash
	Human immunodeficiency virus	AIDS
Protozoa	*Cryptosporidium*	cryptosporidiosis
	Giardia lamblia	giardiasis
	Plasmodium	malaria
	Trypanosoma cruzi	chagas disease
Fungi	*Pneumocystis jiroveci*	opportunistic pneumonia
	Tinea	ringworm
	Candida	candidiasis
Parasites	Roundworm	
	Scabies	
	Tapeworm	
	Flatworm	
Proteins	Prions	BSE, vCJD

Transmission of pathogens

One of the primary pathways of food or water become contaminated is from the release of untreated sewage into a drinking water supply or onto cropland, with the result that people who eat or drink contaminated sources become infected. In developing countries most sewage is discharged into the environment or on cropland as of 2006; even in developed countries there are periodic system failures resulting in a sanitary sewer overflow. This is the typical mode of transmission for the infectious agents of (at least):

1. Cholera
2. Hepatitis A
3. Polio
4. Rotavirus

Transmission to vascular plants

In the case of terrestrial vascular plants, pathogenic infection can occur by contact with foliage, and also from root uptake of soil pathogens. The latter pathway explains why some plant families such as orchids are more disease resistant, since they rely upon fungal hyphae to supply nutrients rather than root structures, which have larger radii for conveying certain pathogens. For more complete information please visit cdc.gov.

Method combines ozone and ionization to kill pathogens: 26/05/2006 - Transforming a method originally developed to decontaminate spacecraft could be new means of destroying pathogens in processing plants, according to scientists.

Scientists at Kansas State University are working with EcoQuest International of Greenville, Tennessee to investigate a way of using ozone along with ionization to reduce several pathogens, including E. coli and Listeria monocytogenes, in food processing plants. The method was originally developed by the US National Aeronautics and Space Agency to decontaminate spacecrafts during long missions.

With the increasing emphasis by consumers and regulators on food safety, and the prospect of costly recalls, fines, and brand damage, processors are constantly on the lookout for quicker and cheaper ways of preventing bacterial contamination of their products.

The new food safety technology consists of an antimicrobial part that uses oxidated gases such as peroxide and ozone and the ionized part, said James Marsden of the university's Food Safety Consortium research unit.

"Here we're talking about oxidated gases that basically fill the room with a somewhat aggressive antimicrobial system – extremely safe and breathable," Marsden said.

The levels of ozone are very low in terms of standards set by the Occupational Safety and Health Administration and the Food and Drug Administration, he said.

The researchers used stainless steel surfaces to test the system's effectiveness in removing contaminating bacteria. The ionization system removed more microbial populations than ozone at shorter exposure times, they claimed in the spring issue of the Food Safety Consortium's newsletter.

Ozone already has a good track record as a disinfectant. In 2001 the FDA approved its use as a sanitizer for food contact surfaces and for direct application to food products. It is also used extensively for purification of bottled and municipal water.

"In the meat and poultry industry there are some applications for ozone where products are being treated with aqueous ozone prior to being sliced," Marsden said. *"They're looking at ozone for decontamination of poultry chillers and for direct decontamination of birds as they go down the processing line."*

Five years since government approval of the process is not a long time to determine how well applications are going to work, particularly in the meat and poultry industry, he said.

The scientists and EcoQuest will also examine its effectiveness in inactivating avian influenza environmentally. They may also investigate how the system could control Listeria in ready-to-eat meat processing plants.

The recent research results showed that ionization was effective in reducing levels of Staphylococcus auerus, leading researchers to consider the implications for hospitals and nursing homes.

"The ionization effect is that it eliminated odors," Marsden said. *"For odors to be present they have to be aeromatic, so if you take it out in particle form and inactivate further with peroxide and ozone, it might have some application as well in hospitals, nursing homes and the food industry."*

Marsden likens a new process using ionization to a *"miniature sun"* of ultraviolet energy interacting with oxygen and drawing particles out of the air, thus producing an antimicrobial effect.

"When Mount St. Helens went off, you had all these particles floating around," he said. *"The reason they're not still floating around is that ionization from the sun caused them to fall out of the air."*

Ozone decays quickly in water, thus, its use may be considered as a process rather than a food additive, with no safety concerns about consumption of residual ozone in food products. Ozone has been used with varied success to inactivate microflora on meat, poultry, eggs, fish, fruits, vegetables, and dry fruits.

Ozone gas is a naturally occurring tri-atomic form of oxygen that is formed as sunlight passes through the atmosphere. It can be generated artificially by passing high voltage electricity through oxygenated air.

Because ozone is an unstable, highly reactive form of oxygen, it is 51 times as powerful as chlorine, the oxidizer most commonly used by most food processors, and 3,000 times as fast at killing bacteria and other microbes.

While chlorine has traditionally been the sanitizer of choice in the food processing industry, there is a growing concern about such byproducts as trihalomethanes or dioxins produced when chlorine reacts with organic matter in the water. The substances are known carcinogens and are regulated in drinking water.

The possibility of replacing chlorine is attractive for industries seeking to reduce chemical use and eliminate the generation of chlorinated wastes

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