
ThermaPureHeat® - A Remediation Process for Floodwater Pathogens

Abstract:

The recent storms across the South have caused a multitude of problems. One significant problem is the presence of biological pathogens found in structures damaged by floodwaters. A process for a safe and effective disinfection of structures impacted by floodwaters is needed. Pasteurization, a process used successfully for 150 years in food products, can be applied similarly to structures for disinfection. By reaching temperatures lethal to many of the pathogens associated with floodwater contamination, ThermaPureHeat® “pasteurizes” structures.

It is difficult to know the extent of contamination that may be present as a result of floodwater; therefore, every drying and/or remediation project in an occupied structure should assume the worst and be disinfected. ThermaPureHeat® is one of the most thorough disinfection processes because of both efficacy toward the target and the ability to penetrate inaccessible areas. This process does not use chemicals or biocides and therefore no additional hazards are added to the space. It is unique as a disinfectant process because it thoroughly dries the structure and kills the unwanted pathogens and their insect vectors with the same treatment.

Description of Problem:

In the current aftermath conditions from the storms of 2005, the extensive flooding has created a significant environmental health concern. The potential contaminants in floodwaters include a variety of biological pathogens. These pathogens present the opportunity for a number of water and excreta-related health problems and diseases. Many of these pathogens can remain viable in a structure for up to a year. Some can remain longer in a moist environment. As structures dry, many can be aerosolized and move within the building. Rodents and insects also act as vectors transporting these pathogens throughout a structure. Disinfection of this group of pathogens in flooded structures is a complex and demanding problem.

Floodwaters present non-biological contamination problems as well. Gasoline, pesticides and other chemicals may be carried by water into structures. The volatile organic compounds (VOCs) associated with many of these chemicals present a potential hazard to occupants as they slowly off-gas over the next several months.

Assumed Hazards:

Typical assessment of pathogens found in floodwater focuses on the measurement of *Escherichia coli*. The presence of *E. coli* is used as a yardstick for the assumption of biological contaminants in structures impacted by floods or other sewage contaminated water. Although this assessment is generally adequate to determine the presence of sewage related biological pathogens, it may not be adequate to determine the appropriate remedial response for the structure. Some floodwater pathogens may be more difficult to kill or reduce to safe levels than *E. coli*.

ThermaPureHeat® - A Remediation Process for Floodwater Pathogens

Recent studies of *E. coli* contaminations indicate that there is a possibility of human infection up to ten months after the original contamination.¹ Other species may have even greater durability. *Salmonella*, for example, has a longer life outside of the host and therefore has the potential of infecting a larger number of species, including flies, cockroaches and other vectors. This may be true of other microbes as well. It is important to note that floodwater contaminated structures can remain a health concern for a long period of time. This is particularly true if the building remains moist or wet. In fact, the conditions will worsen over time.

The bulk of data used in this paper regarding pathogens in floodwater is found in studies provided to assist in the management or design of water supply and sanitation systems.² Because of the size and magnitude of some of the hurricane floodplains the contaminated water and attendant pathogens are comparable to sewage contamination. Efficacy studies regarding the thermal death rate of floodwater pathogens are derived from these sources.

Pathogens found in buildings affected by sewage-impacted floodwaters include bacteria, viruses, protozoa, and helminths. According to the World Health Organization (WHO) these pathogens impact human health. Although it is not the purpose of this paper to understand specific health concerns associated with these pathogens, it is the intent to understand the resolution – structural disinfection of floodwater contaminated buildings. Included in these categories are a few of the assumed water and excreta-related pathogens.

- Bacteria:
 - *Escherichia coli*
 - *Salmonella enterica*
- Viruses
 - Rotovirus
- Protozoa
 - *Giardia lamblia*
 - *Entamoeba histolytica*
- Helminths
 - *Nematodes* – roundworms, hookworms, *Ascaris lumbricoides*
 - *Cestodes* - tapeworms

The potential for infection of occupants in a structure comes from various vectors. The vectors found to transport or transmit these pathogens in buildings include³:

- Feco-oral
- Water-washed
- Water-based

¹ Varma, J.K., et al, (2003). “An outbreak of *Escherichia coli* infection following exposure to a contaminated building”. *Journal of American Medical Association*, 290(20), 2709-2712.

² Feachem, R. et al,(1983). *Sanitation and Disease Health Aspects of Excreta and Wastewater Management*. Wiley, Dorchester, England.

³ Mara, D.D., Feachem, R.G.A., (1999) “Waterborne and Excreta-Related Disease: Unitary Environmental Classification”, *Journal of Environmental Engineering-ASCE*, 125 (4), 334-339.

ThermaPureHeat® - A Remediation Process for Floodwater Pathogens

- Excreta-based insect and rodent vectors
- Aerosol

The importance of this is to demonstrate the dynamic nature of a floodwater-contaminated building. Occupants can be affected by a wide variety of routes and vectors making the resolution more complex. ThermaPureHeat® is the only process that effectively treats all of the pathogens present as well as impacting the vectors and routes.

Thermal Inactivity of Specific Pathogens:

Temperature is a more thorough intervention process in the inactivation of enteric pathogens. According to the WHO, "...heating to pasteurization temperatures (generally 60C) for periods of minutes to tens of minutes will destroy most waterborne pathogens of concern" (Sobsey, 2002)⁴. This general statement may be adequate to recommend utilization of heat for the disinfection of floodwater-impacted structures. However, for the purpose of this paper, more specific targets have been identified to further define the efficacy of the process. The following table shows specific pathogens that can be rendered inactive by temperatures within the range of ThermaPureHeat®:

Pathogen Genus, Species	Family	Thermal Death Rate	Time Required	Source
Escherichia coli	Bacteria	60C/140F	45 minutes	Padhye & Doyle ⁵
Salmonella	Bacteria	60C/140F	1 hour	Feachem ⁶
Shigella	Bacteria	55C/131F	1 hour	Feachem ⁷
Giardia lamblia	Protozoa	60C/140F	2-3 minutes	Univ of Utah ⁸
Entamoeba histolytica	Protozoa	60C/140F	1 minute	Feachem ⁹
Rotovirus	Virus	63C/145F	30 minutes	G.N. Woode ¹⁰
Poliovirus 1	Virus	60C/140F	5 minutes	Wiley (1969) ¹¹
Enteroviruses	Virus	60C/140F	2 hours	Feachem ¹²
Ascaris lumbricoides	Helminths	55C/131F	1 hour	Feachem ¹³

⁴ Sobsey, M., (2002) "Managing water in the home, accelerated health basis of improved water supply", World Health Organization.

⁵ Padhye, N.V. and Doyle, M.P. 1992. "Escherichia coli O157:H7: Epidemiology, pathogenesis, and methods for detection in foods". *J. Food Protect.* 55(7):555-565.

⁶ Feachem, R. et al, (1983) *Sanitation and Disease Health Aspects of Excreta and Wastewater Management*, Wiley, Dorchester, England, p278.

⁷ Feachem, R. et al, (1983) *Sanitation and Disease Health Aspects of Excreta and Wastewater Management*, Wiley, Dorchester, England, p294.

⁸ *Wilderness Medicine*, (2005) University of Utah, School of Medicine.

⁹ Feachem, R. et al, (1983) *Sanitation and Disease Health Aspects of Excreta and Wastewater Management*, Wiley, Dorchester, England, p342.

¹⁰ Feachem, R. et al, (1983) *Sanitation and Disease Health Aspects of Excreta and Wastewater Management*, Wiley, Dorchester, England, p188.

¹¹ Feachem, et al, (1983).

¹² Feachem, et al, (1983)

¹³ Feachem, et al, (1983).

ThermaPureHeat® - A Remediation Process for Floodwater Pathogens

Application of ThermaPureHeat® Technology:

The efficacy of ThermaPureHeat® in its simplest form is a result of the combination of temperature and duration. The complexity of any disinfection is achieving efficacy in all areas of the structure. What differentiates ThermaPureHeat® is the ability to disinfect the entire structure, including inaccessible areas. Buildings are complex and the requirement for uniform temperature throughout a structure is necessary to achieve efficacy. Heat technicians are thoroughly trained in construction materials, thermal dynamics and the intended targets. Buildings have materials that conduct heat, that create radiant losses, and that are heat sinks. The heat technician must understand each of these conditions and others. Temperatures are monitored real-time in difficult to heat locations. In a wooden structure these places might be under sill plates and between header boards. Crawlspace and sub-areas provide additional difficulties. ThermaPureHeat® can treat all structures. Additionally, this process typically includes laboratory testing to document the reduction of bacteria following treatment.

The process of pasteurization of a structure appears to uniformly impact these pathogens related to floodwaters. Other methods of disinfection are not as uniform in result. For example, *Giardia* cysts are resistant to chlorination and a wide range of pH.¹⁴ Other methods may not be ovacidal, for example in the case of helminthes the eggs of *Ascaris* are more resistant than the larvae. Other processes are not as safe and are not as effective. Heat, as a disinfectant, is uniform and non-discriminatory in application. Pasteurization of a building is an effective process to reduce pathogens to safe levels.

Conclusion:

All buildings affected by floodwaters should be disinfected. The most thorough method of disinfection is ThermaPureHeat®. ThermaPureHeat® is a patented, non-chemical, engineered process that “pasteurizes” structures. This process is the most effective because it is the only process that kills or inactivates the majority of pathogens present. Additionally, it is the only treatment that inactivates these pathogens in inaccessible areas. By more thoroughly drying the structure it prevents these pathogens from vectoring from other sources and becoming viable. Vector sources include rodents, cockroaches, and other insects. Added value for the process is the reduction of VOCs that may have resulted from chemical contamination associated with the floodwaters. Much like the pasteurization of food products, ThermaPureHeat® reduces the biological contaminants in a structure to levels safe for occupants.

Larry D. Chase, Vice President, E-Therm, Inc.

Article reviewed by Sean P. Abbott, Ph.D., E-Therm Inc., Scientific Advisory Board

December 2005

¹⁴ Feachem, et al, (1982) p354.