Deicing/Propylene Glycol (PG) Microbial Remediation Technology

Environment, Energy Security, & Sustainability (E2S2) Symposium & Exhibition
Ernest N. Morial Convention Center
New Orleans, Louisiana

David J Dougherty, PMt, *CTC* - presenter
Elizabeth Berman, Ph.D., AFRL/RXSCP

CTC Concurrent Technologies Corporation

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
MAY 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Deicing/Propylene Glycol (PG) Microbial Remediation Technology	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Air Force Research Laboratory,AFRL/RXSCP,2179 12th St, Ste 122,Wright Patterson AFB,OH,45433-7718**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Presented at the NDIA Environment, Energy Security & Sustainability (E2S2) Symposium & Exhibition held 9-12 May 2011 in New Orleans, LA.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**19**	

Outline

A. Background
B. Issues
C. PG Remediation Project
D. Summary
E. Questions

Background

- Aircraft deicing fluids (ADF) work ⇨ planes fly in the winter
  - Military uses ADF with propylene glycol (PG) per specifications
  - PG is purchased in a concentrated form and applied as a 40:60 fluid to water mixture
- Airports use significant amounts of PG-based ADF
  - Maine Air National Guard Base (ANGB), Bangor uses approximately 40,000 gallons a season
- Currently, no approved alternatives to PG-based ADF
  - Aeronautical Enterprise Deicing Working Group is actively seeking solutions

PG-Related Issues

- Deicing creates significant environmental compliance and pollution prevention issues
  - Heavily regulated by the EPA under the Clean Water Act and through the National Pollution Discharge Elimination System (NPDES) program
  - BOD concerns because biodegradation process of PG consumes free oxygen molecules in water and can stress or kill aquatic life
  - Toxicity concerns associated with the fire-suppression additives and corrosion inhibitors in ADF

PG Remediation Project

- USAF AFMC F-16 Corrosion Office, AFRL/RXSCP, and *CTC* will:
  - Conduct a requirements analysis and technology assessment
  - Conduct laboratory test on microbial solutions to determine their effectiveness at bench scale
  - Conduct a field demonstration at Maine ANGB, Bangor
  - Transition the most successful technology

Technology Assessment

- Identified 10 technologies, consisting of
  - Bioremediation
  - Standard Mechanical Filtration (RO & UF)
  - Evaporative Processes (MVR and TVR)
- Chose bioremediation because it is:
  - Less capital intensive
  - Requires less maintenance
  - Requires less oversight

Bioremediation

- Bacteria consume a targeted contaminant by
  - Consuming it and/or converting into something else (i.e., CO_2 & water)
- In general, well established and field-proven process
  - Use for deicing runoff needs to be validated

Deicing runoff is captured and sent to a treatment plant

PG Bioremediation Product

- Operator pours the microbial solution into runoff containing spent ADF
  - Amount will be predetermined given the holding container's size
- Some agitation may be required for mixing and aeration for oxygenating the solution into the spent ADF
  - Stirring should be minimal
- Runoff degrades PG content and then is sent to the Publicly Owned Treatment Works (POTW)
  - Amount of retention time to be validated by laboratory testing

PG Remediation Project

- **Military criteria for ADF Remediation Products**
  - Remediates spent PG-based ADF (at least 20,000 gallons per day) to <350 milligrams per liter (mg/L) chemical oxygen demand (COD)
  - Commercially available
  - Cost effective
  - On-site treatment
  - User friendly, low maintenance

Laboratory Testing

- Tested 3 microbial solutions on a 5% PG concentrate solution
  - Samples were taken at 0-, 48-, 96- and 144-hour intervals
- Used Maine ANGB's deicer runoff and a commercial deicer
- Validated all three products could remediate the PG at 5%

PG Remediation Project

- Laboratory test results example

Sample ID	Date Sampled	Hours Incubated	COD_{TOTAL} (mg/L)	COD_{SOL} (mg/L)	pH	SPC Bacteria (CFU/mL)	%PG (FTIR)	%PG (GC)
10-03330-C	9/17/10	0	81,700	59,700	5.52	830,000	5.64	5.97
10-03338-C	9/19/10	48	84,800	69,400	6.08	2,120,000,000	5.47	0
10-03346-C	9/21/10	96	104,700	61,400	6.06	3,800,000,000	5.08	0
10-03354-C	9/23/10	144	91,800	64,800	6.07	4,500,000,000	4.04	0

- Overall results showed the PG concentration was reduced to a non-detect level after 96 hours
- Additional testing occurred with 10% and 20+% concentrations

Field Demonstration

- Laboratory-proven products underwent field demonstration testing
- Maine ANGB, Bangor is home to 101st Air Refueling Wing (ARW) Medical Group (MDG)
  - Equipped with deicing pads with dedicated drains
- Site contains three 57,000-gallon underground tanks as well as three 6,000-gallon tanks
  - Microbes are added into the 6,000-gallon tanks

Field Demonstration Preparation

Three 57,000-gallon tanks that Maine ANGB uses as holding tanks prior to release of runoff to the POTW

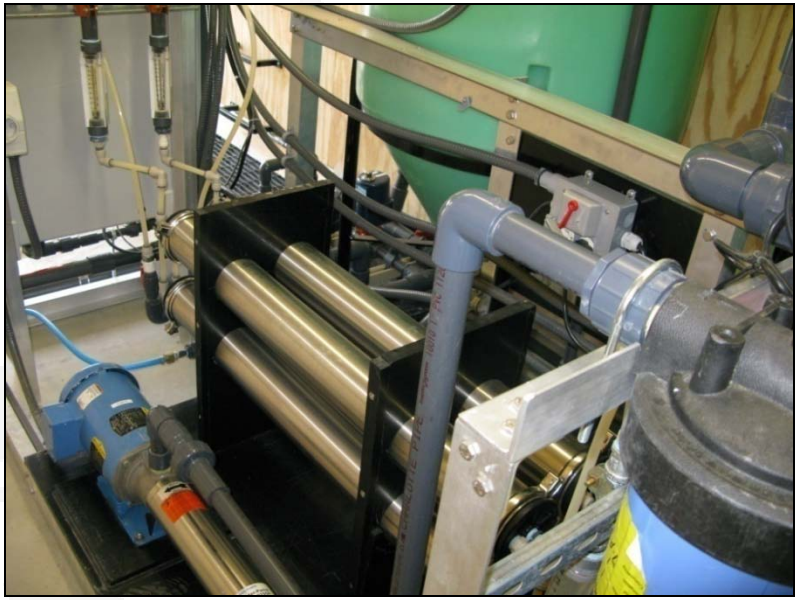
Field Set Up

Three 6,000-gallon tanks have been installed for the application of the microbial products

Field Equipment

Test Site Shed

Control panel inside shed



Pumps, filters and gauges inside shed

Summary

- PG bioremediation products have good potential
  - Additional testing is required prior to implementation
  - Maine ANGB has been a great partner and would support future endeavors
- Regulations will only get more stringent
- Knowledge gained can be directly applied to other Air Force and Department of Defense Weapon Systems as well as civilian applications

Questions

Contacts

David J. Dougherty, PMt
Concurrent Technologies Corporation
100 *CTC* Drive
Johnstown, PA 15904
Phone: (814) 262-6972
E-mail: **dougherd@ctc.com**

Elizabeth S. Berman, Ph.D.
USAF AFMC AFRL/RXSCP
Pollution Prevention Group
Materials & Manufacturing Directorate
Air Force Research Laboratory
2179 12th St, Ste 122
WPAFB, OH 45433-7718
Phone: (937) 656-5700
E-mail: **Elizabeth.Berman@wpafb.af.mil**

Paul H. Hoth, CHMM
USAF AFMC OO-ALC/GHBEX
F-16 Engineering Sustainment Branch
6080 Gum Lane
Hill AFB, UT 84056-5825
Phone: (801) 775-4889
E-mail: **Paul.Hoth@hill.af.mil**

Concurrent Technologies Corporation

Putting ideas into action.SM

1-800-CTC-4392

www.ctc.com