

The Use of Anhydrous Ammonia for Bioventing

R.G. Zytner, M. Hallman, R. Jennings,
B.Fernandez- Gimenez, and K. Leek

School of Engineering
University of Guelph

Overview

- Bioventing
- Challenges
- Objective
- Method
- Results and Discussion
- Conclusions

Bioventing

- Popular in-situ remediation technology for hydrocarbon contamination
- Application
 - nutrients
 - oxygen
 - water
- Stimulates growth of hydrocarbons degraders

Challenges

- Nutrient requirements
 - type of nutrient
 - concentration
- Means of supplying nutrients

Objective

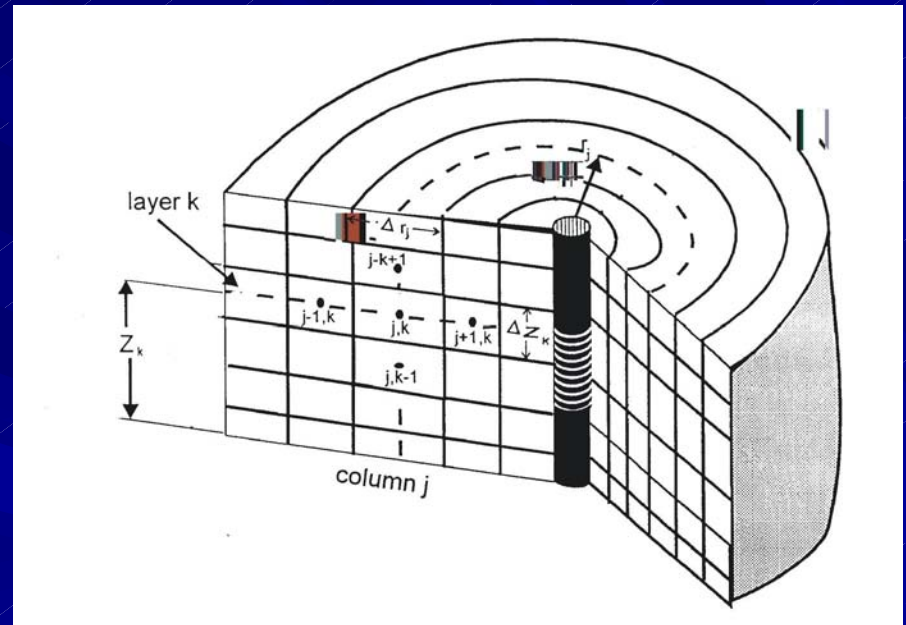
- Investigate the possibility of injecting anhydrous ammonia into subsurface to satisfy nutrient requirements
 - popular agricultural amendment
 - gaseous form

Method

- Modelling
 - 2-D finite difference
 - application approach
- Laboratory
 - respirometry
 - comparison of two ammonium sources
 - microbial counts

Method - Modelling

- Determine plausibility of easily and safely dispersing AA into the subsurface
- Model written to describe radial flow of AA



Method – Modelling – cont.

- Assumptions

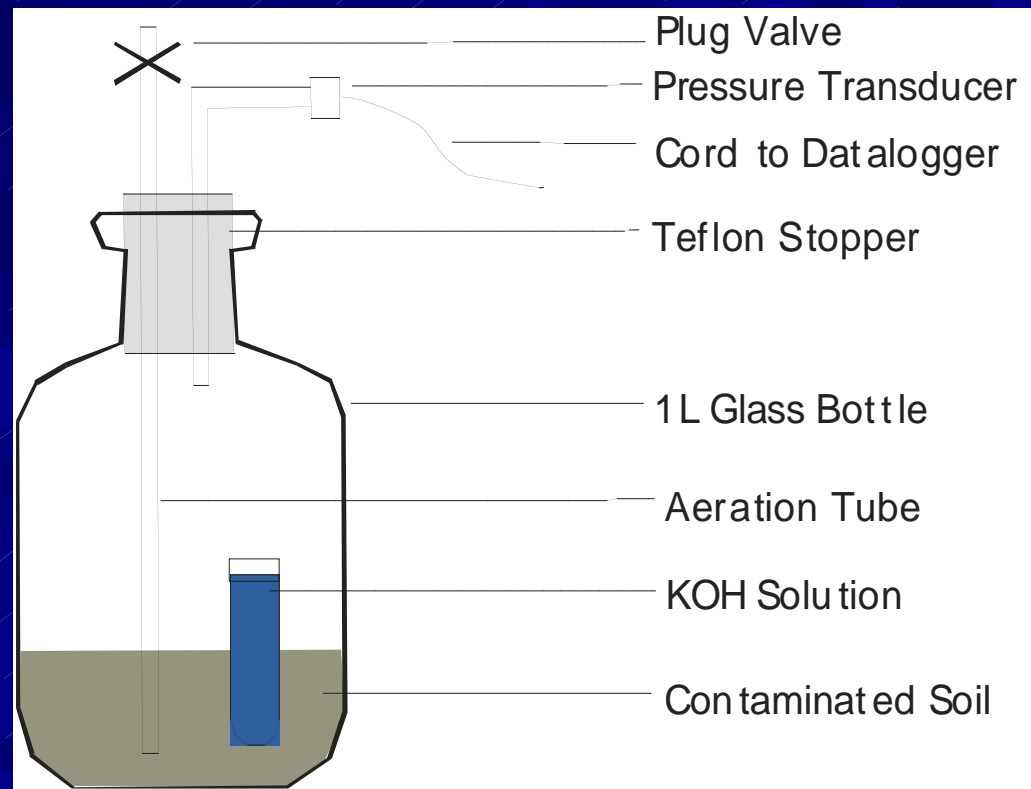
- AA behaves as ideal gas
- aqueous and organic phases stagnant
- biological and chemical degradation of AA during injection negligible
- gas flow according to Darcy's law

Method - Modelling – cont.

- Boundary Conditions
 - Depth of contamination 2.5 m
 - Well screened for 2 m
 - Radius of influence 7.5 m

Method - Laboratory

- Respirometer



Method - Laboratory – cont.

- Soil tested
 - gasoline contaminated soil
 - fine sand
 - TPH @ 2300 mg/kg
 - water content @ 10 wt%
- Nutrients added to attain C:N of 10:1
 - NH_4Cl powder
 - Anhydrous Ammonia gas
- Incubator temperature @ 25 C

Method - Laboratory – cont.

Experiments Completed

Run No.	C:N	Nutrient	H ₂ O (wt%)	Incubation Period (d)
1	10:1	NH ₄ Cl	15	2,5,10,15,30
2	10:1	AA	15	2,5,10,15,30

Method - Laboratory – cont.

- Tests completed
 - TPH levels over time
 - microbial counts

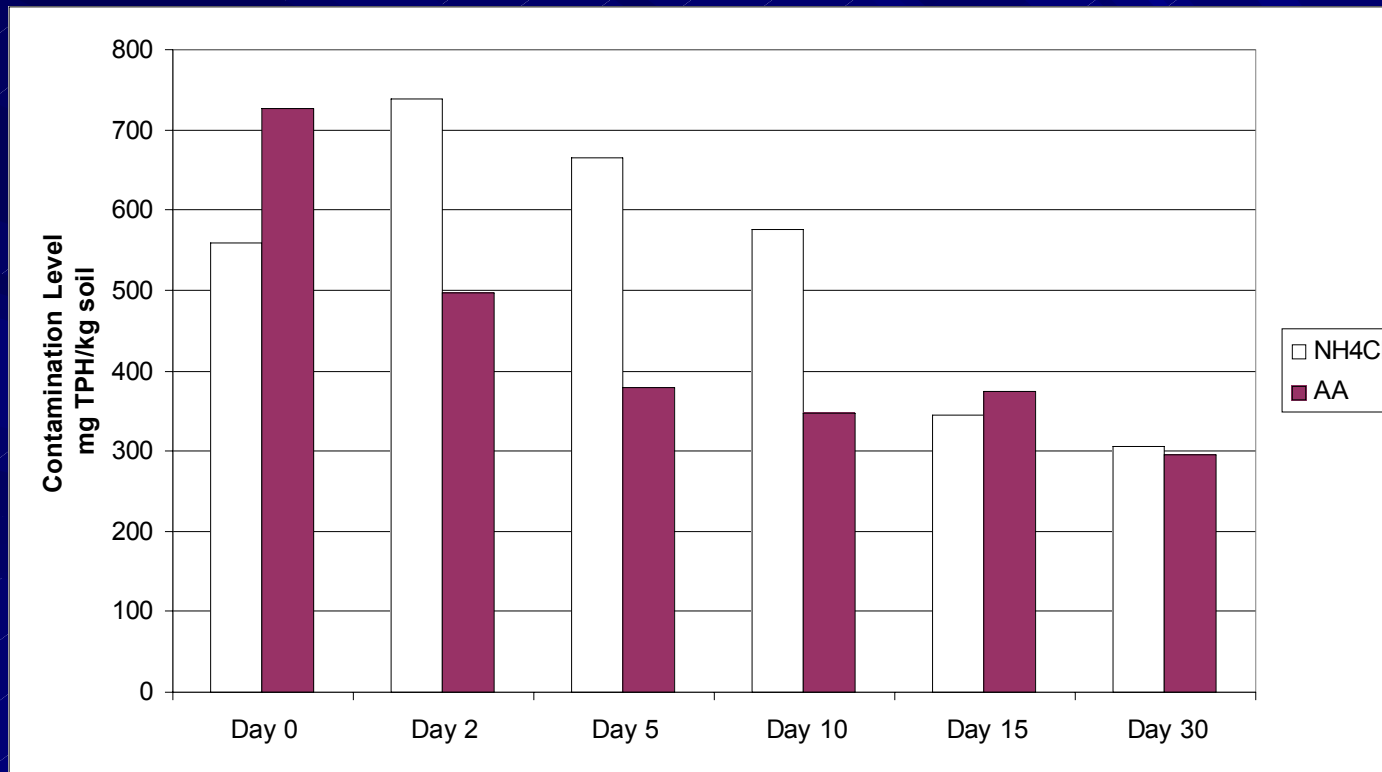
Results - Modelling

- AA could easily be injected into subsurface
 - sparge time of 30 min @ 2 atm
 - resulting concentration 0.15 kg/m³
- Safety
 - handling protocol available
 - application concentrations should be less than 0.15 kg/m³
- Behavior
 - satisfactory degradation of hydrocarbons
 - replenish AA every 30 d

Results - Laboratory

- pH
 - NH_4Cl : 7.7 to 8.2
 - AA: 9.1 to 9.2
- Microbial counts
 - NH_4Cl : 10^5 to 10^6 for hydrocarbon degraders
 - AA: 10^4 for hydrocarbon degraders
- Degradation Rate
 - NH_4Cl : 0.028 d^{-1}
 - AA: 0.023 d^{-1}

Results - Laboratory



TPH Concentrations over Time

Conclusions

- Modelling showed that AA easily and safely injected
 - sparge time of 30 minutes
 - AA would reduce by 80% over 30 d
- AA effective in degrading gasoline
- AA inhibits the growth of microorganisms

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