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ELS Manager's Telecon March 2006

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ELS MANAGER'S TELECON MARCH 2006 4/6/06

Center Director/PI meeting to discuss Year 4

 Cary Mitchell, Dave Kotterman and Leonard Williams at AAMU met to discuss year 4 money and research strategy.

Center Staff Reorganization

 Beginning March 6th, Dave Kotterman accepted another position and is now splitting his time 50% / 50% between Operations Manager of the ALS NSCORT and the Managing Director of the NASA Institute of Nanoelectronics and Computing.

John Kiss Presentation

 On March 30th John Z. Kiss, Department of Botany, Miami University,Oxford, OH gave a presentation entitled" The TROPI experiments on the ISS - the interaction between gravitropism and phototropism in plants"

March's Defense

Mindy Shroyer, Bruce Applegate's Master Student on March 30th.

March's System Group Meeting

- The Systems Group met on March 8th to discuss expected deliverables from the group Emphasis was placed on the scope and breadth of each deliverable and plans were discussed as to how to achieve these between now and September 30th.
 - Development of a menu-driven, crop schedule program to determine edible and inedible input characteristics for pending PAABLO/WAABLO experiments continued.
 - Consulted with Alan Drysdale from Boeing and Ray Wheeler over email and with Cary Mitchell and Gioia Massa from the Biomass/Crop Production group in meetings about crop parameter values from the BVAD.
 - Systems group revisited its deliverables and re-prioritized its activities to maximize its value-added to the ALS community in the wake of the early termination decision of ALS-NSCORT program by NASA on September 30th as:
 - Scholarly Deliverables:
 - Publication Compilation
 - Dissertations
 - Papers
 - Reports
 - Data used in the studies
 - Integrative Deliverables:
 - ALS NSCORT Process Map
 - Map project data sheets (using the survey responses)
 - Map project contact information
 - Map references
 - Synergistic Deliverables:
 - Write white paper "lessons learned"

Education and Outreach

• Dave Kotterman presented "Exploring: How Will We Live on Other Planets?" at Burnett Creek Elementary School for 25 fifth graders and their teacher on March 14th.

Featured Research Project

Dr. Al Heber

Gas-Phase Revitalization Using Biofilters in Advanced Life Support

Research Outcome from First BREATHe II Experiment

- The first BREATHe II experiment was accomplished after 145 days of operation. This experiment investigated the feasibility of biofilters and biotrickling filters to remove multiple contaminants most commonly found in cabin air during long duration space missions. The model waste gas stream contained a five-component mixture of acetone, n-butanol, methane, ethylene, and ammonia at influent concentrations ranging from 6 to 50 ppmv. The experiment employed 10 identical bioreactors that were operated either as biofilters or biotrickling filters. The packing medium types for the biotrickling filters included perlite and polyurethane foam. The packing medium types for the biofilters included perlite, polyurethane foam, and a mixture of compost, wood chips, and straw. Duplicate reactors were run for each of the five operating strategies.
- Under an empty bed residence time (EBRT) of 30 sec, the removal efficiency varied between different contaminants. Complete removal was achieved for easily soluble compounds such as acetone, n-butanol, and ammonia after a short startup period (4-10 days) for all reactors except the foam biofilters. A longer acclimation period existed for the foam biofilter in terms of butanol and acetone removal, this was probably due to the fact that the foam packing media had a poorer moisture retaining capacity and was more susceptible to drying of the packing medium at the startup period.
- Methane was not removed at inlet concentrations ranging from 20 to 50 ppmv under such short EBRT. Biological conversion of methane in a biofilter has been reported to be a slow process due to the extremely low water solubility of methane. Data from this experiment demonstrated that at such short residence time, a methane gaseous substrate level of 20-50 ppmv is too low to sustain the maintenance and growth energy of methanotrophs.
- Ethylene removal varied between reactors with different operating strategies. Both perlite biofilter and perlite biotrickling filters exhibited greater than 95% ethylene removal after day 60, although a decline in performance was observed following a simultaneous increase in inlet ammonia concentration and discontinuance of nitrogen supply in nutrient solution. The foam biotrickling filters, foam biofilters, and compost biofilter also gained momentum in ethylene removal starting from day 45, however, the increase in ethylene removal in these reactors was much slower in comparison with the reactors packed with perlite.
- The desirable biofiltration operating strategy was recommended based on results from the
 above experiment. The perlite biofilters exhibited the highest overall performance in terms of
 contaminant removal over time, followed by the perlite biotrickling filters, the foam biotrickling
 filters, and the foam biofilters. The compost biofilters exhibited the worst overall performance
 in contaminant removal.
- A journal manuscript is currently being developed summarizing the findings from the first BREATHe II experiment.
- An Agilent 6890 GC and Agilent 5875 MS were ordered and received. The GC includes an FID detector. A Gerstel TDS-G Online Thermal Desorption and a cooled injection system for the 6890 GC were ordered and received. This system will be used to measure secondary

volatile organic compounds that are generated by the biofiltration process in the next biofiltration experiment. This purchase was augmented by an equipment grant from the Purdue Center for Environment. Equipment will be installed by mid-May and managed by Dr. Hua Xu, a new post-doc who arrives on May 7.

On-going Experiments

- New biological experimental design has been made and the experimental set-up is currently being carried out to assess: 1) the interactions between ammonia and ethylene removal, 2) the feasibility of using gaseous ammonia as a nitrogen source for ethylene removal, and 3) the effects of liquid recirculation rates on biotrickling filter performance. This new experiment will involve up to 22 bioreactors operated in parallel to accomplish the above objectives.
- Physico-chemical treatment of trace contaminants using charcoal filter adsorption will also be incorporated in the new experiment.

Simulation of Biofiltration and Indoor Air Quality in the ALS System

- A simulation of biofiltration processes was developed to predict the removal efficiency of the
 gas phase contaminants in the ALS cabin during long term space missions. The influences of
 physical, chemical, and biological parameters (e.g., liquid recirculation rate, air flow rate,
 support matrix surface area, matrix depth, Henry's law constant) on the removal efficiency for
 various gaseous contaminants were studied.
- The BREATHe II biofiltration model simulation will be calibrated and validated using the experimental data to be obtained from the new experiment.

Graduate Student Mentoring

- M.S. trainee Hong Huang finished her M.S. study with her thesis entitled *Biofiltration Experimental Testing Lab Setup for Advanced Life Support*.
- Continuing Ph.D. graduate student, Sang-hun Lee, is preparing to take his preliminary exam and proposal defense entitled *Dynamic Simulation of the Biotrickling Filter for Space Cabin Air* in April.

Publications and Presentations

- 1. Lee, S.H., Heber, A.J., and Banks, M.K. (2005). Simulation of Air Quality in ALS System with Biofiltration. *International Conference on Environmental Systems*, Rome, Italy, July 11-14, 2005.
- 2. Li, **C.**, Heber, A.J., Hong, H., Ni, J.Q., Lee, S.H., and Banks, M.K. (2005). A New Lab for Testing Biofiltration for Advanced Life Support. *International Conference on Environmental Systems*, Rome, Italy, July 11-14, 2005.
- 3. **Li**, C., Heber, A.J., Lee, S.-H., Ni, J.-Q. (2006). Biofiltration for Gaseous Trace Contaminant Removal from Spacecraft during Long-term Space Missions. Poster presented at *Habitation Conference*, Orlando, Florida, Feb. 5-8.
- 4. **Li**, C., Heber, A.J. Lee, S-H. Biofiltration for Gaseous Trace Contaminant Removal from Spacecraft during Long-term Space Missions. *Manuscript in preparation*.