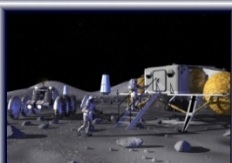




Pressure Flammability Thresholds in Oxygen of Selected Aerospace Materials

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Agenda



- Background of this Investigation
- Experimental Approach
- Results and Discussion
- Conclusions and Recommendations



- Leak rate design of Crew Module (CM) Environmental Control and Life Support Systems (ECLSS)
- Scenario for CM depressurization
- Issue: Flammability in low-pressure oxygen of materials qualified in 30% oxygen at 10.2 psia



Experimental Approach: Test Logic



- Self-extinguishment total pressure limits were determined in oxygen following NASA-STD-6001 Test 1.
- The experimental approach consisted of concentrating the testing in the flammability transition zone following the Bruceton Up-and-Down Method. For attribute data, the method has been shown to be very repeatable and most efficient. Other methods for characterization of critical levels (Karber and Probit) were also considered.
- The data yielded the upward limiting pressure index (ULPI), the pressure level where ~50% of materials self-extinguish in a given environment.



Experimental Approach: Test Logic



- The Bruceton method is from 30 to 50% more efficient than Probit for the same accuracy; the method is widely used for determining the limiting oxygen index as defined and accepted by the combustion community.
- Furthermore, we conducted a number of tests at the highest total pressure the material passes (the material would fail in an environment with 0.1 psia or higher), to determine the maximum total pressure (MTP) - defined as the MTP where all samples tested (at least five) self-extinguish following the NASA-STD-6001 failure criteria.



Test Materials



- Rigid plastics: polysulfone (Udel), PVC/PMMA alloy (Kydex)
- Composite: epoxy/fiberglass (NEMA G-11, Westinghouse)
- Foam: polyimide (TA-301)
- Fabric: aramid (Nomex)
- Films: PET (Melinex), polyetherimide (Ultem)



Results and Discussion



Material	ULPI	MTP	ULOI	MOC
Epoxy/glass	0.9	0.8	28.6	24
Udel P1700	1.0	0.9	31.7	29
Kydex 100	1.8	0.6	33.5	32
Solimide TA-301	0.7	0.5	29.3	28
Melinex 515	0.9	0.4	21.2	20
Nomex HT90-40	0.6	0.5	28.5	25
Ultem 1000	1.5	0.9	26.5	24

Pressure and oxygen concentration flammability limits for selected materials



Conclusions and Recommendations



- Parametric flammability thresholds other than oxygen concentration can be determined with the methodology proposed for evaluating the MOC when extinguishment occurs.
- In this case, a pressure threshold in 99.8% oxygen was determined with the methodology and found to be 0.4 to 0.9 psia for typical spacecraft materials.
- Correlation of flammability thresholds obtained with chemical, hot wire, and other ignition sources will be conducted to provide recommendations for using alternate ignition sources to evaluate flammability of aerospace materials.

