AIAA-00-3556
Commercial Production and Use of Hydrogen Peroxide

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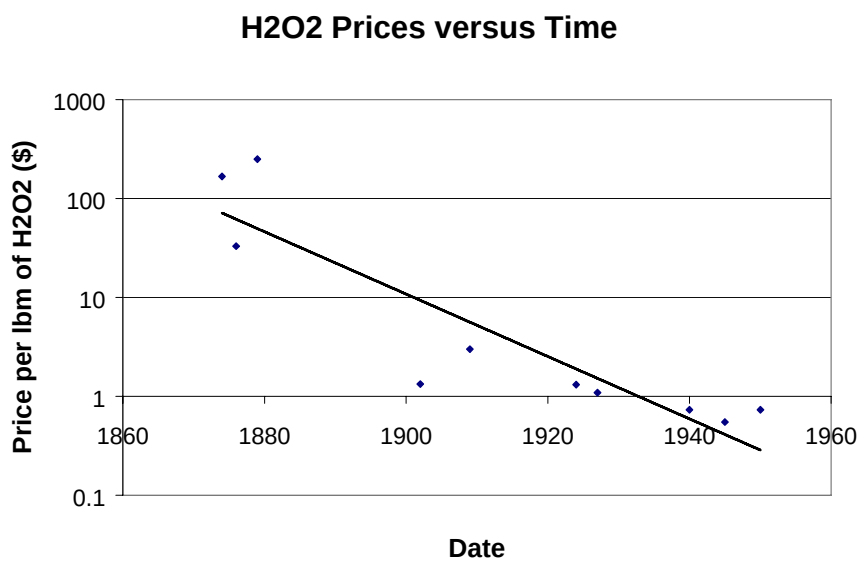
Overview

- *Assess the commercial use of H2O2 as a basis for understanding various issues current within the aerospace and defense industries*
- Background of H2O2
- H2O2 commercial market
- H2O2 commercial production
- H2O2 commercial uses
- H2O2 commercial handling
- Conclusions

Background

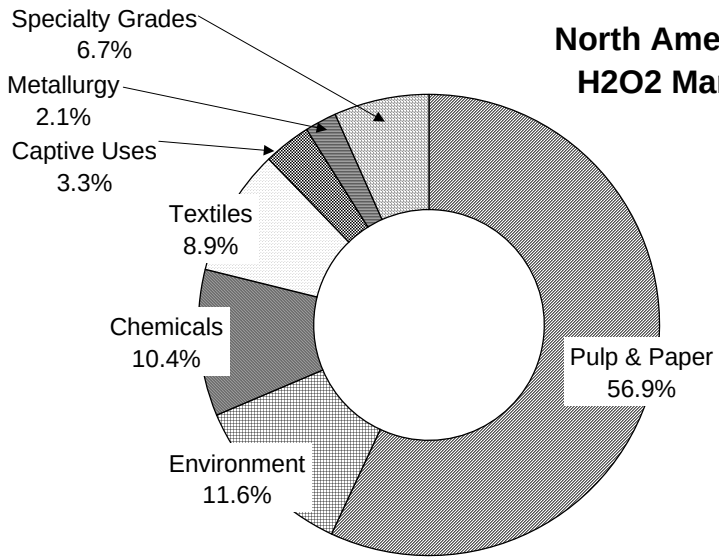
- Strong liquid oxidizer
- Similar properties to water
- Decomposes - exothermic
- Industrial chemical for > 100 years
- Discovered in 1818 by Thernard
- Begins industrial life at ~ 1860's
- Significant increase in usage after 1925
- Primary entry into commercial use was paper/pulp
- First used as propellant in 1930's
- Growth follows paper market

	50% H2O2	70% H2O2	90% H2O2
Density (lbm/gal.)	10.0	10.8	11.6
Freezing Point (deg. C)	-52	-40	-11.5
Boiling Point (deg. C)	114	125	141

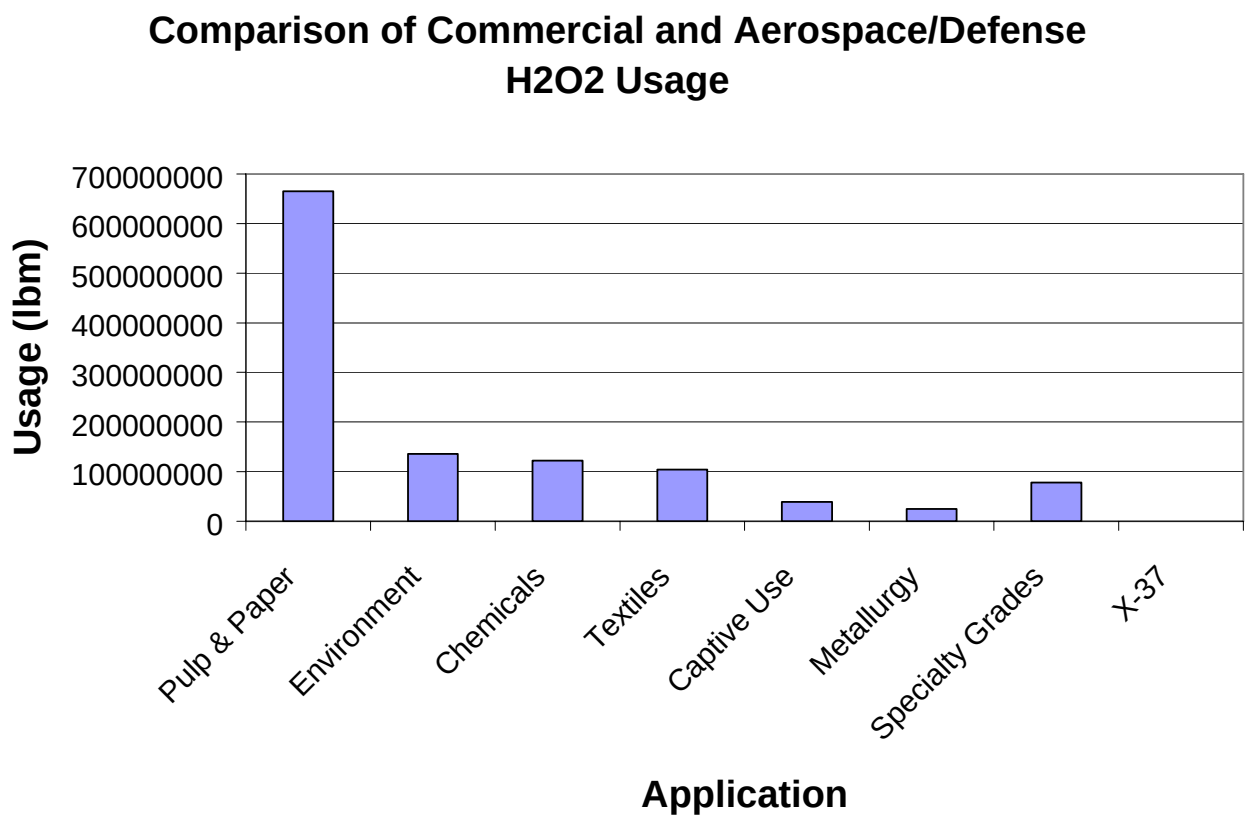


H2O2 Market

- World market is huge
- Total consumption excluding water is ~ 5 billion lbm per year
- 1997 North American market was ~ 1.2 billion lbm
- Primary users are:
  - Paper/pulp
  - Environmental
  - Chemical mfg
  - Textiles
  - Captive uses
  - Metallurgy
  - Specialty grades (electronics)
- H2O2 suppliers motivated by paper/pulp



H2O2 Market - Comparison of Commercial to X-37



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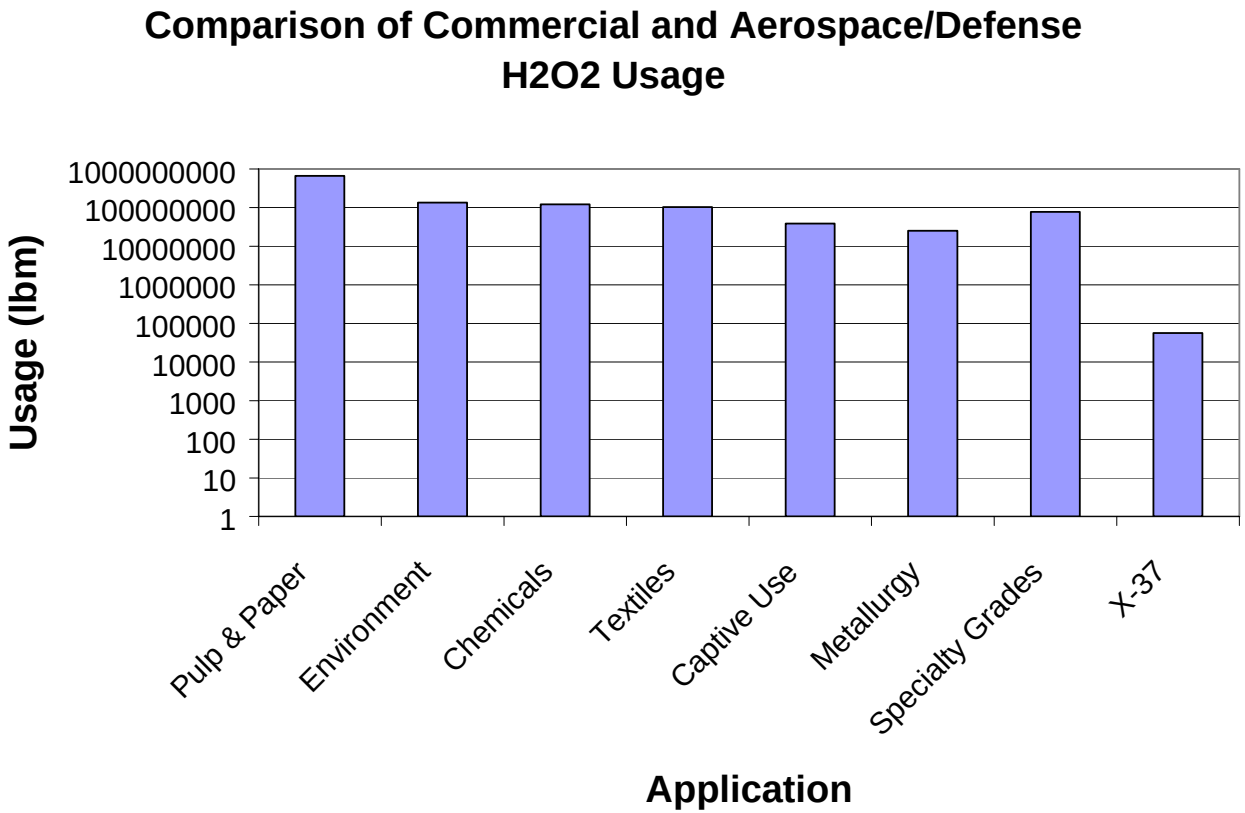
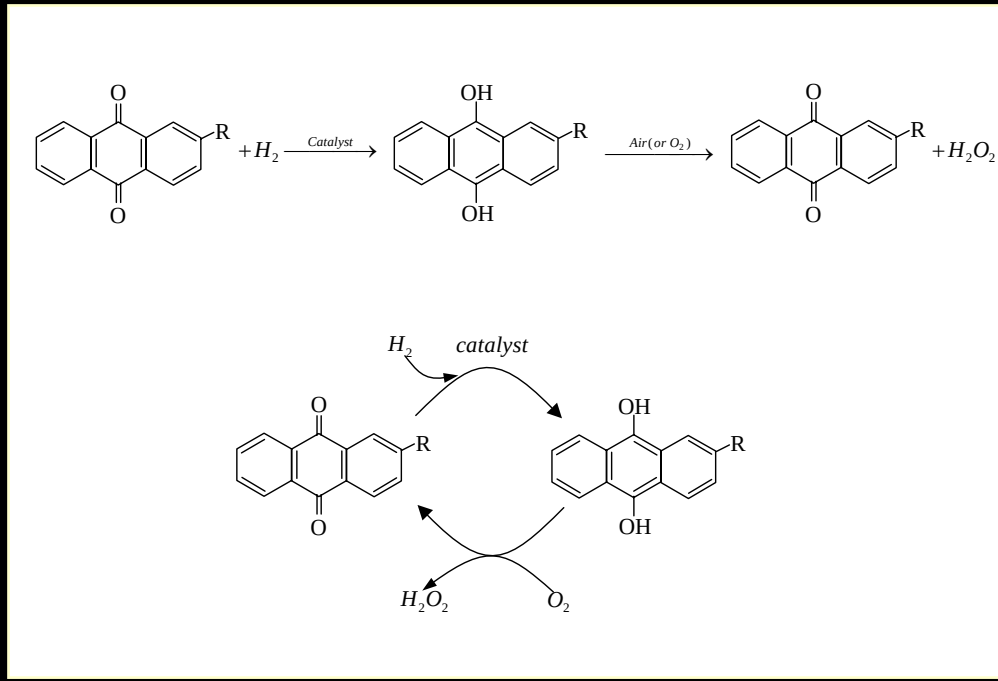
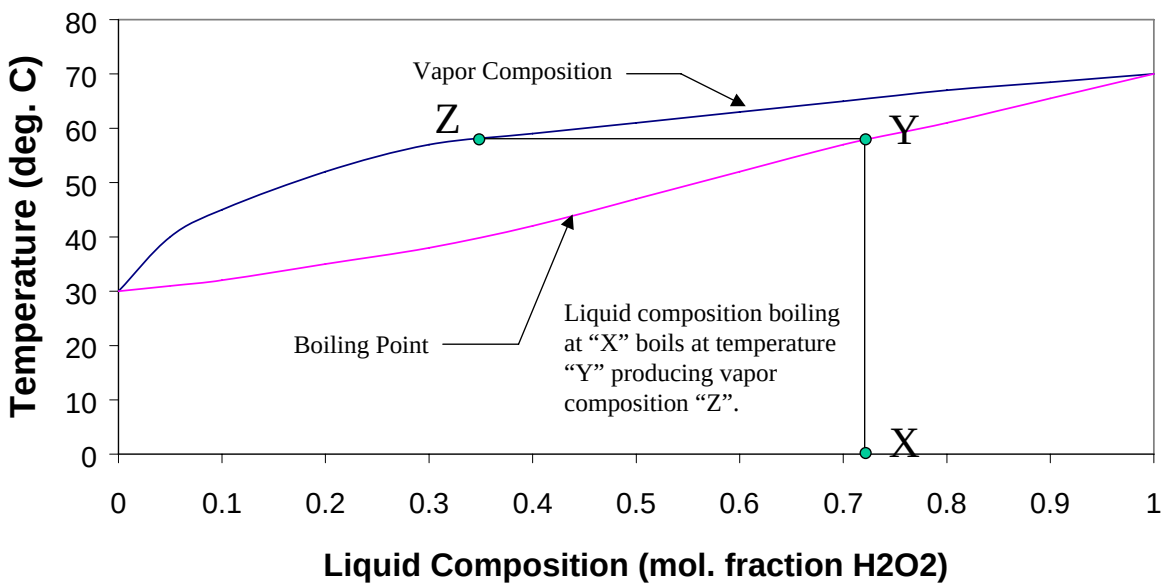


Manufacturing Process

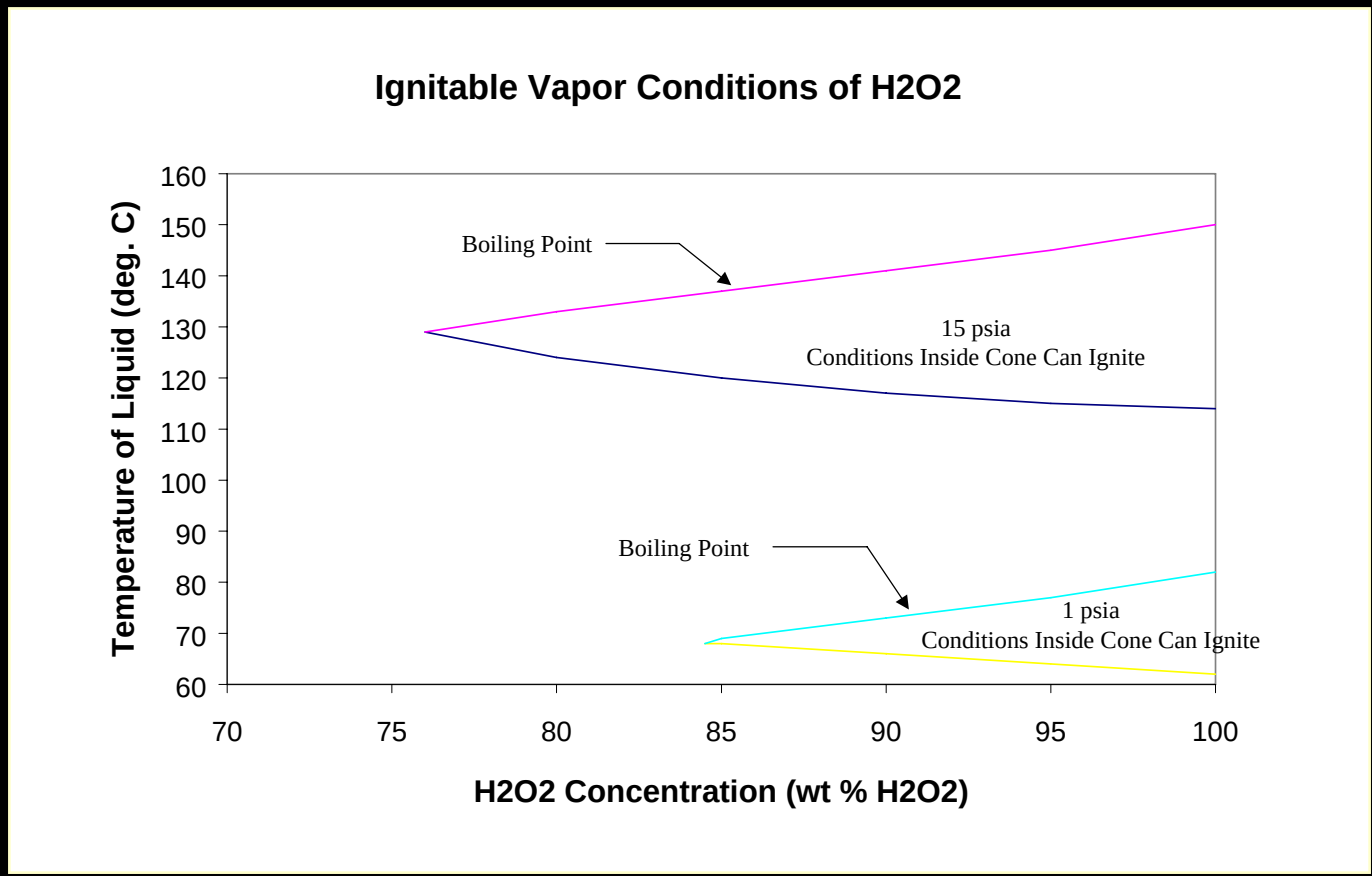
- In the past several processes used: electrolytic, batch processes, etc…
- Modern economy has selected one process
- AO-process
- Hydrogenation of anthraquinone with catalyst
- Separate catalyst
- Oxidize with air
- Separate H2O2 from regenerated anthraquinone
- Further processing required before use



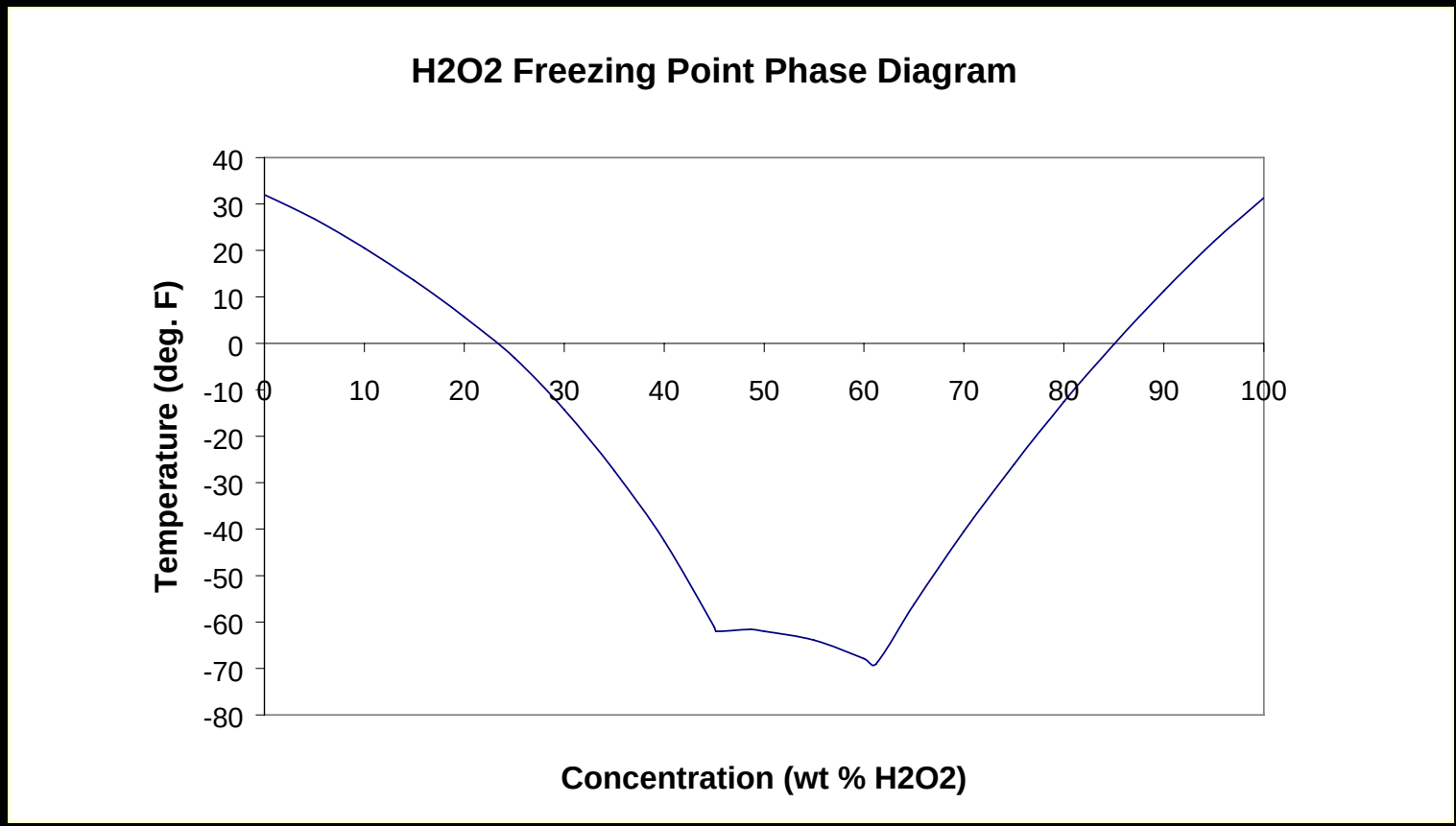
Concentration and Purification
Distillation



Concentration and Purification
Distillation - Practical Limits



Concentration and Purification
Fractional Crystallization



Primary Commercial Uses

- Paper/pulp - Used as a bleach
- Also used as a bleach for: oils, waxes, fats, silk, straw, ivory, acids, flour, bone, feathers, fruit, fur, hair, soap, gelatin, glue, teeth
- Environmental
  - Hydrogen sulfide
  - Ground contamination injection
  - KSC MON-3 scrubber
- Electronics
  - Blended with acids to etch silicon
  - ~ 1000 to 1,000,000X higher purity levels
- Chemical synthesis
- Metals manufacturing

Other Commercial Uses

- Things that go in or on your body
  - Cosmetics, sterilizing food and wine, aging wine and liquors, mouth wash, ear wax removal, toothpaste, contact lens sterilization, hair bleach
- Disinfecting
  - Disinfecting hides, seed disinfectant, sterilization of medial equipment, disinfecting pools and spas
- Other
  - Oxygen generators, felt hat manufacturing, sponge rubber, buttons, photography, painting engraving restoration, viscosity control,, household water treatment, septic field treatment, anti-microbial in cooling and process water, slime control, liquid detergent bleach,,

Aerospace Uses

- Liquid Oxidizer
  - X-37 MPS
  - USFE
  - Hypergolic thrusters
- Monopropellant thrusters
  - X-37
  - LLNL
- Hot gas systems
  - Tactical High Energy Laser
  - Air Born Laser

H2O2 Aerospace Specification

- Increase in aerospace/defense need
- New FMC production unit for 70% to 98% at Bayport TX
- Largest H2O2 facility in the world
- Fluid meets MIL-P-16005E
- Current capacity meets current and projected North American demands for HTP
- Can be shipped in fully DOT compliant 30 gallon drums and 4,000 gallon tanker trucks

	MIL-P-16005E (mg/l)	MIL-P-16005E (mg/kg)	Type 70 (mg/kg)	Type 90 (mg/kg)	Type 98 (mg/kg)
Hydrogen Peroxide Assay % by wt	90.0 - 91.0	90.0 - 91.0	71.0 - 73.0	90.0 - 92.0	98.0 - 99.0
Aluminum	0.5 max	0.35 max	0.2 max	0.2 max	0.25 max
Chloride	1.0 max	0.7 max	0.2 max	0.3 max	0.35 max
Ammonium	3.0 max	2.2 max	1.7 max	2.2 max	2.1 max
Nitrate	5.0 max 3.0 min	3.5 max 2.2 min	2.7 max 1.7 min	3.5 max 2.2 min	3.5 max 2.1 min
Phosphate	0.2 max	0.15 max	0.08 max	0.15 max	0.14 max
Sulfate	3.0 max	2.2 max	0.2 max	0.3 max	0.35 max
Tin	4.0 max 1.0 min	2.9 max 0.7 min	2.1 max 1.0 min	2.9 max 1.0 min	2.7 max 0.7 min
Carbon	200 max	145 max	30 max	30 max	30 max
Evaporation residue	20 max	15 max	10 max	15 max	14 max
Stability	2% max of active O2	98% min	98% min	98% min	98% min
Particulate	1.0 max	0.7 max	0.8 max	0.7 max	0.6 max
*Chromium			0.02 max	0.02 max	0.02 max
*Lead			0.02 max	0.02 max	0.02 max
*Manganese			0.02 max	0.02 max	0.02 max
*Iron			0.02 max	0.03 max	0.035 max
*Copper			0.02 max	0.02 max	0.02 max
*Nickel			0.02 max	0.02 max	0.02 max

* Catalytic metal contaminants are expected below 0.02 ppm (0.03 ppm for Fe) for each metal, but will not be reported on the routine certificate of analysis

Plant Size and Typical Operation

- Commercial production requires plants of significant size and complexity
- Market forces keep plants modernized and growing
- Plant complexity and manufacturing processing hazards are more severe that aerospace usage
- Commercial usage is well understood and implemented.

Commercial Transportation

- H2O2 is routinely shipped throughout the world and the United State
- Typically shipped in dedicated tanker trucks
- Other containers are drums and various bulk containers
- DOT has changed regulation in the past 20 years to better conform with UN standards
- Requires H2O2 manufacturer to prove container meets requirements
- Permits greater flexibility to mfg
- Creates more diverse types of packaging

Conclusions

- Commercial H2O2 market is several orders of magnitude greater than the aerospace and defense markets
- Commercial users routinely handle large quantities of H2O2 safely and cost effectively
- H2O2 can be handled in concentrations and quantities needed by the aerospace/defense community without undue difficulties
- A better understanding of the commercial H2O2 usage will provide a valuable perspective when developing new aerospace H2O2 platforms