A Brief History of Concentrated Hydrogen Peroxide Uses

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Overview

- H2O2 Summary
- Early History of H2O2
- Manufacturing History of H2O2
- Rocket Propellant Grade H2O2 History
- First Major Application WWII
- Post WWII Uses
- Reduction in Usage in 1970's
- Current Uses
- Conclusions

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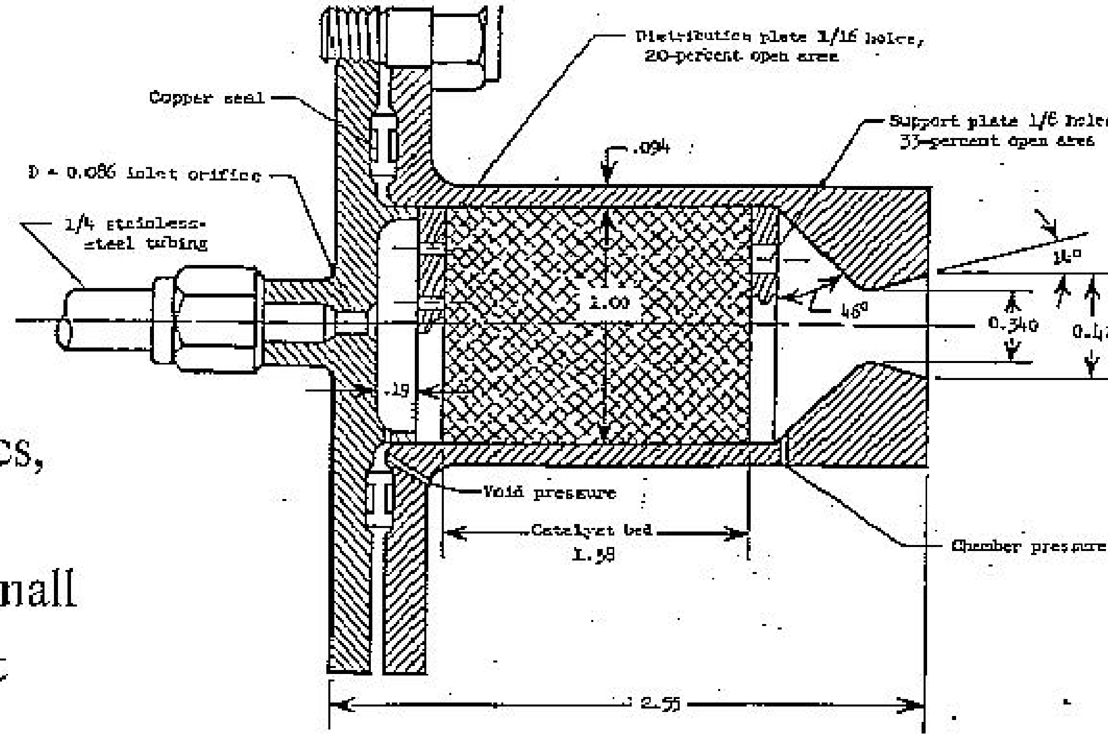
H2O2 Summary

- In use for ~ 100 yrs.
- First monopropellant
- Widely used as an industrial chemical
  - Paper pulp mfg
  - Textiles, metals, electronics, waste-water, etc..
  - Propellant usage will be small
- High density liquid oxidizer & monopropellant
- Used most often as a monopropellant or hot gas source



(a) Sketch of decomposition chamber.

Figure 1.- Hydrogen peroxide decomposition chamber A. All linear dimensions are in inches.

Early History of H2O2

- Discovered by Thenard in 1818 by working on voltaic cells
- Developed a barium peroxide mfg process and made 100% H2O2
- Identified difference of reactant from catalyst (new concept)
- Applied it as a bleach
- Thenard mfg process was modified and generally used at first

Manufacturing History of H2O2

- Initially variants of Thernard's process are used (batch processes)
- ~1880 industrial production begins in US and in England (LaPorte)
- By 1912, there are 100 H2O2 mfg's in US
- Early 1900's Barium Products is bought by what is later to become FMC
- Early electrolytic H2O2 requires low cost electricity
  - Two companies form at Niagara Falls
    - Becco (later to become part of FMC)
    - Roessler and Hassalacher (later acquired by DuPont)
- 1925 H2O2 production increases successively when introduced into textile industry

Rocket Propellant Grade H2O2 History

- First propellant grade fluid made by Germany in mid 1930's
- Three major processes used from 1940's to 1960's
  - Electrolytic (FMC)
  - Anthroquinone (DuPont)
  - Oxidation of propane derivative or isopropyl alcohol (Shell)
- All process produce low concentration H2O2 ~ 30%
- Vacuum distillation used to increase concentration to ~ 80% to 90%
- Further concentration typically done by fractional crystallization
- 1955 Becoo produced "tonnage" quantities of 99.7%
- Current capabilities
  - Maximum concentration ~ 85% to 90%

Specification History

- Two US specifications used:
  - MIL-P-16005 (rockets)
  - MIL-H-22868 (torpedo)
- Specification not is use
- Suppliers and users all using different specifications
- Potential issues with consistent behavior for handling and catalyst life

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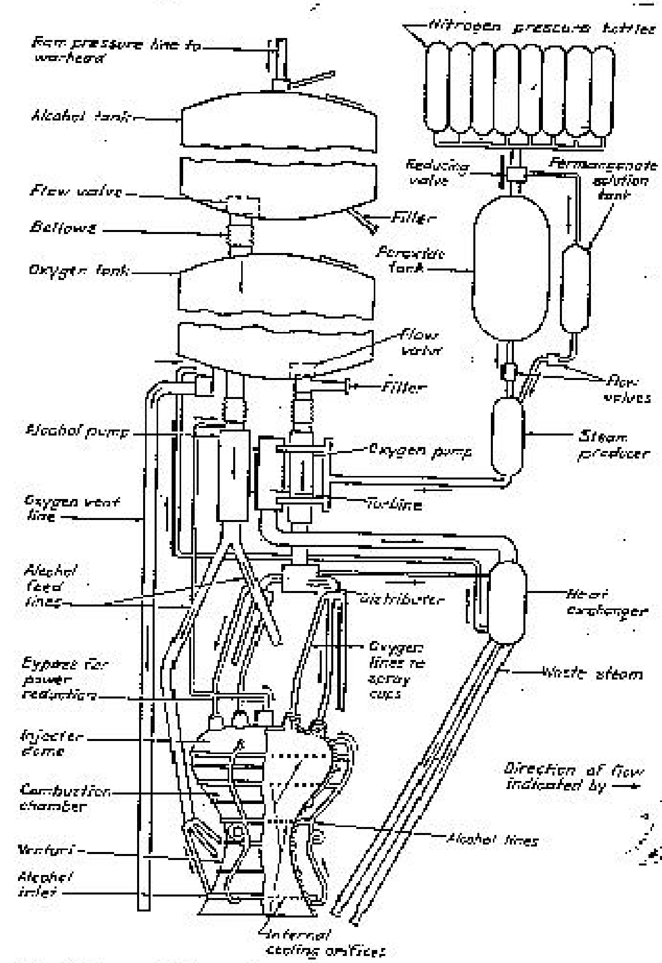
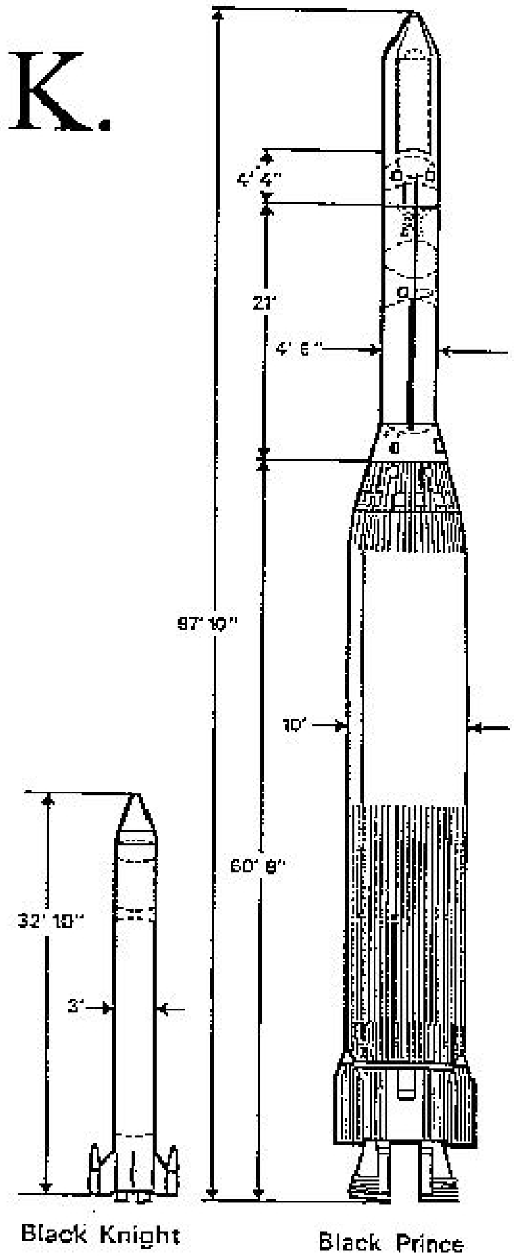
First Major Use - Germany WWII

- Proposed by Walter in 1933 as a submarine propellant
- Germany develops 80% to 82% fluid from 1933 to 1936
- Walter produces mono and bi-prop ATO's
- Derivative products follow for Me 163
- Variant products for catapults, torpedoes, submarines
- Most notable is V-2



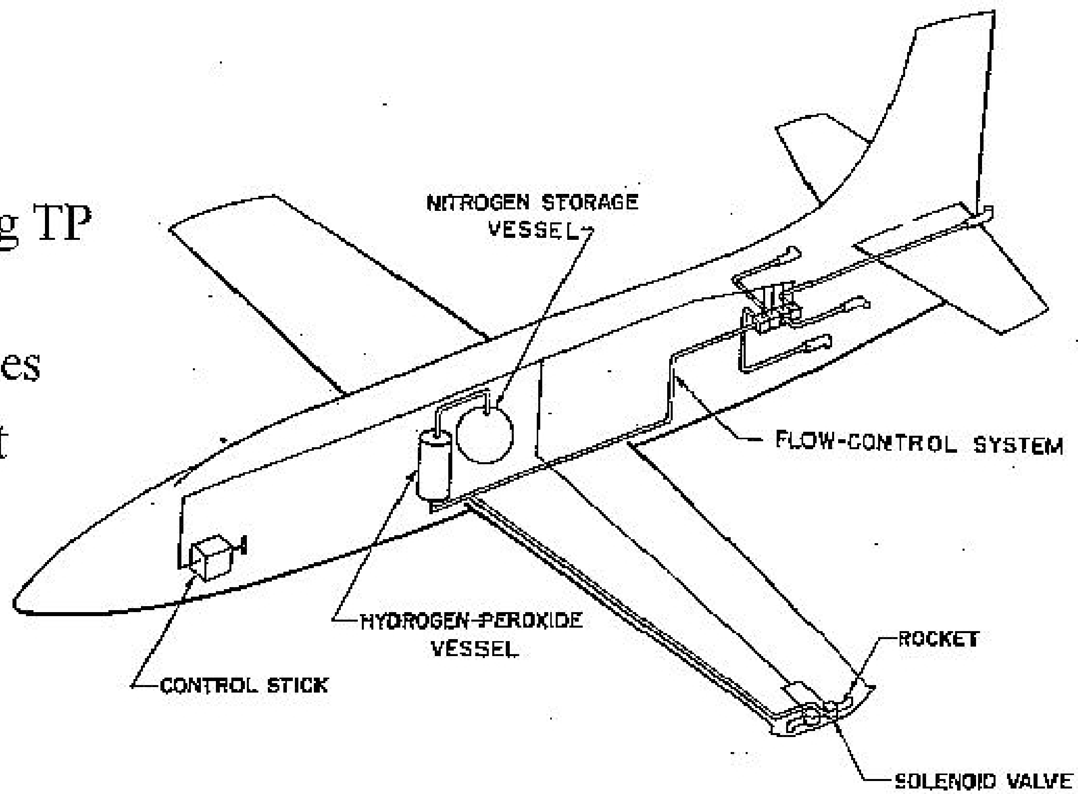
Post WWII - U.K.

- Improves Walter ATO with Sprite/Super Sprite
- Evolves Me 163 engine into several rocket engines
  - Gamma 201/301
- Develop launch vehicles, Black Knight, Black Arrow
- Almost got to a useful small launcher - Black Prince
- Several other engines produces



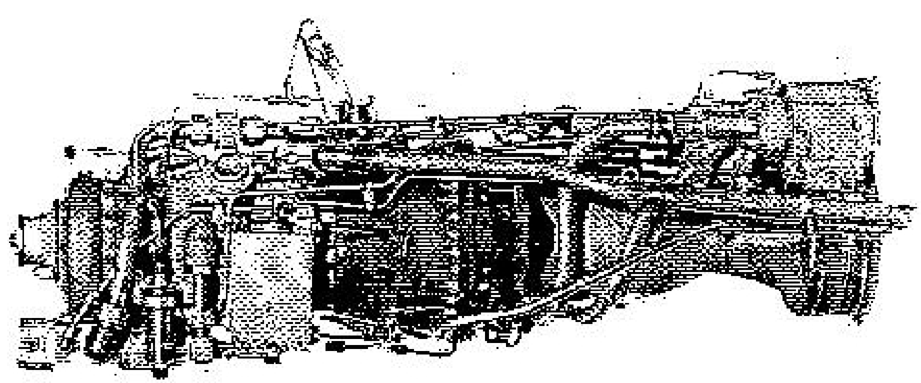
Post WWII - U.S.

- Many applications
  - X-1, X-15
  - Redstone, Jupiter, Viking TP GG's
  - Superperformance engines
  - Steam ejectors for rocket engine testing
  - Lunar Lander Simulator
  - Rocket on Rotor



Superperformance Engine

- Post WWII, US military wants aircraft rocket assist
- Engines must be robust, man-rated, re-usable, easy to operate, throttleable
- AF develops AR with Rocketdyne
- BuAer (Navy) develops LR-40 with Reaction Motors
- AR used for various flight test
- Engine concept terminated due to increase in aircraft and missile performance
- BuAer used 7M lbm from 1956 to 1958



Reduction in Usage of H_2O_2

- Hydrazine technology develops after H2O2
  - Catalyst
  - UHP propellant
- Cold war ballistic missile technology trends towards LO2 and NTO (higher performance)
- H2O2 last left as a torpedo propellant
- Almost entirely unused from 1985 to 1990
- Current trends away from N2H2 and NTO favor H2O2 for some applications

Current Usage

- Chemical laser systems
- Spacecraft reaction control
- Upper-stage main propulsion
- RLV reaction control
- Commercial launch vehicles
- Rocket on rotor
- Hypergolic research
- Hybrid research

Conclusions

- History is in two phases
  - WWII era through late 1960's
  - 1990's to present
- Performance requirements of cold war favored other design solutions
- New requirements suggest potential applications
- Prior historical usage and lessons learned concur with current applications