Handheld Fire Extinguisher Optimization Using SNAP-Listed Agent Update

Systems Working Group Meeting
Cologne, Germany

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23 May 2013

ADA Technologies, Inc.

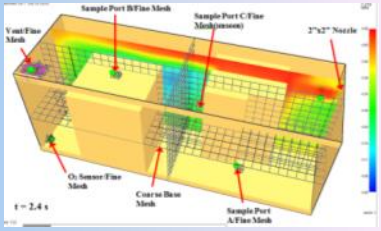
Taking Today's Technologies into Tomorrow's Markets

ADA Recent and Current Projects in Fire Protection

Expertise in Innovative Designs of Fire Suppression Systems

- Customer: NASA JSC
- Application: ISS Portable Extinguisher
- Status: TRL 7 – flight hardware prototype assembled, validated in zero-g, now building flight units
- Technology: Fine Water Mist (droplets < 50 µm) propelled by N_2

- Customer: USAF 96th Test Group, partner: ARA
- Funds: USAF SBIR
- Application: Modeling of dry bay fire suppressant delivery and transport
- Status: TRL 5 – on-going
- Technology: Open source low-Mach CFD software

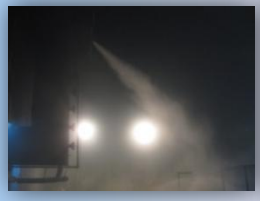


- Customer: FAA
- Funds: FAA Phase III
- Application: Handheld Extinguisher for Commercial Aircraft
- Status: TRL 6 – prototype
- Technology: Fine Halocarbon Mist

- Customer: MDA, partner: ARA
- Application: Airborne Laser (Boeing YAL-1) protection
- Status: TRL 6 – cancelled
- Technology: Fine Water Mist propelled by CO_2

- Customer: OSD/US Navy
- Funds: OSD SBIR Ph. I
- Application: Fireproof enclosure for Li-ion batteries
- Status: TRL 2 – concept
- Technology: Thin walls and flameless venting

- Customer: AFRL, partner: ARA
- Application: Hush house fire suppression
- Status: TRL 5 – cancelled
- Technology: Long-Reach (40 ft) Fine Water Mist (150 µm), N_2 propulsion



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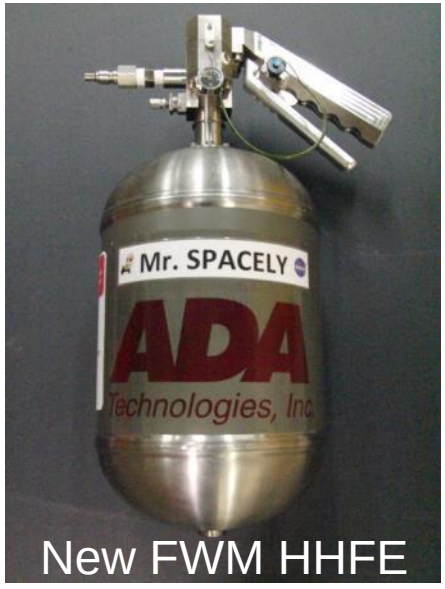
Project Background

Civil aviation has seen an increase in Halon 1211 hand-held fire extinguisher (HHFE) in-use restrictions since the 1989 Montreal Protocol.

- Most recent cut-off dates for aviation
  - –International Civil Aviation Organization (ICAO)
    - 2015 for new aircraft production
    - 2017 for new aircraft type certificate
  - –European Aviation Safety Agency (EASA)
    - 2015 for new aircraft production
    - 2025 for new aircraft type certificate
  - –Underwriters Laboratories (UL)
    - Pulling its UL 1093 Certification in October 2014.
      - –Dated March 2009, Withdrawal of the Fifth Edition of the Standard for Halogenated Agent Fire Extinguishers

ADA Tech has proposed atomized liquids (mist) as a new option

- NASA has been trying to develop non-CO_2/non-halon fire extinguishers for spacecraft for years.
- NASA contracted with ADA to adapt ADA's Fine Water Mist technology to a handheld extinguisher for the International Space Station.
- The flight qualification program has proven the design to perform *better than the old CO_2 system – especially against highly exothermic fire threats* (e.g., Li-ion batteries and oxygen candles)
- Finely atomized liquids open a new and potentially rich category of substances for consideration as Halon replacements



New FWM HHFE


Old CO2 HHFE

Proposed Atomization Technology Background

- Features of Fine Mists (applicable to water or other liquids)
  - Droplets < 50 μm possess very large surface area per unit volume
  - Very fine droplets (10-20 μm) behave most like gas but are difficult to generate and deliver with sufficient momentum to a fire
  - More practical solution is the 25-50 μm range (our focus)

  - Rapid phase change of small droplets provide a huge heat sink
  - When properly designed, mists can propagate into cluttered spaces
  - Propellant gas is used and serves multiple functions:
    - Liquid agent expulsion
    - Atomization assist
    - Entrain liquid droplets & mist to fire
    - Dilutes O_2, helps extinguishment by inerting

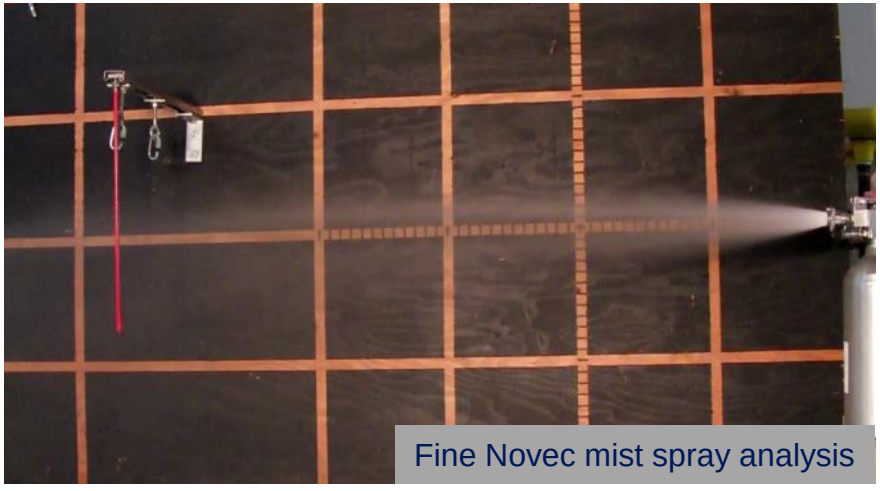
- ADA's atomization technology is theoretically applicable to most liquid agents and to a variety of Halon replacement problems (engine nacelle, cargo bay), delivering fine mists with high momentum

Adaptation of Technology to Novec 1230

Fine-Halocarbon-Mist (FHM) Hand-Held Fire Extinguisher

Agent: Novec 1230 (FK 5-1-12)
Discharge time: 9 s (testing with 4.0 lb of agent)
Spray: Fine Novec mist
Propellant gas: N_2 or CO_2
Pressure: 300-1000 psi (tested primarily at 500 psi)
Delivery assembly/nozzle: patented by ADA Technologies
Cylinder: COTS DOT aluminum
Operation orientation: optional bladder allows operation in all orientations, including upside down

Twin-fluid atomizer (without nozzle)



Fine Novec mist spray analysis

Fine Novec mist spray demonstration

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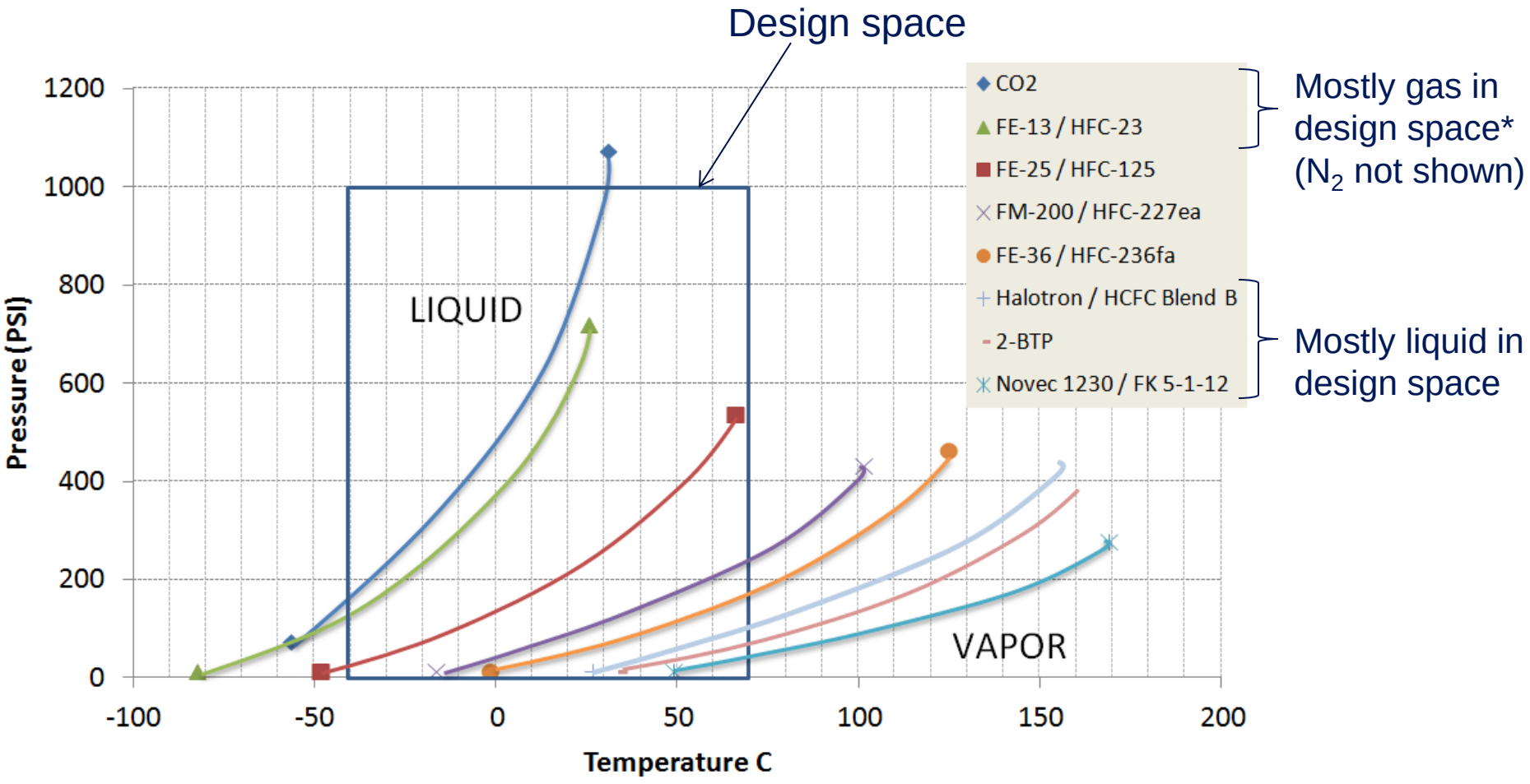
Thermophysical properties of agents of interest

FHM Concept requires 1 Liquid and 1 Gas for proper mixing and atomization



* CO_2 and FE-13 may be liquid at low temperatures

Requirements (AC20-42D) and Status

Requirement	Description	Proposed Design
UL Approved	At least 5B:C per UL 711 standards	Class C requirement met. Class 5B not tested yet. ←
EPA SNAP Approval	Listed by EPA	Requirement met
FAA Hidden Fire Test	Extinguish at least 9 out of 20 heptane cups	Requirement met
FAA Seat Toxicity Test	Extinguish fire and limit toxic by-products formation	Not tested yet ←
Temperature Envelope	-65°F to 120°F	Requirement met
Minimum Throw	8 feet or more	Requirement met
Corrosivity	Not corrosive	Requirement met

- In-house class B testing has started (3B & 5B pan fires)
- Seat test not yet attempted

March 2013 Class B Tests

- Performed at US Army Aberdeen (MD) Test Center
  - Indoor facility set up for up to 10B fire (heptane & JP-8)
  - Experienced firefighter, including with Halon 1211 and Novec 1230 HHFE

- Goal of test series: define performance envelope of ADA's experimental Novec HH unit + advance component design

- Test Series Summary:
  - 3 days, 30 pan fire tests
  - 5B heptane fires with Halon 1211 HHFE for practice (5 reps)
  - 3B heptane fires with Novec HHFE (18 tests)
  - 5B JP-8 fires with Novec HHFE (7 tests)

Class B Fire Tests with Experimental Novec HHFE

Success achieved for 2 fires:

- 3B pan / fuel: Heptane (1)
- 5B pan / fuel: JP-8 (2)

Novec used: 3.2 lb
(6.6 sec)

Novec used: 4.0 lb
(7.2 sec)

Next Steps

- Need to further optimize atomizer and nozzle to improve performance on heptane fires (target 5B)
- Plan to perform new series of tests in June/July 2013 with Novec (dates TBD)
- Will focus on 5B pan fire (and possibly FAA seat test)
- Review potential other liquid agents if Novec falls short
- Project final report by end of this summer

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