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Ammonia Fuel Standard

Where do we go from here?

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David Richardson • Airgas Specialty Products

Ammonia Fuel Standard

The work so far…

Standards, Standards Everywhere!

- Ammonia Training Standards
- Ammonia Regulatory Standards
- Ammonia Safety Standard
- Ammonia Handling Standards
- Ammonia Environmental Standards
- Ammonia Emission Standards
- Ammonia Product Standards
- Ammonia Fuel Standard

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The Draft Standard

- **Ammonia, "a New old product"**
- **Ammonia as a FUEL needs a new <u>set</u> of standards**
- **p a**

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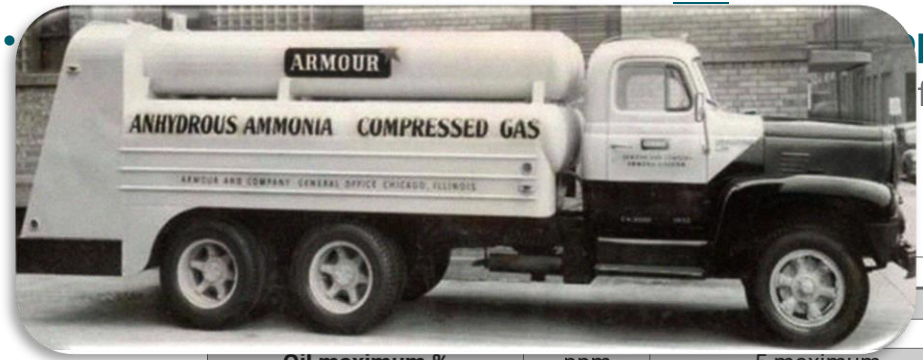

ami,
eb 2016

Oil maximum %	ppm	5 maximum	FTIR Analysis
Appearance	n/a	Clear, Colorless liquid or gas	Visual

Specification P
NH3 (anhydrous
H20 (water) mi
Oil maximu
Appearar

Different Issues w 99.995%!?!
(Also To be discussed)

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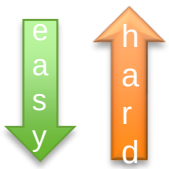
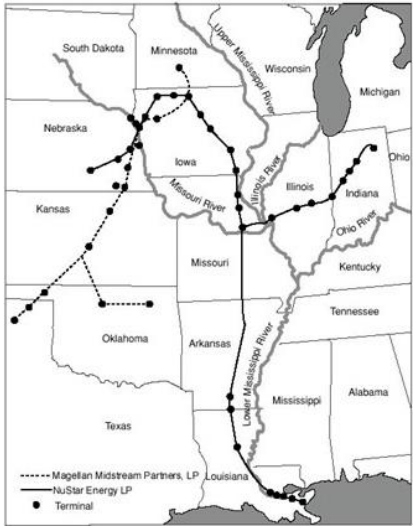
Current Draft Mirrors Industry of Today.

- **Grades of Anhydrous Ammonia**
  - Premium Grade, “Metallurgical” – 99.995% purity
  - Refrigeration Grade, “R-Grade” – 99.98% purity
  - Commercial Grade, “C-Grade” or “Ag Grade” – 99.5% Purity
  - Fuel Grade – in development.
- **Majority of tons consumed in the world are “C-Grade”**
  - Large Scale Transport (Barge and pipelines)
- **Why?**
  - Ag application make up the lion share of the current market.
    - #1 application doesn’t impact, doesn’t care.
  - Ammonia Loves Water.
    - Energy ($$) required to remove water once present.
  - Stress Corrosion Cracking
    - SCC may occur with dry (<0.2wt% H2O) NH3 and storage systems not to standard.
    - Stationary Storage vessels made to code, ANSI G2.1, can store <u>all grades</u>.
      - Code includes Post Weld Heat Treatment “Stress Reliving”



Hellas Eagle
40,000 tons of NH3
Sailing from Point Comfort, TX to Trinidad



The Case for higher Purity…

- **Why Consider Higher Purity Ammonia?**
  - Currently recommended by ammonia disassociaters
    - Water results in oxidation of metal parts, “spotting”.
    - Water and Oil will shorten the life of the commonly used Nickel Catalysts
    - Avoids impurity concentration common to vapor application
  - Small industrial storage delivery infrastructure established for premium grade NH3
    - Heat Treatment (disassociaters)
    - Refrigeration
  - 2,000 gallon tank (~8,755lbs of NH3) is below EPAs-RMP & OSHAs-PSM limits
- **NH3 is commonly manufactured at higher purity, than dosed with water.**
  - Easier to “downgrade” ammonia quality then “upgrade”.
- **Purification also possible via re-condensing vapor or membranes.**
  - Requires appropriate CapEx

What is not included in the current spec?

- **Vapor or Liquid?**
  - Ammonia is used as either a vapor (gas) or liquid in industrial processes
  - One 6,000 gallon load of C-Grade can have up to 155lbs of impurities.
    - If used as a vapor, A load per day would result in ~6,750 gallons of water/oil over a year.
  - One 6,000 gallon load of “Met” would only have up to 0.2lbs of impurities
- **Pressure Tank or Refrigerated Storage…**
  - Ammonia boils at -27.4deg F
  - Thanks to the ideal gas law…
    - Can be stored in a pressurized vessel.
    - OR refrigerated and stored at atmospheric pressure
- **How Should a Fuel Standard account for these options?**
  - Liquid?
  - Vapor?
  - Pressure Tank?
  - Atmospheric Tank?

Mobile Unit that can supply vapor or liquid onsite!

Ammonia Fuel Standard

The work to come…

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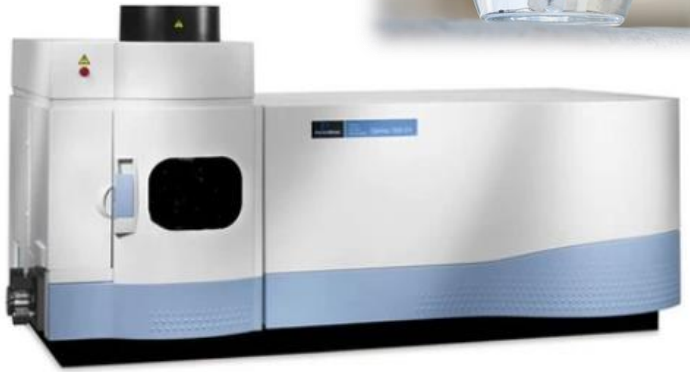
The Measurements

- **“You can Expect, what you inspect” W Edwards Deming**
  - Current Analytical
    - Evaporative Residue Purity analysis
    - FTIR Oil measurement
    - Water by CGA G-2.2, KF titration, or Laser Spectroscopy
    - Elemental by ICP-OES
    - Light Hydrocarbon by GC-FID
    - Visual Analysis
    - Particle Analysis
  - Future Analytical
    - Energy Content - BTU measurement.
    - ?

$$1\ kW = \frac{BTU/hr}{3.412,14}$$



Beyond the measurement

Special Thanks!!!

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- **Emile Herben, Yara**
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- **Jennifer Beach, Starfire Energy**
- **Ron Stanis, GTI Energy**

Questions?

"Ammonia! Ammonia!"

Drawing by R. Grossman; © 1962. The New Yorker Magazine, Inc.