UREA INFRASTRUCTURE FOR UREA SCR NOX REDUCTION

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Outline of talk

- Introduction
- Applications
- Urea characteristics
- Urea infrastructure
- Quality problems
- Dye?
- Diesel cross-cut group
- Conclusions

Introduction

- Urea SCR is currently the only proven NOX aftertreatment for diesel engines
  - high NOX reduction possible
  - some SCR catalyst systems are robust against fuel sulfur
  - durability has been demonstrated
  - many systems in the field
  - long history in other markets
- Major limitations to acceptance
  - distribution of urea solution to end user
  - ensuring that urea solution is added to vehicle

“Easy” applications for urea

- Fixed location applications
  - power generation
- Fixed base fleets
  - municipal vehicles
  - single base truck fleets
  - single refueling point
- Fixed route fleets
  - several refueling sites
- ‘Educated’ users

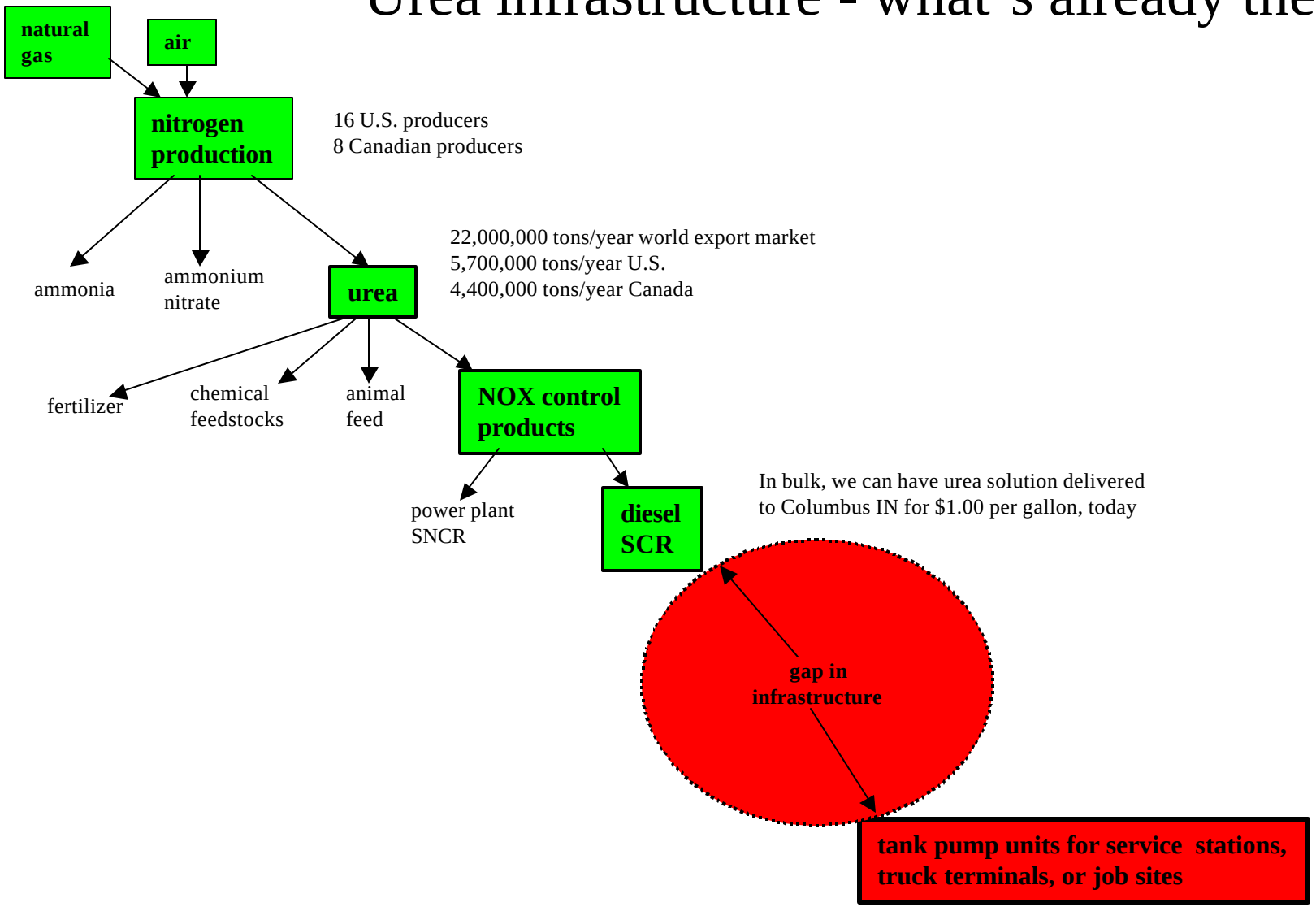
“Difficult” applications for urea

- Trucks not running fixed routes
- Small industrial users
- Passenger car
- ‘General public’ users
- ‘Experimenters’

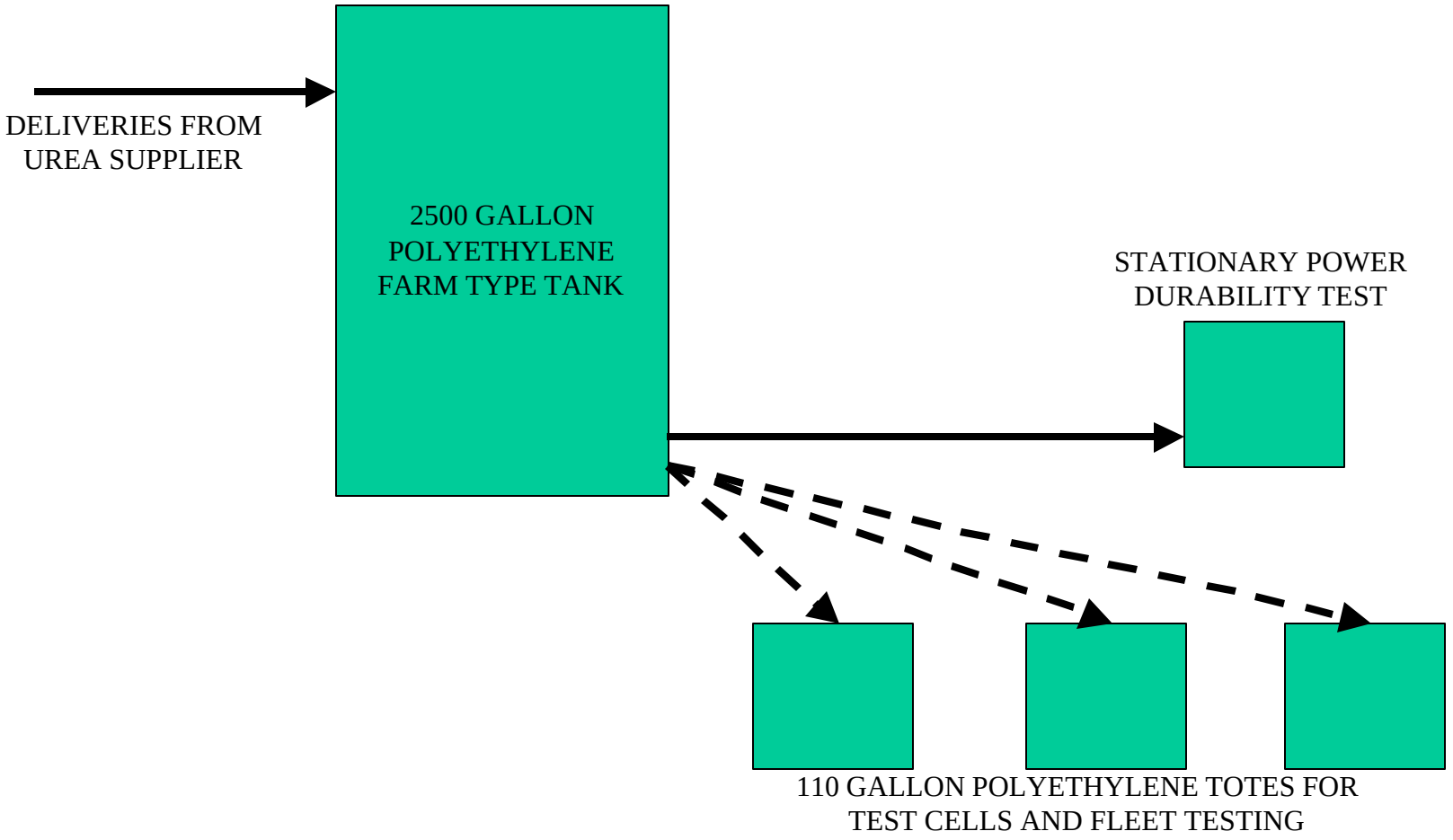
General urea considerations

- clear solution, slightly heavier than water
- 32 weight percent solution of urea in deionized water
- urea is considered non-hazardous, not DOT regulated
- Corrosive to brass, copper, and mild steel
- compatible with stainless steel, plastics, and some aluminums
- freezes at 11 deg.F
  - maintains concentration in ice and liquid
  - does not salt out
- decomposes above 280 deg.F
  - hot soak concerns
- can loose water by evaporation
- creeps through seals and fittings
- spills leave a lot of white residue
- urea solution is mild irritant
- urea solution costs about the same as diesel fuel
- may require periodic mixing in storage (evaporation/condensation inside of storage tank)

Urea infrastructure - what's already there



How Cummins solved urea infrastructure for test work



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Longer term Cummins plan for urea infrastructure

- Mainly aimed at stationary power
- Use Fleetguard / Nelson Division to mix and distribute urea
- 275 gallon totes or bulk deliveries
- Totes stocked at Cummins distributors to support local needs
- Solution available for public sale

UREA QUALITY PROBLEMS FOUND IN THREE YEARS OF TESTING AT CUMMINS

QUALITY PROBLEM	RESULT	HOW SOLVED
DIRT IN UREA	PLUGGING OR POOR SEALING	LET SOLUTION SETTLE, ADD FILTER
UREA CONCENTRATION TOO HIGH	EXCESS NOX REDUCTION, AMMONIA SLIP	ADJUST SOLUTION WITH DISTILLED WATER
UREA CONCENTRATION TOO LOW	NOT ACHIEVE NOX REDUCTION TARGETS	ADD ADDITIONAL UREA TO SOLUTION
SALT (NaCl) CONTAMINATION	CATALYST PLUGGING, EXHAUST SYSTEM CORROSION	DISCARD SOLUTION, CHANGE SUPPLIER
STRATIFIED SOLUTIONS (SMALL CONTAINERS)	UREA CONCENTRATION NOT CORRECT	MIX SOLUTIONS BEFORE USING

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Should urea solution be dyed?

- Identification of solution
- Safety alert to public
- Dilution detection by dye strength
- Need industry and regulatory consensus

Diesel cross-cut urea group

- Current members
  - Caterpillar
  - Cummins
  - Daimler Chrysler
  - Detroit Diesel
  - Ford
  - General Motors
- Group is soliciting input from other interested parties
  - common needs
  - concerns
  - technical solutions

Diesel cross-cut urea group

Infrastructure

- **What are the fluid properties: freezing, evaporation**
- **Distribution: where to do the mixing**
- **Maintaining quality control**
- **Affordable retail outlet kit**
- **Metering and customer charges**

Delivery to the vehicle

- **Select an approach (will co-fueling work?)**
- **Design and develop the nozzle and fill port (all applications, backward compatibility)**
- **Communication system for independent turn-on and shut-off**
- **Demonstrate and conduct robustness trials**

Tasks

- **Agree on the goals and objectives**
- **Concept disclosure and selection**
- **Define specific projects and working groups**
- **Obtain approval and budget and initiate projects**
- **Recommendation for preferred system**

Goal

- **to be transparent to the end user**

Not covered

- **vehicle system design**
- **catalyst technology**

Conclusions

- Urea SCR is an effective method for NOX reduction
- Major drawbacks
  - distribution of urea
  - ensuring it is used
- Some applications are easier than others
  - stationary applications
  - fixed base operations
- Team work will be needed to bring SCR to wide usage
  - standards, specifications
  - manufacturing, distribution
  - filling method
  - public education