



Single Battlefield Fuels (SBF) Made From Unconventional Resources Material Issues – An Army Perspective

National Materials Advisory Board Meeting
April 25, 2007
Plenary Session II – Materials for Power and Energy

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Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE 26 APR 2007		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Single Battlefield Fuels (SBF) Made From Unconventional Resources Material Issure - An Army Perspective				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Muzzell, Patsy A				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) REDCOM TARDEC 6501 E 11 Mile Road Warren, MI 48397-5000				8. PERFORMING ORGANIZATION REPORT NUMBER 17078	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S) TARDEC	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) 17078	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES The original document contains color images.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 11	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



DOD Key Fuels and Specifications

Single Battlefield Fuel

Kerosene-type fuels

JP-8/F-34

- MIL-DTL-83133

JP-5/F-44

- MIL-DTL-5624

Jet A-1/F-35

- ASTM D 1655 (U.S.)
- Defence Standard 91-91 (most ROW)

Commercial & Other Military Fuel

Diesel fuels

No. 2-D and No. 1-D

- A-A-52557 (CID*)
 - ASTM D 975

F-76 (mil-spec marine distillate fuel)

*Commercial Item Description

End-uses in DoD fleets



**CI engines
designed to use
diesel fuel**



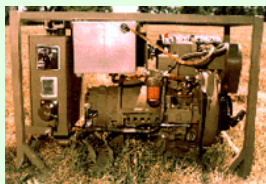
Army Tactical/Combat Vehicles and Equipment

- Tactical/combat vehicle fleets
- CE & MHE
- Other Equipment
 - Fuel storage, distribution, handling
 - Power generation
 - Future
- Army aircraft and watercraft

Other



**POWER
PLANTS**



GENSETS



FORK LIFTS

Wheeled Vehicles



HMMWV



FMTV



STRYKER



HEMTT

Tracked Vehicles



ABRAMS



BRADLEY



M113

Construction & Materials Handling Equipment



**CRANES / DOZERS /
SCRAPERS / GRADERS**

Future Equipment



**HYDROCARBON
REFORMERS**



**FUEL CELL
APUs**



Introduction – Fuels of the Future

- Petroleum-derived fuels will be around for years, such as JP-8 (current SBF)
- However, non-petroleum derived fuels will increasingly make their way into the fuels supply, typically as blends
 - Semi-synthetic jet fuel (partly FT IPK*) used at Johannesburg International Airport
 - E-85 ethanol fuel, biodiesel fuel blends (B1 - B20)
- Key reasons for blends (excluding energy policy drivers)
 - Limited volumes of unconventional fuels
 - May allow an otherwise unfit-for-use fuel to be used in existing equipment (or slightly-modified equipment)

* FT IPK is Iso-Paraffinic Kerosene – discussed in separate slide

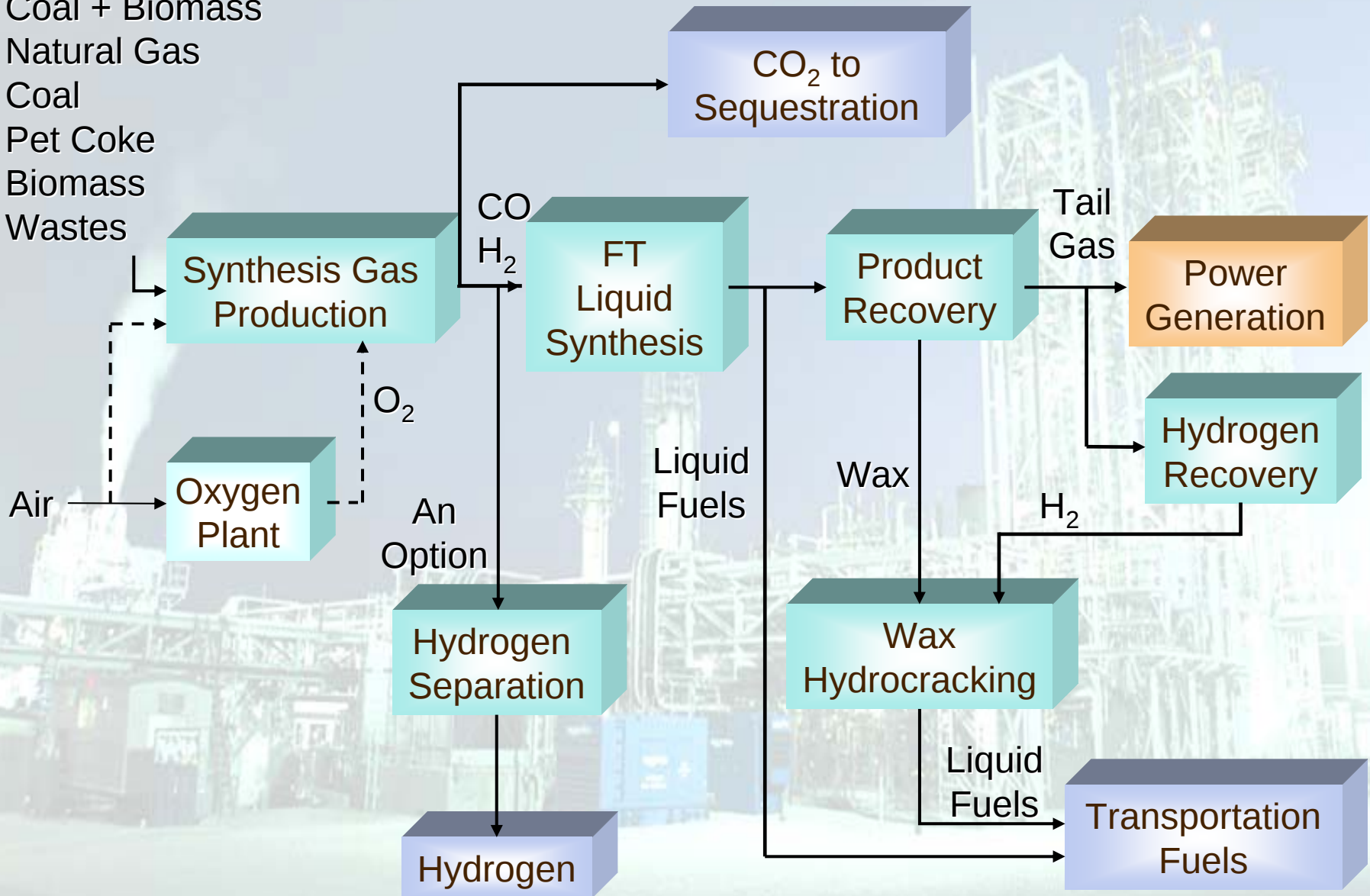


Unconventional SBF on the Horizon

- Fischer-Tropsch (FT) derived
- BioJet
 - Synthesized from crop oils via thermal, and/or catalytic, and/or enzymatic processing [BioJet per DARPA BAA 06-43]
 - How compatible will this fuel be with existing equipment? Need samples for characterization of fuel – starting point to determining compatibility
- Other?

FISCHER-TROPSCH (FT) TECHNOLOGY

Coal + Biomass
Natural Gas
Coal
Pet Coke
Biomass
Wastes



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Fischer-Tropsch Derived Kerosene

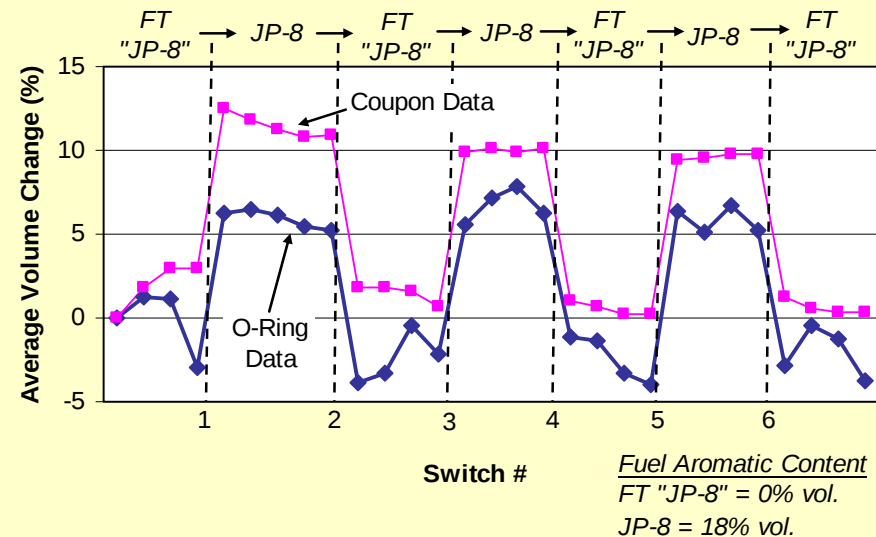
- FT synthesis step – product variations possible based on FT reaction parameters (catalyst, temperature, pressure, etc.)
 - Product typically contains only paraffins, mostly normal paraffins; many paraffins of long chain lengths (“waxy”)
 - Possible to produce product containing other species such as aromatics, olefins
- Upgrading step
 - Hydrocracking breaks up long chains into kerosene boiling range compounds
 - Hydroisomerization rearranges chains from n-paraffins to isoparaffins yielding kerosene meeting JP-8 freeze point requirement
- FT kerosene compositions meeting JP-8 freeze point requirement
 - FT Iso-Paraffinic Kerosene (FT IPK) – containing no aromatics
 - Possible to also produce FT-derived kerosene that containing aromatics



Fuel Leaks Possible From Sudden Switch to Lower Aromatic Content Fuel

- Some elastomers affected by change in fuel solvency (esp. aromatics in fuel)
 - Swelling: absorption of aromatic solute
 - Shrinkage: purging of aromatic solute
- Affected elastomers include Nitrile, common in Military fuel distribution system sealing applications
- Low aromatic fuels becoming more prevalent
 - Ultra-low sulfur diesel fuel
 - FT fuels
- Introducing lower aromatic fuels into existing equipment may result in some fuel leaks
- Mitigate risk of leaks through use of
 - Unaffected elastomers
 - Fuel blends

**Nitrile Elastomer Coupon & O-Ring
Volume Changes With Switches Between
Synthetic FT "JP-8" & JP-8**



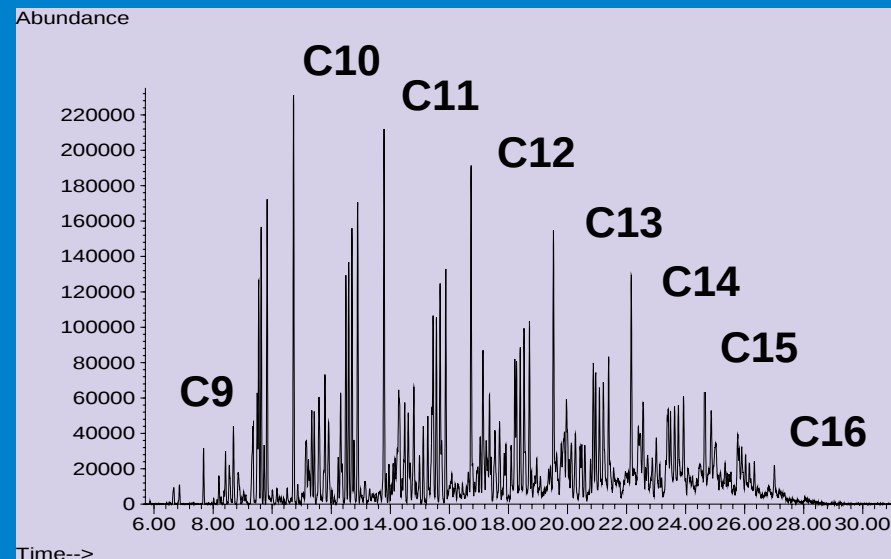
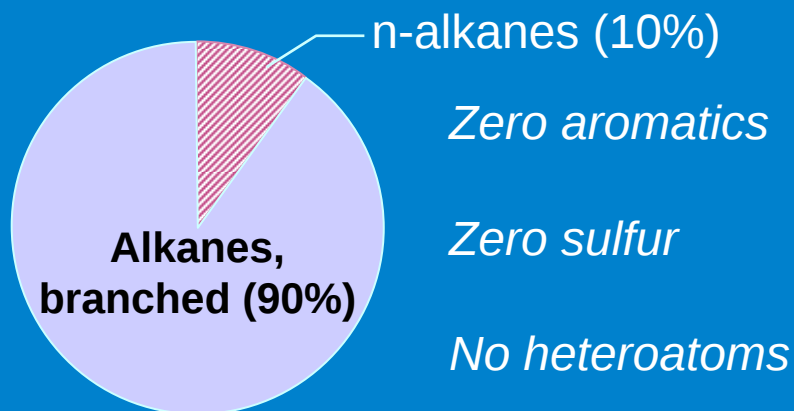
Data courtesy TARDEC Lab

SAE Paper No. 2007-01-1453, April 2007
"The Effect of Switch-Loading Fuels on Fuel-Wetted
Elastomers"
(by TARDEC and SwRI™ authors)



FT Iso-Paraffinic Kerosene

Hydrocarbon Types In FT IPK (Iso-Paraffinic Kerosene)



**FT IPK is paraffinic – contains mostly isoparaffins
whereas
Petroleum-derived fuels are rich in aromatics, cycloparaffins, and
hetero-compounds**

Some of these are polar compounds (N, O), typically trace amounts,
responsible for much of a fuel's inherent lubricity



Fuel Lubricity Critical for Performance of Fuel-Lubricated Rotary Injection Pumps

- Some vehicles have fuel-lubricated fuel pumps
 - HMMWV (high density vehicle in Army ground vehicle fleet)
 - Some others (smaller populations in Army fleet)
- Test rig testing
 - HMMWV pump with hardened components: FT IPK lubricity appears adequately improved with use of Military approved lubricity improver
 - Other fuel-lubricated pumps (testing in progress-one common to Army and Navy)

HMMWV Rotary Injection Pump Test Results

Test	Pump	Duration (hours)	Pre-test (mm)	Post-test (mm)	Change (mm)	Lubricity additive (CI/LI) treat level in FT IPK
1	1	95.6	5.017*	5.113	0.096	None
	2	150.7	5.017	5.085	0.068	
2	3	500	5.017	5.024	0.007	12 (minimum treat level)
	4	500	5.017	5.011	-0.006	
3	5	500	5.017	5.022	0.005	22.5 (maximum treat level)
	6	500	5.017	5.019	0.002	

*= Roller-to-Roller Dimension Pump Assembly Specification is 5.017 cm $\pm$ 0.001 cm

Treated fuel tests run 500 hrs with minimal wear – indicative of acceptable field performance

chipped roller shoe

Excessive wear occurred with untreated fuel



Data courtesy of SwRI™



Concluding Remarks

- Fueling-up with unconventional SBF
 - Early use most likely in blends with petroleum fuel
 - Use of blends minimizes/eliminates fitness-for-use issues
 - Early acceptance by users critical when introducing new fuel
 - Strategic fueling flexibility would be enhanced by establishing the capability for freely interchangeable use of current SBF (JP-8) and unconventional SBF (not as a blended fuel)
- Determining fitness-for-use in existing equipment
 - Current SBF specifications evolved from history of use with petroleum-based fuels; are not performance-based specifications
 - An unconventional fuel may have properties meeting the chemical / physical property requirements found in these specifications, but not be fit-for-use