DOE-ANSI Sponsored Biofuels Standards and Codes Workshop
Addressing the Harmonization of Biofuels Related
Standards, Codes, and Regulations
January 24-25, 2007

Background:

Our Nation has embarked on an initiative to accelerate the development and use of biofuels to reduce America's dependence on foreign sources of oil. This Biofuels Initiative was announced by the President as part of the 2006 State of the Union address is a major component of his Advanced Energy Initiative which will lead to the use of non-food based biomass, such as agricultural waste, trees, forest residues, and perennial grasses in the production of transportation fuels, electricity, and other products. Among the ambitious goals pursued through this initiative are the goals to:

- Make production of ethanol from cellulosic feedstocks cost-competitive with grain based production methods by 2012, and;
- Reduce U.S. light-duty vehicle gasoline consumption by 20% by 2017 (the "20 in 10" goal) through
    - Increase alternative fuel use to approximately 35 billion gallons per year (15% reduction), and;
    - Enhanced energy efficiency standards (CAFÉ) (5% reduction).

The large-scale introduction of biofuels into consumer markets, especially in sufficient quantities to decrease the country's reliance on foreign sources of energy, poses significant challenges throughout the production, supply, transport, and utilization cycle. These challenges if not properly and effectively addressed, may become barriers that prevent the successful achievement of the Advanced Energy Initiative, thereby negatively affecting our nation's economic and national security. The implementation of this initiative and the widespread deployment and use of biofuels will depend in large part on the harmonization of existing codes, standards, and regulations, and the development and promulgation of new codes and standards where they are deemed necessary. This will ensure consumer confidence, safety, environmental protection, and the integrity of our nations fuel supply, distribution, and utilization infrastructure.

The U.S. Department of Energy (DOE) first began the effort of working with industry to sponsor work in codes and standards development as a key part of its hydrogen energy efforts in 1995. These efforts have helped encourage standards development and code development organizations (SDOs and CDOs, respectively) to develop hydrogen codes and standards, and work together to establish mechanisms to distribute information to relevant stakeholders. One of the success stories from this effort was the development of the Hydrogen Codes and Standards Portal which grew out of discussions between the DOE and the American National Standards Institute (ANSI). The initial idea was to provide a single point for people to find information about the various codes, standards, and regulations that apply to the use of hydrogen as a fuel source. ANSI coordinated the effort to develop the portal with DOE and other federal government agencies, private sector standards developing organizations, and state and local governments. The portal has become a web-based hydrogen data center with the core information about standards provided by the individual SDOs.

In addition to working with industry, DOE also engaged other Federal agencies who had specific regulatory or mission-related interests in hydrogen regulations, codes, and standards. Similar efforts are now underway to work with industry stakeholders and other federal agencies to accelerate the widespread use of biofuels. Through the efforts discussed in this document, follow-on activities with ANSI and other stakeholders, and the development of the Interagency Plan for Biofuel Codes, Standards, and Regulation, DOE seeks to ensure the expeditious development of an efficient and reliable biofuels infrastructure and widespread deployment and utilization of biofuels to meet our nation's energy needs.

Introduction:

The DOE – ANSI Biofuels Standards and Codes Workshop was held on January 24 and 25 in direct response to the need to identify potential barriers to meeting the Biofuels Initiative. In attendance were approximately 50 representatives of federal agencies, standards development organizations (SDOs), code development organizations (CDOs), and representatives of the biofuel and permitting industries. The meeting included opening statements by Frances Schrotter of ANSI and Neil Rossmeissl of DOE OBP, and presentations by each of the other organizations and federal agencies represented, and a case study on a biomass feedstock supply system. All of the presentations made to the meeting attendees are included in the workshop proceedings and accessible at www.biofuelsstandards.biomass.govtools.us.

During the process of planning this workshop it became apparent that neither the federal government, nor the nongovernmental sector possessed the resources or comprehensive technical capabilities for developing the extensive technical information and conducting the necessary conformity assessments and standard development activities that would be needed to "pave the way" for the widespread use of biofuels in our energy supply. With that realization, the workshop planning committee decided to use compression facilitation planning techniques to gather detailed information from participants to better define the breadth of issues related to the wide-scale use of biofuels and develop an approach for addressing the larger issue of harmonizing biofuel related Standards, Codes, and Regulations. The context and agenda for DOE – ANSI workshop was formed utilizing the farm to tank topic areas and barriers identified by participants in the DOE Biomass Research and Development Technical Advisory Committee, Regional Biomass Roadmap Workshops; outputs from the National Biofuels Action Plan Workshop (November 2006); and recent incidents involving the certification of dispensing equipment.

Workshop Summary:

The intent of the workshop was to review the potential barriers relating to standards, codes, and regulations, and identify any potential gaps. The headings that were used were the generic categories of Feedstock (including farm, forest, other types); Pretreatment and Preprocessing (on-farm and off-farm approaches); Plant/Processing (assumed to be biochemical and thermochemical processes); Distribution; Vehicles, other end-products & co-products; and Federal and State Government Issues.

Working backwards from the barriers in these categories, the participants were asked to consider whether specific Standards/Codes existed; their Status; the Lead Organization/s; Supporting Activities or Issues; and the approximate time to completion if they needed to be addressed. During the first 4 hours of facilitated session, participants worked through the feedstock and pretreatment and preprocessing issues. As the participants, organizers, and facilitators quickly learned, there were many things to consider and many details that were revealed as the participants engaged one another with their inputs and ideas.

To demonstrate the depth that these topic areas involved, Figure 1 has been provided to illustrate how feedstocks break down into agricultural residues, forest materials, dedicated energy crops, and other waste streams. Our facilitated sessions did not "drill-down" to these more distinct feedstock classifications, but it is anticipated that this level of depth and attention will be captured through future activities.

Figure 1. Feedstocks for the Future Bioindustry

Agricultural Residues
- Corn stover, various straws and hulls, bagasse, orchard prunings

Forestry
- Residues (logging slash, forest thinnings, fuel reductions, understory brush) and pulping process wastes (e.g., black liquor, other wastes)
- Conventional (e.g., Southern pine)

Dedicated Energy Crops
- Starch and sugar (e.g., corn, wheat, sorghum, sugarcane)
- Oil crops (e.g., soybeans, canola, other minor oilseeds) and other oils (microalgae)
- Lignocellulosics
- Herbaceous (e.g., alfalfa, reed canary grass, switchgrass, large grass)
- Short Rotation Woody Crops (e.g., poplar, willow)

Other Wastes
- Municipal Solid Wastes (MSW) (includes landfill gases)
- Industrial (includes food processing)
- Domestic wastewater
- Animal wastes
- Construction/demolition
- Yard waste
- Biosolids (wastewater treatment sludge)
- Waste oils
- Disposal method for invasive species

At the start of the second day of the Workshop, participants choose to start with discussion of end-use technologies, but the group quickly found itself questioning the specifics characteristics the various biofuel commodities being considering. At this point, participants opted to depart from the official meeting agenda and dedicated approximately 45 minutes discussing the various biofuel commodities and their fuel-related characteristics. The participants identified the following commodities and their blends as representative of the biofuel commodities that have, or could be, entering the marketplace: biobutanol, green diesel (e diesel), renewable diesel, biodiesel (trademarked), biomethanol, hydrogen, ethanol, renewable/green gasoline.

Participants quickly realized that many of the characteristics which are needed to compare these to the existing codes and standards are probably not available for all of the biofuel products and their blends. The participants recommended that NIST be tasked with the responsibility of gathering this information on these biofuel commodities. Participants also scoped out the needed technical information in specific topical areas, including: technology definitions; establishing similar understanding on these commodities to ensure comparisons; listing of consumer issues; listing of known technical issues; identified appropriate performance specifications; analysis and Testing; EPAct Fuels Harmonization requirement; and things to be addressed by the

development of a ANSI Biofuels panel which was proposed and agreed to during the workshop. After these matters were addressed the participants made good progress on the completion of both end-use technologies and distribution methods that could be used to move biofuel products to commercial markets. The materials captured during the facilitated sessions are contained in the Workshop Proceedings in the section titled, Raw Output from Facilitated Sessions.

Pursuit of Performance-based Standards over Prescriptive Standards:

The trend toward performance based standards allows engineers to optimize their designs and provide innovative solutions, achieve potential cost benefits, and meet safety requirements. In order to develop performance-based standards and regulations, appropriate and defensible data must be generated and analyzed. As the facilitated session seemed to demonstrate, some of this appropriate and defensible data for the identified biofuels commodities may exist, but it is believed that a substantial amount of information would need to be generated. The Standard Development Organizations (SDOs) and Code Development Organizations (CDOs) do not have the necessary technical expertise on staff to research and gather all the information necessary to developed, modified, and harmonize standards for biofuels. Because of the importance of this the integrity of our nations fuel supply. As such it is in the best interest of the government and industry to collaborate in this area through cost-shared development activities. As stated previously, NIST was identified as the appropriate organization to gather the critical information on the biofuel commodities. Prescriptive or mandated fuel standards might offer some interim advantages in the standardization of transportation technologies by limiting the number of possible fuel choices which developers would need to considered in their designs. Future activities would need to consider where and when prescriptive standards might make sense and how to implement such standards to facilitate a safe and expeditious transition to increased biofuel production and use.

Template Development Activities

As a follow-up to the DOE – ANSI Biofuels Workshop a National Template is being developed to enable and facilitate the development safe and effective technical codes and standards and to support the widespread deployment and use of biofuels. The structure for the template is still under development and will be presented as a follow-up product to this workshop. When complete, the draft template will be distributed to the workshop participants for their review and comment. The National template will also be accessible at the meeting workshop website www.biofuelsstandards.biomass.govtools.us. This website also includes a working documents forum where registered users can post and reply to messages posted by registered users; they can also use the forum to upload and share files with other registered users. The working documents forum is a password protected page that was prepared to serve as a useful medium for reference and dialog associated with the development of biomass related codes and standards.

Potential Biofuel Implementation Barriers

Identified in the Biofuel Vision Workshops Modified by DOE -- ANSI Workshop Participants

Feedstock (farm, forest, other)	Pretreatment	Plant/Processing	Distribution	Vehicles, other end-products & co-products.	Federal and State Government Issues
Feedstock production efficiency - Single pass harvest - Multi-pass harvest	Pretreatment/ Preprocessing (at farm or at the plant)	Exact processes need to be defined	Equipment Standards (rail, truck, barge, pipelines)	Dispensing related standards	Crop development issues. Most programs are state-based (this is a potential regulatory and deployment barrier).
GMO Acceptance by the general public	Environmental Issues	Fire Hazard concerns	Moisture content	Environmental considerations (tailpipe emissions, evaporative emissions)	Farm related regulations (state and Federal)
GMO standards to: grow, harvest, and utilize for fuel.		Depot concept - specifics on the concept need to be clarified. - no appropriate Stds exist.	Materials compatibility issue	insufficient infrastructure (new equipment and retrofit equipment issues)	Stakeholder education - decision makers - farmers - consumers
Utilization of large quantities of underutilized wastes.		Air Emission Standards	Ethanol Fuel and Blend Standards	Mismatch issues (emissions, regulations, and intended fuel usage).	Interstate transport issues: - truck load limits - invasive plant species
Development of performance based standards for feedstocks		Production Facility Classifications (EPA Rule - making)	Transfer & Distribution safety issues unknown	Fuel economy and emission data on biofuels is not available.	International harmonization of biofuel codes and standards
Harvesting Issues and Standards (relating to noise, fire, particulates, etc.)		Water Use (plant processes)	Transfer & Distribution fuel blend quality issues	Consideration of biofuels as a future h\hydrogen energy carrier.	Legal issues including preemption; displacing effect that federal law will have on a conflicting or inconsistent state law.
Lack of appropriate farm policies for biomass energy crops			mix spill containment & recovery procedures.		International land issues, including deforestation.
Feedstock storage issues (at farm or at plant).					Climate change issues (GHG emissions, CO2 cycle and recycle, treaties and agreements).
Development or modifications to harvesting equipment standards.					International industrial competitiveness

Potential Biofuel Implementation Barriers

Identified in the Biofuel Vision Workshops Modified by DOE -- ANSI Workshop Participants

-- Barriers Continued --

Feedstock (farm, forest, other)	Pretreatment	Plant/Processing	Distribution	Vehicles, other end-products & co-products.	Federal and State Government Issues
Feedstock bulk density (as received or bone dry basis).					
Food -vs- Fuel issues. Can also be expressed as a Starch -vs- protein issue. (Should there be standards or % requirements to ensure production of food supplies?)					
Soil Biodiversity. Monocultured grasses, etc.					
Farm land conversion to residential and commercial use. Reduced resource base.					
Crop yields/acre					

Feedstock Related Standards and Codes

	Standards/Codes	Status	Lead Organization	Supporting Activities or Issues	Time to completion
Production of Feedstocks					
	Develop procedure to define feedstock composition (dependent on processing options)	Does not exist	ASABE	Future market parameters	
	Feedstock impact on final products (traces, GMO in DDGs, etc)	Example: d245.5 - moisture content	ASABE		
	Development of measurement standards and certified reference materials for both GMO/Non-GMO	Does not exist			
	Some reference materials does exist for the biomass feedstocks but it is not comprehensive. (USDA, National Labs)	NIST w/ Industry		Need to define all biofuel feedstocks and develop comprehensive database of information.	
	Test method (private industry)	Reference materials (NIST)			
	Review existing standards	Develop analysis tools that could be certified against the standard			
	Best Practices (Sustainable Farming/Forest Standard)	ISO 14000/Env. Mgmt Some parts exist	USDA (ASABE), DOI, USDA (FS)	Review existing practices work to development vol. standards	

Feedstock Related Standards and Codes

	Standards/Codes	Status	Lead Organization	Supporting Activities or Issues	Time to completion
Harvesting/ Collection					
	ISO 22006: Application of ISO 9001 to Production Ag.	What about mature energy feedstock (back with potential to GMO for protein issues) based co-production			
	Differentiate GMO and traditional crops	Committee Draft; work comments Energy crops over take ag land. Resolve concerns about GMO	USDA, ASABE, AOCS		
	FDA (check fed regs)	Harvest Equipment standards			
	Cab filter standards	Sensors on equipment			
	Combine cleanout: GMO/non-GMO	Some parts exist lots of work done Various testing protocols Dust fires are big issues			
	Review Existing equip. standards.	Catalytic converters on outdoor power equipment (EPA)	Major equip manufacturers, SAE AEM FEMA (farm equip.)	Air Quality Issues	
	Particulates and Odors	Standardization of harvesting energy crops for new processes	Some exist at the federal and state level; many state exempt, but new standards on the way	Modeling? Monitoring-not local	
	State and local dust and odor issues	Possible need for mitigation strategies			
	Need to understand the Chemical composition of the biomass materials	EPA (NACAA, ASABE, States)			
	ASTM (E48, E56)	Tag TC 229, NNI			

	Standards/Codes	Status	Lead Organization	Supporting Activities or Issues	Time to completion
Storage-Dry Storage (on farm or plant)					
	NFPA 69, NFPA 654, NFPA 499, NFPA 61 (A.6.2.1), NFPA 1, NFPA 70, NFPA 86 ICC codes would also apply Assess Existing Practices	NFPA and ICC Fire Codes exist, but will need modification; large storage Silage tubes	NFPA, ICC	* Mitigate loose fibers * Flow properties * Crop pretreatment standards, drying others	
	Rodent infestation (regulation)	EPA, Chemical Safety Board, FPA, ASABE, ICC			

Pre-Processing Pre-Treatment Related Standards and Codes

	Standards/Codes	Status	Lead Organization	Supporting Activities or Issues	Time to completion
Preprocessing					
	Standardization of material properties		NIST American Chemistry Council; material processing industry (experience dealing with material slurries)	Mitigate loose fibers	
Pretreatment					
	Preprocessing standards for agricultural products		Existing but would need to be reviewed ASABE		
	Grinding mixing standardization		ASABE		
	Transportation of Pretreated Agricultural Materials: * Truck * Rail * Barge	Some things exists - But they would need to reconsidered this in context. There may be material compatibility issues for transport of pretreated Ag. Materials on exisitng transportation modes.	* Rail car storage (PHMSA) * FRA Issue if the pretreated material is stored on rail cars * Association of American Railroads (AAR) * American Chemistry Council (ACC) * Coast Guard (responsible for barging operations) * Truck DOT NHTA	Feedstock (intermediate ag residue) classification (pretreated biomass) --- for rail. Would treated Ag residue be classified as a Hazardous materials?	
	Liquid Material Storage	EPA has waste treatment processes/model Mixing standards (manure lagoon)	EPA		
	Material Aging Study		Materials compatibility; DOE (lead)	Develop standard reference materials	
	Tank bladders	DOD has experience with the use of bladders	DOD	European bladder like storage study	
	Technical Information on Materials, Properties, and Interactions		NIST American Chemistry Council; material processing industry (experience dealing with material slurries)		

Listing of Recognized Biofuel Commodities

Biofuel	Formula/ Discription	Composition	Comment or Additional info
biobutanol	**$C_4H_{10}O$**	homogeneous main component worries: a) contaminents b) impurities	
green diesel (e diesel)	Fuel made from biomass-derived carbohydrates can be converted to sulfur-free liquid alkanes resulting in an ideal additive for diesel transportation fuel.	not homogeneous	
renewable diesel	Renewable Diesel High-quality, pure hydrocarbon diesel fuel made from virgin or used vegetable oils or animal fats • Fits existing infrastructure • No storage stability problems • Excellent performance in cold climates • Very high cetane number (84 ... 99) • Free of aromatics, sulfur, oxygen • Reduces exhaust emissions of NOx(15%), PM(25%), TCH(20%), CO(5%) • 60% less fossil CO2 than fossil diesel fuel	if registered, it meets specifications of ASTM D-975.	
biodiesel (trademark)	Biodiesel refers to a diesel-equivalent, processed fuel derived from biological sources (such as vegetable oils), which can be used in *unmodified* diesel-engined vehicles.	various blends - not homogeneous	
biomethanol	**CH_3OH**	homogeneous	
hydrogen	**H_2**	homogeneous	H2 refueling computer interface protocol
ethanol	C_2H_5OH	homogeneous products	E-10 based system (use co-mingling procedure"
renewabe/green gasoline	A clean burning, environmentally friendly gasoline-like fuel produced entirely from biomass.	not homogeneous	

NOTES

1. The major issue with regard to these biofuel commodities is the apparent lack of common nomenclature and/or specifications.

2. It was not clear to the participants which of these fuels are included in existing standards

3. There is a strong need to develop of technical definition for each fuel of the biofuel commodities

4. Performance characteristics for each of these biofuel commodities should be prepared (for example some standards are based on the potential for biol-over, but this information probably does not exist for these commodities).

5. There exists biodiesel stability issues. These stablity issues may also apply to other biofuels.
6. Biofuel testing methods need to be developed
7. European example model cited (2nd gneration hydrotreating ---- goes to diesel

Needs in Specific Topical Areas

Technology Definitions	Establish similar understanding	Consumer issues	Technical issues	Identify appropriate performance spec	Analysis and Testing	EPAct Fuels Harmonization requirement	ANSI/HLS panel model to issue standards
ASTM standard D. 975 (no current measurement of biofuels)	for biofuels that we have for petro (by fuel type	who determines what/when goes in?	everywhere	non existent for biofuels	Life cycle analysis (energy balance) - need for a standardized approach	doe (policy) EPA (policy and air offices)	ANSI - establish biofuel standards panel
inclusive specifications standards codes (fire safety, health and environmental - consequences of looking at them separately)	determine progress of state and local standard work	terminal operators	effort to understand biofuel impact on vehicles (by feed)	supporting activities/analysis	Engine Testing - biodiesel test just started - some test info may exist that can be used as a starting point	DOE analysis - stability of fuel market	proposal because of the - SOTU - international competition/standards - international issues
need to define properties for standard biodiesel control application/ performance of product	develop blend standards	supply chain nodes	respective emission issues	ASTM -factor in up front -funding needed		implication of fuel quality	timely response is needed (3-6 months for kickoff)
OR determine which additives would counter differences in performance (weather, feed, etc)	new to review burn characteristics of fuels and apply appropriate suppressants	consider quality impacts thru supply chain (detreated/blending)	not just vehicles			SOW/draft is posted to the EPA website	ANSI model - 100's of organizations involved
biofuel definition in energy bill 2005		big ramifications to end users	pressurized hydrogen tanks - different from the fuel tanks issues			the report is based on the previous targets (before the 07 SOTU - 35 b gallons target)	GAP Analysis
cellulosics are renewable ---- no need for external energy		consumer has no clue as to the feed/fuel variation variation of % of biodiesel in blend					out reach to industry
		dispenser issues (H2, others, all different)					does an atm spec & weights and measure requirement eliminate these problems? Challenges: - identify experimental data needs - identify various needs to move quickly - is there a funding need?

End-Use Related Standards and Codes

Overarching statements: 1. SAE vehicles standards list is extensive and not full captured herewith; 2. Dispenser disconnect standards apply for all vehicles and fuel types.

	Codes/Standards needed	Status	Supporting Activities/Analysis	Lead Organizations
Vehicles/Other End Uses				
Environmental Consideration (tailpipe and evaporative emissions	Small engines & related will need to be developed	No standards specific to biofuels		EPA
Fuel Economy and emission data issues	EPA requirements for vehicle & fuel	Updates needed		
Other:	Small industrial wood chip power generation equipment	Committee would review biofuel use	International issues	EPA ASTM
	NFPA 110 Backup Power Systems	Looking into biofuel issues & additive needs	Standard compatibility issues?	NFPA, ICC
	NFPA 850 Recommend Practice for Electric Generating Plans	Some cruise ships are actually already burning B100 exclusively	Material issues (turbine blade corrosion, deposits	NFPA
	NFPA 505 Industrial trucks - first user (fleet ops)		Canadian standards exist for	NFPA
	PowerGen & Maritime ASTM D2880 industrial gas turbine fuels		HEARTH (some assoc.)	ASTM
	NFPA 37 stationary combustion engines & gas turbines		Would need standard reference materials for certification of equipment	NFPA

	Codes/Standards needed	Status	Supporting Activities/Analysis	Lead Organizations
Heating Equipment	ASTM D396 (fuel oil) ASTM D3699 (kerosene specs)	Appropriate orgs Committee would review biofuel use		CSA -America SAE ASME
	NFPA 86 standard for ovens & furnaces (check for appropriate ICC code)	Exists, would need to be reviewed		Portable equipment manufactures UL
	NFPA 85 boiler and combustion systems code (check for appropriate ICC code)	Exists, would need to be reviewed		

End-Use Related Standards and Codes

	Codes/Standards needed	Status	Supporting Activities/Analysis	Lead Organizations
Woody Materials	NFPA 211 Standard for Chimneys, Fireplaces, Vents and Solid Fuel-Burning Appliances (check for appropriate ICC code)	Exists, would need to be reviewed		NFPA, ICC
	CSA - America standards (Z 21/83)	In progress	Liquid-fuel standards need to be developed *using new source performance standards for emissions)	CSA
	NFPA 31 Oil Burning Appliances	Exists, would need to be reviewed	Co-fire composition studies	UL, NFPA, ICC
	ASABE Project: Properties of Biomass from Energy Crops Used for Direct Combustion x564)		Council on forestry engineering	CSA America
	European wood pellet standards		EPA New source performance standards	ASABE
			Some ag waste composition studies	EPA

	Codes/Standards needed	Status	Supporting Activities/Analysis	Lead Organizations
Biomass fuel by-product utilization	DDG Standards for animal feed products		Concern regarding mycotoxins[1] which get concentrated by a factor of 4 in the ethanol production process.	USDA, FDA

Footnote 1

Mycotoxins appear in the food chain as a result of fungal infection of the crop. If an infected crop is not eaten by humans, the mycotoxin is still dangerous to human health, because the crop may be given as animal feed to farm animals. Mycotoxins greatly resist decomposition or being broken down in digestion, so they remain in the food chain in meat and dairy products.

Distribution Related Standards and Codes

	Codes/ Standards needed	Status	Supporting Activities/Analysis	Lead Organizations
Distribution Method				
Pipeline Transport issues	API 1004 using ASME	Exist may need updating Material issues biofuel compatibility	-Material compatibility for pipeline distribution -Pipeline industry regulations & practices -National association of corrosion engineers (material compatibility testing)	
Interim on-site storage	NFPA 30A farm & remote site fuel storage	Exist may need updating		Petroleum interf. DOT supported DOE & NIST
Rail car	Manual of standards and recommended practices Part III tank cars AAR	Exist may need updating		AAR
Barge	See Coast Guard Regulations	Exist may need updating		Coast Guard
Truck TTMA standards		Exist may need updating	Toxins and other issues from participants	TTMA (tank truck manufacturers association
Pyrolysis oil transport	AF&PA standards for tall oils	Does not exist for py oil	-Tall oils from pulp & paper (ht. requirements) -Polymerization inhibitors -Flammability properties similar to #2)	