

SORBENTS FOR HYDROCARBON DESULFURIZATION

Gökhan Alptekin, Ph.D, Rita Dubovik, Matt Schaefer, Mike Ware, Bob Amalfitano

TDA Research, Inc. □ Wheat Ridge, CO □ 80033 USA □ www.tda.com

Objective: TDA Research, Inc. is developing adsorbents to remove organic sulfur compounds from gaseous and liquid fuels

Motivation: Distributed fuel cell power systems using natural gas, LPG or liquid fuels as a feedstock requires removal of sulfur (both naturally occurring and sulfur bearing odorants) to protect fuel cell anode catalysts and fuel processor components

Sorbent Requirements

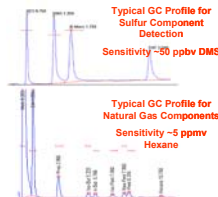
- High sulfur absorption capacity
- Reduce concentration of sulfur species to sub ppm levels
- High selectivity for targeted species
- Ability to operate in reducing gas environments
- Low cost
- Safe and easy disposal

Natural Gas Odorants

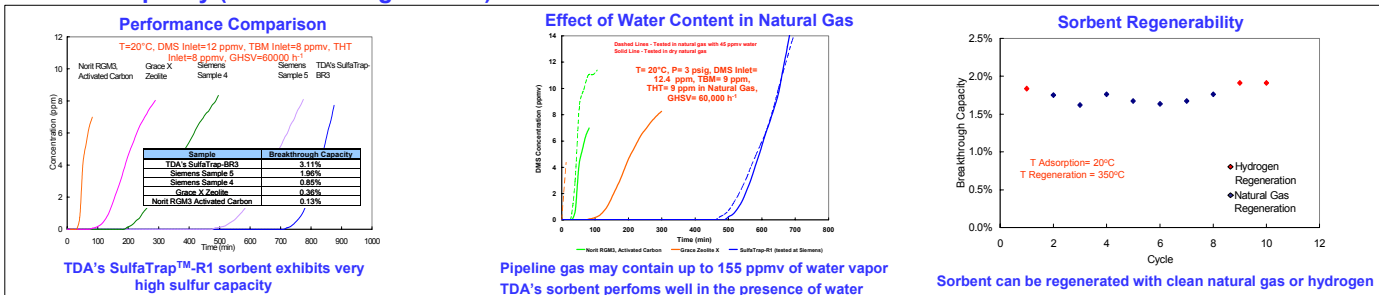
Odorant	Structure
Dimethyl Sulfide (DMS)	
Tetra-butyl Mercaptan (TBM)	
Tetrahydrothiophene (THT)	

*Hydrodesulfurization is particularly difficult due to steric effects

Analysis of Natural Gas and



Sorbent Capacity (3.12% on weight basis)



Natural Gas Desulfurization

A demonstration with Siemens Power Corporation showed 2.2 L sorbent removed all sulfur for over 6,500 hrs

Average concentration of sulfur species in Pittsburgh pipeline gas:

HES	EM	DMS	TBM	THT	NPM	Total S
ppmv	ppmv	ppmv	ppmv	ppmv	ppmv	ppmv
0.10	0.07	0.45	0.59	0.61	0.52	2.98

*Data provided by Gordon Israelson, SPC

A demonstration with Siemens and Logan Energy in Fuel Cell Test Center Facility in Johnstown, Pennsylvania and a US Army base at Fort Meade, MD is underway

2.2 L sorbent removed all sulfur for over 8,000 hrs

*Three other demonstrations are underway with 125 kW CHP systems in the US and Europe (in Italy and Germany)

LPG Desulfurization

Liquefied petroleum gas (LPG) has higher power density than natural gas on volume basis

LPG-fed systems are suitable fuel for portable systems and applications in remote locations

Mercaptans (mostly ethyl, n-propyl and isopropyl mercaptans) are the primary sulfur species in LPG

T=20°C, P=5 psig, GHSV=5,000-30,000 h⁻¹, Ethyl Mercaptan Inlet = 13 ppmv-25 ppmv

GHSV = 30,000 h⁻¹
13 ppmv EM

GHSV = 5,000 h⁻¹
25 ppmv EM

C2H5SH → C2H4S2
Ethyl Mercaptan → Diethyl disulfide

TDA's SulfaTrap™-P sorbent achieves 0.63% and 2.35% wt. capacity at GHSV of 30,000h⁻¹ and 5,000h⁻¹, respectively

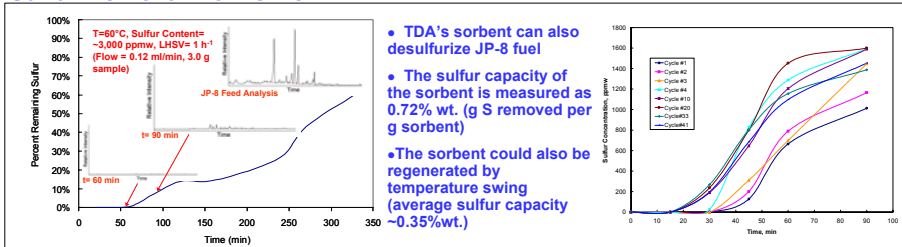
25 cc sorbent desulfurized the whole content of 20 lb LPG tank

TDA's SulfaTrap™-P sorbent achieved 0.51% wt. pre-breakthrough sulfur capacity with commercial LPG tank

SulfaTrap™-P Sorbent
LPG Fuel Tanks
75 W MesoGen SOFC Battery Charger

Field Test results with 75W MesoGen LPG-fed SOFC battery charger were successful

Sulfur Removal from JP-8



Acknowledgements

Funding for the research is provided by DOE Phase II SBIR Grant, Contract No. DE-FG02-03ER83795 and DOD Phase I SBIR Grant

Authors also thank
Mr. Donald Collins, NETL, DOE
Ms. Magda Rivera, NETL, DOE
Mr. Kevin Mills, US Army TACOM