Comparative radiocarbon analysis for artificial mixes of petroleum and biobased products

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Advances in Liquid Scintillation Spectrometry
6-10 September 2010, Paris, France

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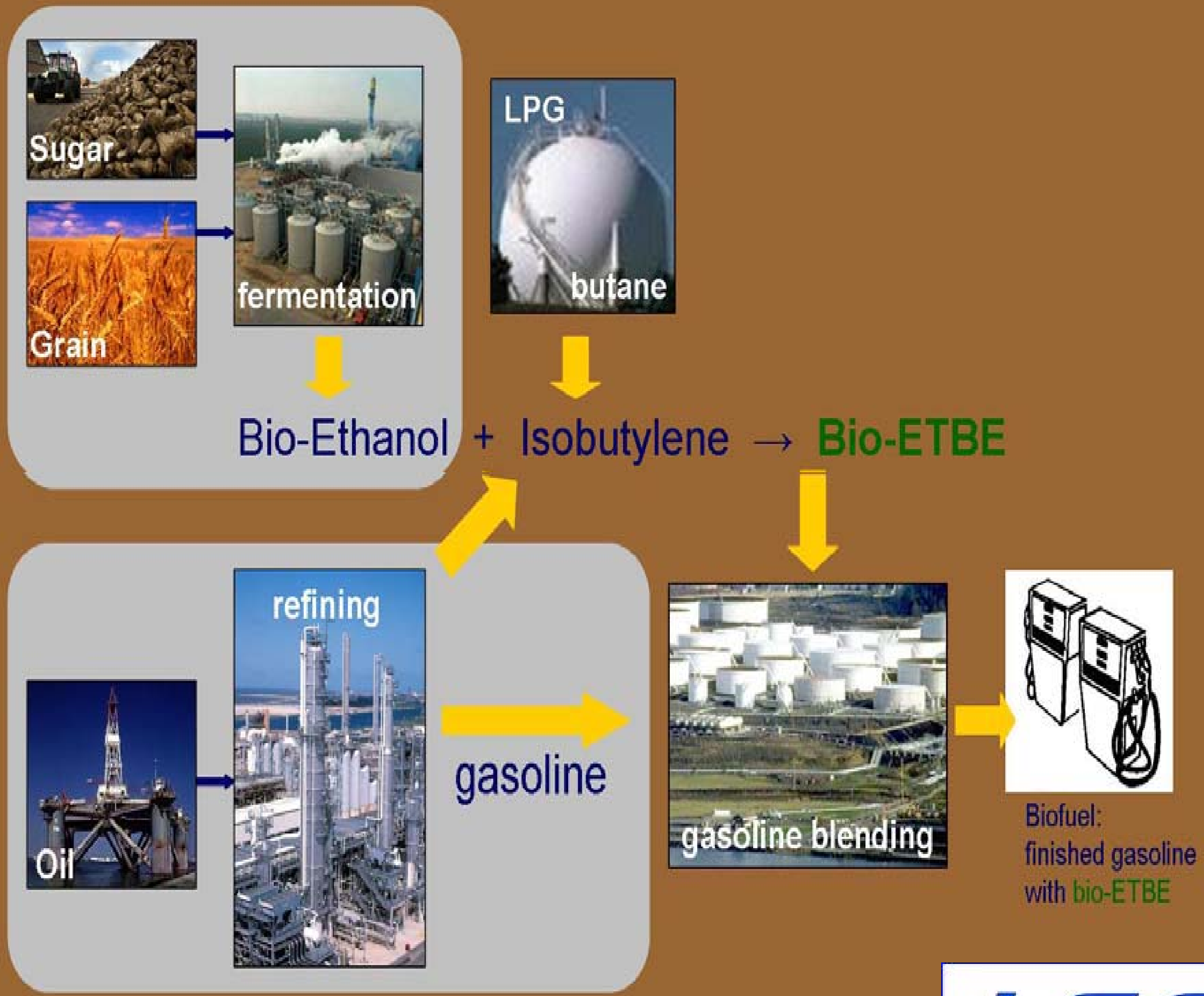
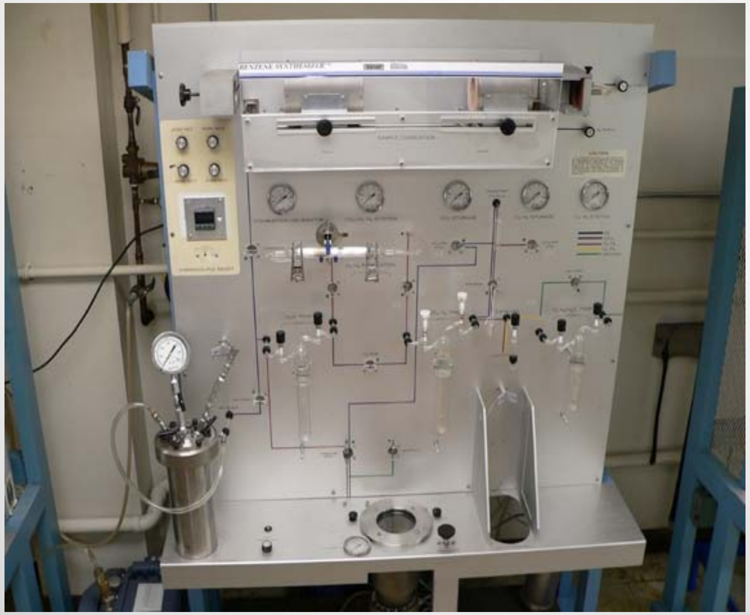

Sugar
Grain
fermentation
LPG
butane
Bio-Ethanol + Isobutylene → Bio-ETBE
Oil
refining
gasoline
gasoline blending
Biofuel:
finished gasoline
with bio-ETBE

LSC equipment for bio-fuel analysis ASTM 6866-08 part C

Parr bomb

Benzene synthesis system TASK



Liquid scintillation counters

Accelerator Mass Spectrometer

NEC 0.5 MeV Pelletron Tandem:

ASTM 6866-08 Part B

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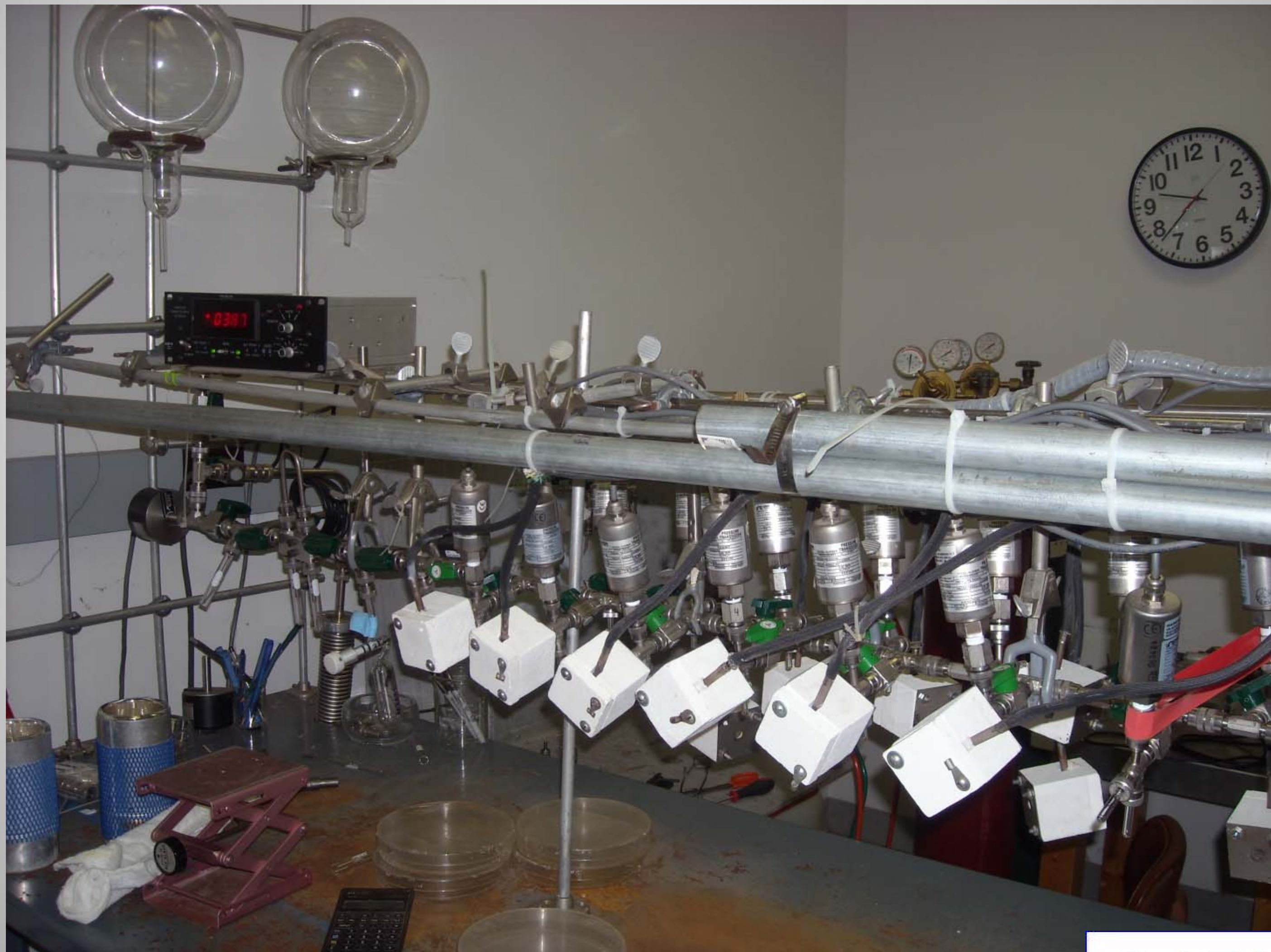
Graphitization system



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EQUATIONS FOR DETERMINATION OF THE BIO-FUEL PERCENTAGE

$$pMC_{mix} = F_{Cbio} \times pMC_{bio} + (1 - F_{Cbio}) \times pMC_{Cpetro} \quad (1)$$

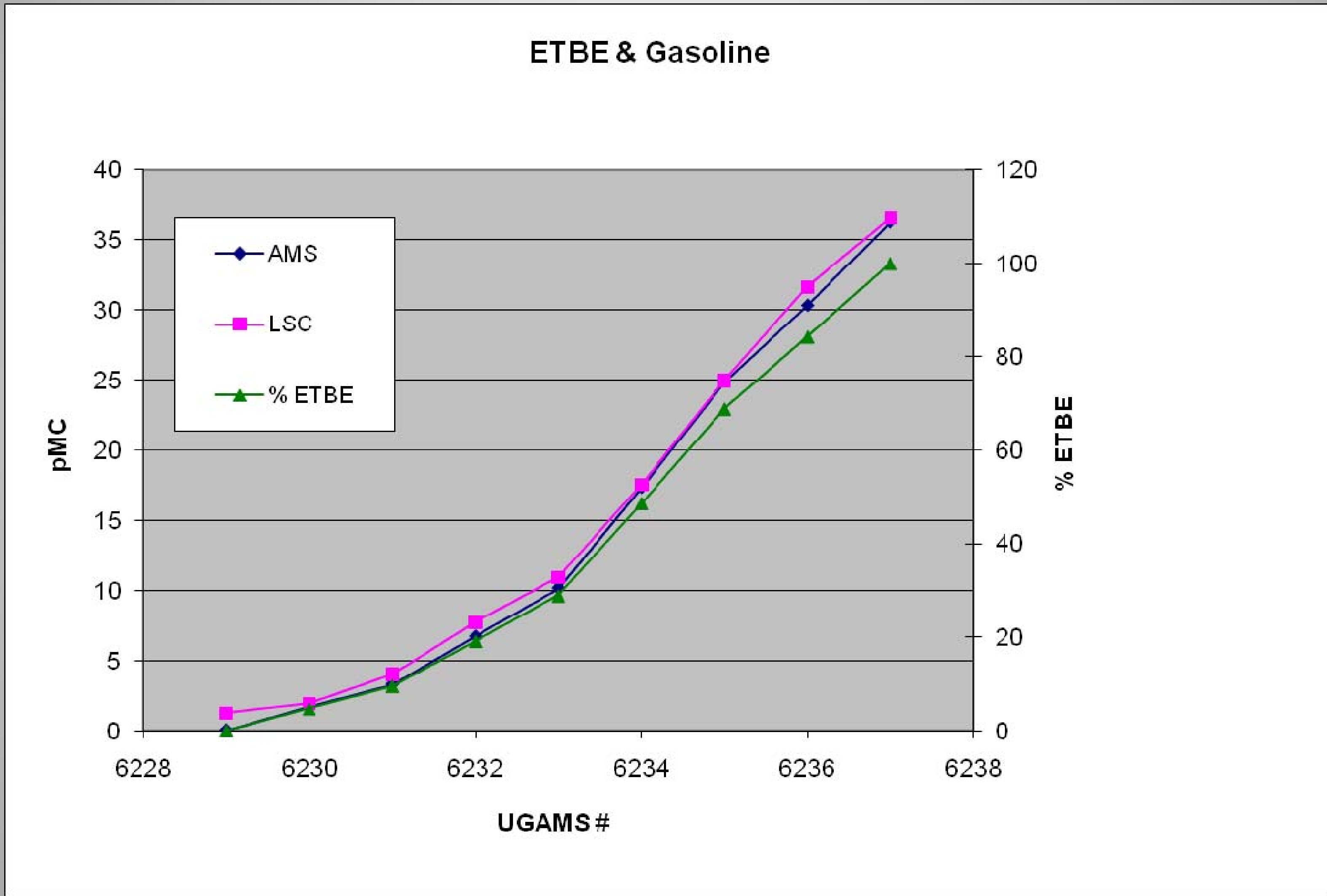
$$F_{Cbio} = \frac{pMC_{mix} - pMC_{Cpetro}}{pMC_{bio} - pMC_{Cpetro}} \quad (2)$$

CLIENT TEST WITH MIXES OF BIO-ETHANOL AND PETRO-ETHANOL

Material	δ13C, ‰	pMC				% of nat. ethanol		
		AMS	±1σ	LSC	±1σ	AMS	LSC	m/m
petro ethanol	-28.15	0.13	0.10	1.11	0.88	0.0	0.0	0.0
ethanol mix	-15.78	85.62	0.28	85.57	0.96	80.5	79.7	80.0
corn ethanol	-12.40	106.31	0.33	107.07	1.20	100.0	100.0	100.0
ethanol mix	-18.82	64.45	0.22	65.55	1.04	60.6	60.8	60.0
ethanol mix	-14.75	96.12	0.29	99.41	1.12	90.4	91.8	89.9
ETBE	-27.30	35.82	0.13	35.85	0.88	33.7	32.8	33.0

ANALYSIS OF ETBE GASOLINE BLENDS PREPARED IN THE LABORATORY

UGA MS #	Material	δ13C, ‰	pMC				% ETBE		
			AMS	±1σ	LSC	±1σ	AMS	LSC	computed
6229	gasoline	-28.37	0.05	0.01	1.26	0.80	0.0	0.0	0
6230	mix	-27.98	1.71	0.02	1.92	0.96	4.6	5.3	4.75
6231	mix	-27.76	3.31	0.03	3.99	0.48	9.0	10.9	9.53
6232	mix	-27.32	6.72	0.04	7.69	0.80	18.4	21.0	19.16
6233	mix	-26.55	10.16	0.06	10.93	0.88	27.9	29.9	28.89
6234	mix	-25.55	17.32	0.08	17.56	0.72	47.6	48.0	48.67
6235	mix	-24.47	24.89	0.10	24.99	0.80	68.5	68.4	68.87
6236	mix	-23.57	30.31	0.11	31.67	1.12	83.5	86.6	84.31
6237	ETBE	-22.54	36.24	0.13	36.56	0.80	100.0	100.0	100



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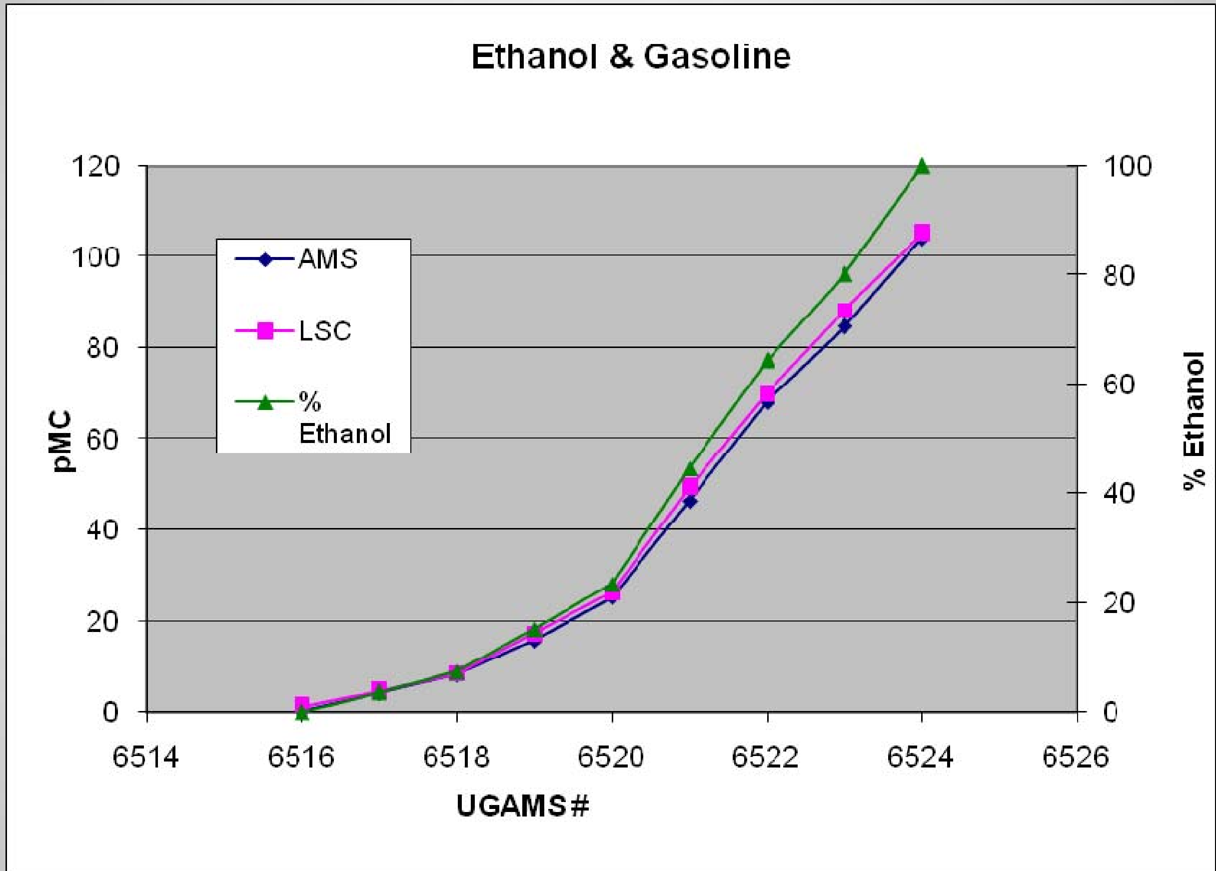
ANALYSIS OF BIO-ETHANOL GASOLINE BLENDS PREPARED IN THE LABORATORY

			pMC						% ethanol			
AMS #	Material	δ13C, ‰	AMS	±1σ	LSC	±1σ	AMS/LSCgas	±1σ	AMS	LSC	AMS/LSCgas	compute
516	gasoline	-29.1	0.19	0.03	1.26	0.80	0.89	0.04	0.00	0.00	0.00	0.00
517	mix	-28.3	4.21	0.06	4.66	0.72	4.37	0.06	3.85	3.24	3.34	3.60
518	mix	-27.8	8.23	0.06	8.43	0.80	8.58	0.07	7.70	6.82	7.39	7.31
519	mix	-26.7	15.64	0.09	17.14	0.48	18.17	0.10	14.80	15.11	16.62	15.08
520	mix	-25.4	25.19	0.12	26.26	0.80	26.34	0.12	23.95	23.79	24.47	23.33
521	mix	-22.1	46.40	0.17	49.27	0.96	49.71	0.20	44.26	45.68	46.94	44.53
522	mix	-19.2	68.06	0.23	70.02	0.88	70.39	0.23	65.01	65.42	66.82	64.37
523	mix	-16.6	84.65	0.26	88.19	1.12	n/a	n/a	80.90	82.71	n/a	80.11
524	ethanol	-14.0	104.04	0.30	105.1	0.88	104.00	0.33	100.00	100.00	100.00	100.00



Ethanol & Gasoline
120
100
80
60
40
20
0
pMC
AMS
LSC
% Ethanol
100
80
60
40
20
0
% Ethanol
6514
6516
6518
6520
6522
6524
6526
UGAMS#

CONCLUSION

- Radiocarbon measurement of renewable biobased versus fossil carbon is the only method that directly defines their concentration in the fuel blend. Both LSC and AMS techniques, ASTM-6866-08 methods C and D, have shown the only approach that has demonstrated less than ±1% accuracy over the real blending range.
- The cost of analysis and labor consumption is the main disadvantages of the presented methods. However, new developments in lower voltage AMS which allows decrease a cost of equipment and high productivity benzene synthesis systems will allow solve this problem and possible to decline the prices.