

Separations of Petroleum Hydrocarbon

General separation technologies, Inc.

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Background

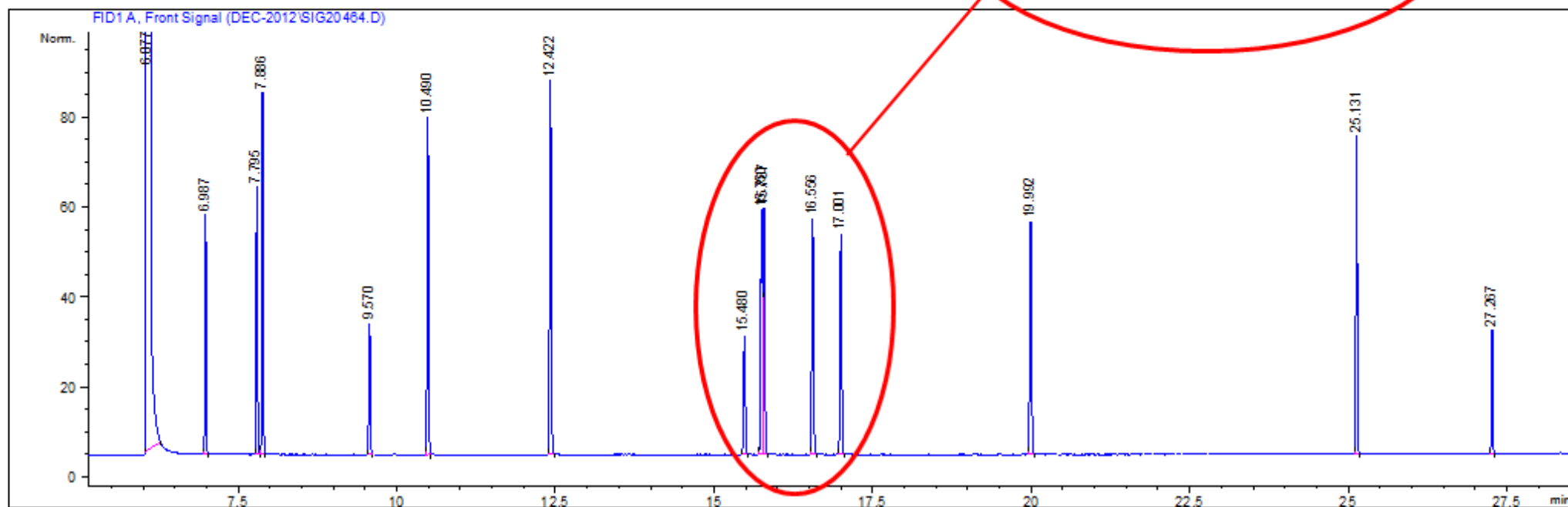
- Spills and releases of petroleum fuels have become the leading source of environmental contamination in Massachusetts. Volatile Petroleum Hydrocarbons (VPHs), which are widely present in contaminated soil and water now, pose a serious threat to the people's health.
- The blending of fuel oxygenate compounds into motor gasoline has increased dramatically in recent 20 years due to necessity of combustion improvement. Unfortunately, because of leaking underground storage tanks or spills, there have been increasing detections of oxygenates in ground water and reservoirs, which is harmful to human being.
- Separating and analyzing VPHs/oxygenates could be achieved with gas chromatography (GC). Non-polar columns such as 1-MS column are widely used. However, the separation of a few pairs of VPHs has a low resolution which can actually be improved with highly efficient columns providing adequate retentions, as demonstrated by GS-Tek's results presented in the following.

Instrumentation Conditions

- GC: Agilent 7890 w/ FID
- Column: GsBP-1, 100m, 0.25mm ID, 0.5 μ m (cat.# 9006-Pona)
- Oven: 50°C(hold 1minute) to 150°C at 5°C /min (hold1minute) to 260°C 15°C /min (hold 5 minutes)
- Carrier: Hydrogen, column flow 1.3ml/min
- Inlet: Split, 275°C, split flow 60ml/min
- Detector: FID 325°C

14 VPH Separations on a 9006-Pona Column

Sample: 1ul 14 components MA VPH Standard With Surrogate

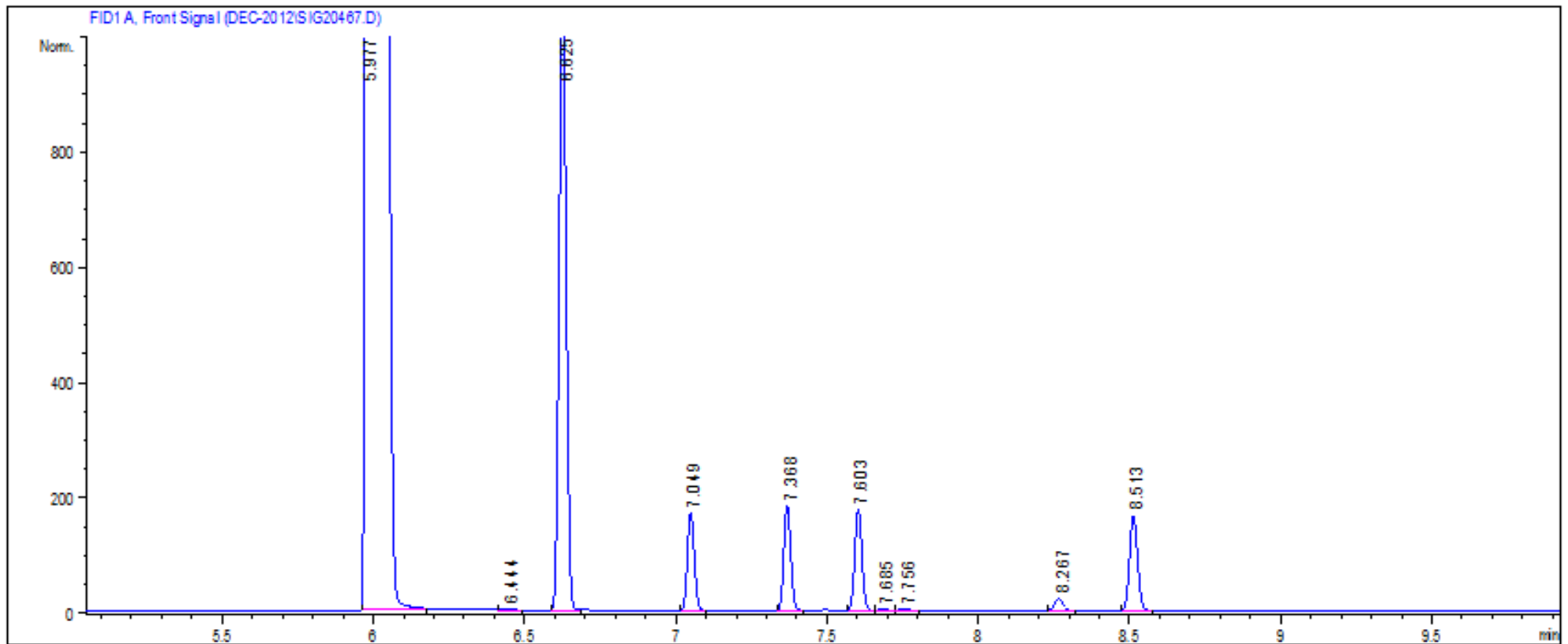


Peak Identifications and Resolutions

Peak #	Component	MeasRetTime	Resolution
1	Methanol	5.984	
2	Pentane	6.578	
3	Methyl Tert-butyl Ether(MTBE)	7.057	
4	2-Methylpentane	7.115	2.38
5	Benzene	8.272	
6	Issoctane	8.917	
7	Toluene	10.605	
8	Ethylbenzene	13.963	
9	m-Xylene	14.320	
10	p-Xylene	14.368	1.20
11	o-Xylene	15.470	
12	Nonane	16.136	

5 Oxygenates Separations on a 9006-Pona Column

Sample: 1ul 5 components California oxygenates standard



Peak Identifications and Resolutions

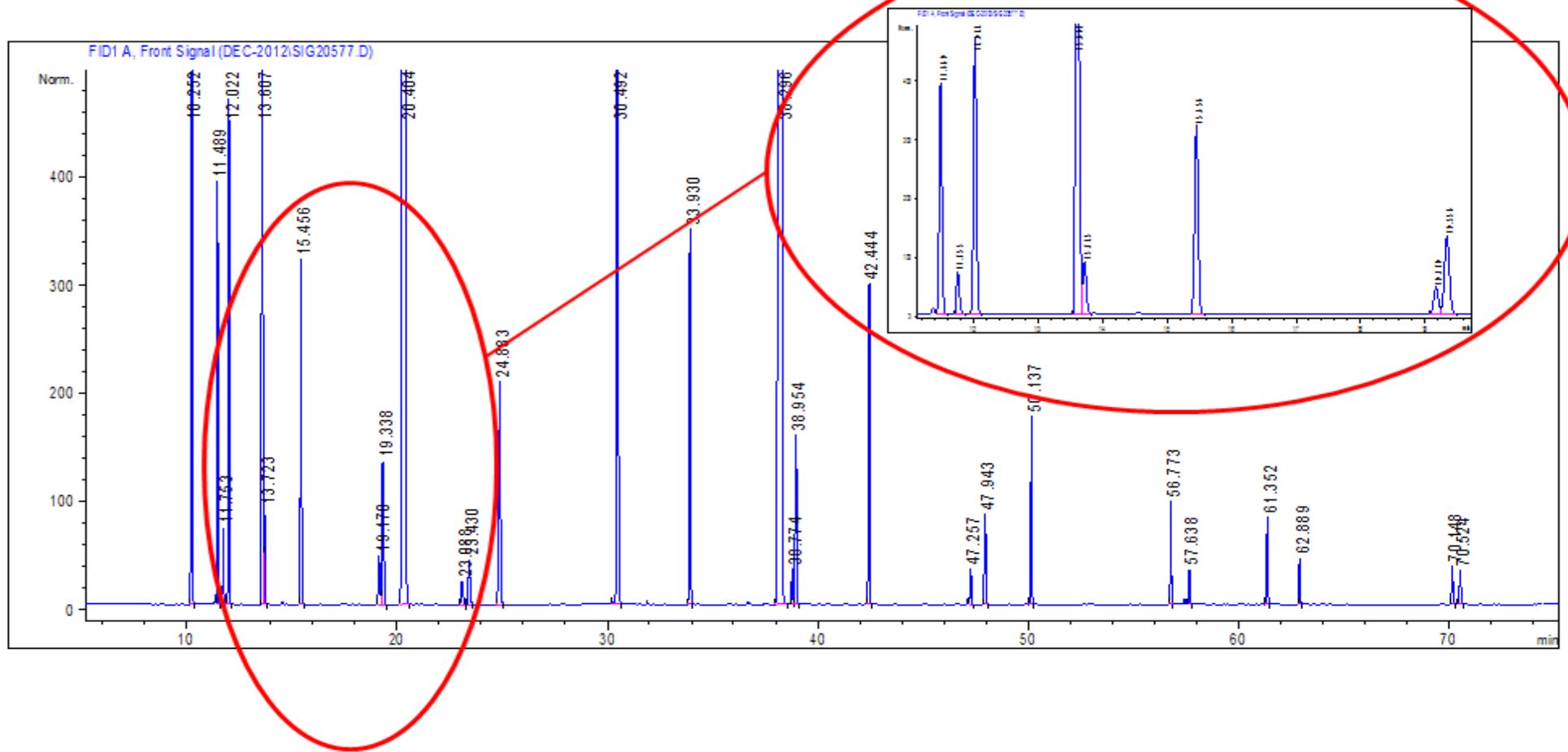
Peak #	Component	MeasRetTime	Resolution
1	Methanol	5.977	
2	Tert-butyl Alcohol	6.444	
3	Methyl Tert-butyl Ether(MTBE)	7.049	
4	Ethyl Tert-butyl Ether (ETBE)	7.368	
5	Tertiary Amyl Methyl Ether(TAME)	7.603	
6	Benzene	8.267	
7	Diisopropyl Ether	8.513	

Instrumentation Conditions

- GC: Agilent 7890 w/ FID
- Column: GsBP-1, 100m, 0.25mm ID, 0.5 μ m (cat.# 9006-Pona)
- Oven: 50°C (hold 27 minutes) to 100°C at 22°C/min (hold 27 minutes) to 160°C at 3°C/min (hold 10 minutes) to 320°C at 5°C/min (hold 10 minutes)
- Carrier: Hydrogen, 1.3ml/min constant flow mode
- Inlet: Split, 275°C, split flow 60ml/min
- Detector: FID, 325°C

Hydrocarbon Separations on a 9006-Pona Column

Sample: 1ul Restek ASTMD 6730 SCE sample (29 components)



Peak Identifications and Resolutions

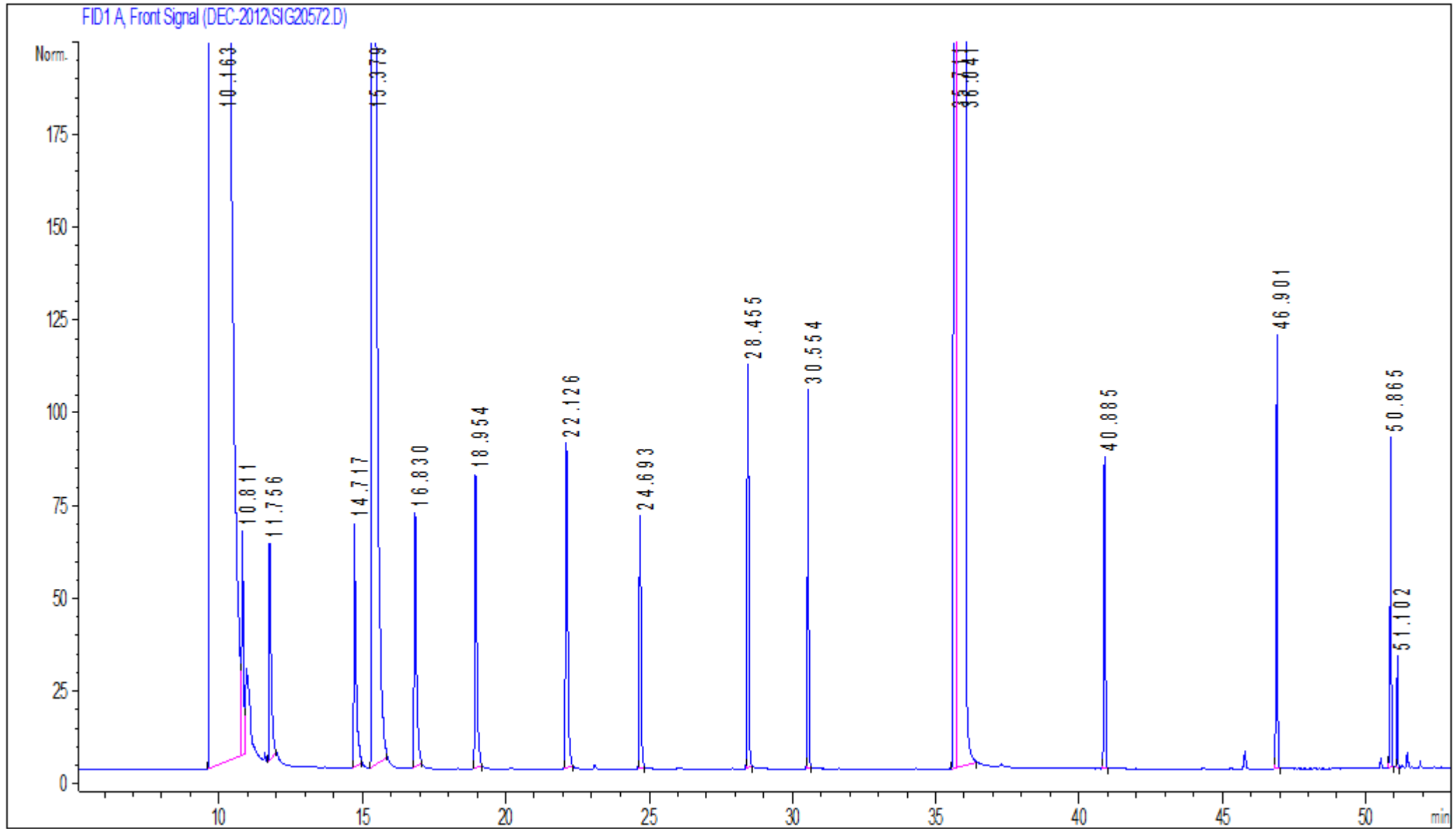
Peak #	Component	Concentration	MeasRetTime	Resolution
1	Ethanol	8%	10.252	
2	n-Pentane	2%	11.489	
3	Tert-butanol	0.50%	11.753	
4	2-methylbutene-2	2.50%	12.022	
5	Methyl Tert Butyl Ether (MTBE)	10%	13.607	
6	2,3-Dimethylbutane	0.50%	13.723	2.11
7	n-Hexane	2%	15.456	
8	1-Methylcyclopentene	0.50%	19.17	
9	Benzene	1%	19.338	2.04
10	Cyclohexane	28.90%	20.404	
11	3-Ethylpentane	0.20%	23.088	
12	Trans-1,2-Dimethylcyclopentane	0.50%	23.43	3.70
13	n-Heptane	2%	24.883	
14	2,2,3-Trimethylpentane	0.50%	30.419	

Peak Identifications and Resolutions

Peak #	Component	Concentration	MeasRetTime	Resolution
15	Toluene	7%	30.494	1.60
16	n-Octane	2%	33.93	
17	Ethylbenzene	25%	38.296	
18	2,3-Dimethylheptane	0.20%	38.774	
19	p-Xylene	1%	38.954	2.63
20	n-Nonane	2%	42.444	
21	5-Methylnonane	0.20%	47.257	
22	1,2-Methylethylbenzene	0.50%	47.943	
23	n-Decane	1%	50.137	
24	Undecane	0.50%	56.773	
25	1,2,3,5-Tetramethylbenzene	0.25%	57.638	
26	Naphthalene	0.50%	70.148	
27	Dodecane	0.25%	61.352	
28	1-Methylnaphthalene	0.25%	70.524	
29	Tridecane	0.25%	62.889	4.74

Instrumentation Conditions

- GC: Agilent 7890 w/ FID
- Column: GsBP-1, 100m, 0.25mm ID, 0.5 μ m (cat.# 9006-Pona)
- Oven: 50°C (hold 27 minutes) to 100°C at 22°C/min (hold 27 minutes) to 160°C at 3°C/min (hold 10 minutes) to 320°C at 5°C/min (hold 10 minutes)
- Carrier: Hydrogen, 1.3ml/min constant flow mode
- Inlet: Split, 250 °C, split flow 60ml/min
- Detector: FID 325 °C
- Samples: C5-C13 hydrocarbons in methanol



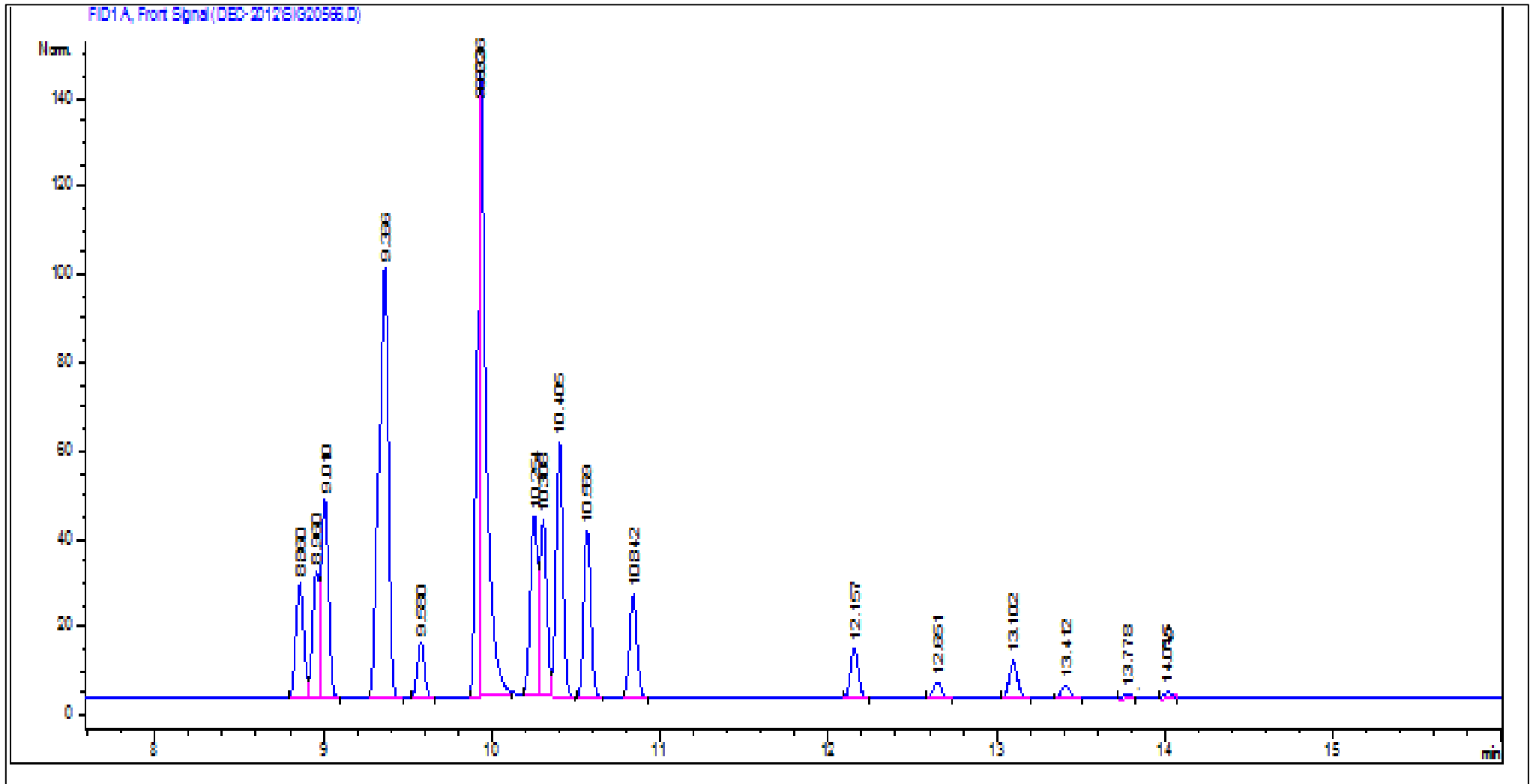
Peak Identifications and Resolutions

Peak #	Compound	Concentration(% in ethanol)	Retention Time	Resolution
1	Ethanol	0.250	10.977	3.79
2	Pentane	0.020	11.682	
3	Hexane	0.020	14.738	
4	2-butanol*	N/A	15.427	
5	Benzene	0.020	15.427	0.00
6	Heptane	0.020	16.856	
7	Toluene	0.020	18.974	
8	Octane	0.020	22.147	
9	P-xylene	0.020	24.704	
10	Nonane	0.020	28.464	
11	Decane	0.020	30.559	
12	Undecane	0.020	35.710	
13	unknown*	N/A	36.168	2.64
14	Dodecane	0.020	40.889	
15	Tridecane	0.020	46.903	
16	Naphthalene	0.020	50.860	
17	1-Methylnaphthalene	0.010	51.100	5.64

* the compounds are the impurities in ethanol.

Instrumentation Conditions

- GC: Agilent 7890 w/ FID
- Column: GsBP-1, 100m, 0.25mm ID, 0.5 μ m (cat.# 9006-Pona)
- Oven: 35 °C
- Carrier: Hydrogen, 0.9ml/min constant flow mode
- Inlet: Split, 250 °C, split flow 60ml/min
- Detector: FID 325 °C
- Samples : C1-C6 in methanol

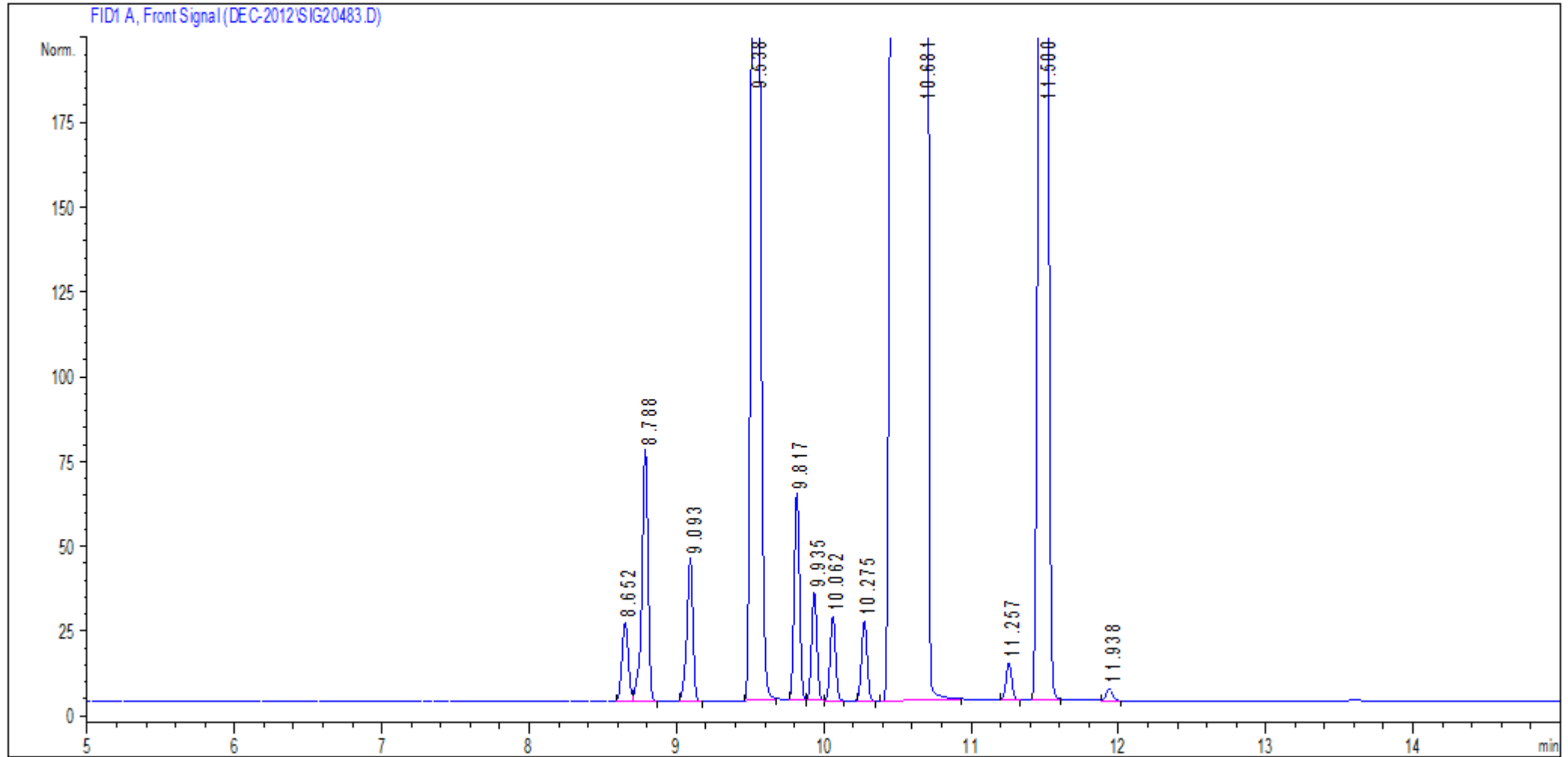


Peak Identifications and Resolutions

Peak #	Compound	Retention Time	Resolution
1	Methane	8.860	
2	Ethylene/acetylene	8.960	2.24
3	Ethane	9.010	1.16
4	Propane/propylene	9.366	
5	Propadiene	9.580	
6	Iso-Butane	9.932	
7	Methanol	9.937	0.14
8	N-Butane	10.254	
9	1-Butene	10.308	1.21
10	Trans-2-Butene	10.405	2.19
11	Iso-Butylene	10.569	3.61
12	Cis-2-Butene	10.842	2.24
13	Iso-Pentane	12.157	1.16
14	N-Pentane	12.651	
15	Pentene-1/Trans-2-Pentene	13.102	
16	2-Methyl-2-butene	13.412	
17	Cis-2-Pentene	13.778	0.14
18	N-Hexane	14.076	

Instrumentation Conditions

- GC: Agilent 7890 w/ FID
- Column: GsBP-1, 100m, 0.25mm ID, 0.5 μ m (cat.# 9006-Pona)
- Oven: 38 °C
- Carrier: Hydrogen, column flow 0.9ml/min
- Inlet: Split, 250 °C, split flow 60ml/min
- Detector: FID 325 °C
- Sample: hydrocarbons #2 in methanol



Peak Identifications and Resolutions

Peak #	Compound	Retention Time	Resolution
1	Methane	8.652	
2	Ethane	8.788	
3	Propane	9.093	
4	Methnol	9.538	
5	N-Butane	9.817	
6	1-Butene	9.935	
7	Trans-2-butene	10.062	
8	Cis-2-butene	10.275	
9	Eethanol	10.681	
10	Isopentane	11.257	
11	Isopropyl alcohol	11.500	
12	N-pentane	11.938	

Conclusion

- *The baseline separations of carbohydrate standards are achieved on a 9006-Pona column.*
- *9006-Pona column exhibits a very good column inertness for components.*