(724) 457-6576

Professional Analytical and Consulting Services, Inc.
409 Meade Drive
Coraopolis PA 15108

Sample Analysis • GC/MS • R & D • Consulting • Training Courses • Activated Carbon Services

To: Anthony Lawson
David Anderson
Aluf Plastics

Report Date: January 30, 2017
PACS Sample ID: GG-247 thru GG-250

From: Henry Nowicki, Ph.D.
Subject: Activated Carbon Testing **PO# 274785R-1**

Your samples were tested as received for Butane Activity and Butane Working Capacity. The sample results are reported below. The results of the GAED Full Characterization Analyses are attached.

Aluf Plastics Sample ID	PACS Sample ID	Apparent Density (gm/cc) Received	Apparent Density (gm/cc) Dry	Oven Moisture (%)	Butane Working Capacity g/100g C	Butane Activity g/100g C
New Carbon IBC	GG-247	0.466	0.456	2.15	2.9	23.8
Used Carbon IBC	GG-248	0.557	0.547	1.80	3.8	13.0
New Carbon Repro	GG-249	0.570	0.563	1.23	2.8	13.0
Used Carbon Repro	GG-250	0.781	0.731	6.40	0.5	2.9

Useful butane working capacities are 6-17 g/100g C. and butane activity numbers are between 20-28 g/100g C.

PACS holds all samples for at least six months before disposal, after the requested analysis is completed. Should you need additional work on these samples, please refer to the PACS sample identifications.

Please keep PACS in mind for your total activated carbon services: routine and advanced testing services, R&D, waste materials to unique activated carbons, GAED aqueous-and vapor-full characterizations, marketing, technical consulting, training courses either scheduled public or at your time and place, and the *40th International Activated Carbon Conference* Sep 14-15, 2017 in Pittsburgh, PA in conjunction with the Activated Carbon School.

PACS will have activated carbon training short courses in Pittsburgh near the airport in May and September. Please see our website at www.pacslabs.com for course descriptions and registration forms or call PACS at 724-457-6576.
Sincerely,

Henry Nowicki

Henry Nowicki, Ph.D. E-mail: henrypacs@aol.com

PACS

Professional Analytical and Consulting Services, Inc
409 Meade Drive
Coraopolis PA 15108

Full GAED Characterization with Vapor -phase comparisons
For Aluf Plastics
New Carbon I.B.C. (GG-247)
Used Carbon I.B.C. (GG-248)
New Carbon Repro (GG-249)
Used Carbon Repro (GG-250)
January 30, 2017

Executive Summary
Four samples of activated carbon, New Carbon I.B.C. (GG-247) Used Carbon I.B.C. (GG-248) New Carbon Repro (GG-249) Used Carbon Repro (GG-250), were fully characterized for vapor phase comparisons using the Gravimetric Adsorption Energy Distribution method (GAED). Each sample consisted in a different form. The New Carbon I.B.C appeared to be coconut. The Used Carbon I.B.C. appeared to be coconut and pellets mixed. The Used Carbon I.B.C. appeared to be smaller granules of coconut with a few pellets, and the Used Carbon Repro appeared to be granular with a high percentage of fines. The samples were compared to BPL a commercially available coal based gas phase carbon. The Apparent Densities (AD's), determined by using the ASTM D-2854-96, were 0.456g/cc for GG-247, 0.547g/cc for GG-248, 0.563g/cc for GG-249 and 0.731g/cc for GG-250, made volume-based comparisons possible. Samples GG-247, GG-248 and GG-249 lost about 2½% or less by weight on conditioning indicating they were fairly clean and dry. Sample GG-250, however, lost almost 7% indicating it had picked up some contaminate, usually water. Comparing the GAED information of new versus used samples for both the IBC and Repro materials, shows the New IBC carbon had over 1½ times the total adsorption pore volume as the used IBC material and was the best of the four. The New Repro carbon had over 5 times the total adsorption pore volume as the used Repro material. The calculated BET surface area showed the same trend. See table.

	Total pore volume	BET surface area	PACS ID
New IBC	42cc/100g carbon	798 sq.meters/g	(GG-247)
Used IBC	25.6cc/100g carbon	429 sq.meters/g	(GG-248)
New Repro	23cc/100g carbon	435 sq.meters/g	(GG-247)
Used Repro	4.6cc/100g carbon	101 sq.meters/g	(GG-250)

The structure of these samples, seen in the Differential Characteristic Curves, shows that they are similar to the BPL and that Used Repro GG-250 has a low value. Calculated vapor-phase isotherms for MTBE, Benzene and Phenol demonstrate how these carbons would perform in specific chemical challenges. Also the six Application Performance graphs showed how these samples would perform in applications Type I through Type VI. Microscopic photographs of these samples are available upon request.

GAED Results:

Samples New Carbon I.B.C. (GG-247), Used Carbon I.B.C. (GG-248), New Carbon Repro (GG-249) and Used Carbon Repro (GG-250) were fully characterized by measuring the entire characteristic curves using the GAED. The AD's of 0.456 g/cc, 0.547 g/cc, 0.563 g/cc and 0.731 g/cc were used allowing volume-based results. PACS Laboratories routinely run ASTM D-2854-96 for Apparent Densities before GAED full characterizations. The carbons were then compared to a commercially activated reference sample.

PACS Sample ID	Client Sample Identification
GG-247	New Carbon I.B.C
GG-248	Used Carbon I.B.C
GG-249	New Carbon Repro
GG-250	Used Carbon Repro
BPL Coal-base gas phase	

The samples were run in as-received form. A summary of the actual test data and conditions used is listed in the data summary table at the end of the report in Appendix A. The New Carbon I.B.C. (GG-247) sample lost 2.56 weight percent, Used Carbon I.B.C. (GG-248) lost 2.23%, New Carbon Repro (GG-249) lost 1.63% and the Used Carbon Repro (GG-250) sample lost 6.96% on conditioning (heating to 240ºC in argon and holding for 25 minutes). Losses of less than 8 percent indicate a well-stored sample(s) that has been protected from the small amount of moisture pick-up from ambient air during handling and storage and was also fresh and not oxidized. All but one sample had well under 8% weight loss indicating they were clean carbons, that were protected (stored in a proper container) from oxidation or picking up humidity. All activities and adsorption capacities were calculated on a clean carbon basis. To observe these capacities in the field may require additional processing of the carbons on site.

The GAED runs were typical. The difference between the adsorption and desorption curves was minor throughout the experiment, therefore there was no hysteresis present, as is normal for commercially activated carbons. This report extends the comparison of these carbons beyond just the presentation of the characteristic curves. The plots of the differential and cumulative characteristic curve data are presented in Figures 1 and 1b in a volume-based comparison. Weight-based comparisons are also available. The specific run data and results are attached as Appendix A.

GAED Raw Data

The GAED (gravimetric adsorption energy distribution method) measured about 500 adsorption and desorption data points covering seven orders of magnitude in relative pressure (isothermal basis) and three orders of magnitude in carbon loading. The mass adsorbed was also divided by the carbon mass to generate a weight percent loading for easier comparison. The raw data is plotted in Figure 2. At 240ºC, the adsorbent gas C134a or 1,1,1,2-tetrafluoroethane was introduced and the loading increased. Note in Figure 2, the mass loading was plotted against temperature but the relative pressure was also changing. There were three variables affecting performance that changed from point to point: vapor pressure, partial pressure, and temperature.

To make comparisons easier, the large data file of adsorption/desorption points at different temperatures and relative pressures was simplified. First the data was interpolated to get 30 evenly spaced points covering the entire data range. Next the adsorption and desorption results were averaged to get the equilibrium values (the difference between adsorption and desorption was minimal for this sample - no hysteresis). The y-axis was converted to pore volume measures, in cc liquid adsorbed or cc pores filled/100grams carbon, instead of weight percent. The average interpolated data for these characteristic curves is presented in Table 1, and Figures 1 and 1b.

Performance Prediction Models

These curves were the only carbon related information required to predict physical adsorption performance using Polanyi Adsorption Potential theory. These single and multicomponent, gas and liquid phase, computer models were used to predict carbon performance and are available from PACS. To do performance predictions the following polynomial describes these carbon samples:

Carbon name	Characteristic curve polynomial - 3rd degree
GG-247	y = 5.2603E-05x3 - 3.1339E-03x2 - 6.1561E-03x + 1.6262E+00
GG-248	y = 1.7781E-05x3 - 1.6232E-03x2 - 5.8767E-02x + 1.4324E+00
GG-249	y = 7.6006E-05x3 - 3.4566E-03x2 - 2.1499E-02x + 1.3889E+00
GG-250	y = -4.1002E-05x3 - 3.1788E-03x2 - 2.5086E-03x + 7.3693E-01
BPL Coal-base gas phase	y = 5.8955E-05x3 - 2.8880E-03x2 - 2.6182E-02x + 1.7029E+00

In the equation, y was the common logarithm of pore volume in cc/100g carbon and x was the e/4.6V adsorption potential in cal/cc. Characteristic curve polynomials are also listed in Appendix A.

Performance in the Six Types of Applications

The simplest comparison of carbon for a specific application is to run the performance prediction calculations for specific conditions, concentrations, and components present in the application. However, our experience with years of carbon optimization and performance comparisons has found that all physical adsorption applications can be placed into six application types. The proof is part of a 16-hour/800 slide-training course on carbon fundamentals given by PACS at least once a year.

The comparative results in Table 2a demonstrate the value of the different carbons for use in the different types of applications on a volume basis. For a given application type, the results are related to the amount of carbon required to get a certain level of performance. Therefore, a carbon with twice the cc/100g adsorption performance in an application type requires half the pounds of carbon to achieve a level of performance in that application type.

Table 2a compares performance on a volume basis and gives the values of the comparative results for the sample carbons versus the performance for the standard commercial carbons for the six application types. These results can also be provided on a weight basis if desired.

A series of two slides are attached as Appendix B, which describe the 6 application types and the classification process to determine what is the application type. Wastewater applications tend to be Type II or Type III. Municipal water purification varies from Type III, Type IV or Type V applications. Removal limits are not low enough and analytical testing is not sensitive enough at this date for Type VI. (Purifying hydrogen of CO and N2 at room temperature is one of the few current Type VI applications). Municipal plants with surface water sources tend to be Type III or Type IV. Plants with ground water sources tend to be Type IV or V.

Trace Capacity Numbers

The characteristic curves were used to predict the values for the acetoxime trace capacity (TCN), gas-phase trace capacity number (TCNG) and mid capacity number (MCN). These results are presented at the bottom of the summary pages in Appendix A.

Adsorption Isotherms

The characteristic curves are also translated into adsorption isotherms using the programs mentioned above: Figure 3 for MTBE (weakly adsorbed material), Figure 4 for benzene (more strongly adsorbed species) and Figure 5 for phenol at pH=7 (quite strongly adsorbed material).

Pore Size Distributions

The Kelvin equation, modified by Halsey, can be used to convert the characteristic curve data to calculated BET surface areas or pore size distributions. This is not useful in terms of performance evaluations, but some audiences are more comfortable with the concepts of pore radius and a series of capillary sizes when thinking about activated carbon. Figure 6 shows the cumulative pore size distributions, which we include but find of little use. The single and multi point BET surface area was calculated from these curves and is presented in the Summary Tables in Appendix A.

Interpretation of the GAED results:

1. Four samples of activated carbon were fully characterized for vapor phase comparison by the GAED (gravimetric adsorption energy distribution method): New Carbon I.B.C. (GG-247), Used Carbon I.B.C. (GG-248), New Carbon Repro (GG-249) and Used Carbon Repro (GG-250).

2. The samples consisted of a variety of forms. Sample GG-247 appeared to be coconut, GG-248 appeared to be coconut and pellets mixed, GG-249 appeared to be smaller granules of coconut with a few pellets and GG-250 appeared to be granular with much fines.
3. The samples were compared to BPL Coal-base gas phase, a commercially available reference carbon on a vapor phase basis.
4. The AD's determined by using the ASTM D-2854-96, were 0.456g/cc for GG-247, 0.547g/cc for GG-248, 0.563g/cc for GG-249 and 0.731g/cc for GG-250 which made volume-based comparisons possible.
5. The first three samples lost around 2½% or less by weight on conditioning indicating that they were fairly clean and dry. Sample GG-250, however, lost almost 7% indicating it had picked up some contaminate, usually water. (Data Summary Table Appendix A).
6. Conditioning entailed heating the samples to 240ºC in argon and holding for 25 minutes so that all activities and adsorption capacities were calculated on a clean carbon basis.
7. In this study a comparison was made between the new and used samples for both the IBC and Repro material. That is to say, the New IBC carbon had over 1.6 times the total pore volume as the used IBC material and was the best of the four. The New Repro carbon had over 5 times the total pore volume as the used Repro material. (Table 1).
8. The calculated BET surface area in the Data Summary Table Appendix A was:
   798 sq.meters/g, for GG-247
   429 sq.meters/g, for GG-248
   435 sq.meters/g for GG-249 and
   101 sq.meters/g, for GG-250
9. The Differential Characteristic Curves in Figure 1b showed the structure of these samples and that GG-248 was the outlier.
10. Graphs of the calculated vapor-phase isotherms, included in this report, showed how these samples would perform next to each other and the references material at most concentrations of MTBE, Benzene and Phenol (Figures 3V, 4V and 5V).
11. The six Application Performance graphs showed how these samples would perform in specific applications: Type I (Regenerable Heavy Loading Applications like Butane Working Capacity), Type II (Heavy Loading Applications like p-Nitrophenol from Water), Type III (Moderate Loading Applications like Benzene Vapor from Air), Type IV (Regenerable Trace Loading Applications like Acetone Solvent Recovery), Type V (Trace Loading Applications like Trichloroethane from Water) and Type VI (Ultra Trace Loading Applications like Vinyl Chloride from Water).
12. Microscopic photographs of these samples are available upon request.

Table 1. Carbon Characteristic Curves - Cumulative basis

ADSORPTION POTENTIAL DISTRIBUTIONS

Carbon Pore Volume Data 10/06 CDM

Contour Line Number or Adsorption Potential e/4.6V	GG-247 GAED Vap (GG-247) 42764.00 Auto GAED ver. 10/09 Capacity cc/100g.C	GG-248 GAED Vap (GG-248) 42764.00 Auto GAED ver. 10/09 Capacity cc/100g.C	GG-249 GAED Vap (GG-249) 42764.00 Auto GAED ver. 10/09 Capacity cc/100g.C	GG-250 GAED Vap (GG-250) 42764.00 Auto GAED ver. 10/09 Capacity cc/100g.C	BPL Coal-base gas phase BPL Coal-base gas phase 38082.00 Auto GAED ver. 10/09 Capacity cc/100g.C
0	42.14	25.65	23.48	4.61	47.35
1	41.33	23.01	22.68	5.01	45.74
2	39.96	20.27	21.41	5.17	43.32
3	38.12	17.57	19.81	5.11	40.26
4	35.90	15.04	18.01	4.86	36.78
5	33.41	12.73	16.13	4.49	33.06
6	30.76	10.68	14.26	4.04	29.30
7	28.03	8.89	12.48	3.55	25.65
8	25.31	7.36	10.82	3.07	22.22
9	22.65	6.06	9.31	2.61	19.08
10	20.12	4.97	7.97	2.18	16.28
11	17.74	4.06	6.80	1.80	13.82
12	15.55	3.31	5.78	1.47	11.69
13	13.55	2.69	4.90	1.17	9.87
14	11.75	2.18	4.15	0.92	8.33
15	10.15	1.76	3.52	0.71	7.04
16	8.73	1.42	2.98	0.53	5.95
17	7.49	1.14	2.52	0.39	5.05
18	6.41	0.91	2.13	0.27	4.29
19	5.48	0.72	1.80	0.19	3.66
20	4.68	0.57	1.52	0.12	3.14
21	3.99	0.44	1.29	0.07	2.70
22	3.41	0.34	1.09	0.04	2.32
23	2.91	0.26	0.91	0.02	2.01
24	2.49	0.19	0.77	0.01	1.74
25	2.13	0.14	0.64	0.00	1.51
26	1.83	0.10	0.53	0.00	1.31
27	1.57	0.07	0.44	0.00	1.13
28	1.36	0.05	0.35	0.00	0.98
29	1.17	0.03	0.29	0.00	0.85
Density g/cc	0.456	0.547	0.563	0.731	0.516

Table 2a. Performance in the Six Application Types on a Volume Basis

Carbon	GG-247	GG-248	GG-249	GG-250	BPL Coal-base gas phase
Application	Performance - Volume Basis				
Type	cc/100cc	cc/100cc	cc/100cc	cc/100cc	cc/100cc
Type I	4.98	6.61	4.81	0.83	8.64
Type II	16.62	8.57	10.39	3.60	19.43
Type III	12.16	4.44	6.56	2.42	12.35
Type IV	3.25	0.97	1.56	0.66	2.88
Type V	2.92	0.50	1.20	0.20	2.22
Type VI	0.97	0.08	0.36	0.00	0.78

Type I Regenerable Heavy Loading Applications
Type II Heavy Loading Applications
Type III Moderate Loading Applications
Type IV Regenerable Trace Loading Applications
Type V Trace Loading Applications
Type VI Ultra Trace Loading Applications

Figure 2. Raw Characteristization Data
1,1,1,2 tetrafluoroethane at 1 atm pressure
Average of adsorption and desorption data points

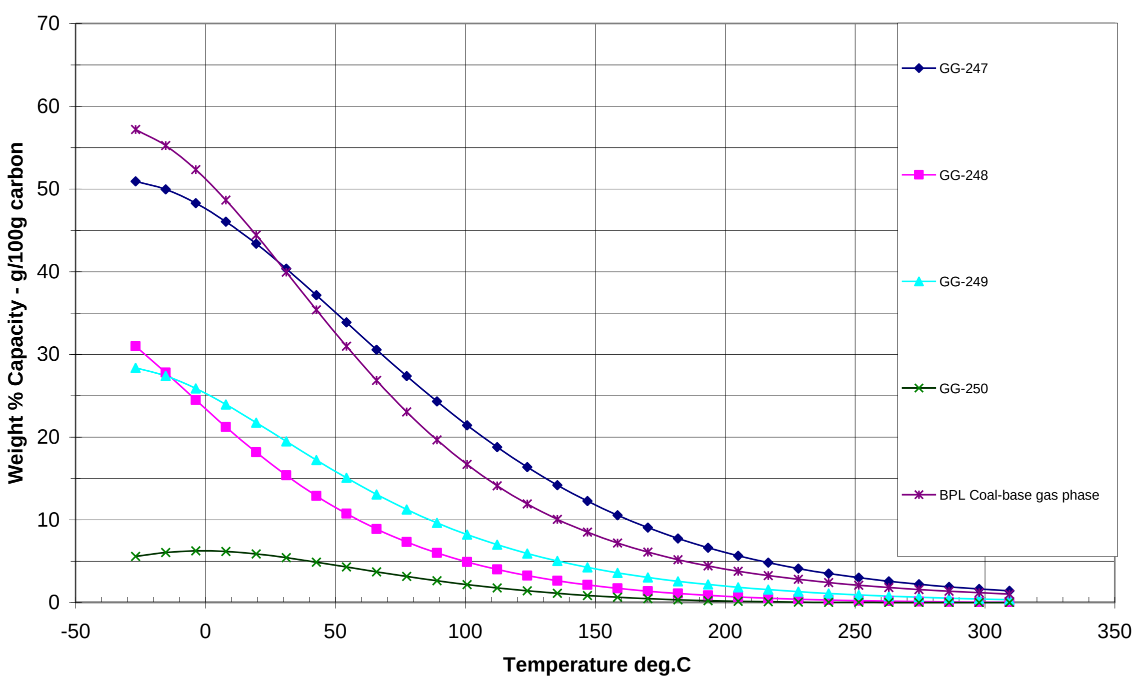
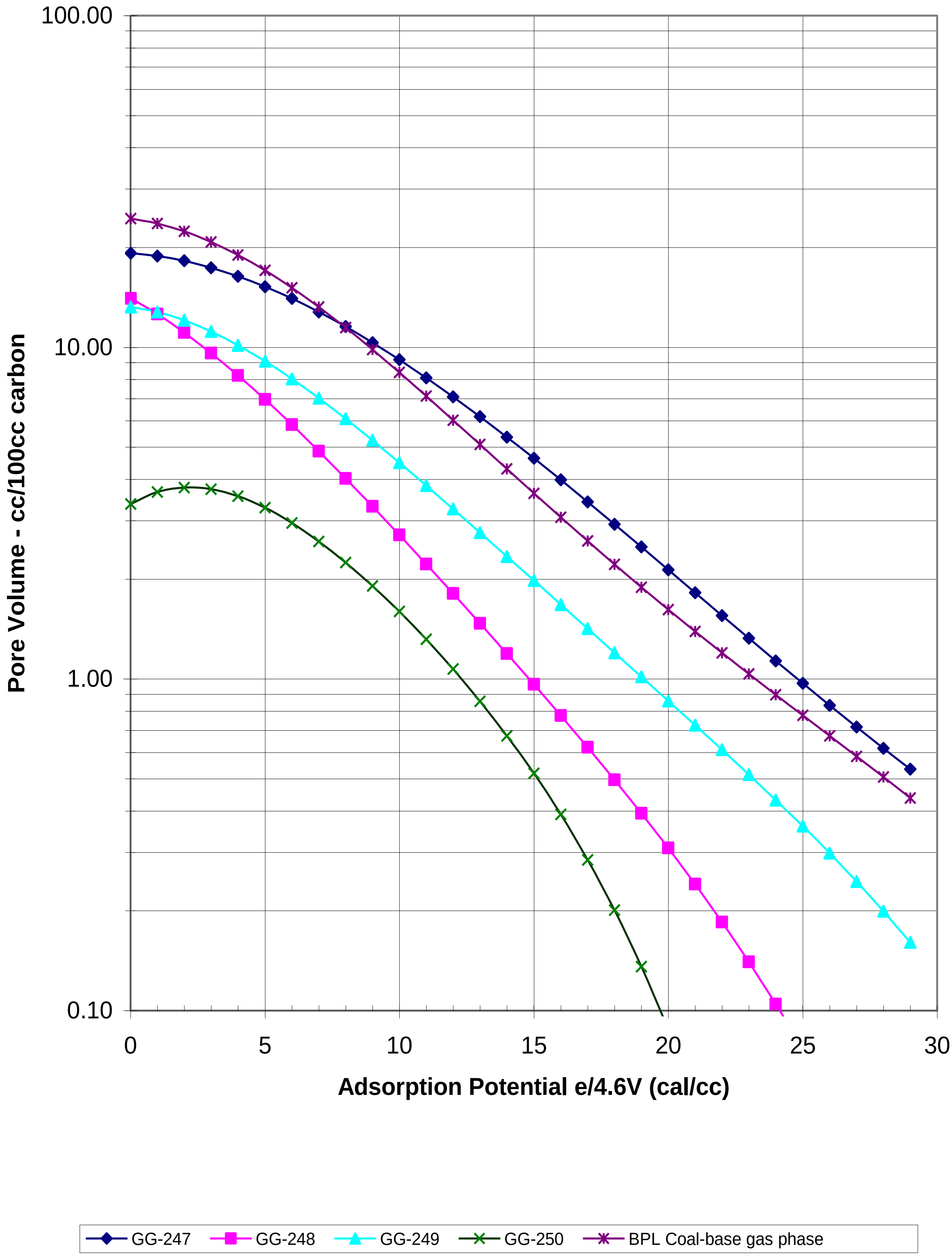


Figure 1. Volume based Carbon Characteristic Curves - Cumulative



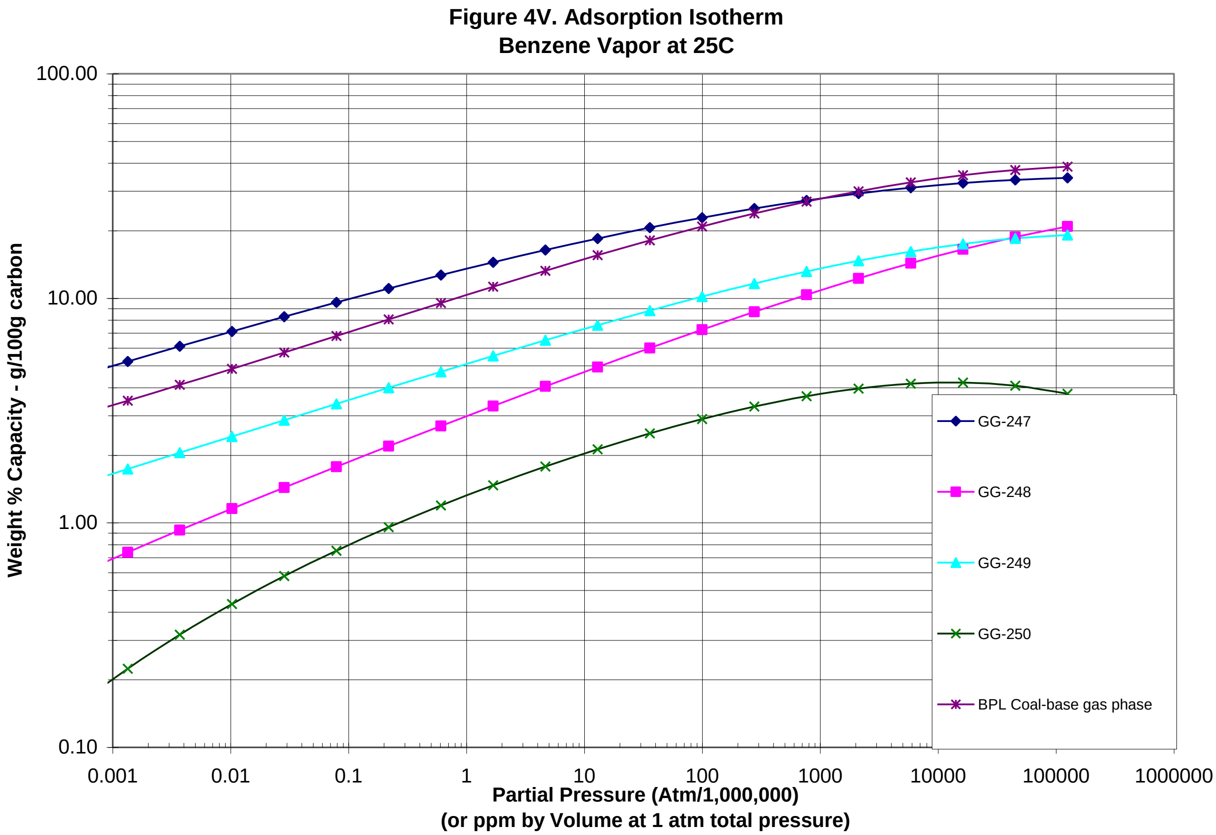


Figure 4V. Adsorption Isotherm
Benzene Vapor at 25C
Weight % Capacity - g/100g carbon
100.00
10.00
1.00
0.10
0.001
0.01
0.1
1
10
100
1000
10000
100000
1000000
Partial Pressure (Atm/1,000,000)
(or ppm by Volume at 1 atm total pressure)
GG-247
GG-248
GG-249
GG-250
BPL Coal-base gas phase

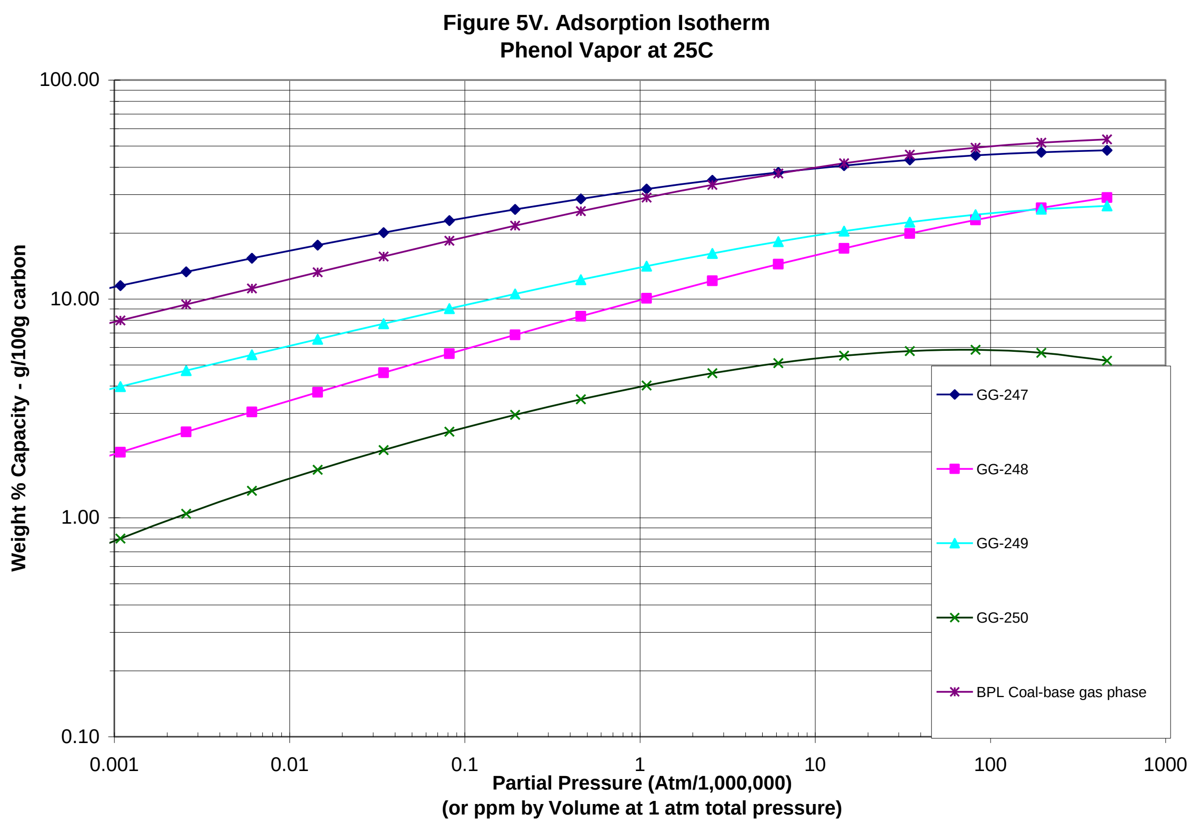


Figure 5V. Adsorption Isotherm
Phenol Vapor at 25C
Weight % Capacity - g/100g carbon
100.00
10.00
1.00
0.10
0.001
0.01
0.1
1
10
100
1000
Partial Pressure (Atm/1,000,000)
(or ppm by Volume at 1 atm total pressure)
GG-247
GG-248
GG-249
GG-250
BPL Coal-base gas phase

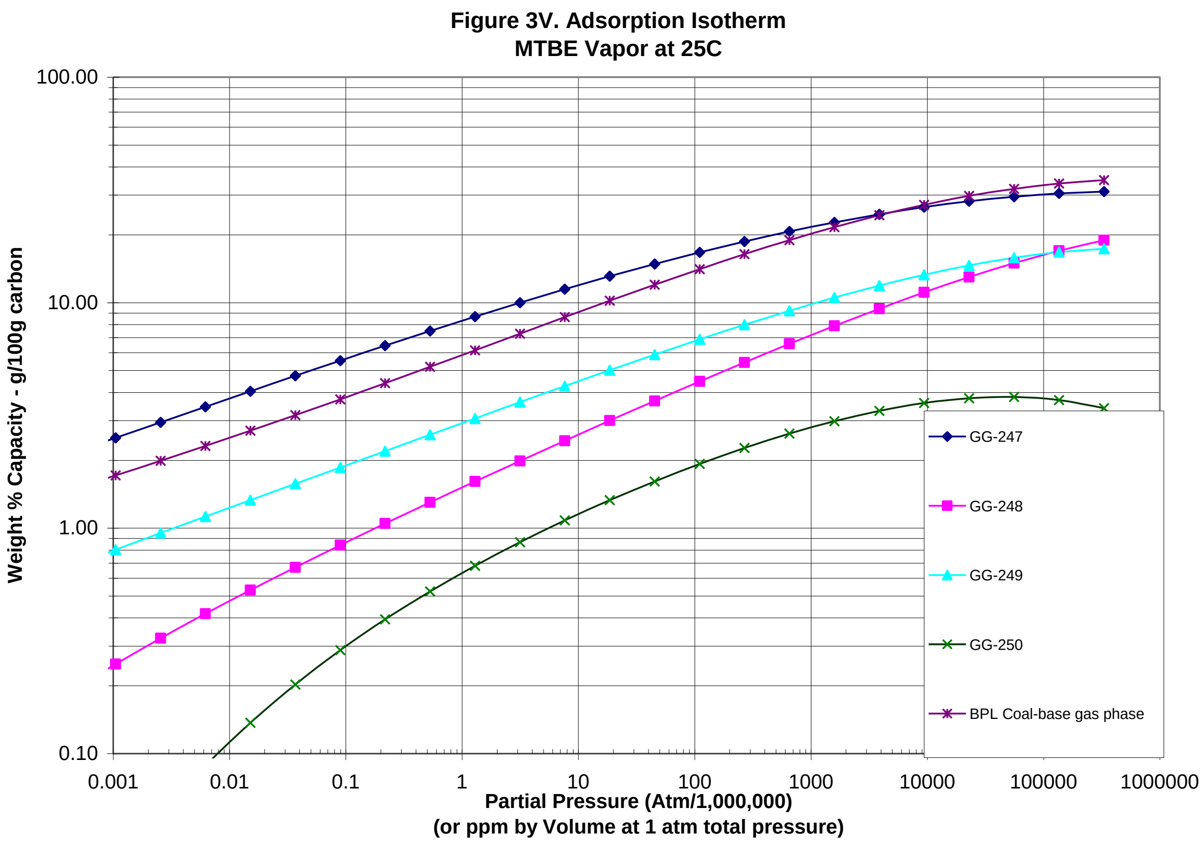


Figure 3V. Adsorption Isotherm
MTBE Vapor at 25C
Weight % Capacity - g/100g carbon
100.00
10.00
1.00
0.10
0.001
0.01
0.1
1
10
100
1000
10000
100000
1000000
Partial Pressure (Atm/1,000,000)
(or ppm by Volume at 1 atm total pressure)
GG-247
GG-248
GG-249
GG-250
BPL Coal-base gas phase

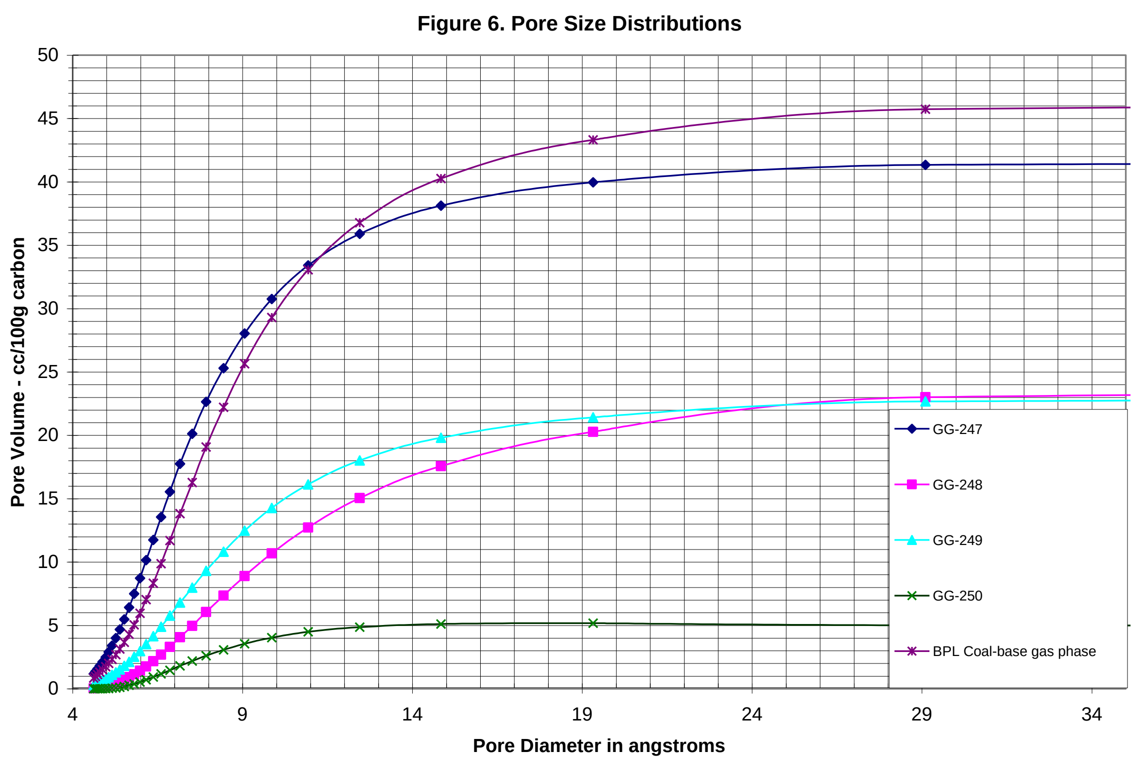
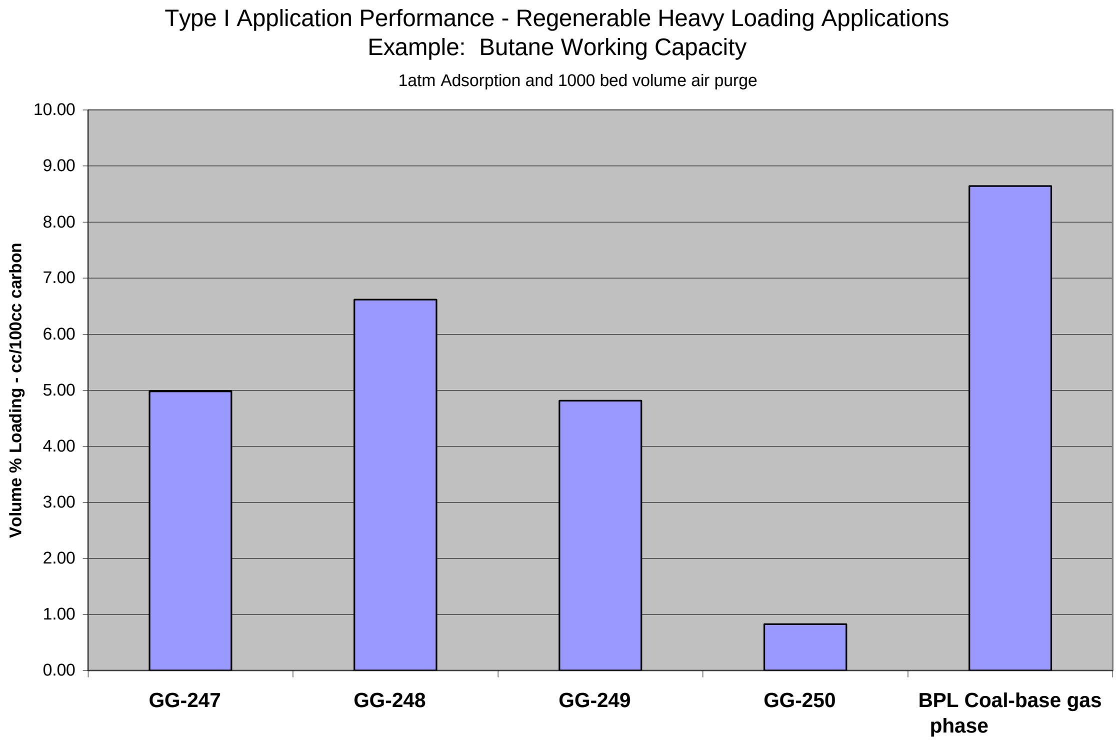
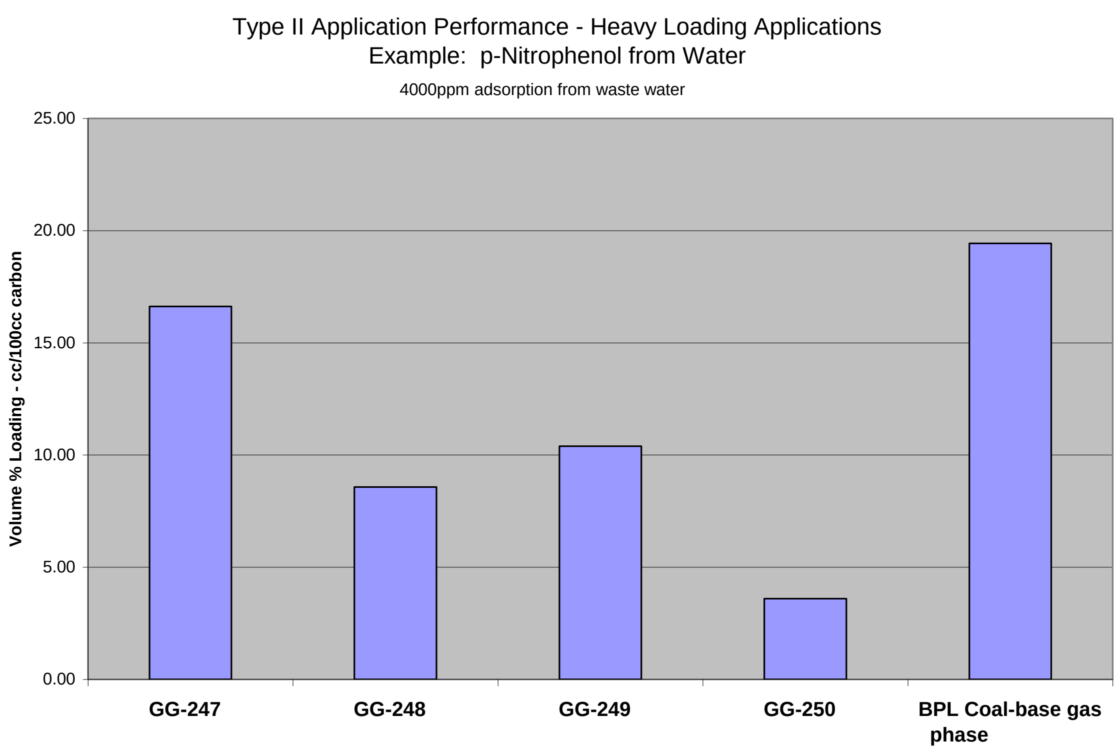


Figure 6. Pore Size Distributions
Pore Volume - cc/100g carbon
50
45
40
35
30
25
20
15
10
5
0
4
9
14
19
24
29
34
Pore Diameter in angstroms
GG-247
GG-248
GG-249
GG-250
BPL Coal-base gas phase

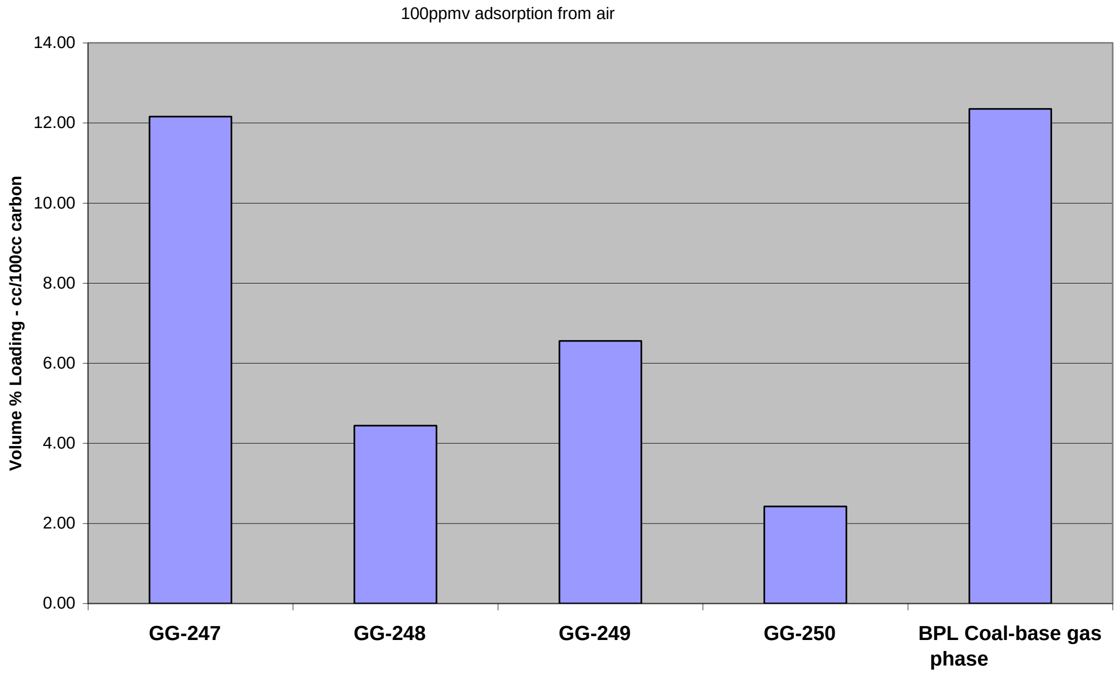


Type I Application Performance - Regenerable Heavy Loading Applications
Example: Butane Working Capacity
1atm Adsorption and 1000 bed volume air purge
Volume % Loading - cc/100cc carbon
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
GG-247
GG-248
GG-249
GG-250
BPL Coal-base gas phase

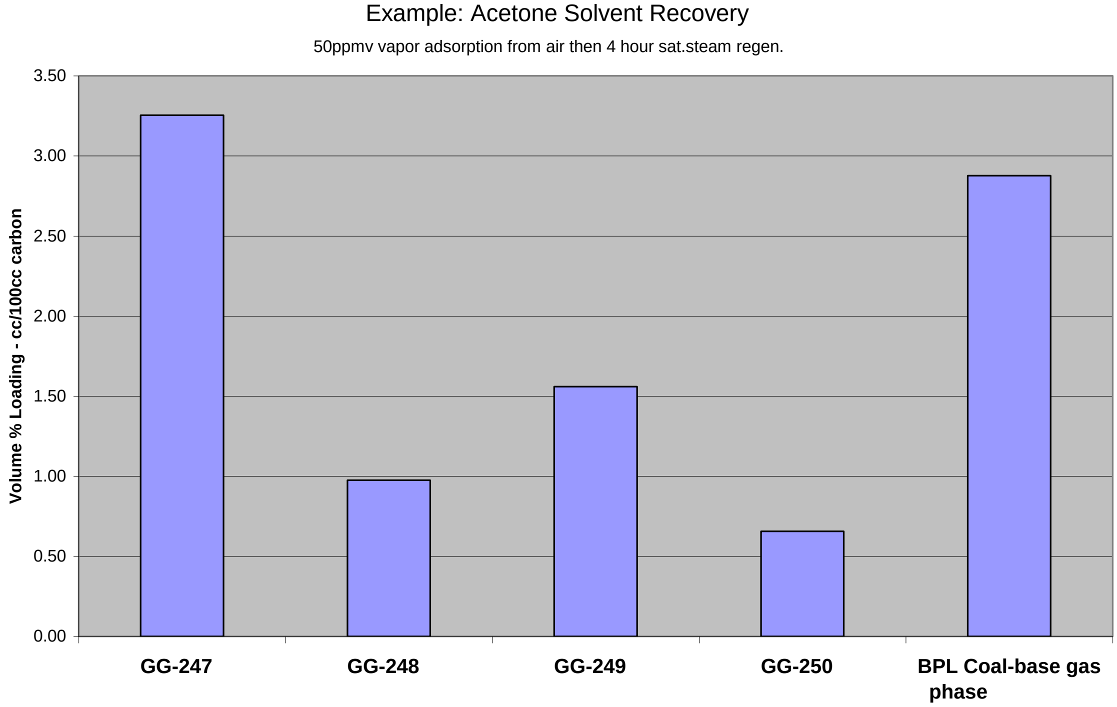


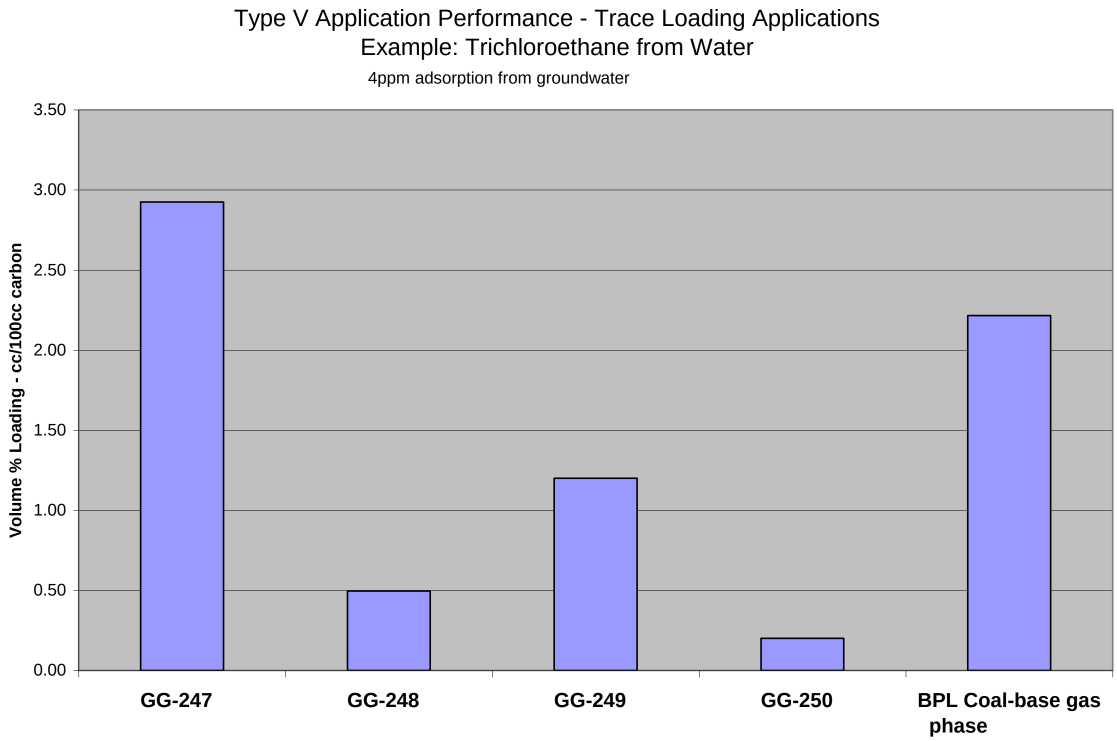
Type II Application Performance - Heavy Loading Applications
Example: p-Nitrophenol from Water
4000ppm adsorption from waste water
Volume % Loading - cc/100cc carbon
25.00
20.00
15.00
10.00
5.00
0.00
GG-247
GG-248
GG-249
GG-250
BPL Coal-base gas phase

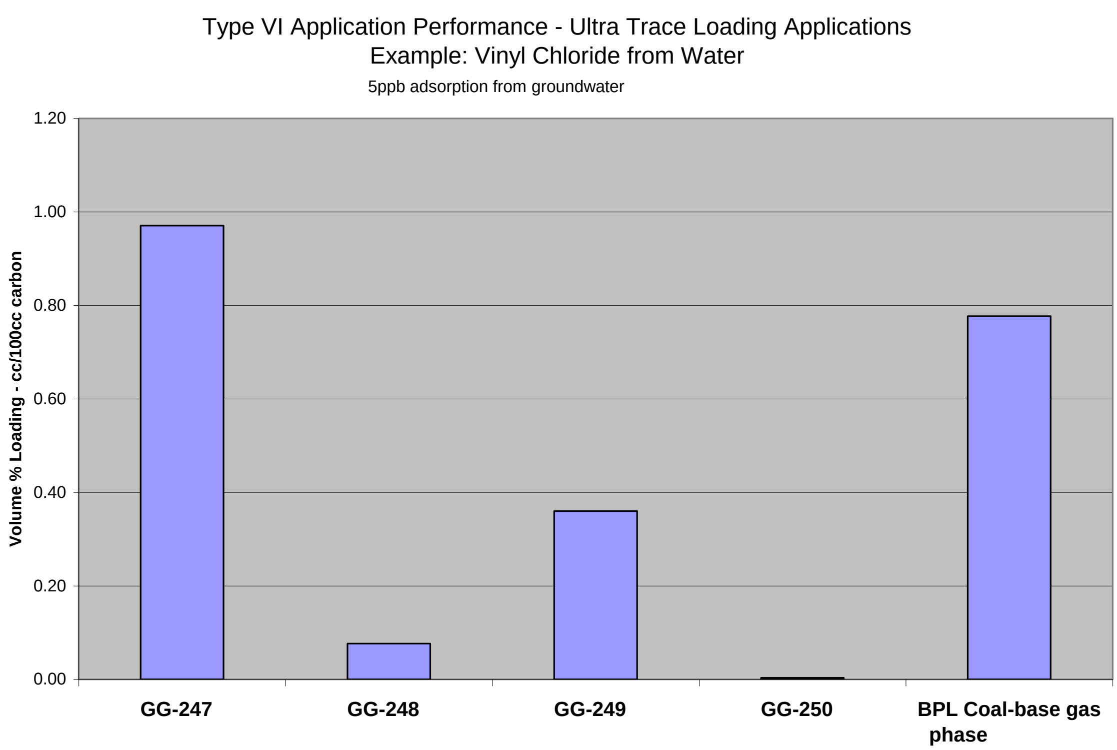
Type III Application Performance - Moderate Loading Applications
Example: Benzene Vapor from Air



Type IV Application Performance - Regenerable Trace Loading Applications
Example: Acetone Solvent Recovery




Type V Application Performance - Trace Loading Applications
Example: Trichloroethane from Water
4ppm adsorption from groundwater
Volume % Loading - cc/100cc carbon
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
GG-247
GG-248
GG-249
GG-250
BPL Coal-base gas phase


Type VI Application Performance - Ultra Trace Loading Applications
Example: Vinyl Chloride from Water
5ppb adsorption from groundwater
Volume % Loading - cc/100cc carbon
1.20
1.00
0.80
0.60
0.40
0.20
0.00
GG-247
GG-248
GG-249
GG-250
BPL Coal-base gas phase

Appendix A.
GAED Summary Tables

GG-247

Sample Description

GG-247
GAED Vap (GG-247)
0.456 g/cc AD

Equipment Information

Operator CDM
Analysis Date 1/29/2017
Start time 2:38:24 AM
Procedure Auto GAED ver. 10/09
File C:\data\PACS
OrgFile C:\data\PACS
Instrument GAED
Module Mettler
Xcomment Pan:Al - Gas1:Argon - Gas2:C134a 100cc/min
Text 500mg Al pan full level - Straight TC

Calculated N2 BET Surface Area

BET sq.meters/g= 798
BET C Constant= -63.33387719
Max. P/Po= 0.298
Min. P/Po= 0.051
R square= 0.9943
Single point BET sq.meters/g= 798

Conditioning the Sample

Pan:Al - Gas1:Argon Conditioning gas
241.0 C Conditioning temperature in Argon
1.0914 g Original Carbon wt
1.0657 g Clean carbon weight
2.56% wt% loading unconditioned

Adsorption/desorption experiments

5 Deg/min adsorption/desorption
Gas2:C134a 100cc/min Adsorbate gas
-8.63 C Minimum adsorption temperature
519 Number of data points
3 pnts/min Data collection rate

Polynomial Curve fit of Results

Comparison Polynomial Coefficients	Calads Polynomial Coefficients
1.625E+00	1.626E+00
-5.136E-03	-6.156E-03
-3.328E-03	-3.134E-03
6.623E-05	5.260E-05
-3.146E-07	
R2 = 9.9666E-01	R2 = 9.9666E-01

Compare Poly y = -3.1455E-07x4 + 6.6233E-05x3 - 3.3284E-03x2 - 5.1364E-03x + 1.6247E+00
Calads Poly. y = 5.2603E-05x3 - 3.1339E-03x2 - 6.1561E-03x + 1.6262E+00

Carbon Characteristic Curve

GG-247

Adsorption Potential e/4.6V (cal/cc)	Differential Pore Volume cc/100g	Cumulative Pore Volume cc/100g
0	0.53	42.14
0.4	0.78	41.89
1	1.13	41.33
1.4	1.35	40.85
2	1.65	39.96
3	2.07	38.12
4	2.38	35.90
5	2.59	33.41
6	2.71	30.76
7	2.74	28.03
8	2.70	25.31
9	2.59	22.65
10	2.45	20.12
11	2.28	17.74
12	2.09	15.55
13	1.89	13.55
14	1.69	11.75
15	1.50	10.15
16	1.32	8.73
17	1.15	7.49
18	1.00	6.41
19	0.86	5.48
20	0.74	4.68
21	0.63	3.99
22	0.54	3.41
23	0.45	2.91
24	0.39	2.49
25	0.33	2.13
26	0.28	1.83
27	0.23	1.57
28	0.20	1.36
29	0.17	1.17
30	0.14	1.02

Calculated Trace Capacity Numbers

Trace capacity no.Gas-phase TCN-G(g/100cc)= 8.14
Acetoxime Trace capacity no.TCN(mg/cc)= 22.26
Mid capacity no.MCN(g/100cc)= 11.54

GG-248

Sample Description

GG-248
GAED Vap (GG-248)
0.547 g/cc AD

Equipment Information

Operator	CDM
Analysis Date	1/29/2017
Start time	8:09:36 AM
Procedure	Auto GAED ver. 10/09
File	C:\data\PACS
OrgFile	C:\data\PACS
Instrument	GAED
Module	Mettler
Xcomment	Pan:Al - Gas1:Argon - Gas2:C134a 100cc/min
Text	500mg Al pan full level - Straight TC

Calculated N2 BET Surface Area

BET sq.meters/g=	429
BET C Constant=	1018.848092
Max. P/Po=	0.298
Min. P/Po=	0.051
R square=	0.9971
Single point BET sq.meters/g=	416

Carbon Characteristic Curve

GG-248

Adsorption Potential e/4.6V (cal/cc)	Differential Pore Volume cc/100g	Cumulative Pore Volume cc/100g
0	2.55	25.65
0.4	2.64	24.62
1	2.73	23.01
1.4	2.75	21.91
2	2.74	20.27
3	2.62	17.57
4	2.42	15.04
5	2.17	12.73
6	1.91	10.68
7	1.65	8.89
8	1.40	7.36
9	1.18	6.06
10	0.98	4.97
11	0.82	4.06
12	0.67	3.31
13	0.56	2.69
14	0.46	2.18
15	0.37	1.76
16	0.31	1.42
17	0.25	1.14
18	0.21	0.91
19	0.17	0.72
20	0.14	0.57
21	0.11	0.44
22	0.09	0.34
23	0.07	0.26
24	0.06	0.19
25	0.04	0.14
26	0.03	0.10
27	0.03	0.07
28	0.02	0.05
29	0.01	0.03
30	0.01	0.02

Conditioning the Sample

Pan:Al - Gas1:Argon Conditioning gas
240.8 C Conditioning temperature in Argon
1.1708 g Original Carbon wt
1.1416 g Clean carbon weight
2.23% wt% loading unconditioned

Adsorption/desorption experiments

5 Deg/min adsorption/desorption
Gas2:C134a 100cc/min Adsorbate gas
-9.00 C Minimum adsorption temperature
488 Number of data points
3 pnts/min Data collection rate

Polynomial Curve fit of Results

Comparison Polynomial Coefficients	Calads Polynomial Coefficients
1.409E+00	1.432E+00
-4.286E-02	-5.877E-02
-4.568E-03	-1.623E-03
2.165E-04	1.778E-05
-4.401E-06	

R2 = 9.8676E-01 R2 = 9.8672E-01

Compare Poly y = -4.4010E-06x4 + 2.1646E-04x3 - 4.5681E-03x2 - 4.2864E-02x + 1.4091E+00
Calads Poly. y = 1.7781E-05x3 - 1.6232E-03x2 - 5.8767E-02x + 1.4324E+00

Calculated Trace Capacity Numbers

Trace capacity no.Gas-phase TCN-G(g/100cc)= 1.64
Acetoxime Trace capacity no.TCN(mg/cc)= -1.15
Mid capacity no.MCN(g/100cc)= 3.06

GG-249

Sample Description

GG-249
GAED Vap (GG-249)
0.563 g/cc AD

Equipment Information

Operator CDM
Analysis Date 1/29/2017
Start time 5:45:36 AM
Procedure Auto GAED ver. 10/09
File C:\data\PACS
OrgFile C:\data\PACS
Instrument GAED
Module Mettler
Xcomment Pan:Al - Gas1:Argon - Gas2:C134a 100cc/min
Text 500mg Al pan full level - Straight TC

Calculated N2 BET Surface Area

BET sq.meters/g= 435
BET C Constant= -93.20448225
Max. P/Po= 0.298
Min. P/Po= 0.051
R square= 0.9951
Single point BET sq.meters/g= 431

Conditioning the Sample

Pan:Al - Gas1:Argon Conditioning gas
241.8 C Conditioning temperature in Argon
1.2085 g Original Carbon wt
1.1910 g Clean carbon weight
1.63% wt% loading unconditioned

Adsorption/desorption experiments

5 Deg/min adsorption/desorption
Gas2:C134a 100cc/min Adsorbate gas
-6.70 C Minimum adsorption temperature
487 Number of data points
3 pnts/min Data collection rate

Polynomial Curve fit of Results

Comparison Polynomial Coefficients	Calads Polynomial Coefficients
1.371E+00	1.389E+00
-9.563E-03	-2.150E-02
-5.653E-03	-3.457E-03
2.256E-04	7.601E-05
-3.375E-06	

Carbon Characteristic Curve

GG-249

Adsorption Potential e/4.6V (cal/cc)	Differential Pore Volume cc/100g	Cumulative Pore Volume cc/100g
0	0.55	23.48
0.4	0.77	23.23
1	1.08	22.68
1.4	1.25	22.22
2	1.47	21.41
3	1.73	19.81
4	1.86	18.01
5	1.89	16.13
6	1.83	14.26
7	1.72	12.48
8	1.58	10.82
9	1.41	9.31
10	1.25	7.97
11	1.09	6.80
12	0.94	5.78
13	0.80	4.90
14	0.68	4.15
15	0.58	3.52
16	0.49	2.98
17	0.42	2.52
18	0.35	2.13
19	0.30	1.80
20	0.25	1.52
21	0.22	1.29
22	0.18	1.09
23	0.16	0.91
24	0.14	0.77
25	0.12	0.64
26	0.10	0.53
27	0.09	0.44
28	0.07	0.35
29	0.06	0.29
30	0.05	0.23

R2 = 9.9496E-01 R2 = 9.9493E-01

Compare Poly y = -3.3750E-06x4 + 2.2563E-04x3 - 5.6531E-03x2 - 9.5625E-03x + 1.3707E+00

Calads Poly. y = 7.6006E-05x3 - 3.4566E-03x2 - 2.1499E-02x + 1.3889E+00

Calculated Trace Capacity Numbers

Trace capacity no.Gas-phase TCN-G(g/100cc)= 3.45
Acetoxime Trace capacity no.TCN(mg/cc)= 4.86
Mid capacity no.MCN(g/100cc)= 5.38

GG-250

Sample Description

GG-250
GAED Vap (GG-250)
0.731 g/cc AD

Equipment Information

Operator CDM
Analysis Date 1/29/2017
Start time 6:43:12 PM
Procedure Auto GAED ver. 10/09
File C:\data\PACS
OrgFile C:\data\PACS
Instrument GAED
Module Mettler
Xcomment Pan:Al - Gas1:Argon - Gas2:C134a 100cc/min
Text 500mg Al pan full level - Straight TC

Calculated N2 BET Surface Area

BET sq.meters/g= 101
BET C Constant= -48.75398017
Max. P/Po= 0.298
Min. P/Po= 0.051
R square= 0.9914
Single point BET sq.meters/g= 102

Conditioning the Sample

Pan:Al - Gas1:Argon Conditioning gas
241.4 C Conditioning temperature in Argon
1.4997 g Original Carbon wt
1.3995 g Clean carbon weight
6.96% wt% loading unconditioned

Adsorption/desorption experiments

5 Deg/min adsorption/desorption
Gas2:C134a 100cc/min Adsorbate gas
-9.26 C Minimum adsorption temperature
526 Number of data points
3 pnts/min Data collection rate

Polynomial Curve fit of Results

Comparison Polynomial Coefficients	Calads Polynomial Coefficients
6.637E-01	7.369E-01
4.822E-02	-2.509E-03
-1.293E-02	-3.179E-03
6.444E-04	-4.100E-05
-1.584E-05	

Carbon Characteristic Curve

GG-250

Adsorption Potential e/4.6V (cal/cc)	Differential Pore Volume cc/100g	Cumulative Pore Volume cc/100g
0	-0.50	4.61
0.4	-0.41	4.80
1	-0.27	5.01
1.4	-0.17	5.10
2	-0.03	5.17
3	0.17	5.11
4	0.32	4.86
5	0.42	4.49
6	0.48	4.04
7	0.49	3.55
8	0.47	3.07
9	0.44	2.61
10	0.40	2.18
11	0.36	1.80
12	0.31	1.47
13	0.27	1.17
14	0.23	0.92
15	0.19	0.71
16	0.16	0.53
17	0.13	0.39
18	0.10	0.27
19	0.08	0.19
20	0.05	0.12
21	0.04	0.07
22	0.02	0.04
23	0.01	0.02
24	0.01	0.01
25	0.00	0.00
26	0.00	0.00
27	0.00	0.00
28	0.00	0.00
29	0.00	0.00
30	0.00	0.00

R2 = 9.3731E-01 R2 = 9.3686E-01

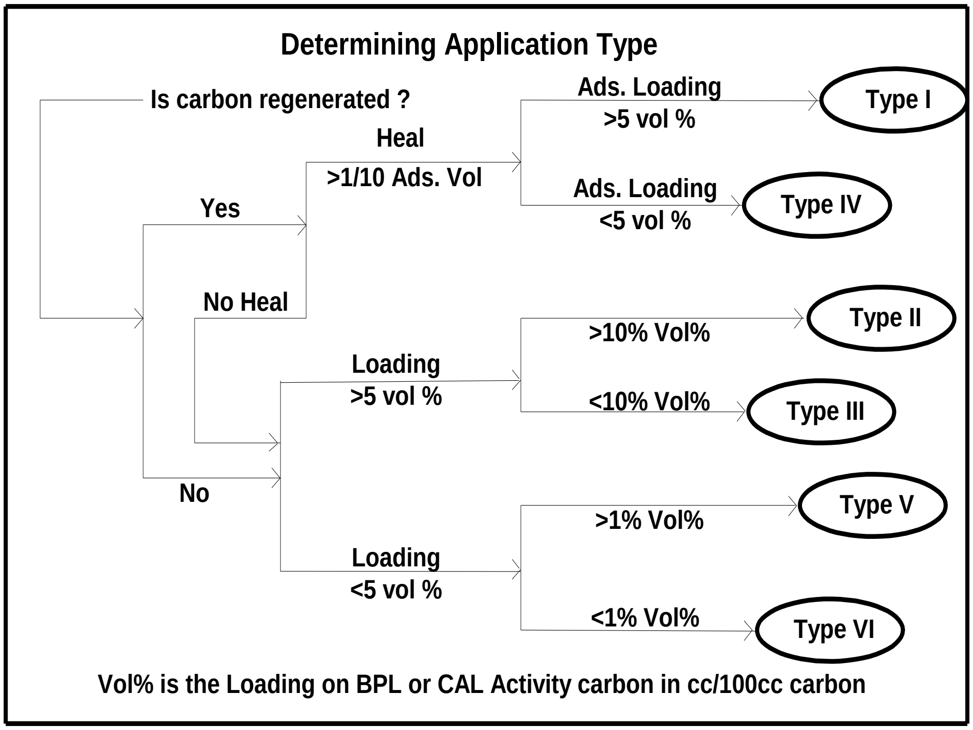
Compare Poly y = -1.5841E-05x4 + 6.4441E-04x3 - 1.2927E-02x2 + 4.8222E-02x + 6.6369E-01

Calads Poly. y = -4.1002E-05x3 - 3.1788E-03x2 - 2.5086E-03x + 7.3693E-01

Calculated Trace Capacity Numbers

Trace capacity no.Gas-phase TCN-G(g/100cc)= 0.86
Acetoxime Trace capacity no.TCN(mg/cc)= -6.13
Mid capacity no.MCN(g/100cc)= 1.82

Appendix B The Six Application Types and Classifying an Application



Six Catagories of Application Types

Based on Effect of Carbon Characteristics Performance and the Optimal Carbon

	Application Types					
	I	II	III	IV	V	VI
Full e/4.6	1.25	3.5	7.5	13	18	25
Empty e/4.6	6.25	------	------	18	-----	------
Component	Butane	PNP	Benzene	Acetone	TCE	Vinyl Cl
Phase	Vapor	Waste Water	Vapor	Vapor	Ground water	Ground water
Concentration	<u>1atm</u> 1000 BV air purge	4000 ppm	100 ppmv	<u>50 ppm</u> 4hr.steam	4 ppm	5 ppm
Temperature	25/25C	25C	25C	25//100 c	25C	25C