

## 7.- ANEXOS

### 7.1.- Informes completos

A continuación se presentan todos los resultados proporcionados por el servicio de análisis del Instituto de Carboquímica, correspondientes a la caracterización químico física tanto del catalizador fresco como del carbono producido en la DCM.

#### 7.1.1.- Difracción de Rayos X (XRD)

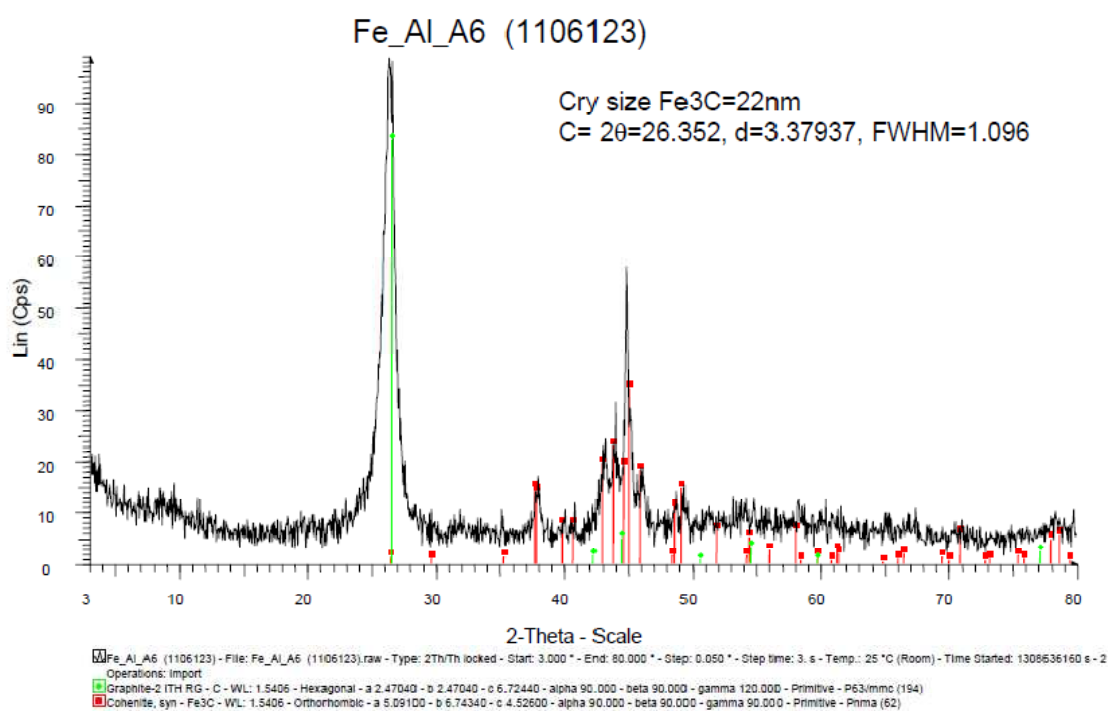


Figura 7.1 - XRD de la muestra de carbono del ensayo A06.

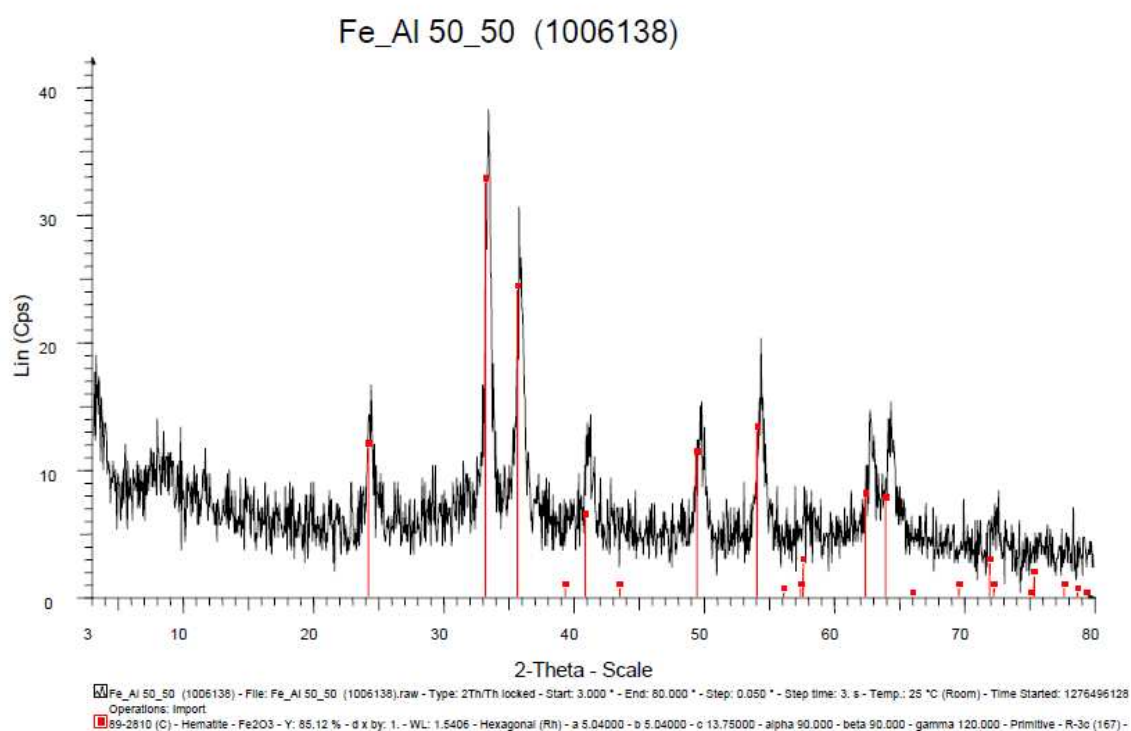





Figura 7.2 - XRD del catalizador  $\text{Fe}_2\text{O}_3:\text{Al}_2\text{O}_3$  (50:50).

## 7.1.2.- Caracterización superficial. Adsorción de N<sub>2</sub>

### 7.1.2.1.- Ensayo A06

		Quantachrome AS1Win™ - Automated Gas Sorption Data Acquisition and Reduction ©1994-2008, Quantachrome Instruments version 2.01	
<b>Analysis</b>		<b>Report</b>	
Operator: Nuria	Date: Wed Jun 22 13:08:20 2011	Operator: Nuria	Date: 6/22/2011
Sample ID: : 1106122	Filename: C:\Documents and Settings\Administrador\Escritorio\1106122.qps		
Sample Desc: Fe/Al-A6	Comment:		
Outgas Time: 5.0 hrs	Outgas Temp: 150.0 °C	Sample Weight: 0.1298 g	
Analysis gas: Nitrogen	Molec. Wt: 28.0134 g	Non-ideality: 5.7e-05 1/mmHg	
Analysis Time: 309.7 min	Instrument: Autosorb Station 1	Bath temp.: 77.4 K	

**Analysis Data**

**Administrative information**

Analysis performed on: ..... Wed Jun 22 13:08:20 2011

Analysis performed by: ..... Nuria

Comments: .....

Instrument: ..... Autosorb Station: 1

Instrument version: ..... n/a

Software version: ..... 1.27

**Sample information**

Id: ..... : 1106122

Description: ..... Fe/Al-A6

Weight: ..... 0.1298 g

**Sample preparation information**

Outgas time: ..... 5.0 hrs

Outgas temperature: ..... 150.0 C

**Analysis information**

Analysis gas: ..... Nitrogen

Cross Section Area: ..... 16.2




Molecular weight: ..... 28.0134

Non-ideality correction: ..... 5.7e-05

Ambient temperature: ..... 300.05 C

Pressure tolerance band: ..... 2

Equilibration time: ..... 1

		Quantachrome AS1Win™ - Automated Gas Sorption Data Acquisition and Reduction ©1994-2008, Quantachrome Instruments version 2.01	
<b>Analysis</b>		<b>Report</b>	
Operator: Nuria	Date: Wed Jun 22 13:08:20 2011	Operator: Nuria	Date: 6/22/2011
Sample ID: : 1106122	Filename: C:\Documents and Settings\Administrador\Escritorio\1106122.qps		

**Volume/Area summary**

Surface Area Data

MultiPoint BET..... 8.679e+01 m<sup>2</sup>/g

Pore Volume Data

Total pore volume for pores with Diameter less than 2588.12 Å at P/Po = 0.992474..... 2.553e-01 cc/g

Pore Size Data

Average pore Diameter ..... 1.177e+02 Å



Quantachrome AS1Win™ - Automated Gas Sorption Data Acquisition and Reduction  
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**Analysis**

Operator: Nuria  
Sample ID: 1106122

**Report**

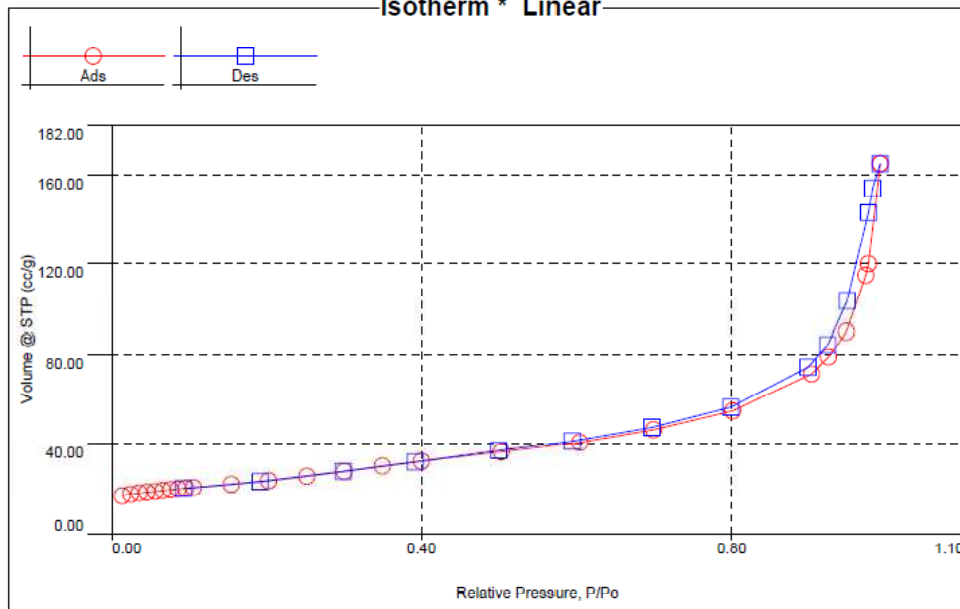
Date: Wed Jun 22 13:08:20 2011  
Operator: Nuria  
Filename: C:\Documents and Settings\Administrador\Escritorio\1106122.qps

Date: 6/22/2011

**Isotherm**

Relative Pressure	Volume @ STP [cc/g]	Relative Pressure	Volume @ STP [cc/g]	Relative Pressure	Volume @ STP [cc/g]
1.38468e-02	16.7810	3.00103e-01	27.7371	9.82623e-01	154.0493
2.49633e-02	17.5938	3.49417e-01	30.0582	9.77363e-01	143.1040
3.58136e-02	18.1325	3.99448e-01	32.2795	9.50353e-01	103.6587
4.61675e-02	18.5573	5.03686e-01	36.4726	9.25084e-01	84.4407
5.63425e-02	18.9263	6.02902e-01	40.7435	8.99171e-01	74.3271
6.64262e-02	19.2815	6.99250e-01	46.3502	7.98617e-01	56.2447
7.64470e-02	19.6146	8.01447e-01	54.7539	6.96849e-01	47.4252
8.65167e-02	19.9345	9.03708e-01	71.2536	5.93117e-01	41.2951
9.65028e-02	20.2445	9.25482e-01	78.8659	4.99706e-01	37.0562
1.06513e-01	20.5508	9.48860e-01	90.2142	3.92543e-01	31.9730
1.52946e-01	21.9777	9.73885e-01	115.0177	2.98724e-01	27.6762
2.02060e-01	23.6394	9.77128e-01	120.1102	1.90878e-01	23.2610
2.51046e-01	25.5685	9.92474e-01	165.0508	9.27958e-02	20.1294

**Isotherm \* Linear**







Quantachrome AS1Win™ - Automated Gas Sorption Data Acquisition and Reduction  
©1994-2008, Quantachrome Instruments  
version 2.01



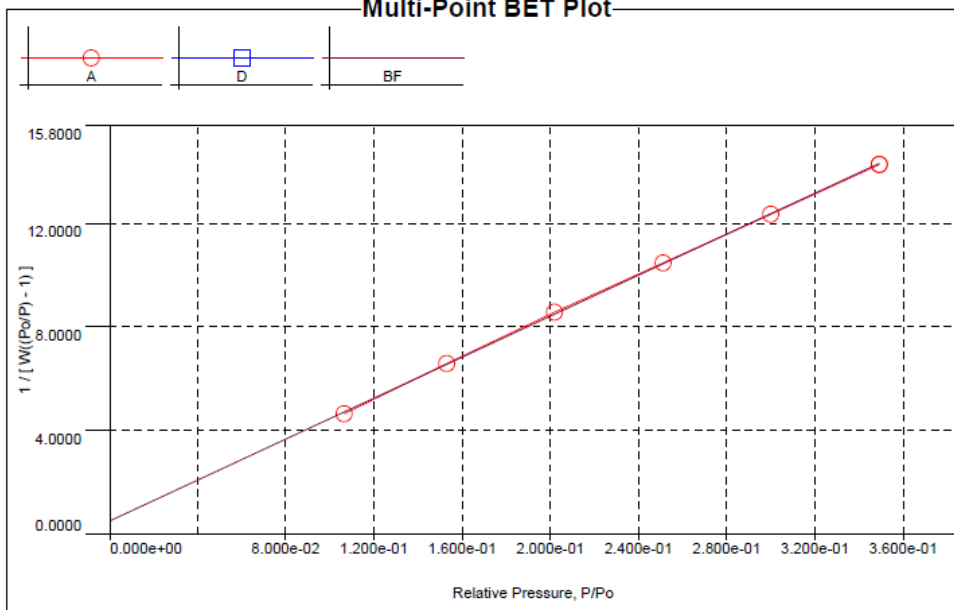
Analysis  
Operator: Nuria  
Sample ID: 1106122

Report  
Date: Wed Jun 22 13:08:20 2011 Operator: Nuria  
Filename: C:\Documents and Settings\Administrador\Escritorio\1106122.qps

### Multi-Point BET

Relative Pressure [P/Po]	Volume @ STP [cc/g]	1 / [ W((Po/P) - 1) ]	Relative Pressure [P/Po]	Volume @ STP [cc/g]	1 / [ W((Po/P) - 1) ]
1.06513e-01	20.5508	4.6413e+00	2.51046e-01	25.5685	1.0489e+01
1.52946e-01	21.9777	6.5735e+00	3.00103e-01	27.7371	1.2369e+01
2.02060e-01	23.6394	8.5709e+00	3.49417e-01	30.0582	1.4296e+01

### Multi-Point BET Plot



### Single Point Surface Area

Relative Pressure [P/Po]	Volume @ STP [cc/g]	1 / [ W((P/Po) - 1) ]	Slope	Surf. Area [m²/g]
3.00103e-01	27.7371	1.2369e+01	41.2149	84.4965

### 7.1.2.2.- Catalizador $\text{Fe}_2\text{O}_3:\text{Al}_2\text{O}_3$ (50:50, mol)



#### Standard Report

ADAP 2020 V3.00 H

Unit 1

Serial #: 457

Page 1

Sample: 1107246  $\text{Fe}_2\text{O}_3:\text{Al}_2\text{O}_3$  (50/50)  
Operator: Nuria  
Submitter: Daniel Torres (I.Guelves)  
File: C:\\_LIDANIELT\1107246.GMP

Started: 27/07/2011 11:11:38	Analysis Adsorptive: N2
Completed: 27/07/2011 18:31:57	Analysis Bath Temp.: 77.300 K
Report Time: 28/07/2011 8:40:30	Thermal Correction: No
Sample Mass: 1.1217 g	Warm Free Space: 20.2538 cm <sup>3</sup> Measured
Cold Free Space: 59.0942 cm <sup>3</sup>	Equilibration Interval: 5 s
Low Pressure Dose: None	Automatic Degas: Yes

Comments: Nanofibras de carbono

#### Summary Report

##### Surface Area

Single point surface area at P/Po = 0.302353113: 141.3438 m<sup>2</sup>/g

BET Surface Area: 143.0558 m<sup>2</sup>/g

##### Pore Volume

Single point adsorption total pore volume of pores  
less than 3592.840 Å diameter at P/Po = 0.994606014: 0.200874 cm<sup>3</sup>/g

##### Pore Size

Adsorption average pore width (4V/A by BET): 56.1665 Å



Standard Report

ASAP 2020 V3.00 H

Unit 1

Serial #: 457

Page 2

Sample: 1107246 Fe2O3/Al2O3 (50:50)  
Operator: Nuria  
Submitter: Daniel Torres (L3uelves)  
File: C:\L3\IDANIELT\1107246.IMP

Started: 27/07/2011 11:11:38  
Completed: 27/07/2011 18:31:57  
Report Time: 28/07/2011 8:40:30  
Sample Mass: 1.1217 g  
Cold Free Space: 59.0942 cm<sup>3</sup>  
Low Pressure Dose: None  
Analysis Adsorptive: N2  
Analysis Bath Temp.: 77.300 K  
Thermal Correction: No  
Warm Free Space: 20.2538 cm<sup>3</sup> Measured  
Equilibration Interval: 5 s  
Automatic Degas: Yes

Comments: Nanofibras de carbono

Isotherm Tabular Report

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm <sup>3</sup> /g STP)	Elapsed Time (h:min)	Saturation Pressure (mmHg)
0.009927877	7.53244	24.4704	01:02	758.95050
0.020286952	15.39108	27.1122	01:47	
0.030905418	23.44568	28.7950	01:56	
			02:04	
0.040586712	30.78760	29.9652	02:07	758.61127
0.049159847	37.28899	30.8494	02:12	
0.059853729	45.39772	31.8184	02:16	
0.067288065	51.03457	32.4333	02:21	
0.079985240	60.66168	33.3949	02:24	
0.089985528	68.24258	34.0996	02:28	
0.099969377	75.81024	34.7651	02:32	
0.149596871	113.43736	37.7378	02:36	
0.200942153	152.36223	40.5617	02:41	
0.252102465	191.13956	43.4051	02:46	
0.302353113	229.22139	46.5407	02:52	
0.351350657	266.34753	50.1930	02:58	
0.400162902	303.31998	54.4799	03:04	
			03:12	
0.498835912	378.07416	64.7317	03:14	757.97217
0.598109096	453.27911	75.9850	03:25	
0.702007784	531.98126	87.0197	03:36	
0.799424020	605.74292	98.7866	03:46	
			04:00	
0.906583763	686.82971	119.2349	04:16	757.63794
0.936339101	709.33881	123.1455	04:23	
0.955926508	724.14325	125.0690	04:30	
0.971653062	736.03168	126.6580	04:37	
0.979755899	742.15454	127.6314	04:42	
0.994606014	753.37274	129.8640	04:45	
0.973102594	737.06982	128.7851	04:51	
0.948447512	718.37555	127.2190	04:54	
0.922023504	698.33777	125.7908	04:58	
0.901334741	682.65430	124.7908	05:03	
0.806780184	611.00732	119.9199	05:06	
			05:14	
0.686562975	519.90771	105.6966	05:19	757.31488
0.589018317	446.01929	95.5387	05:35	
0.500276237	378.79321	82.2579	05:46	
0.397725658	301.11600	54.9310	06:03	
			06:25	
0.280324468	212.22937	45.2105	06:28	757.08472
0.201953817	152.89615	40.5436	06:37	
0.101962951	77.19414	34.8691	06:44	
			06:51	



Standard Report

ASAP 2020 V3.00 H

Unit 1

Serial #: 457

Page 3

Sample: 1107246 Fe<sub>2</sub>O<sub>3</sub>/Al<sub>2</sub>O<sub>3</sub> (50:50)

Operator: Nuria

Submitter: Daniel Torres (L. Suelves)

File: C:\\_IDANIELT\1107246.OMP

Started: 27/07/2011 11:11:38

Completed: 27/07/2011 18:31:57

Report Time: 28/07/2011 8:40:30

Sample Mass: 1.1217 g

Cold Free Space: 53.0942 cm<sup>3</sup>

Low Pressure Dose: None

Analysis Adsorptive: N<sub>2</sub>

Analysis Bath Temp.: 77.300 K

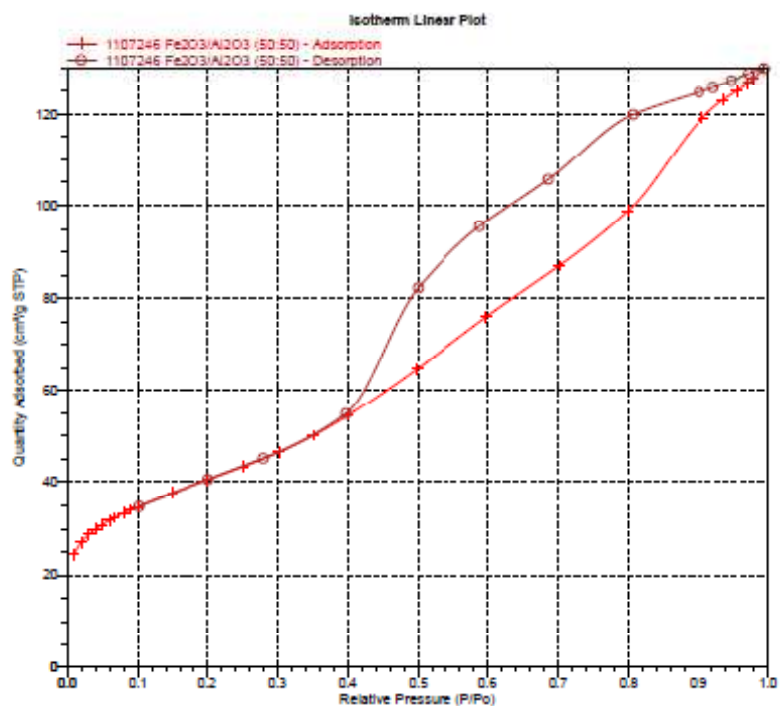
Thermal Correction: No

Warm Free Space: 20.2536 cm<sup>3</sup> Measured

Equilibration Interval: 5 s

Automatic Degas: Yes

Comments: Nanofibras de carbono





Standar Report

ASAP 2020 V3.00 H

Unit 1

Serial #: 457

Page 4

Sample: 1107246 Fe2O3/Al2O3 (50:50)  
Operator: Nuria  
Submitter: Daniel Torres (LSueltas)  
File: C:\\_IDANIELTY\1107246.SMP

Started: 27/07/2011 11:11:38  
Completed: 27/07/2011 18:31:57  
Report Time: 28/07/2011 8:40:30  
Sample Mass: 1.1217 g  
Gold Free Space: 59.0942 cm<sup>3</sup>  
Low Pressure Dose: None

Analysis Adsorptive: N2  
Analysis Bath Temp.: 77.300 K  
Thermal Correction: No  
Warm Free Space: 20.2538 cm<sup>3</sup> Measured  
Equilibration Interval: 5 s  
Automatic Degas: Yes

Comments: Nanofibras de carbono

BET Surface Area Report

BET Surface Area: 143.0558 ± 0.5012 m<sup>2</sup>/g  
Slope: 0.030289 ± 0.000104 g/cm<sup>3</sup> STP  
Y-intercept: 0.000141 ± 0.000025 g/cm<sup>3</sup> STP  
C: 216.363562  
Qm: 32.8622 cm<sup>3</sup>/g STP  
Correlation Coefficient: 0.9995766  
Molecular Cross-Sectional Area: 0.1620 nm<sup>2</sup>

Relative Pressure (P/P <sub>0</sub> )	Quantity Adsorbed (cm <sup>3</sup> /g STP)	1/[Q(P <sub>0</sub> /P - 1)]
0.099869377	34.7651	0.003195
0.149596871	37.7378	0.004661
0.200942153	40.5617	0.006200
0.252102465	43.4051	0.007766
0.302353113	46.5407	0.009312
0.351350657	50.1930	0.010792



Standar Report

ASAP 2020 V3.00 H

Unit: 1

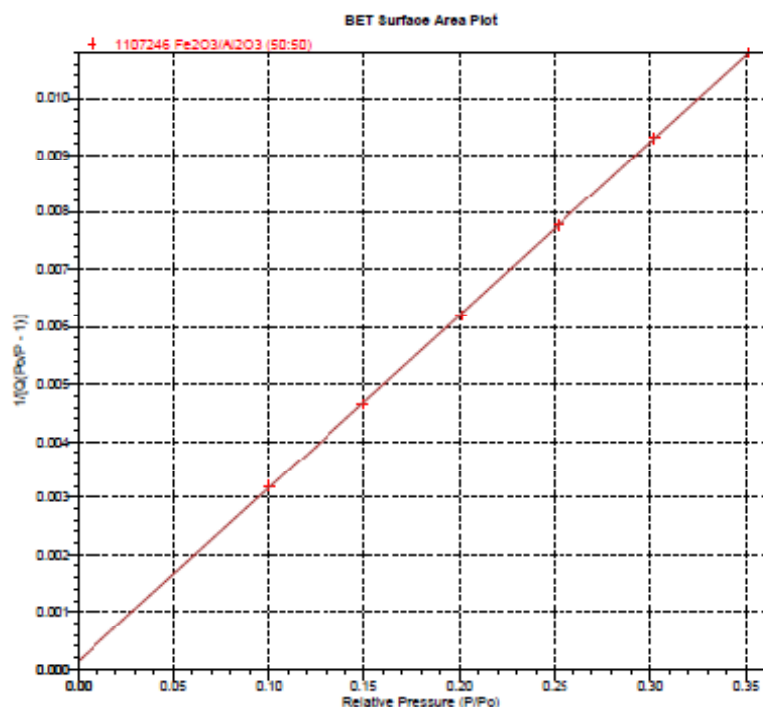
Serial #: 457

Page 5

Sample: 1107246 Fe2O3/Al2O3 (50:50)  
Operator: Nuria  
Submitter: Daniel Torres (I.Suñes)  
File: C:\L\IDANIELT\1107246.SMP

Started: 27/07/2011 11:11:38  
Completed: 27/07/2011 18:31:57  
Report Time: 28/07/2011 8:40:30  
Sample Mass: 1.1217 g  
Cold Free Space: 59.0942 cm<sup>3</sup>  
Low Pressure Dose: None  
Analysis Adsorptive: N2  
Analysis Bath Temp.: 77.300 K  
Thermal Correction: No  
Warm Free Space: 20.2536 cm<sup>3</sup> Measured  
Equilibration Interval: 5 s  
Automatic Degas: Yes

Comments: Nanofibras de carbono



### 7.1.3.- Microscopia electrónica de barrido (SEM)

#### 7.1.3.1.- Ensayo A06

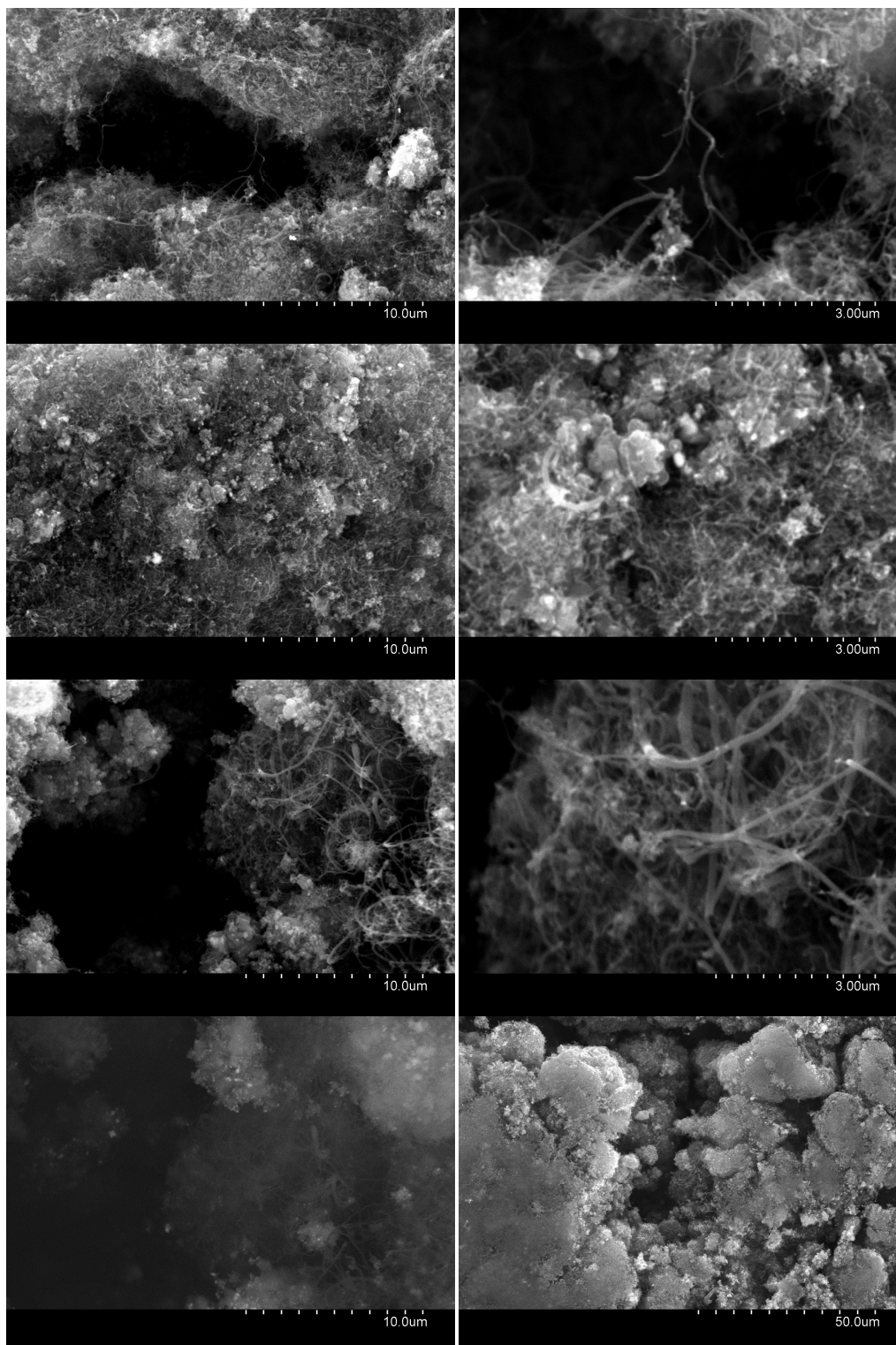


Figura 7.3 – Imágenes SEM del producto de carbono del ensayo A06. De izda. a dcha. y de arriba a abajo: 1) aumentos x 5000, 2) x 15000, 3) x 5000, 4) x 15000, 5) x 5000, 6) x 15000, 7) x 5000 (electrones retrodispersados), 8) x 1000.

### 7.1.3.2.- Ensayo A15

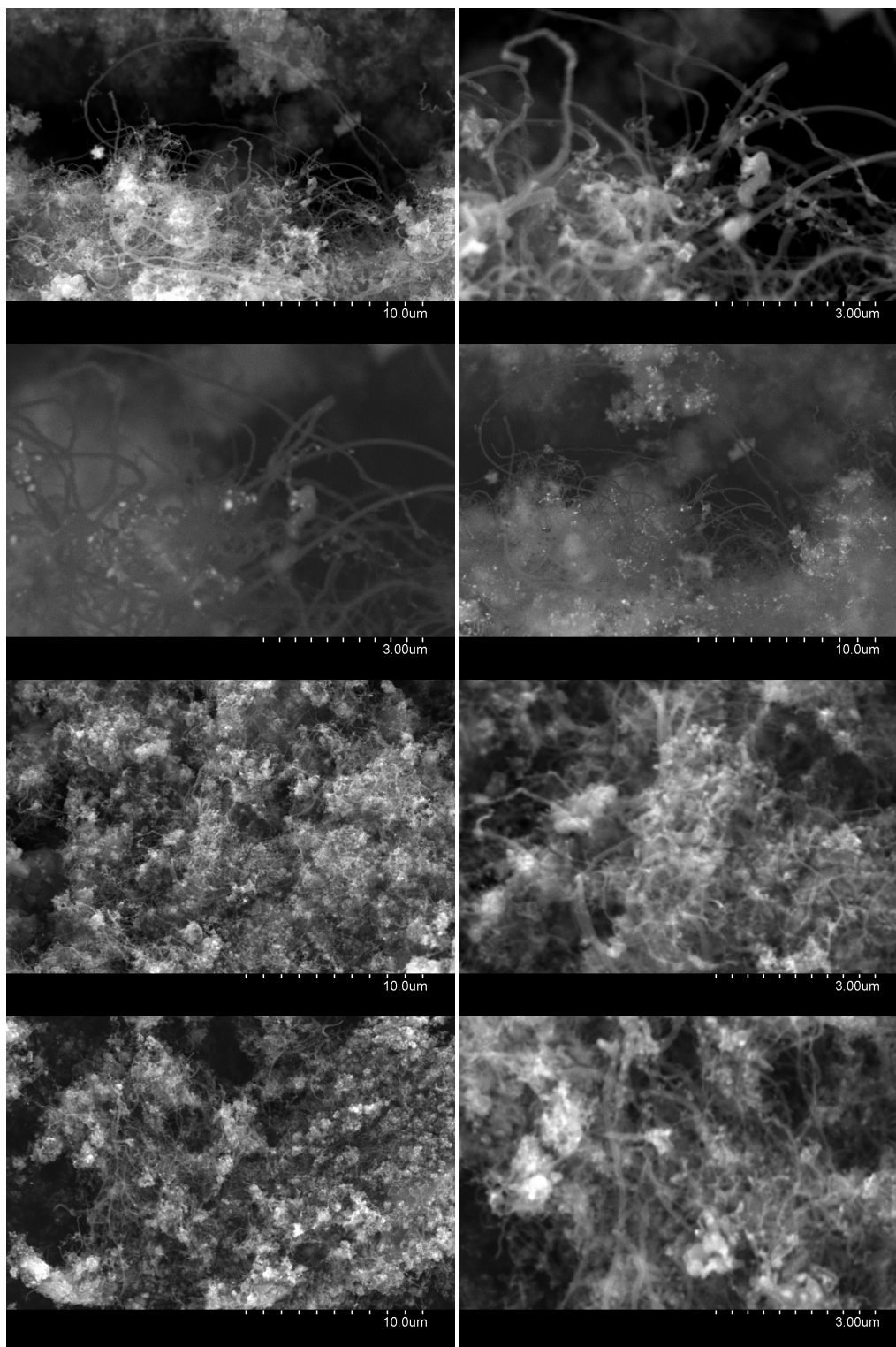


Figura 7.4 – Imágenes SEM del producto de carbono del ensayo A15. De izda. a dcha. y de arriba a abajo: 1) aumentos x 5000, 2) x 15000, 3) x 15000 (elect. retrodispersados), 4) x 5000 (elect. retrodispersados), 5) x 5000, 6) x 15000, 7) x 5000, 8) x 15000.



## 7.1.4.- Distribución del tamaño de partícula (ensayo A06)

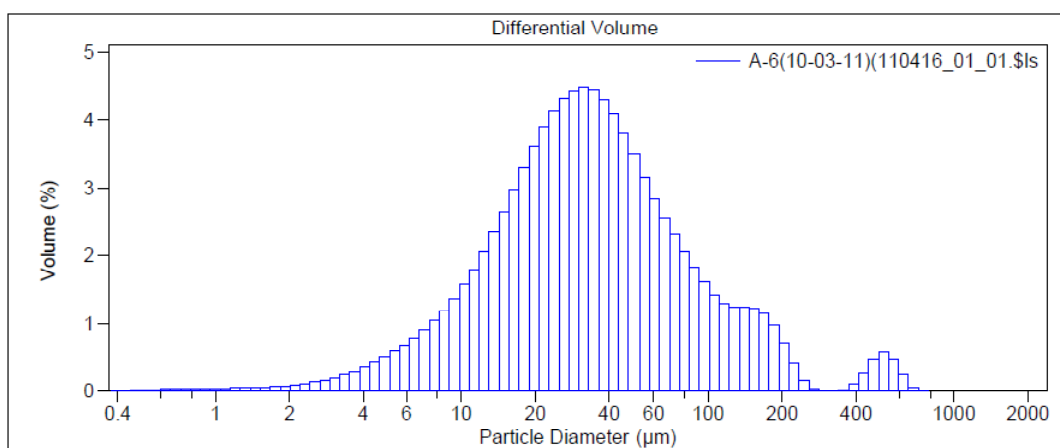


LS Particle Size Analyzer

15 Apr 2011 15:42

Beckman Coulter LS 13 320

File name:	C:\Documents and Settings\izasa\Escritorio\Muestras Tamaño Partícula\Muestras interna		
	A-6(10-03-11)(110416_01_01.\$ls		
File ID:	A-6(10-03-11)(1104169)		
Sample ID:	A-6(10-03-11)(1104169)		
Operator:	Anabel		
Run number:	1		
Comment 1:	11-S-548		
Optical model:	Fraunhofer.rf780d		
Residual:	0.23%		
LS 13 320	Dry Powder System		
Start time:	15:41 15 Apr 2011	Run length:	34 seconds
Average Vacuum:	24.2" H2O		
Obscuration:	7%		
Software:	5.01	Firmware:	2.02



Volume Statistics (Arithmetic) A-6(10-03-11)(110416\_01\_01.\$ls

Calculations from 0.375 µm to 2000 µm

Volume:	100%	S.D.:	82.11 µm
Mean:	55.72 µm	Variance:	6742 µm <sup>2</sup>
Median:	32.06 µm	C.V.:	147%
Mean/Median ratio:	1.738	Skewness:	4.416 Right skewed
Mode:	31.51 µm	Kurtosis:	23.00 Leptokurtic

<10%	<25%	<50%	<75%	<90%
9.882 µm	18.07 µm	32.06 µm	58.35 µm	116.6 µm

## 7.2.- Ensayos DCM (datos completos)

Se incluyen a continuación los datos de producción de H<sub>2</sub> (% y vol), de pérdida de carga en el lecho y de la conversión de metano durante el transcurso de todos los ensayos realizados.

ENSAYO 01					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,08	-	1,76	-	3,85	26,48
0,17	-	1,76	-	7,90	27,82
0,33	42,23	1,88	-	15,69	26,77
0,50	36,95	1,88	-	22,28	22,67
1,00	29,07	2,37	37,12	37,12	17,00
2,00	22,36	4,93	59,09	96,21	12,59
3,00	12,57	6,88	70,80	167,01	6,71
4,00	8,95	7,62	78,98	245,98	4,69

ENSAYO 02					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	76,08	2,00	-	20,09	61,39
0,50	72,39	2,12	-	38,65	56,72
1,00	66,78	2,73	71,47	71,47	50,13
2,00	62,36	15,55	59,31	130,77	45,30
3,00	57,27	52,91	52,52	183,29	40,12
4,00	56,80	134,45	51,92	235,22	39,66
5,00	55,19	274,46	49,89	285,10	38,11
6,00	45,88	352,34	38,97	324,07	29,77

ENSAYO 03					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	64,84	1,88	-	26,17	47,97
0,50	56,57	5,79	-	47,68	39,44
1,00	48,93	67,55	83,01	83,01	32,39
2,00	40,38	180,19	55,19	138,20	25,30
3,08	32,21	279,35	45,38	183,58	19,20
4,00	22,74	362,48	25,66	209,24	12,83
5,00	17,90	429,36	21,45	230,69	9,83
6,00	14,42	449,88	16,95	247,64	7,77

ENSAYO 04					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	-	2,73	-	32,52	59,63
0,50	90,89	5,91	-	77,96	83,30
1,00	67,73	8,11	133,82	133,82	51,21
2,25	26,39	8,96	41,46	175,28	15,20
3,00	20,40	9,20	18,58	193,86	11,36
4,00	16,69	9,33	19,86	213,72	9,10
5,00	13,55	9,81	15,86	229,59	7,27
6,00	11,63	10,18	13,47	243,05	6,17

ENSAYO 05					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	-	6,15	-	29,59	45,21
0,50	69,66	7,62	-	64,58	53,44
1,00	49,30	23,00	107,41	107,41	32,72
2,00	38,41	68,00	62,23	169,64	23,77
3,00	37,37	132,13	60,17	229,80	22,98
4,00	33,71	238,09	53,08	282,88	20,27
5,08	25,28	435,60	41,04	323,92	14,47
6,00	19,41	-	25,80	349,72	10,75

ENSAYO 06					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	55,72	3,22	-	25,28	38,62
0,50	52,64	3,59	-	48,66	35,72
1,00	48,00	6,03	90,00	90,00	31,58
2,00	39,24	21,41	63,91	153,91	24,41
3,00	39,22	41,55	63,86	217,77	24,39
4,00	37,50	58,00	60,42	278,19	23,08
5,00	36,21	103,69	57,89	336,08	22,11
6,00	28,85	305,83	44,14	380,22	16,86

ENSAYO 07					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	55,03	2,25	-	24,84	37,95
0,50	48,81	2,37	-	45,97	32,28
1,00	42,75	3,22	81,56	81,56	27,19
2,00	31,83	6,64	47,43	128,99	18,12
3,00	16,23	7,74	23,12	152,11	8,83
4,00	11,86	8,59	16,50	168,62	6,30
5,00	10,16	8,96	14,01	182,63	5,35
6,00	9,26	9,81	12,72	195,34	4,86

ENSAYO 08					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	80,75	3,96	-	44,32	67,72
0,50	75,67	11,52	-	84,16	60,86
1,00	49,47	10,67	127,18	127,18	32,86
2,00	23,09	4,32	34,18	161,36	13,05
3,00	18,06	3,83	25,98	187,34	9,92
4,00	16,94	4,08	24,22	211,56	9,25
5,17	17,57	4,20	29,42	240,98	9,63
6,00	18,01	4,32	21,60	262,58	9,90

ENSAYO 09					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	38,01	3,71	-	15,36	23,46
0,50	30,91	4,20	-	27,32	18,28
1,00	30,48	4,81	50,86	50,86	17,98
2,00	45,31	7,01	76,69	127,55	29,29
3,00	42,45	17,99	70,54	198,09	26,94
4,00	38,10	74,02	61,61	259,70	23,53
5,00	33,61	11,04	52,89	312,59	20,20
6,00	31,46	44,85	48,88	361,47	18,67

ENSAYO 10					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	26,64	4,32	-	10,06	15,36
0,50	21,70	4,44	-	18,02	12,17
1,00	19,88	4,81	32,47	32,47	11,03
1,50	22,20	5,18	-	48,81	12,49
2,00	27,57	5,54	37,28	69,74	15,99
2,50	27,97	6,15	-	91,03	16,26
3,00	27,44	7,13	42,10	111,84	15,90
4,00	24,01	11,60	35,72	147,56	13,64
5,00	21,51	29,96	31,55	179,11	12,05
6,00	20,34	30,44	29,64	208,75	11,32

ENSAYO 11					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	44,88	2,49	-	25,25	28,93
0,5	40,84	2,86	-	47,64	25,66
1	39,91	10,79	91,16	91,16	24,93
1,5	36,81	26,66	-	130,53	22,56
2	36,16	102,10	77,90	169,06	22,07
3	35,93	277,12	76,45	245,51	21,90
4	33,30	270,68	69,74	315,25	19,98
5	31,44	-	65,11	380,37	18,65
6	28,33	-	57,60	437,97	16,50

ENSAYO 12					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	71,54	5,54	-	29,35	44,85
0,5	61,82	6,27	-	53,54	36,95
1	26,67	8,11	72,00	72,00	14,10
1,5	18,37	8,72	-	84,41	9,48
2,5	13,01	6,4	29,72	101,72	6,61
3	11,76	6,15	7,75	109,47	5,92
4	9,94	6,64	13,02	122,49	4,97
5,1	8,25	6,76	11,76	134,25	4,08
6	7,39	7,37	8,52	142,77	3,62

ENSAYO 13					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	74,26	9,69	-	77,31	59,06
0,5	5	11,65	-	112,06	26,54
1	15,44	11,77	133,97	133,97	8,37
1,5	11,87	11,89	-	150,48	6,31
2	9,53	11,77	29,62	163,58	5,00
2,5	8,53	12,26	-	175,24	4,45
3	7,63	12,38	23,78	187,36	3,97
4	6,71	12,01	16,66	204,03	3,47
5	5,93	12,62	16,00	220,02	3,06
6	4,95	12,87	13,29	233,32	2,54

ENSAYO 14					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	65,35	3,71	-	12,95	39,58
0,5	59,89	3,83	-	24,53	35,36
1	53,63	4,93	44,71	44,71	30,84
1,5	47,49	6,03	-	62,10	26,57
2	44,71	7,01	33,62	78,33	24,79
2,5	42,73	8,35	-	93,73	23,53
3	42,58	9,45	30,81	109,14	23,54
4,25	43,42	14,21	39,06	148,20	23,87
5	39,84	15,8	21,78	169,98	22,18
6	35,79	16,53	26,14	196,12	19,97

ENSAYO 15					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	85,96	3,47	-	9,64	58,90
0,5	80,53	3,47	-	18,35	53,24
1	76,03	4,2	34,25	34,25	48,58
1,5	73,39	4,81	-	49,40	46,28
2	70,99	5,54	29,61	63,85	44,18
2,5	69,42	6,64	-	77,90	42,94
3	67,73	8,11	27,50	91,35	41,09
4	61,13	11,28	23,72	115,07	36,23
5	57,47	20,43	21,56	136,63	32,94
6	50,94	29,1	19,02	155,64	29,05

ENSAYO 16					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	67,70	6,52	-	33,50	51,17
0,5	66,61	8,23	-	66,18	49,93
1	34,42	11,4	40	93,39	20,79
1,5	27,55	12,13	-	114,31	15,98
2	16,71	12,13	32,85	126,24	9,12
2,5	14,05	12,5	-	136,14	7,56
3	12,43	12,74	18,57	144,81	6,63
4	10,51	13,6	14,53	159,34	5,55
5,12	8,75	15,06	13,38	172,72	4,58
6	8,29	16,04	10,00	182,72	4,32

ENSAYO 17					
Tiempo (h)	Producción H <sub>2</sub> (%)	$\Delta P_{\text{lecho}}$ (mbar)	Vol. H <sub>2</sub> (l)	Vol. H <sub>2</sub> acum. (l)	$\chi_{\text{CH}_4}$ (%)
0,25	77,60	6,4	-	34,58	63,41
0,5	54,14	10,18	-	54,83	37,12
1	48,01	22,14	89,29	89,29	31,59
1,5	42,19	41,67	-	118,45	26,73
2	30,71	49,12	48,95	138,24	18,14
2,5	21,80	50,1	-	151,59	12,24
3	17,86	63,04	24,04	162,28	9,80
4	13,91	85,38	16,31	178,59	7,47
5	12,08	107,84	14,03	192,62	6,43
6	10,04	141,16	11,53	204,15	5,29

