

Table 1. Major events in Run SB-0665

TOS (h)	Event
	Slurry loading: 316 g of Ethylflo 164 oil, 10.0 g of catalyst (particle size < 270 mesh)
	Catalyst pretreatment: H ₂ , 250°C for 4 h
	Wax withdrawal through filter: 51.1 g of wax
0	Initiate synthesis gas flow, achieve process conditions: T = 260°C, P = 1.48 MPa, SV = 2.0 NI/g-cat/h, (H ₂ /CO) = 0.67
48	Change process conditions: SV = 1.8 NI/g-cat/h
136	Change process conditions: SV = 1.6 NI/g-cat/h
377	End of run: 222 g slurry recovered from the reactor
	Wax and catalyst removed during the run: 409 g wax; 0 g catalyst
	Wax recovery: 87 %

Table 2. Summary results for slurry run SB-0665.

Catalyst: 10.00 g^a, 100Fe/5Cu/6K/24SiO₂

Slurry liquid: 265.0 g, EthylHo-164

Reactor volume: 430. cc^b

Period	1	2	3	4
Time on Stream (h)	38.0	110.0	182.0	290.0
Balance Duration (h)	7.5	10.0	24.8	18.0
Average Temperature (°C)	260.	260.	260.	260.
Pressure (MPa)	1.48	1.48	1.48	1.48
H ₂ /CO Feed Ratio	.667	.667	.667	.667
Space Velocity (NI/g-cat.h) ^a	2.00	1.80	1.60	1.60
Space Velocity (NI/g-Fe.h)	3.73	3.38	3.00	3.00
GHSV (h ⁻¹) ^b	46.2	41.9	37.2	37.2
CO Conversion (%)	76.2	71.1	70.7	69.2
H ₂ +CO Conversion (%)	71.5	67.0	66.6	65.4
H ₂ /CO Usage	.563	.569	.570	.575
STY (mols H ₂ +CO/g-cat.h) ^a	.063	.054	.048	.047
P _{CO₂} · F _{H₂} /P _{CO} · F _{H₂O}	21.8	19.9	33.5	19.7
Weight % of Outlet				
H ₂	1.63	1.83	1.84	1.85
H ₂ O	1.04	.967	.562	.910
CO	22.7	27.9	28.4	29.5
CO ₂	55.2	51.8	51.2	50.3
Hydrocarbons	7.02	10.3	10.5	10.5
Oxygenates	.423	.793	.762	.835
Wax ^c	12.0	6.39	6.75	6.09
Yield (g/Nm ³ H ₂ + CO Converted)				
CH ₄	6.35	7.81	8.27	8.29
C ₂ -C ₄ Hydrocarbons	25.6	29.5	30.1	30.7
C ₅ -C ₁₁ Hydrocarbons	34.0	44.1	44.1	45.6
C ₁₂ + Hydrocarbons	143.	111.	118.	114.
Wax ^c	131.	73.8	78.5	72.7
Oxygenates	4.64	9.17	8.86	9.97
Total	213.	202.	209.	209.
1+2 Olefins/n-Paraffin Ratio				
C ₂	1.24	1.34	1.29	1.33
C ₃	4.99	4.93	5.23	5.17
C ₄	4.07	4.12	4.11	4.03
C ₈	2.26	2.58	2.59	2.71
C ₁₀	1.64	2.05	2.19	2.29

^a Based on unreduced catalyst

^c Unanalyzed wax withdrawn from reactor

^b Based on static slurry volume

Table 2 (con'd). Summary results for slurry run SB-0665.

Weight % of Hydrocarbons	Period			
	1	2	3	4
CH ₄	3.04	4.05	4.13	4.17
Ethane	1.44	1.74	1.76	1.78
Ethylene	1.66	2.17	2.12	2.21
Propane	.861	1.08	1.01	1.05
Propylene	4.10	5.10	5.03	5.17
<i>n</i> -Butane	.784	.957	.951	.989
1+2 Butenes	3.08	3.80	3.77	3.85
C ₄ Isomers	.351	.435	.409	.413
<i>n</i> -Pentane	1.15	1.30	1.42	1.42
1+2 Pentenes	2.93	3.50	3.64	3.81
C ₅ Isomers	.159	.165	.211	.210
<i>n</i> -Hexane	.694	.840	.806	.812
1+2 Hexenes	1.91	2.41	2.40	2.38
C ₆ Isomers	.539	.295	.248	.407
<i>n</i> -Heptane	.478	.575	.508	.547
1+2 Heptenes	1.28	1.68	1.55	1.60
C ₇ Isomers	.366	.454	.442	.406
<i>n</i> -Octane	.423	.523	.517	.524
1+2 Octenes	.940	1.33	1.31	1.40
C ₈ Isomers	.236	.341	.389	.394
<i>n</i> -Nonane	.471	.687	.670	.694
1+2 Nonenes	.831	1.49	1.52	1.62
C ₉ Isomers	.223	.414	.389	.435
<i>n</i> -Decane	.567	.903	.804	.843
1+2 Decenes	.917	1.83	1.74	1.91
C ₁₀ Isomers	.355	.489	.462	.479
<i>n</i> -Undecane	.575	1.09	.833	.814
1+2 Undecenes	.890	1.97	1.67	1.74
C ₁₁ Isomers	.382	.580	.478	.491
C ₂ -C ₄	12.3	15.3	15.0	15.5
C ₅ -C ₁₁	16.3	22.9	22.0	22.9
C ₁₂ +	68.4	57.8	58.8	57.4
Wax ^c	63.0	38.3	39.2	36.6

^c Unanalyzed wax withdrawn from reactor

Table 3. Major events in Run SB-0045

TOS (h)	Event
	Slurry loading: 340 g of Ethylflo 164 oil, 7.0 g of catalyst (particle size < 270 mesh)
	Catalyst pretreatment: H ₂ , 250°C for 2 h
	Wax withdrawal through filter: 41.0 g of wax
0	Initiate synthesis gas flow, achieve process conditions: T = 260°C, P = 1.48 MPa, SV = 1.4 NI/g-cat/h, (H ₂ /CO) = 0.67
257	Change process conditions: P = 2.17 MPa, SV = 2.05 NI/g-cat/h
400	End of run: 416 g slurry recovered from the reactor
	Wax and catalyst removed during the run: 353 g wax; 0 g catalyst
	Wax recovery: 113 %

Table 4. Summary results for slurry run SB-0045.

Slurry liquid: 296.0 g, Ethylflo-164

Catalyst: 7.00 g^a, 100Fe/3Cu/4K/16SiO₂Reactor volume: 430. cc^b

Period	1	2	3	4	5	6	7
Time on Stream (h)	47.0	95.0	168.0	215.0	292.0	336.0	379.0
Balance Duration (h)	17.0	17.0	16.0	16.5	12.0	17.0	17.5
Average Temperature (°C)	260.	260.	260.	260.	260.	260.	260.
Pressure (MPa)	1.48	1.48	1.48	1.48	2.17	2.17	2.17
H ₂ /CO Feed Ratio	.667	.667	.669	.669	.669	.669	.669
Space Velocity (Nl/g-cat.h) ^a	1.41	1.41	1.41	1.41	2.05	2.05	2.05
Space Velocity (Nl/g-Fe.h)	2.42	2.42	2.42	2.42	3.53	3.53	3.53
GHSV (h ⁻¹) ^b	22.9	22.9	22.9	22.9	33.3	33.3	33.3
CO Conversion (%)	88.0	87.1	86.4	86.7	84.4	85.0	85.3
H ₂ +CO Conversion (%)	81.9	81.0	80.3	80.8	79.3	79.9	80.6
H ₂ /CO Usage	.552	.550	.552	.557	.570	.570	.576
STY (mols H ₂ +CO/g-cat.h) ^a	.051	.051	.050	.051	.073	.073	.074
P _{CO₂} · F _{H₂} /P _{CO} · F _{H₂O}	45.7	40.8	44.2	38.9	25.9	20.6	24.3
Weight % of Outlet							
H ₂	1.24	1.28	1.31	1.27	1.30	1.27	1.21
H ₂ O	.886	.946	.833	.944	1.19	1.51	1.28
CO	11.4	12.2	12.9	12.6	15.0	14.4	13.9
CO ₂	65.6	64.5	63.5	63.9	62.4	61.8	62.6
Hydrocarbons	6.99	7.97	10.9	9.65	10.2	8.56	8.30
Oxygenates	.264	.249	.385	.326	.442	.348	.327
Wax ^c	13.6	12.8	10.2	11.4	9.46	12.1	12.4
Yield (g/Nm ³ H ₂ + CO Converted)							
CH ₄	5.38	5.55	5.99	6.01	5.54	5.36	5.02
C ₂ -C ₄ Hydrocarbons	21.1	21.2	21.2	21.4	22.0	21.8	22.2
C ₅ -C ₁₁ Hydrocarbons	25.9	26.9	33.1	28.9	34.3	29.5	29.0
C ₁₂ + Hydrocarbons	145.	150.	147.	151.	131.	146.	146.
Wax ^c	131.	125.	100.	112.	93.0	119.	121.
Oxygenates	2.53	2.43	3.79	3.21	4.34	3.42	3.20
Total	200.	206.	211.	210.	198.	206.	206.
1+2 Olefins/n-Paraffin Ratio							
C ₂	1.92	1.89	1.75	1.73	2.33	2.30	2.40
C ₃	8.08	6.16	8.23	7.25	6.73	6.18	4.67
C ₄	6.20	6.32	6.39	6.37	5.52	5.64	5.65
C ₈	3.38	3.67	3.86	4.01	3.74	3.64	3.66
C ₁₀	2.30	2.82	3.13	3.19	3.28	3.31	3.31

^a Based on unreduced catalyst^b Based on static slurry volume^c Unanalyzed wax withdrawn from reactor

Table 4 (con'd). Summary results for slurry run SB-0045.

Period		1	2	3	4	5	6	7
Weight % of Hydrocarbons								
CH ₄		2.72	2.73	2.89	2.90	2.87	2.64	2.48
Ethane		1.06	1.07	1.14	1.15	1.03	.975	.945
Ethylene		1.90	1.88	1.86	1.86	2.23	2.09	2.11
Propane		.488	.611	.455	.517	.607	.625	.827
Propylene		3.77	3.59	3.58	3.58	3.90	3.68	3.68
n-Butane		.487	.452	.440	.446	.559	.510	.519
1+2 Butenes		2.91	2.75	2.71	2.74	2.98	2.78	2.83
C ₄ Isomers		.0646	.0541	.0501	.0514	.0728	.0552	.0483
n-Pentane		.492	.452	.421	.409	.518	.441	.488
1+2 Pentenes		2.61	2.47	2.48	2.42	2.44	2.42	2.59
C ₅ Isomers		.0880	.0683	.0730	.0784	.107	.0991	.0975
n-Hexane		.473	.431	.414	.381	.580	.382	.420
1+2 Hexenes		1.64	1.54	1.56	1.45	1.98	1.33	1.45
C ₆ Isomers		.412	.581	.164	.175	.262	.376	.359
n-Heptane		.327	.276	.303	.256	.327	.230	.251
1+2 Heptenes		1.24	1.15	1.26	1.10	1.29	.914	.999
C ₇ Isomers		.309	.320	.366	.310	.408	.348	.323
n-Octane		.274	.222	.277	.219	.297	.245	.239
1+2 Octenes		.909	.800	1.05	.861	1.09	.877	.860
C ₈ Isomers		.291	.265	.351	.307	.383	.401	.323
n-Nonane		.357	.243	.393	.292	.382	.324	.302
1+2 Nonenes		.907	.745	1.17	.985	1.23	1.11	1.01
C ₉ Isomers		.263	.207	.338	.322	.465	.294	.269
n-Decane		.320	.312	.487	.386	.528	.410	.373
1+2 Decenes		.725	.869	1.50	1.21	1.71	1.34	1.22
C ₁₀ Isomers		.271	.232	.338	.259	.603	.450	.413
n-Undecane		.305	.476	.657	.531	.605	.476	.437
1+2 Undecenes		.680	1.22	1.85	1.54	1.88	1.48	1.36
C ₁₁ Isomers		.215	.321	.513	.464	.672	.608	.558
C ₂ -C ₄		10.7	10.4	10.2	10.3	11.4	10.7	11.0
C ₅ -C ₁₁		13.1	13.2	16.0	14.0	17.8	14.5	14.3
C ₁₂ +		73.5	73.7	70.9	72.8	68.0	72.1	72.2
Wax ^c		66.1	61.7	48.4	54.2	48.1	58.6	59.9

^c Unanalyzed wax withdrawn from reactor

Table 5. Major events in Run SA-0705

TOS (h)	Event
	Slurry loading: 320 g of Durasyn 164 oil, 8.9 g of catalyst (particle size < 270 mesh)
	Catalyst pretreatment: H ₂ , 250°C for 2 h
	Wax withdrawal through filter: 41.6 g of wax
0	Initiate synthesis gas flow, achieve process conditions: T = 260°C, P = 1.48 MPa, SV = 1.4 NI/g-cat/h, (H ₂ /CO) = 0.67
264	Change process conditions: P = 2.17 MPa, SV = 2.05 NI/g-cat/h
526	End of run: 329 g slurry recovered from the reactor
	Wax and catalyst removed during the run: 791 g wax, 0 g catalyst
	Wax recovery: 86 %

Table 6. Summary of results for slurry run SA-0705 .

Catalyst: 8.90 g^a, 100Fe/3Cu/4K/16SiO₂

Slurry liquid: 278.0 g, Durasyn-164

Reactor volume: 400. cc^b

Period	1	2	3	4	5
Time on Stream (h)	41.0	88.0	197.0	364.0	457.0
Balance Duration (h)	14.0	26.5	16.0	13.0	16.0
Average Temperature (°C)	260.	260.	260.	260.	260.
Pressure (MPa)	1.48	1.48	1.48	2.17	2.17
H ₂ /CO Feed Ratio	.667	.667	.667	.667	.667
Space Velocity (Nl/g-cat·h) ^a	1.40	1.40	1.40	2.04	2.04
Space Velocity (Nl/g-Fe·h)	2.41	2.41	2.41	3.52	3.52
GHSV (h ⁻¹) ^b	31.2	31.2	31.2	45.5	45.5
CO Conversion (%)	89.6	87.5	86.9	83.8	81.6
H ₂ +CO Conversion (%)	83.9	81.4	81.1	79.2	77.2
H ₂ /CO Usage	.559	.551	.555	.574	.577
STY (mols H ₂ +CO/g-cat·h) ^a	.052	.051	.051	.072	.070
P _{CO₂} · P _{H₂} /P _{CO} · P _{H₂O}	35.2	35.6	39.9	26.3	25.4
Weight % of Outlet					
H ₂	1.15	1.27	1.27	1.28	1.35
H ₂ O	1.21	1.09	.914	1.09	1.01
CO	9.98	12.0	12.6	15.5	17.7
CO ₂	65.5	64.3	63.6	61.2	59.2
Hydrocarbons	6.01	6.32	6.91	6.55	6.93
Oxygenates	.231	.270	.226	.269	.356
Wax ^c	16.0	14.8	14.4	14.1	13.5
Yield (g/Nm ³ H ₂ + CO Converted)					
CH ₄	6.51	7.20	7.71	7.44	7.13
C ₂ -C ₄ Hydrocarbons	24.8	25.5	26.7	29.1	29.5
C ₅ -C ₁₁ Hydrocarbons	23.7	25.1	23.4	24.8	28.5
C ₁₂ + Hydrocarbons	149.	146.	148.	142.	141.
Wax ^c	148.	142.	139.	139.	136.
Oxygenates	2.15	2.60	2.18	2.65	3.59
Total	206.	206.	208.	206.	209.
1+2 Olefins/n-Paraffin Ratio					
C ₂	1.26	1.40	1.39	1.75	2.07
C ₃	6.66	7.00	6.77	6.38	5.99
C ₄	5.82	6.03	6.01	5.40	5.25
C ₈	2.82	3.35	3.28	3.57	3.57
C ₁₀	2.32	2.71	2.26	2.91	3.04

^a Based on unreduced catalyst

^b Based on static slurry volume

^c Unanalyzed wax withdrawn from reactor

Table 6 (cont'd). Summary of results for slurry run SA-0705.

Period	1	2	3	4	5
Weight % of Hydrocarbons					
CH ₄	3.19	3.54	3.74	3.66	3.47
Ethane'	1.52	1.56	1.65	1.53	1.38
Ethylene	1.79	2.04	2.14	2.50	2.66
Propane	.667	.652	.690	.808	.860
Propylene	4.24	4.36	4.46	4.92	4.92
n-Butane	.543	.529	.545	.664	.686
1+2 Butenes	3.05	3.08	3.16	3.46	3.48
C ₄ Isomers	.315	.300	.328	.395	.391
n-Pentane	.845	.812	.830	.992	1.02
1+2 Pentenes	2.88	2.76	2.80	3.06	3.12
C ₅ Isomers	.150	.152	.151	.0909	.178
n-Hexane	.437	.394	.407	.515	.498
1+2 Hexenes	1.74	1.68	1.74	1.94	1.85
C ₆ Isomers	.363	.129	.182	.197	.302
n-Heptane	.290	.235	.262	.297	.323
1+2 Heptenes	1.06	.975	1.06	1.19	1.17
C ₇ Isomers	.335	.316	.347	.465	.308
n-Octane	.251	.227	.204	.166	.222
1+2 Octenes	.695	.747	.658	.581	.779
C ₈ Isomers	.231	.302	.254	.236	.313
n-Nonane	.240	.285	.211	.184	.258
1+2 Nonenes	.590	.784	.573	.542	.782
C ₉ Isomers	.171	.261	.151	.195	.310
n-Decane	.197	.277	.208	.177	.255
1+2 Decenes	.450	.740	.462	.509	.764
C ₁₀ Isomers	.222	.278	.156	.210	.332
n-Undecane	.0874	.208	.184	.129	.208
1+2 Undecenes	.211	.521	.404	.346	.588
C ₁₁ Isomers	.139	.237	.124	.177	.260
C ₂ -C ₄	12.1	12.5	13.0	14.3	14.4
C ₆ -C ₁₁	11.6	12.3	11.4	12.2	13.8
C ₁₂ +	73.1	71.6	71.9	69.9	68.3
Wax ^c	72.6	70.1	67.6	68.3	66.0

^c Unanalyzed wax withdrawn from reactor

Table 7. Elemental Analysis and Textural Properties of Synthesized Catalysts

Nominal Composition Designation	Amount prepared (g)	Composition 100 Fe x Cu /y K /z SiO ₂	BET Surface Area (m ² g ⁻¹)		Pore Volume cm ³ g ⁻¹
			Single point	BET plot	
100 Fe/3 Cu/4 K/16 SiO ₂					
S-3416-1	40	3.5 / 5.8 / 17.0		257	0.66
		3.0 / 6.7 / 15.5(a)		245 (a)	0.65(a)
		3.0 / 5.9 / 15.5(b)			
S-3416-2	101	3.1 / 3.6 / 19.0	316	315	0.43
S-3416-3(d)	173	2.9 / 3.5 / 16.0	262	291	0.43
100 Fe/5 Cu/6 K/24 SiO ₂					
S-5624-1	67	5.4 / 6.2 / 24.0		235	0.71
		5.1 / 8.1 / 26.0(a)		222(a)	0.68(a)
		5.5 / 6.6 / 24.0(c)			
S-5624-2	90	5.4 / 5.1 / 21.9	228	238	0.23
S-5624-3(d)	240	4.8 / 5.2 / 24.2	258	284	0.51
S-5624-4	200	4.1 / 5.4 / 24.5			

(a): Bukur (1994)

(b): measurements conducted at Universal Oil Products Inc..

(c): measurements conducted at Pittsburgh Energy Technology Center.

(d): Sodium contents in S-3416-3 and S-5624-3 catalysts are 0.34 wt-% and 0.02 wt-%, which correspond to 0.58 and 0.03 parts of Na per 100 parts of Fe, respectively. Sodium contents in other catalysts are undetectable.