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APPENDIX E

COMPOSITION OF CONDENSED HYDROCARBON PRODUCTS

Composition of Condensed Hydrocarbon Products

Run 4

Catalyst -- 100 Co : 15.9 ThO₂ : 92.9 Kieselguhr : 1.96 K₂CO₃

Experiment 4-1

Reactor ¹	1	3	4	5
Nominal S, wt%	0.29	0.43	0.5	0
Carbon number	<u>Weight %</u>			
C ₄	0.05	0.04	--	0.19
C ₅	0.42	0.26	0.04	0.93
C ₆	1.19	0.87	0.26	1.69
C ₇	1.25	1.13	0.90	1.66
C ₈	1.54	1.31	2.18	2.04
C ₉	3.00	2.55	3.64	3.53
C ₁₀	5.18	4.80	5.41	5.52
C ₁₁	7.02	6.86	6.68	6.55
C ₁₂	7.65	7.58	7.13	6.95
C ₁₃	8.19	7.93	7.20	6.93
C ₁₄	7.71	7.48	6.91	6.50
C ₁₅	7.58	7.45	6.47	6.71
C ₁₆	6.69	7.30	5.81	6.24
C ₁₇	6.19	6.73	4.88	6.58
C ₁₈	5.74	5.78	3.94	5.18
C ₁₉	4.80	5.17	3.52	4.33
C ₂₀	4.32	4.71	3.70	3.87
C ₂₁	3.74	4.33	4.32	3.90
C ₂₂	3.33	4.17	5.21	4.09
C ₂₃	3.05	3.78	5.59	4.14
C ₂₄	2.61	3.06	4.42	4.12
C ₂₅	2.18	2.74	4.39	3.51
C ₂₆	2.12	1.80	3.44	2.10
C ₂₇	1.23	0.95	1.88	1.20
C ₂₈	0.70	0.45	0.85	0.65
C ₂₉	0.37	0.17	0.34	0.33
C ₃₀	0.16	--	0.16	0.15
C ₃₁	0.01	--	0.07	0.04

¹Experimental conditions are given in Appendix D, page 137.

Experiment 4-2

Reactor ¹	1	2	4	5
Nominal S, wt%	0.29	0.43	0.5	0
Carbon number	<u>Weight %</u>			
C ₄	0.02	0.01	0.01	0.07
C ₅	0.14	0.15	0.14	0.58
C ₆	0.70	0.78	0.89	2.12
C ₇	1.78	1.76	2.41	3.87
C ₈	3.26	2.53	4.65	4.97
C ₉	5.24	4.04	6.69	5.48
C ₁₀	7.13	5.89	8.33	5.76
C ₁₁	8.23	7.77	9.50	6.70
C ₁₂	8.43	8.27	8.82	7.12
C ₁₃	8.01	7.67	7.54	6.89
C ₁₄	7.72	7.48	6.43	6.73
C ₁₅	7.38	7.66	4.73	6.33
C ₁₆	6.90	7.57	4.19	6.01
C ₁₇	6.23	7.15	4.71	5.72
C ₁₈	5.29	6.38	5.65	5.07
C ₁₉	4.45	5.38	5.17	4.47
C ₂₀	3.83	4.29	3.12	3.89
C ₂₁	2.88	3.20	2.18	2.86
C ₂₂	2.07	2.59	2.07	2.37
C ₂₃	1.73	2.37	2.43	2.36
C ₂₄	1.64	2.03	2.32	2.56
C ₂₅	1.51	1.81	2.36	2.65
C ₂₆	1.62	1.31	2.00	1.81
C ₂₇	1.05	0.67	1.12	1.10
C ₂₈	0.60	0.33	0.51	0.62
C ₂₉	0.36	0.15	0.20	0.32
C ₃₀	0.15	0.02	0.08	0.15
C ₃₁	0.06	--	0.02	0.06
C ₃₂	0.02	--	--	--

¹Experimental conditions are given in Appendix D, page 138.

Experiment 4-4

Reactor ¹	1	2	3	4	5
Nominal S, wt%	0.29	0.43	0.5	0.5	0
Carbon number	<u>Weight %</u>				
C ₄	0.01	--	--	--	0.03
C ₅	0.10	0.11	--	--	0.39
C ₆	0.63	0.65	0.04	0.13	1.31
C ₇	2.63	1.49	0.39	1.10	3.02
C ₈	5.02	2.19	1.19	2.44	4.81
C ₉	6.18	2.55	1.71	2.57	5.32
C ₁₀	6.18	3.77	2.55	2.70	5.35
C ₁₁	5.91	4.91	3.30	2.79	5.37
C ₁₂	5.29	5.89	3.84	2.97	5.41
C ₁₃	4.62	6.04	4.19	3.44	5.55
C ₁₄	4.13	5.34	4.51	3.52	5.67
C ₁₅	3.93	4.56	4.41	3.90	5.34
C ₁₆	3.37	4.42	5.15	4.56	4.56
C ₁₇	2.10	4.68	5.77	5.29	2.52
C ₁₈	2.15	5.27	6.91	6.05	1.84
C ₁₉	4.44	5.89	8.30	7.11	3.21
C ₂₀	6.33	7.68	9.23	8.04	5.20
C ₂₁	7.73	8.46	10.56	10.01	7.67
C ₂₂	9.52	7.38	8.94	9.11	8.99
C ₂₃	7.41	4.88	4.83	5.91	6.84
C ₂₄	4.47	3.17	2.96	3.64	4.04
C ₂₅	2.64	2.15	1.85	2.59	2.80
C ₂₆	1.52	1.83	1.49	2.34	1.95
C ₂₇	1.07	1.13	0.96	1.80	0.94
C ₂₈	0.53	0.81	0.71	1.30	0.47
C ₂₉	0.29	0.64	0.55	0.95	0.24
C ₃₀	0.15	0.51	0.43	0.71	0.10
C ₃₁	0.04	0.42	0.36	0.56	0.02
C ₃₂	--	0.34	0.31	0.46	--
C ₃₃	--	0.27	0.28	0.36	--
C ₃₄	--	0.23	0.24	0.32	--
C ₃₅	--	0.19	0.22	0.28	--
C ₃₆	--	0.16	0.21	0.24	--
C ₃₇	--	0.14	0.18	0.19	--
C ₃₈	--	0.12	0.17	0.18	--
C ₃₉	--	0.10	0.14	0.11	--
C ₄₀	--	0.08	0.10	0.14	--
C ₄₁	--	0.06	0.11	0.09	--
C ₄₂	--	--	0.09	0.03	--

¹Experimental conditions are given in Appendix D, page 140.

Experiment 4-5

Reactor ¹	1	2	3	4	5
Nominal S, wt%	0.29	0.43	0.5	0.5	0
Carbon number	Weight %				
C ₄	0.04	--	0.05	0.01	--
C ₅	0.59	0.30	0.34	0.13	--
C ₆	2.37	0.82	1.07	0.91	0.06
C ₇	4.47	2.33	1.37	2.77	3.02
C ₈	5.85	3.28	1.83	3.99	7.37
C ₉	7.40	4.23	3.84	4.85	9.24
C ₁₀	8.73	5.33	5.09	5.25	10.36
C ₁₁	8.30	5.30	5.55	5.45	10.03
C ₁₂	7.50	5.08	5.82	5.36	8.89
C ₁₃	5.41	4.82	5.90	5.38	6.64
C ₁₄	5.54	4.74	5.83	5.24	5.13
C ₁₅	5.12	4.85	5.88	5.25	4.59
C ₁₆	5.43	4.72	6.03	5.25	5.20
C ₁₇	6.66	4.98	5.90	5.09	6.11
C ₁₈	6.04	4.51	5.56	4.24	4.01
C ₁₉	3.16	4.47	5.68	3.64	2.67
C ₂₀	1.99	4.37	5.88	3.65	2.54
C ₂₁	1.89	4.66	6.02	3.97	2.87
C ₂₂	2.19	4.37	5.66	4.24	3.18
C ₂₃	2.92	3.82	4.05	3.97	2.95
C ₂₄	2.45	2.98	2.53	3.13	1.92
C ₂₅	1.67	2.50	1.70	2.56	1.29
C ₂₆	1.09	2.32	1.43	2.25	0.91
C ₂₇	0.82	1.92	1.01	2.03	0.50
C ₂₈	0.44	1.58	0.79	1.70	0.26
C ₂₉	0.30	1.52	0.63	1.49	0.15
C ₃₀	0.23	1.26	0.52	1.18	0.08
C ₃₁	0.13	1.14	0.45	0.99	0.04
C ₃₂	0.08	1.03	0.40	0.82	0.02
C ₃₃	0.05	0.89	0.37	0.70	--
C ₃₄	0.03	0.85	0.35	0.61	--
C ₃₅	0.03	0.74	0.33	0.55	--
C ₃₆	0.01	0.67	0.33	0.51	--
C ₃₇	--	0.62	0.35	0.47	--
C ₃₈	--	0.57	0.31	0.44	--
C ₃₉	--	0.53	0.32	0.49	--
C ₄₀	--	0.50	0.30	0.42	--
C ₄₁	--	0.47	0.25	0.34	--
C ₄₂	--	0.39	0.29	0.32	--
C ₄₃	--	0.38	--	0.31	--
C ₄₄	--	0.33	--	--	--

¹Experimental conditions are given in Appendix D, page 141.

Experiment 4-7

Reactor ¹	1	2	4	5
Nominal S, wt%	0.29	0.43	0.5	0
Carbon number	<u>Weight %</u>			
C ₄	--	--	--	--
C ₅	--	--	--	--
C ₆	0.73	0.35	0.85	0.45
C ₇	1.88	1.11	1.72	1.22
C ₈	3.36	2.28	3.22	2.34
C ₉	4.47	3.61	4.47	3.54
C ₁₀	4.96	4.80	4.82	4.54
C ₁₁	4.87	5.90	5.48	4.78
C ₁₂	4.45	5.80	5.22	4.84
C ₁₃	4.52	5.08	4.85	4.83
C ₁₄	4.76	4.69	4.59	4.88
C ₁₅	4.69	4.44	4.33	4.70
C ₁₆	4.76	4.60	3.93	4.43
C ₁₇	4.64	5.11	3.39	4.80
C ₁₈	4.92	5.82	3.44	4.76
C ₁₉	4.64	4.66	3.09	3.75
C ₂₀	3.69	3.58	2.57	3.21
C ₂₁	2.77	2.67	2.20	2.43
C ₂₂	1.90	2.05	2.17	1.89
C ₂₃	1.97	2.24	2.59	2.46
C ₂₄	2.54	2.50	2.91	2.98
C ₂₅	2.64	2.54	2.89	2.81
C ₂₆	2.55	2.45	2.90	2.80
C ₂₇	2.62	2.36	2.97	2.80
C ₂₈	2.35	2.11	2.65	2.51
C ₂₉	2.06	1.92	2.40	2.26
C ₃₀	1.89	1.76	2.18	2.09
C ₃₁	1.79	1.65	1.97	1.87
C ₃₂	1.59	1.57	1.79	1.81
C ₃₃	1.51	1.47	1.66	1.64
C ₃₄	1.37	1.40	1.56	1.51
C ₃₅	1.25	1.28	1.45	1.41
C ₃₆	1.19	1.27	1.30	1.31
C ₃₇	1.09	1.17	1.22	1.22
C ₃₈	1.01	1.19	1.18	1.13
C ₃₉	0.94	1.10	1.04	1.06
C ₄₀	0.85	0.99	0.99	0.96
C ₄₁	0.78	0.80	0.82	0.90
C ₄₂	0.57	0.73	0.74	0.80
C ₄₃	0.31	0.32	0.65	0.72
C ₄₄	0.19	--	0.31	0.54
C ₄₅	0.24	--	0.26	0.24
C ₄₆	0.14	--	0.29	--

¹Experimental conditions are given in Appendix D, page 142.

Composition of Condensed Hydrocarbon Products

Run 5

Catalyst -- 100 Fe : 21.8 Cu : 1.0 K₂CO₃

Experiment 5-3

Reactor ¹	1	2	3	4	5	7
Nominal S, wt%	0.08	0.24	0.24	0.4	0	0
Carbon number	<u>Weight %</u>					
C ₇	--	--	—	0.02	—	0.66
C ₈	0.23	—	—	0.34	0.16	0.76
C ₉	1.87	1.17	0.56	1.16	0.53	1.67
C ₁₀	2.35	2.46	2.41	2.13	2.93	3.46
C ₁₁	3.64	3.87	4.70	3.72	4.78	5.30
C ₁₂	5.50	4.88	4.90	4.65	5.88	6.32
C ₁₃	6.63	5.79	5.51	4.96	6.23	6.37
C ₁₄	6.45	5.77	5.47	5.60	5.32	6.11
C ₁₅	5.99	5.48	5.20	5.48	5.15	5.54
C ₁₆	5.88	4.91	4.98	5.02	4.92	4.78
C ₁₇	5.56	4.72	4.60	4.85	4.52	4.53
C ₁₈	5.22	3.93	4.65	4.29	4.25	4.13
C ₁₉	4.85	3.60	4.43	4.32	4.04	3.94
C ₂₀	4.61	3.66	3.70	3.75	3.38	3.92
C ₂₁	4.18	3.19	3.53	3.49	3.58	3.55
C ₂₂	3.71	3.19	3.43	3.31	3.11	2.98
C ₂₃	3.58	3.26	3.30	3.15	3.04	2.85
C ₂₄	3.53	3.08	3.23	2.98	3.07	2.82
C ₂₅	3.41	2.97	3.20	2.72	3.12	2.80
C ₂₆	2.95	3.07	3.14	2.63	3.05	2.68
C ₂₇	2.64	2.95	3.07	2.44	3.09	2.67
C ₂₈	2.33	2.67	2.93	2.21	3.16	2.64
C ₂₉	2.06	2.43	2.70	2.24	2.95	2.84
C ₃₀	1.73	2.24	2.43	2.09	2.24	2.66
C ₃₁	1.54	2.11	2.19	2.00	1.92	2.28
C ₃₂	1.37	2.01	1.99	1.92	1.97	1.97
C ₃₃	1.03	2.22	1.86	1.79	1.70	1.64
C ₃₄	1.09	1.97	1.71	1.66	1.46	1.32
C ₃₅	0.91	1.60	1.51	1.49	1.27	1.05
C ₃₆	0.77	1.57	1.29	1.36	1.04	0.95
C ₃₇	0.77	1.37	1.19	1.29	0.99	0.83
C ₃₈	0.67	1.33	1.11	1.23	0.88	0.67
C ₃₉	0.62	1.26	1.00	1.13	0.89	0.66
C ₄₀	0.53	0.97	0.93	1.16	0.74	0.59
C ₄₁	0.48	1.02	0.74	1.09	0.61	0.49
C ₄₂	0.40	0.70	0.77	1.02	0.75	0.47
C ₄₃	0.14	0.52	0.65	1.06	0.82	0.35
C ₄₄	0.13	—	0.63	1.01	0.66	0.25
C ₄₅	0.15	—	0.34	1.03	0.88	0.18
C ₄₆	0.16	—	—	0.80	—	—
C ₄₇	—	—	—	0.75	—	—
C ₄₈	—	—	—	0.05	—	—
C ₄₉	—	—	—	0.57	—	—

¹ Experimental conditions are given in Appendix D, page 147.

Experiment 5-6

Reactor ¹ Nominal S, wt%	<u>1</u> 0.08	<u>3</u> 0.24	<u>4</u> 0.4	<u>5</u> 0
Carbon number	<u>Weight %</u>			
C ₆	--	0.02	0.30	0.68
C ₇	0.23	0.12	0.53	0.97
C ₈	0.49	0.23	0.74	1.17
C ₉	2.53	1.37	3.19	2.27
C ₁₀	3.58	2.89	7.16	6.79
C ₁₁	4.73	4.03	8.42	6.33
C ₁₂	5.46	6.25	7.94	8.38
C ₁₃	5.33	6.25	7.11	7.31
C ₁₄	5.71	7.49	6.23	6.29
C ₁₅	5.34	6.35	5.62	5.57
C ₁₆	5.00	5.99	5.02	4.89
C ₁₇	4.64	6.20	4.70	4.28
C ₁₈	4.40	5.74	4.28	3.92
C ₁₉	3.71	4.90	3.57	3.20
C ₂₀	4.19	4.84	3.48	3.48
C ₂₁	3.68	4.68	3.11	2.74
C ₂₂	3.36	4.54	2.85	2.71
C ₂₃	3.16	4.07	2.76	2.56
C ₂₄	3.14	3.76	2.57	2.53
C ₂₅	2.90	3.35	2.22	2.27
C ₂₆	2.79	3.02	2.07	2.23
C ₂₇	2.59	2.58	1.85	2.14
C ₂₈	2.47	2.16	1.55	1.98
C ₂₉	2.43	1.79	1.41	2.09
C ₃₀	1.99	1.43	1.35	2.05
C ₃₁	1.79	1.14	1.31	1.97
C ₃₂	1.59	0.81	1.21	1.63
C ₃₃	1.58	0.79	1.06	1.20
C ₃₄	1.39	0.64	0.95	1.09
C ₃₅	1.22	0.50	0.83	0.86
C ₃₆	1.03	0.43	0.74	0.80
C ₃₇	0.93	0.34	0.70	0.67
C ₃₈	0.86	0.31	0.62	0.60
C ₃₉	0.81	0.29	0.57	0.54
C ₄₀	0.71	0.28	0.52	0.43
C ₄₁	0.70	0.21	0.40	0.41
C ₄₂	0.63	0.17	0.37	0.33
C ₄₃	0.70	--	0.31	0.26
C ₄₄	0.67	--	0.26	0.16
C ₄₅	0.69	--	0.14	0.13

¹ Experimental conditions are given in Appendix D, page 150.

Experiment 5-8

Reactor ¹	1	2	3	4	7
Nominal S, wt%	0.08	0.24	0.24	0.4	0
Carbon number	<u>Weight %</u>				
C ₆	--	0.61	0.40	0.73	0.86
C ₇	--	1.17	0.98	0.93	1.82
C ₈	0.34	1.03	1.36	0.97	1.53
C ₉	1.85	2.74	2.11	2.99	2.07
C ₁₀	5.56	5.56	4.02	6.53	4.07
C ₁₁	8.23	7.91	5.81	8.57	6.12
C ₁₂	7.36	6.96	5.36	7.58	7.87
C ₁₃	6.87	7.29	6.83	6.71	7.13
C ₁₄	6.34	6.84	5.68	6.05	6.31
C ₁₅	4.48	5.17	5.36	5.17	5.80
C ₁₆	5.07	5.38	5.66	4.76	4.42
C ₁₇	4.64	4.80	5.23	4.43	4.60
C ₁₈	4.36	4.30	4.63	4.05	4.10
C ₁₉	3.97	3.53	4.26	3.51	3.59
C ₂₀	3.85	3.52	3.90	3.26	3.28
C ₂₁	3.53	3.11	3.42	2.90	2.86
C ₂₂	3.09	2.74	2.95	2.69	2.60
C ₂₃	2.98	2.39	2.73	2.49	2.30
C ₂₄	2.75	2.25	2.50	2.29	2.25
C ₂₅	2.44	2.19	2.36	2.21	2.08
C ₂₆	2.34	2.06	2.25	2.06	1.95
C ₂₇	2.15	1.96	2.16	1.88	1.85
C ₂₈	1.93	1.87	2.18	1.65	1.86
C ₂₉	1.85	1.80	2.20	1.55	1.87
C ₃₀	1.71	1.74	2.17	1.43	1.96
C ₃₁	1.53	1.66	2.13	1.38	2.25
C ₃₂	1.40	1.35	1.81	1.15	2.38
C ₃₃	1.23	1.36	1.91	1.23	2.01
C ₃₄	0.86	1.28	1.56	1.17	1.56
C ₃₅	0.91	1.11	1.26	1.09	1.18
C ₃₆	0.75	0.95	1.00	0.99	0.93
C ₃₇	0.74	0.83	0.81	0.88	0.81
C ₃₈	0.67	0.74	0.72	0.83	0.74
C ₃₉	0.60	0.62	0.62	0.81	0.63
C ₄₀	0.53	0.52	0.52	0.71	0.52
C ₄₁	0.46	0.42	0.42	0.59	0.47
C ₄₂	0.46	0.40	0.34	0.53	0.39
C ₄₃	0.30	0.34	0.24	0.49	0.36
C ₄₄	0.34	0.27	0.15	0.39	0.41
C ₄₅	0.27	0.18	--	--	0.18

¹ Experimental conditions are given in Appendix D, page 152.

Experiment 5-10

Reactor ¹	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>7</u>
Nominal S, wt%	0.08	0.24	0.24	0.4	0	0
Carbon number	<u>Weight %</u>					
C ₆	0.26	0.23	0.30	—	0.61	0.86
C ₇	0.45	0.85	0.47	0.51	1.09	2.53
C ₈	0.67	1.54	0.71	0.95	2.32	3.16
C ₉	2.85	3.66	1.69	2.98	3.58	2.91
C ₁₀	4.39	7.16	4.29	6.19	6.68	5.44
C ₁₁	10.13	9.43	6.84	9.40	8.58	6.27
C ₁₂	9.25	9.15	7.75	9.47	10.30	7.96
C ₁₃	7.34	7.49	7.23	7.34	8.31	7.87
C ₁₄	6.30	6.47	5.60	6.37	6.50	5.48
C ₁₅	5.32	5.80	6.23	5.67	4.89	5.74
C ₁₆	4.68	4.96	5.44	4.63	4.43	4.28
C ₁₇	4.23	4.09	4.58	4.60	4.19	3.94
C ₁₈	3.94	4.04	4.69	3.84	3.89	3.86
C ₁₉	3.63	3.35	3.78	3.57	3.64	3.13
C ₂₀	3.62	3.12	3.61	3.51	3.13	2.93
C ₂₁	3.20	2.83	3.17	3.08	2.93	2.53
C ₂₂	2.89	2.59	2.84	2.85	2.61	2.55
C ₂₃	2.46	2.20	2.59	2.59	2.18	2.16
C ₂₄	2.40	1.93	2.39	2.32	2.08	2.02
C ₂₅	2.27	1.80	2.25	2.27	1.97	1.85
C ₂₆	2.07	1.70	2.11	2.08	1.81	1.76
C ₂₇	1.96	1.57	2.03	1.90	1.68	1.64
C ₂₈	1.90	1.50	1.89	1.71	1.66	1.58
C ₂₉	1.79	1.44	1.71	1.45	1.63	1.57
C ₃₀	1.68	1.42	1.69	1.46	1.25	1.62
C ₃₁	1.55	1.10	1.79	1.34	1.39	1.65
C ₃₂	1.35	1.13	1.80	1.24	1.20	1.81
C ₃₃	1.19	1.30	1.75	1.07	1.05	1.85
C ₃₄	0.83	1.12	1.53	0.95	0.99	1.55
C ₃₅	0.90	0.98	1.26	0.76	0.63	1.18
C ₃₆	0.79	0.77	1.04	0.69	0.50	0.94
C ₃₇	0.67	0.66	0.88	0.60	0.44	0.84
C ₃₈	0.61	0.60	0.79	0.48	0.34	0.88
C ₃₉	0.55	0.54	0.82	0.60	0.32	0.72
C ₄₀	0.50	0.45	0.73	0.44	0.22	0.59
C ₄₁	0.37	0.33	0.61	0.47	0.17	0.54
C ₄₂	0.36	0.28	0.46	0.33	0.15	0.46
C ₄₃	0.30	0.17	0.30	0.18	0.09	0.35
C ₄₄	0.25	0.06	0.27	0.14	0.12	0.36
C ₄₅	0.13	—	0.05	—	—	0.21

¹ Experimental conditions are given in Appendix D, page 154.

Experiment 5-11

Reactor ¹	1	2	3	4	5	7
Nominal S, wt%	0.08	0.24	0.24	0.4	0	0
Carbon number	<u>Weight %</u>					
C ₆	0.58	0.44	0.48	0.56	0.04	0.49
C ₇	1.08	0.73	1.11	1.05	0.39	1.44
C ₈	1.11	1.29	1.86	1.74	0.83	1.99
C ₉	2.78	3.10	2.68	2.16	2.49	3.47
C ₁₀	4.06	4.90	4.15	3.84	4.39	7.19
C ₁₁	5.57	5.27	5.86	5.61	6.04	8.48
C ₁₂	8.25	7.99	7.20	5.61	7.59	9.02
C ₁₃	7.61	8.12	5.80	6.69	7.44	8.65
C ₁₄	6.80	6.17	7.05	6.42	5.50	7.19
C ₁₅	5.42	5.82	6.52	5.97	5.93	5.00
C ₁₆	5.55	5.84	5.91	4.57	4.83	4.40
C ₁₇	5.15	5.10	4.66	4.23	4.85	3.92
C ₁₈	4.79	4.40	4.39	4.48	4.47	3.57
C ₁₉	4.32	3.81	3.92	4.34	3.54	3.60
C ₂₀	3.37	3.41	3.63	3.43	3.32	3.08
C ₂₁	3.52	2.86	3.17	3.02	2.97	2.76
C ₂₂	3.34	2.62	2.82	2.84	2.85	2.28
C ₂₃	2.99	2.25	2.47	2.45	2.39	1.99
C ₂₄	2.87	2.12	2.22	2.28	2.33	1.89
C ₂₅	2.66	1.93	2.04	2.12	2.16	1.55
C ₂₆	2.36	1.73	1.86	2.02	2.10	1.25
C ₂₇	2.06	1.59	1.73	1.92	2.09	1.17
C ₂₈	1.98	1.63	1.73	1.87	2.07	1.20
C ₂₉	1.57	1.62	1.60	1.80	2.09	1.10
C ₃₀	1.58	1.45	1.62	1.83	2.16	1.01
C ₃₁	1.16	1.70	1.51	1.80	2.10	1.05
C ₃₂	1.25	1.66	1.74	1.57	1.98	1.06
C ₃₃	1.02	1.69	1.76	1.70	1.80	1.44
C ₃₄	0.90	1.50	1.57	1.60	1.49	1.48
C ₃₅	0.44	1.26	1.29	1.44	1.29	1.27
C ₃₆	0.47	1.09	1.05	1.31	1.11	1.06
C ₃₇	0.39	0.87	0.88	1.16	0.95	0.91
C ₃₈	0.32	0.81	0.75	1.08	0.87	0.81
C ₃₉	0.35	0.70	0.67	0.98	0.76	0.71
C ₄₀	0.25	0.48	0.57	0.87	0.70	0.66
C ₄₁	0.24	0.41	0.45	0.75	0.55	0.57
C ₄₂	0.16	0.36	0.43	0.70	0.50	0.42
C ₄₃	0.11	0.35	0.34	0.60	0.45	0.42
C ₄₄	--	0.13	0.23	0.52	0.29	0.30
C ₄₅	--	--	0.22	0.43	0.26	0.21

¹Experimental conditions are given in Appendix D, page 155.

Composition of Condensed Hydrocarbon Products

Run 6

Catalyst — 3% Co-oxide + 11% MoO₃ Supported on Alumina
[used without Alkali Promoter or with 3.45% K₂O
Promoter]

Experiment 6-7

Reactor ¹ Catalyst ²	1 CM-RS	2 CM-S	4 CMK-S	6 CMK-R	7 CMK-R
Carbon number	<u>Weight %</u>				
C ₆	--	--	--	0.04	--
C ₇	--	--	--	0.06	--
C ₈	--	--	--	0.76	0.37
C ₉	--	--	--	2.85	0.94
C ₁₀	--	--	--	5.07	1.83
C ₁₁	0.11	--	0.04	6.32	2.53
C ₁₂	1.07	0.24	0.40	7.84	4.00
C ₁₃	3.27	1.66	1.17	9.25	6.71
C ₁₄	4.73	4.63	3.08	12.32	9.74
C ₁₅	5.86	6.92	5.43	9.93	9.47
C ₁₆	6.23	7.69	6.57	9.00	9.81
C ₁₇	6.95	7.47	6.73	6.67	8.92
C ₁₈	6.56	6.67	6.30	6.49	8.75
C ₁₉	6.07	5.67	5.76	5.06	7.65
C ₂₀	5.17	4.81	5.27	4.28	6.71
C ₂₁	5.08	4.09	4.44	3.12	4.86
C ₂₂	4.38	3.49	4.18	2.50	3.77
C ₂₃	3.81	3.19	3.97	2.25	3.78
C ₂₄	3.49	3.14	3.82	1.30	2.22
C ₂₅	3.39	3.19	3.76	1.08	2.01
C ₂₆	3.08	3.23	3.58	0.82	1.24
C ₂₇	3.06	3.26	3.61	0.70	0.89
C ₂₈	2.95	3.28	3.47	0.59	0.80
C ₂₉	2.99	3.17	3.37	0.47	0.66
C ₃₀	2.98	2.70	3.16	0.31	0.46
C ₃₁	2.95	2.41	3.17	0.24	0.30
C ₃₂	3.12	2.47	2.93	0.19	0.26
C ₃₃	2.96	2.42	2.77	0.18	0.21
C ₃₄	2.43	2.40	2.17	0.12	0.20
C ₃₅	1.90	2.22	1.84	0.08	0.20
C ₃₆	1.34	2.07	1.61	0.04	0.15
C ₃₇	0.90	1.59	1.38	0.05	0.10
C ₃₈	0.62	1.27	1.20	--	0.10
C ₃₉	0.63	1.14	1.04	--	--
C ₄₀	0.57	1.09	0.91	--	--
C ₄₁	--	0.65	0.79	--	--
C ₄₂	--	0.83	0.49	--	--
C ₄₃	--	0.61	0.24	--	--
C ₄₄	--	--	0.12	--	--

¹Experimental conditions are given in Appendix D, page 170.

²Catalyst symbols are explained in Table 3.17, page 64.

Experiment 6-8

Reactor ¹ Catalyst ²	<u>5</u> CM-R	<u>6</u> CMK-R	<u>7</u> CMK-R
Carbon number	<u>Weight %</u>		
C ₆	--	--	--
C ₇	--	--	--
C ₈	--	0.04	--
C ₉	--	0.07	--
C ₁₀	0.02	0.48	0.09
C ₁₁	0.29	1.49	0.66
C ₁₂	2.11	3.23	2.07
C ₁₃	7.51	5.25	5.21
C ₁₄	12.00	9.13	9.45
C ₁₅	10.79	8.89	10.12
C ₁₆	9.31	10.37	11.27
C ₁₇	6.90	10.19	10.40
C ₁₈	6.23	9.82	9.37
C ₁₉	5.73	9.27	8.31
C ₂₀	5.04	7.92	7.47
C ₂₁	4.46	5.60	5.56
C ₂₂	4.06	4.33	4.50
C ₂₃	3.94	4.34	4.23
C ₂₄	3.44	2.60	2.48
C ₂₅	3.29	2.50	2.23
C ₂₆	2.89	1.63	1.52
C ₂₇	2.40	1.08	1.17
C ₂₈	1.90	0.67	0.96
C ₂₉	1.51	0.37	0.79
C ₃₀	1.09	0.20	0.52
C ₃₁	0.85	0.12	0.30
C ₃₂	0.86	0.10	0.24
C ₃₃	0.77	0.09	0.21
C ₃₄	0.68	0.07	0.18
C ₃₅	0.61	0.06	0.19
C ₃₆	0.50	0.04	0.16
C ₃₇	0.27	0.02	0.08
C ₃₈	0.20	0.01	0.01
C ₃₉	0.12	--	--
C ₄₀	0.07	--	--

¹ Experimental conditions are given in Appendix D, page 172.

² Catalyst symbols are explained in Table 3.17, page 64.

Experiment 6-9

Reactor ¹ Catalyst ²	5 CM-R	6 CMK-R	7 CMK-R
Carbon number	<u>Weight %</u>		
C ₆	--	--	--
C ₇	--	--	0.02
C ₈	--	--	0.37
C ₉	--	0.05	1.35
C ₁₀	--	0.13	2.89
C ₁₁	0.25	2.09	3.74
C ₁₂	2.54	4.68	5.02
C ₁₃	9.82	7.98	8.09
C ₁₄	10.70	9.49	10.45
C ₁₅	9.82	10.54	8.28
C ₁₆	8.38	9.03	7.78
C ₁₇	7.32	9.20	7.29
C ₁₈	8.22	7.45	6.85
C ₁₉	6.55	6.90	6.56
C ₂₀	6.43	6.34	5.54
C ₂₁	5.50	4.80	4.82
C ₂₂	4.82	3.80	4.27
C ₂₃	4.47	4.05	3.60
C ₂₄	3.52	2.92	2.77
C ₂₅	3.24	2.79	2.35
C ₂₆	2.55	1.89	1.74
C ₂₇	1.89	1.50	1.29
C ₂₈	1.51	1.18	1.10
C ₂₉	0.86	0.86	0.83
C ₃₀	0.35	0.52	0.56
C ₃₁	0.17	0.36	0.32
C ₃₂	0.05	0.34	0.30
C ₃₃	0.01	0.26	0.28
C ₃₄	0.05	0.22	0.29
C ₃₅	0.20	0.19	0.30
C ₃₆	--	0.16	0.29
C ₃₇	--	0.13	0.26
C ₃₈	--	0.08	0.10
C ₃₉	--	0.04	0.03
C ₄₀	--	0.01	0.09
C ₄₁	--	0.01	--

¹Experimental conditions are given in Appendix D, page 174.

²Catalyst symbols are explained in Table 3.17, page 64.

Composition of Condensed Hydrocarbon Products

Run 7

Catalyst -- Molybdenum Disulfide
[Used with 3% KOH Promoter]

Experiment 7-8

Reactor¹
Catalyst

$\frac{4}{\text{MoS}_2 + \text{KOH}}$

Carbon number

Weight %

C ₇	7.10
C ₈	9.82
C ₉	5.46
C ₁₀	3.61
C ₁₁	6.42
C ₁₂	10.70
C ₁₃	12.09
C ₁₄	11.47
C ₁₅	7.07
C ₁₆	3.65
C ₁₇	2.25
C ₁₈	2.28
C ₁₉	1.88
C ₂₀	1.78
C ₂₁	1.54
C ₂₂	1.18
C ₂₃	1.02
C ₂₄	0.90
C ₂₅	0.89
C ₂₆	0.81
C ₂₇	0.83
C ₂₈	0.81
C ₂₉	0.75
C ₃₀	0.63
C ₃₁	0.56
C ₃₂	0.50
C ₃₃	0.47
C ₃₄	0.47
C ₃₅	0.43
C ₃₆	0.38
C ₃₇	0.39
C ₃₈	0.22
C ₃₉	0.22
C ₄₀	0.19
C ₄₁	0.15
C ₄₂	0.13

¹Experimental conditions are given in Appendix D, page 197.

Composition of Condensed Hydrocarbon Products

Run 8

Catalyst — 1% Ru Supported on Alumina
[Used without Alkali Promoter or with 10% KOH
Promoter]

Catalyst -- 1% Ru/Al₂O₃ + Alkali
Reactor 3

Experiment ¹	<u>8-7</u>	<u>8-8</u>
Carbon number	<u>Weight %</u>	
C ₆	--	0.31
C ₇	16.61	1.75
C ₈	29.35	9.71
C ₉	17.49	14.10
C ₁₀	8.84	11.00
C ₁₁	5.62	8.16
C ₁₂	4.14	6.91
C ₁₃	3.38	6.48
C ₁₄	2.74	5.96
C ₁₅	2.40	6.00
C ₁₆	2.03	5.89
C ₁₇	1.53	4.98
C ₁₈	1.04	3.78
C ₁₉	0.73	2.90
C ₂₀	0.57	1.92
C ₂₁	0.44	1.69
C ₂₂	0.36	1.45
C ₂₃	0.33	1.27
C ₂₄	0.28	1.05
C ₂₅	0.27	1.03
C ₂₆	0.24	0.89
C ₂₇	0.18	0.73
C ₂₈	0.15	0.60
C ₂₉	0.10	0.45
C ₃₀	0.04	0.22
C ₃₁	0.05	0.17
C ₃₂	0.03	0.14
C ₃₃	0.04	0.13
C ₃₄	0.03	0.12
C ₃₅	0.03	0.12
C ₃₆	0.03	0.08
C ₃₇	0.01	0.03
C ₃₈	--	0.01

¹Experimental conditions are given in Appendix D, pages 214 and 216.

Catalyst -- 1% Ru/Al₂O₃ + Alkali
Reactor 6

Experiment ¹	<u>8-8</u>
Carbon number	<u>Weight %</u>
C ₅	--
C ₆	0.39
C ₇	0.16
C ₈	1.34
C ₉	4.18
C ₁₀	3.79
C ₁₁	4.31
C ₁₂	6.63
C ₁₃	9.95
C ₁₄	11.22
C ₁₅	11.03
C ₁₆	8.59
C ₁₇	7.85
C ₁₈	6.08
C ₁₉	4.93
C ₂₀	3.89
C ₂₁	2.73
C ₂₂	1.90
C ₂₃	1.37
C ₂₄	1.11
C ₂₅	1.14
C ₂₆	1.06
C ₂₇	1.16
C ₂₈	1.22
C ₂₉	1.19
C ₃₀	0.82
C ₃₁	0.53
C ₃₂	0.46
C ₃₃	0.36
C ₃₄	0.25
C ₃₅	0.18
C ₃₆	0.10
C ₃₇	0.09
C ₃₈	0.02

¹Experimental conditions are given in Appendix D, page 216.

Catalyst -- 1% Ru/Al₂O₃ [No Promoter]
Reactor 7

Experiment ¹	<u>8-1</u>	<u>8-2</u>	<u>8-3</u>	<u>8-4</u>	<u>8-5</u>
Carbon number	<u>Weight %</u>				
C ₄	0.06	0.06	0.03	0.07	0.11
C ₅	1.00	0.90	0.89	1.03	0.96
C ₆	3.78	3.95	6.30	5.23	3.80
C ₇	7.05	8.77	12.60	10.84	7.02
C ₈	10.54	13.08	14.04	12.37	9.56
C ₉	11.60	15.17	15.08	13.16	11.87
C ₁₀	11.12	14.71	14.18	11.86	12.54
C ₁₁	10.16	11.65	9.75	10.64	11.65
C ₁₂	9.27	7.91	5.32	8.42	9.97
C ₁₃	7.75	5.48	3.60	6.78	8.18
C ₁₄	6.87	4.13	3.29	5.48	6.60
C ₁₅	5.89	3.17	2.73	4.32	5.05
C ₁₆	4.73	2.56	2.47	3.23	3.73
C ₁₇	3.42	2.18	1.90	2.15	2.34
C ₁₈	2.25	1.96	1.77	1.36	1.72
C ₁₉	1.46	1.78	1.43	0.86	1.13
C ₂₀	0.94	1.08	0.93	0.62	0.77
C ₂₁	0.70	0.57	0.66	0.37	0.56
C ₂₂	0.43	0.34	0.51	0.27	0.41
C ₂₃	0.27	0.19	0.44	0.21	0.35
C ₂₄	0.19	0.12	0.34	0.17	0.30
C ₂₅	0.16	0.08	0.33	0.13	0.28
C ₂₆	0.12	0.06	0.29	0.12	0.23
C ₂₇	0.09	0.04	0.27	0.09	0.23
C ₂₈	0.06	0.03	0.24	0.07	0.17
C ₂₉	0.03	0.02	0.19	0.05	0.15
C ₃₀	0.02	0.01	0.12	0.03	0.11
C ₃₁	0.01	--	0.07	0.02	0.07
C ₃₂	--	--	0.04	0.01	0.05
C ₃₃	--	--	0.02	0.00	0.03
C ₃₄	--	--	0.04	0.01	0.01
C ₃₅	--	--	0.01	--	--
C ₃₆	--	--	--	--	--

¹Experimental conditions are given in Appendix D, pages 202 to 213.

Catalyst -- 1% Ru/Al₂O₃ [No Promoter]
Reactor 7

Experiment ¹	<u>8-6</u>	<u>8-7</u>	<u>8-8</u>	<u>8-9</u>	<u>8-10</u>
Carbon number	<u>Weight %</u>				
C ₄	--	0.03	0.00	--	0.01
C ₅	0.02	0.26	0.02	0.02	0.07
C ₆	0.39	2.17	0.32	0.20	0.34
C ₇	2.67	6.76	1.38	1.10	1.11
C ₈	5.87	10.93	4.34	3.35	2.32
C ₉	10.01	12.81	8.40	6.76	2.41
C ₁₀	12.67	12.48	11.45	10.90	4.82
C ₁₁	13.27	10.98	12.58	13.50	8.27
C ₁₂	12.10	9.58	12.19	13.09	11.06
C ₁₃	10.30	8.10	10.96	11.06	11.71
C ₁₄	8.81	6.73	9.51	9.11	11.05
C ₁₅	7.28	5.55	7.96	7.47	9.80
C ₁₆	5.63	4.33	6.40	6.17	8.39
C ₁₇	3.86	3.22	4.78	4.93	7.01
C ₁₈	2.55	2.27	3.37	3.78	5.55
C ₁₉	1.63	1.47	2.24	2.73	4.18
C ₂₀	0.98	0.89	1.43	1.85	3.02
C ₂₁	0.56	0.46	0.85	1.20	2.12
C ₂₂	0.32	0.26	0.48	0.84	1.51
C ₂₃	0.21	0.15	0.28	0.53	1.08
C ₂₄	0.15	0.11	0.18	0.38	0.81
C ₂₅	0.14	0.09	0.15	0.27	0.56
C ₂₆	0.12	0.08	0.13	0.21	0.47
C ₂₇	0.10	0.07	0.13	0.16	0.38
C ₂₈	0.10	0.06	0.11	0.12	0.28
C ₂₉	0.09	0.05	0.10	0.10	0.20
C ₃₀	0.07	0.03	0.08	0.07	0.14
C ₃₁	0.04	0.02	0.06	0.05	0.10
C ₃₂	0.03	0.02	0.05	0.04	0.07
C ₃₃	0.02	0.02	0.04	0.03	0.04
C ₃₄	0.01	--	0.02	0.01	0.02
C ₃₅	0.01	--	0.01	0.01	0.02
C ₃₆	--	--	0.01	--	--

¹Experimental conditions are given in Appendix D, pages 214 to 221.

APPENDIX F

COMPARATIVE SUMMARY OF CATALYTIC TEST RESULTS

Though comparisons of catalysts have been discussed and tabulated in Section 3, Tables 3.16, 3.30a, 3.30b, 3.38, and 3.49, results of representative experiments on various catalysts will be summarized in order to compare some key aspects of Fischer-Tropsch catalysis.

Symbols and notation used in Table A2.

Treatment: Shows whether the catalyst has alkali (K) promoter or not, and the amount of sulfur on the catalyst. "g" denotes the presence of a sharp gradient (discussed in various parts of Section 3), and "full" denotes complete catalyst sulfidation. "calc." means catalyst was calcined in air before sulfiding. In all cases without the notation "calc.", the catalyst was treated in H₂ before use.

Condition: Temp. (°C) / Pressure (MPa) / space velocity (V/V/h) / H₂/CO ratio

Conv.: Total conversion (%) of H₂ + CO

The selectivity (% CO converted to X)

$$= \frac{\text{CO converted to product X}}{\text{Total CO converted}} \times 100$$

corrected to 1 decimal place.

TABLE A2
COMPARATIVE SUMMARY OF CATALYTIC TEST RESULTS

Catalyst	Treatment	Condition	Conv %	% CO Converted to				
				CO ₂	CH ₄	C ₂ -C ₄	C ₅ +	
Co-based	K/0% S	196/1.1/217/1.9	96.3	7.8	5.3	8.5	78.4	
	K/0.5% S-g	200/1.1/212/1.9	98.4	8.6	10.6	5.6	75.2	
	K/0% S	195/1.1/208/1.5	80.9	2.9	4.7	12.2	80.2	
	K/0.5% S-g	198/1.1/197/1.5	79.3	3.5	5.4	13.0	78.1	
Fe-based	K/0% S	250/1.0/196/1.6	81.6	32.6	6.8	21.1	39.5	
	K/0.4% S-g	250/1.0/213/1.6	80.0	35.2	6.2	19.2	39.4	
	K/0% S	239/2.3/257/1.5	72.6	40.6	3.3	13.3	42.8	
	K/0.4% S-g	240/2.3/260/1.5	73.3	42.4	4.2	14.7	38.7	
Co-Mo-based	K/calc./S--full	302/1.5/197/2.1	40.5	29.8	10.6	21.4	38.2	
	-/calc./S--full	303/1.5/218/2.1	41.7	42.9	21.9	29.3	5.9	
MoS ₂ + KOH		353/2.1/179/2.0	51.2	5.1	2.7	1.8	90.4	
Ni-W-based	K/calc./S--full	348/2.1/196/2.0	13.8	22.1	16.9	14.5	46.5	
	-/calc./S--full	349/2.0/210/2.0	8.6	39.6	35.4	25.0	0.0	
Ru/Al ₂ O ₃	-/0% S	245/2.2/195/2.0	90.3	3.4	4.1	5.0	87.5	
	-/S--full	238/2.2/194/2.0	2.2	1.0	0.2	0.1	98.7	
	K/0% S	241/2.2/198/2.0	2.3	15.1	0.5	0.9	83.5	
	K/S--full	240/2.2/204/2.0	2.0	2.1	0.2	0.2	97.5	
	-/0% S	241/3.1/193/2.0	95.5	0.0	0.2	0.2	99.6	
	-/S--full	238/3.1/192/2.0	52.9	0.1	0.0	0.0	99.9	
	K/0% S	240/3.1/209/2.0	49.1	2.5	0.1	0.2	97.2	
	K/S--full	240/3.1/206/2.0	35.8	0.1	0.1	0.0	99.8	

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			14.																			
15. Supplementary Notes																						
16. Abstract An experimental study was conducted in a tubular, packed-bed reactor system to investigate the effects of adding sulfur to catalysts for the Fischer-Tropsch synthesis. Small amounts of sulfur were added to precipitated cobalt, iron, and alumina-impregnated ruthenium catalysts before CO hydrogenation was carried out. Non-traditional catalysts, molybdenum and tungsten-based catalysts, were also tested in the oxidized and sulfided forms. The results on all the catalysts used in this study are discussed in this report. In particular, the results of unsulfided and sulfided catalysts are compared, and in several cases distributions of condensed products are represented graphically. Besides sulfur-catalyst interactions, it was noted that there were often significant interactions of process conditions with different sulfided and unsulfided catalysts. Care was taken to minimize the effects of transport phenomena on our catalytic studies.																						
17. Key Words and Document Analysis. 17a. Descriptors.																						
<table border="0"> <tr> <td>Carbon Monoxide</td> <td>Gasoline</td> <td>Hydrodesulfurization</td> </tr> <tr> <td>Catalysts</td> <td>Hydrocarbons</td> <td>Promoters</td> </tr> <tr> <td>Coal Gasification</td> <td>Hydrogen</td> <td>Sulfur</td> </tr> <tr> <td>Diesel Fuels</td> <td>Hydrogen Sulfide</td> <td>Synfuel</td> </tr> <tr> <td>Fischer-Tropsch</td> <td>Hydrogenation</td> <td>Synthesis</td> </tr> <tr> <td></td> <td></td> <td>Transition Metals</td> </tr> </table>					Carbon Monoxide	Gasoline	Hydrodesulfurization	Catalysts	Hydrocarbons	Promoters	Coal Gasification	Hydrogen	Sulfur	Diesel Fuels	Hydrogen Sulfide	Synfuel	Fischer-Tropsch	Hydrogenation	Synthesis			Transition Metals
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