

Performance of Co.053

Dates: 03/21/95 - 03/22/95 Run #11a

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.2 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	45.5	48.5
reaction temperature, °C	280	280
pressure, atm	1.0	1.0
flow, cc/min	90.0	90.0

C1 - C15 product distribution, weight %

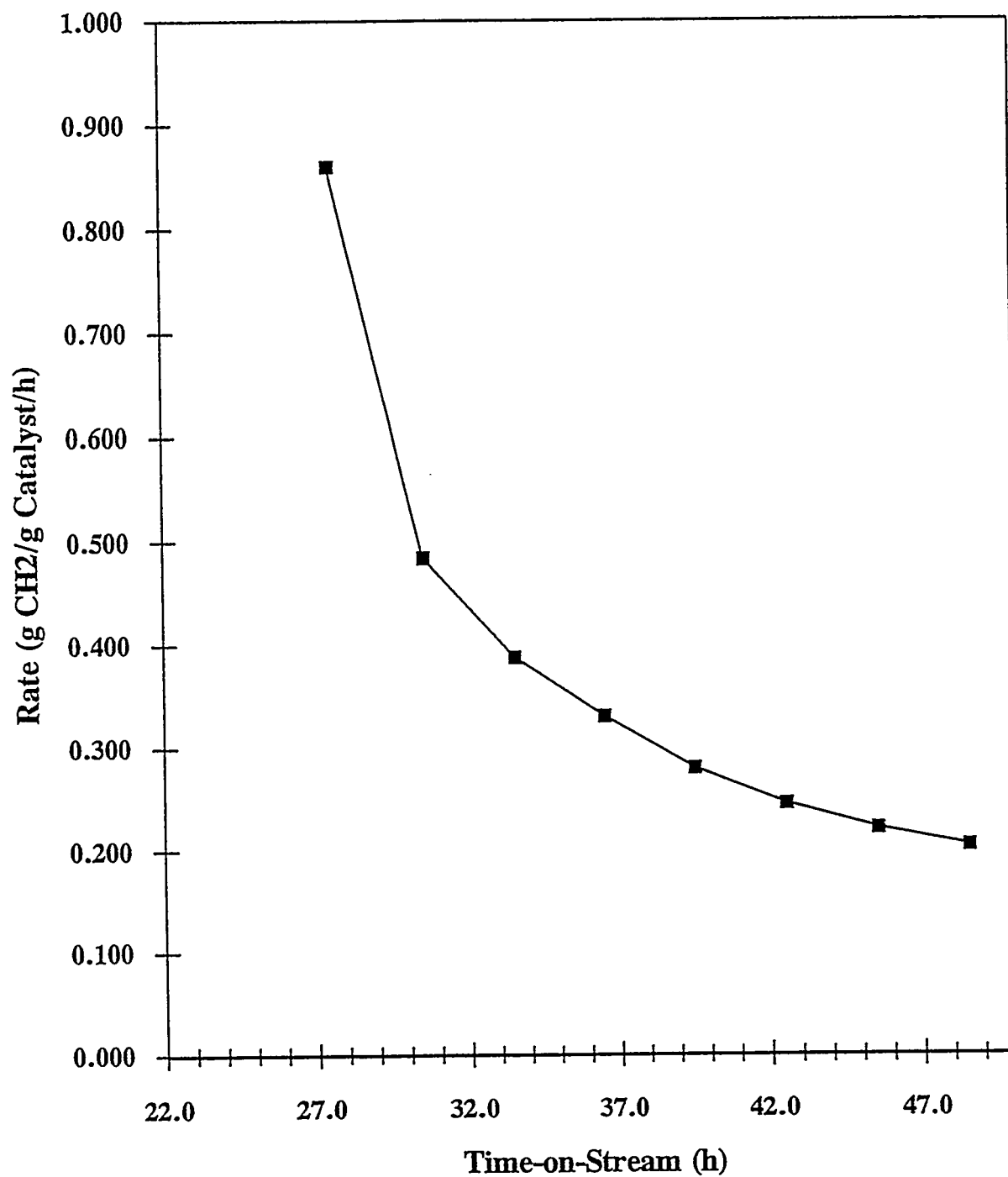
C1	41.35	40.56
C2	11.45	11.66
C3	13.93	13.79
C4	9.06	8.94
C5	7.03	7.01
C6	4.62	4.56
C7	3.46	3.64
C8	2.42	2.55
C9	1.73	1.83
C10	1.28	1.39
C11	1.00	1.05
C12	0.72	0.77
C13	0.58	0.67
C14	0.68	0.88
C15	0.68	0.70
alpha chain growth probability	0.69	0.69

C1 - C50 estimated total product distribution, weight %

C1	39.4	38.7
C2 - C4	32.8	32.8
C5 - C12	23.3	23.8
C13 - C50	4.5	4.6

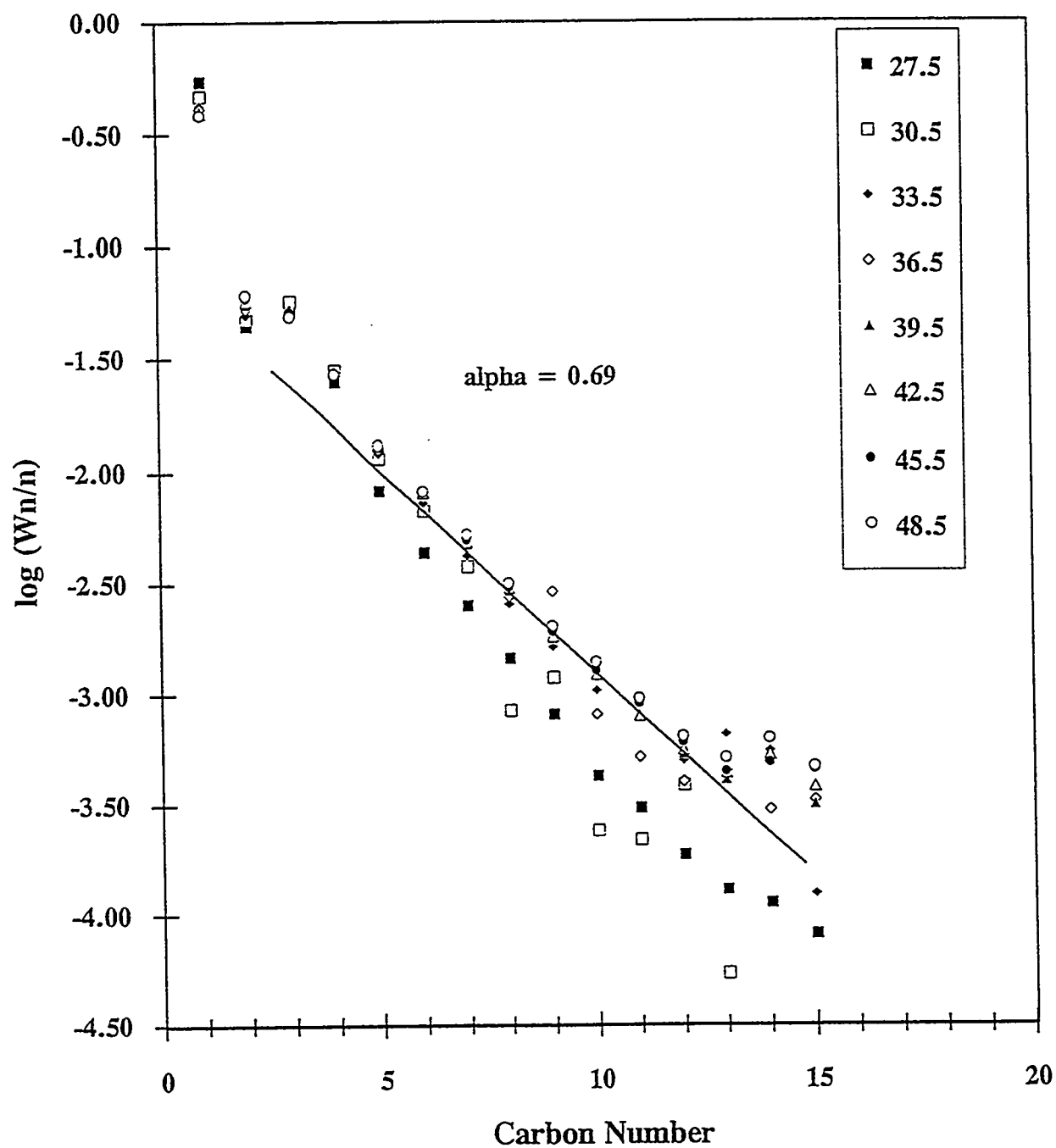
CO conversion, %	4.2	3.8
rate, g CH ₂ /g cat/hr	0.22	0.20
CO ₂ formation, %	0.4	0.3

Time-on-Stream Plot for C0.053 - Run #11a



Schulz-Flory Plot for Co.053 - Run #11a
Time on Stream (hrs)

hrs.



Co.053 - Run #12

Co wt%	NM wt %	Promotor wt%		Support
20	Ru 0.50			Al ₂ O ₃

SUMMARY REACTION DATA

Reaction Conditions:

P = 1.0 atm

T = 220 °C

H₂/CO = 2

weight of catalyst = 0.210 g

WHSV = 12.24 1/hr

time on stream = 3.5 hrs

CO₂ (g/g cat/hr) = 0.029CO₂ (% of CO) = 0.2

O/P = 0.98

CO conversion (%)	8.1
rate (g CH ₂ /g cat/hr)	0.43
alpha	0.60
C1 (wt%)	26.6
C2 - C4 (wt%)	29.2
C5 - C12 (wt%)	42.9
C13 + (wt%)	1.3

Performance of Co.053

Dates: 03/23/95 - 03/24/95 Run #12

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.2 l/hr, H₂/CO ratio in feed = 2

time on stream, hr	0.5	3.5	18.5	21.5	24.5	30.5
reaction temperature, °C	220	220	220	220	220	280
pressure, atm	1.0	1.0	1.0	1.0	1.0	1.0
flow, cc/min	90.0	90.0	90.0	90.0	90.0	90.0

C1 - C15 product distribution, weight %

C1	26.33	26.22	25.93	27.04	26.95	61.30
C2	5.02	4.51	4.32	4.48	4.74	8.61
C3	12.10	11.86	10.84	11.41	11.33	12.82
C4	12.27	12.38	11.02	11.59	11.62	7.57
C5	11.46	11.86	10.49	11.27	11.10	4.11
C6	8.89	9.29	8.80	8.85	8.83	1.90
C7	7.23	7.50	6.70	7.18	7.08	1.23
C8	5.08	5.34	4.85	5.15	5.13	0.83
C9	3.65	3.83	3.60	3.75	3.74	0.57
C10	2.60	2.59	2.63	2.64	2.68	0.32
C11	2.05	2.01	2.10	2.00	2.00	0.25
C12	1.36	1.22	1.53	1.38	1.43	0.16
C13	0.93	0.79	2.75	1.09	1.12	0.11
C14	0.70	0.42	3.73	1.43	1.21	0.10
C15	0.33	0.19	0.71	0.73	1.03	0.11
alpha chain growth probability	0.63	0.60	0.68	0.68	0.70	0.55

C1 - C50 estimated total product distribution, weight %

C1	26.5	26.6	26.4	26.3	25.4	60.4
C2 - C4	29.5	29.2	26.6	26.7	26.1	28.6
C5 - C12	41.8	42.9	42.1	42.1	41.7	10.2
C13 - C50	2.2	1.3	4.9	4.8	6.8	0.7

CO conversion, %	8.5	8.1	7.5	7.2	7.5	25.0
rate, g CH ₂ /g cat/hr	0.45	0.43	0.40	0.38	0.40	1.34
CO ₂ formation, %	0.2	0.2	0.1	0.1	0.2	4.7

Performance of Co.053

Dates: 03/23/95 - 03/24/95 Run #12

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.2 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	33.5	36.5	39.5	42.5	45.5
reaction temperature, °C	280	280	280	280	280
pressure, atm	1.0	1.0	1.0	1.0	1.0
flow, cc/min	90.0	90.0	90.0	90.0	90.0

C1 - C15 product distribution, weight %

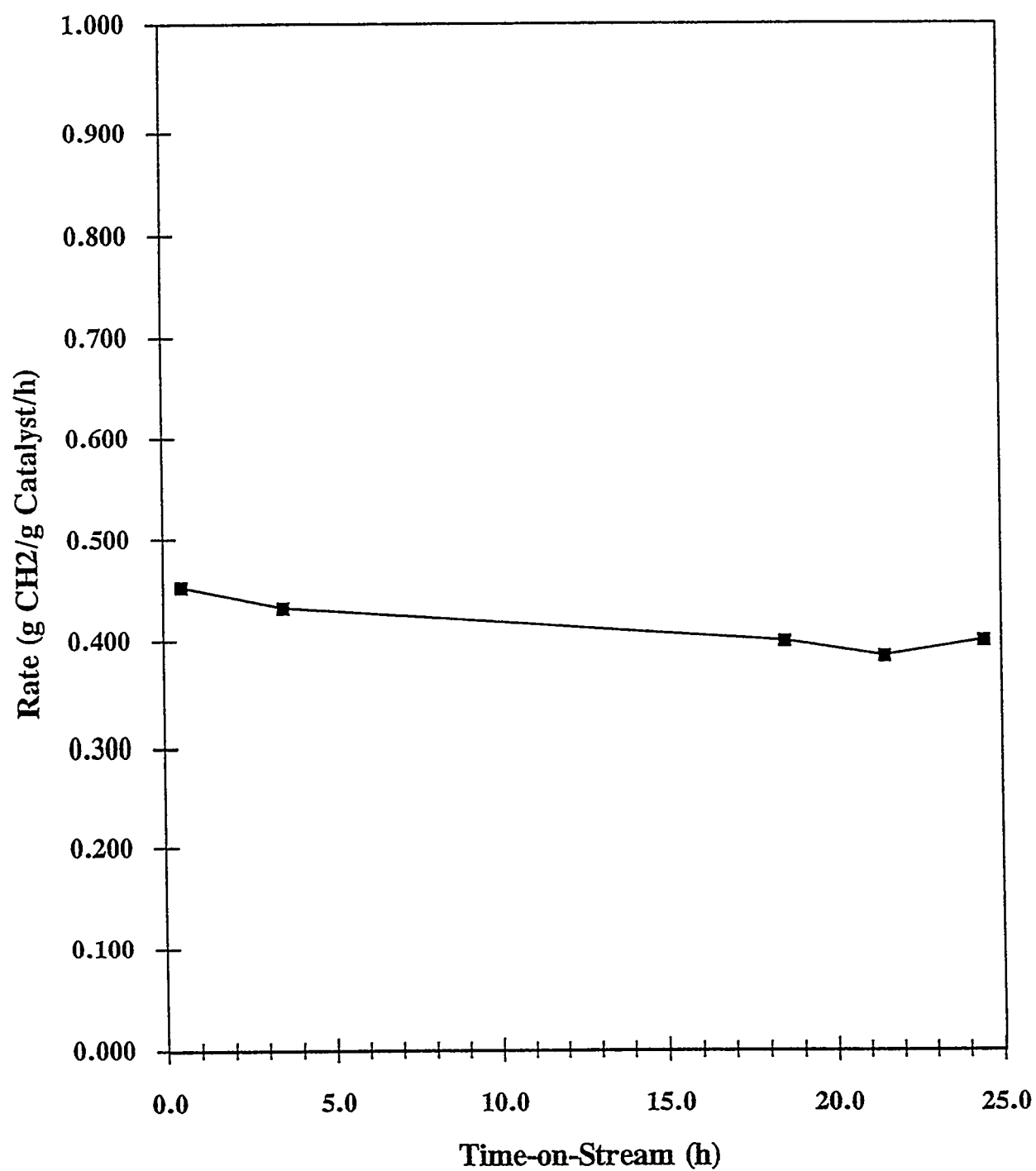
C1	49.90	46.39	44.25	42.94	41.67
C2	9.11	10.00	10.75	11.46	11.89
C3	15.30	14.80	14.53	14.45	14.25
C4	9.01	9.02	9.05	9.07	8.95
C5	6.13	6.49	6.75	6.84	6.83
C6	2.93	3.94	4.30	4.52	4.66
C7	2.47	2.84	3.14	3.22	3.33
C8	1.67	1.89	2.09	2.33	2.30
C9	1.08	1.30	1.43	1.49	1.58
C10	0.72	0.90	1.03	1.06	1.19
C11	0.50	0.68	0.80	0.76	0.84
C12	0.37	0.44	0.49	0.54	0.61
C13	0.30	0.34	0.41	0.43	0.52
C14	0.25	0.40	0.47	0.48	0.65
C15	0.26	0.58	0.50	0.42	0.74
alpha chain growth probability	0.63	0.68	0.67	0.66	0.69

C1 - C50 estimated total product distribution, weight %

C1	48.9	44.2	42.6	41.7	39.4
C2 - C4	32.7	32.2	33.0	33.9	33.1
C5 - C12	16.7	19.8	21.1	21.6	22.7
C13 - C50	1.7	3.8	3.3	2.7	4.8

CO conversion, %	11.8	8.9	7.0	5.9	5.3
rate, g CH ₂ /g cat/hr	0.63	0.48	0.38	0.32	0.28
CO ₂ formation, %	1.2	0.9	0.6	0.5	0.4

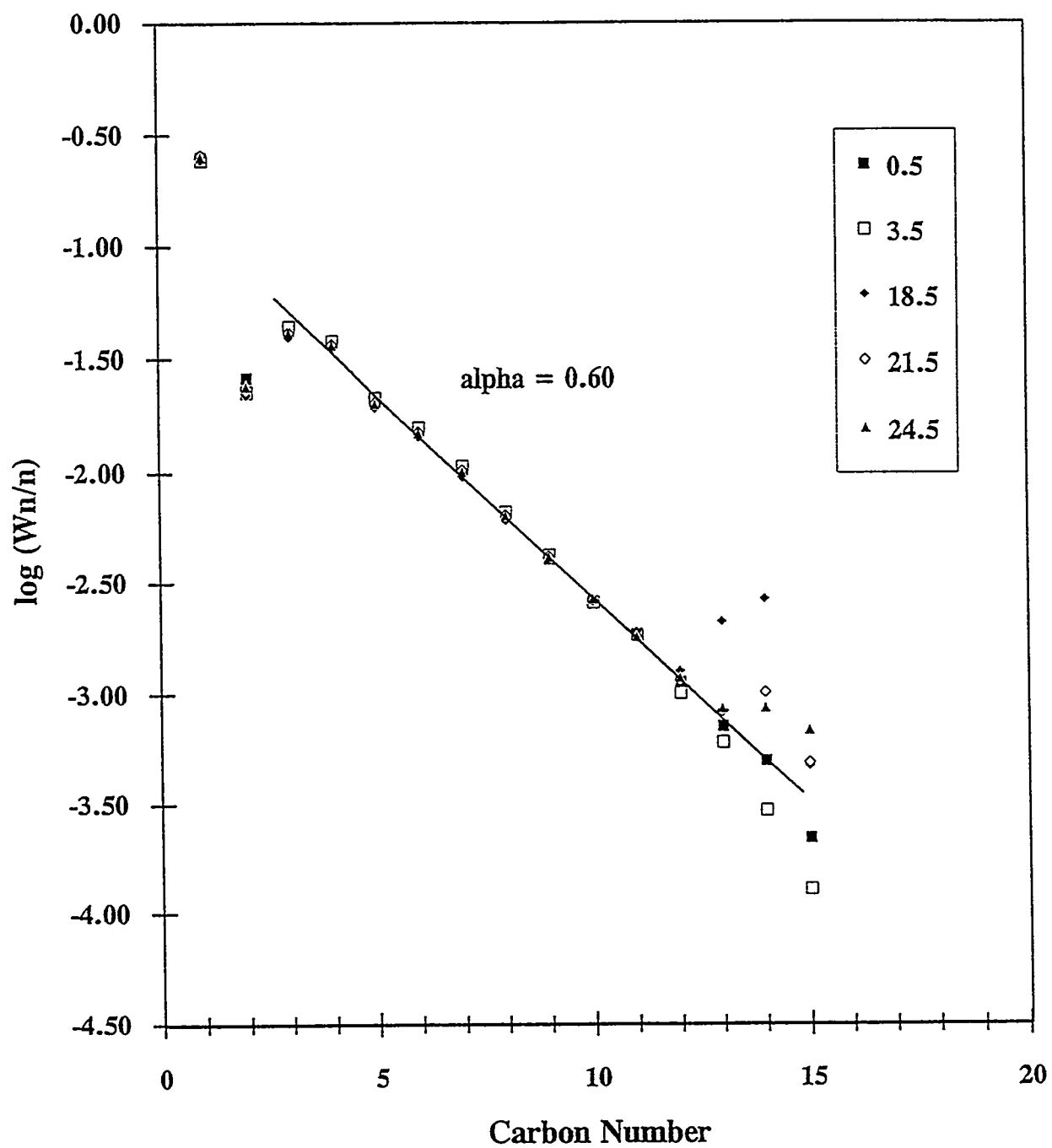
Time-on-Stream Plot for C0.053 - Run #12



Schulz-Flory Plot for Co.053 - Run #12

Time on Stream (hrs)

hrs.



Co.053 - Run #12a

Co wt%	NM wt %	Promotor wt%		Support
20	Ru 0.50			Al ₂ O ₃

SUMMARY REACTION DATA

Reaction Conditions:

P = 1.0 atm

T = 280 °C

H₂/CO = 2

weight of catalyst = 0.210 g

WHSV = 12.24 1/hr

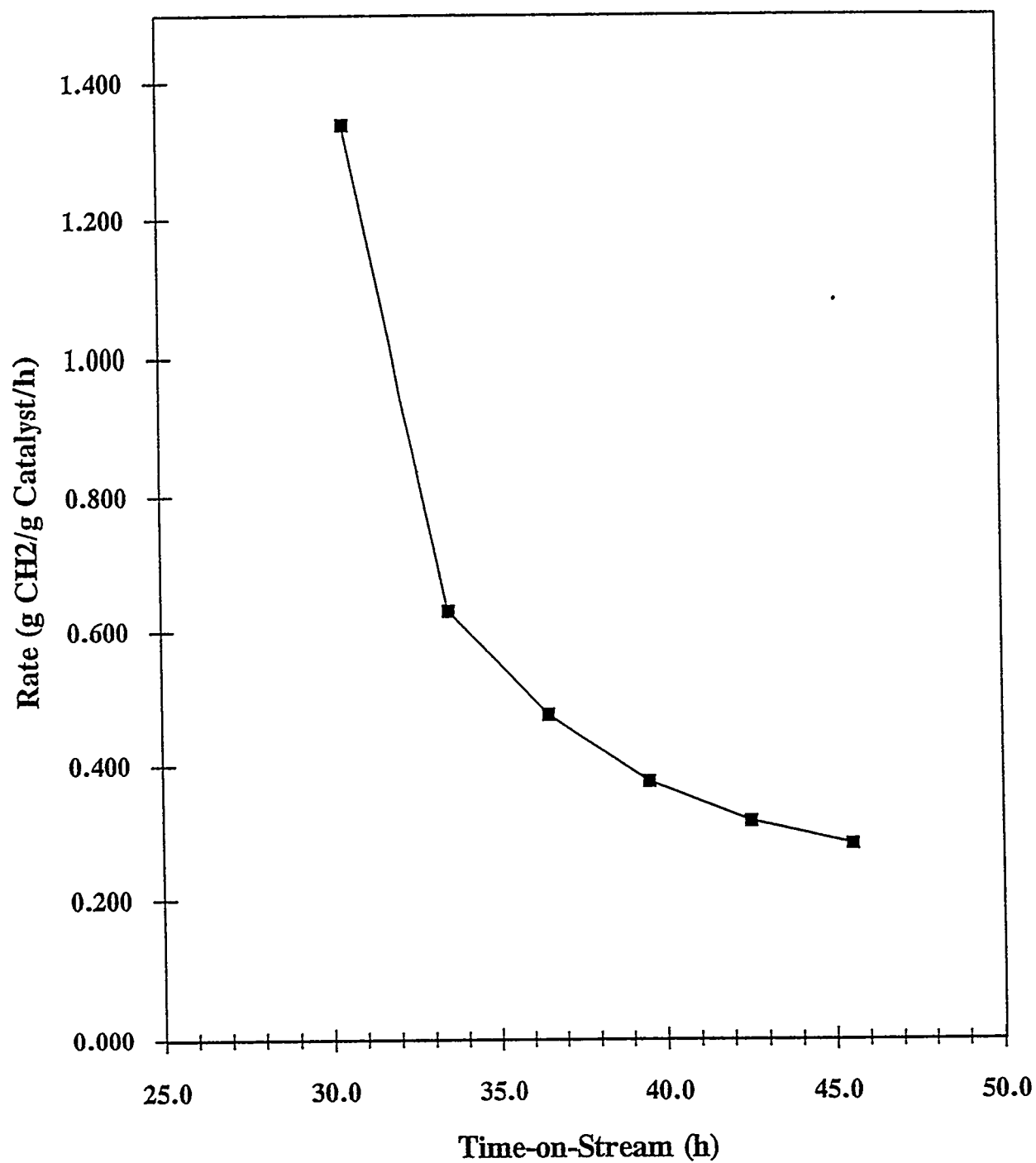
time on stream = 45.5 hrs

CO₂ (g/g cat/hr) = 0.083CO₂ (% of CO) = 0.4

O/P = 9.41

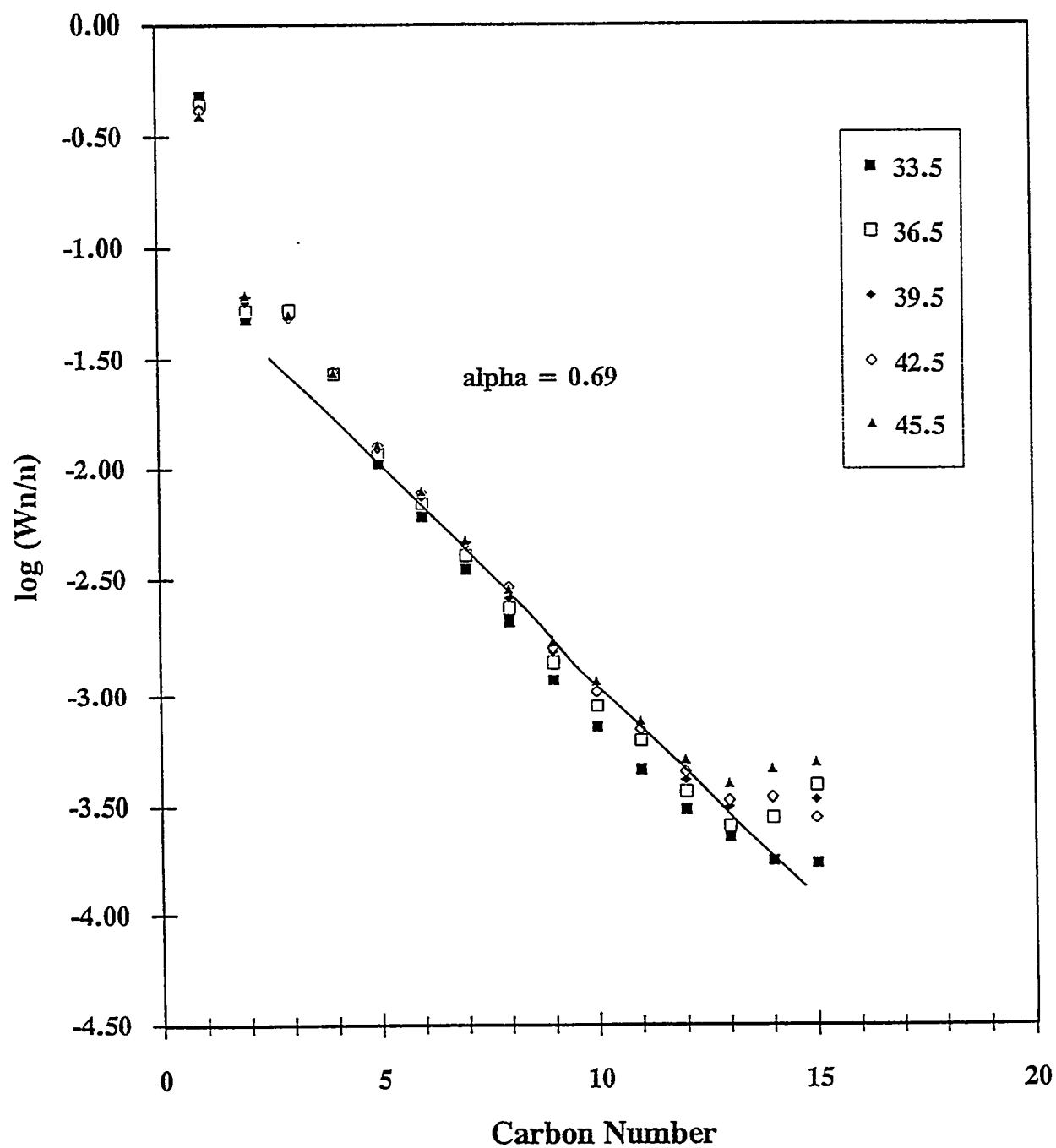
CO conversion (%)	5.3
rate (g CH ₂ /g cat/hr)	0.28
alpha	0.69
C1 (wt%)	39.4
C2 - C4 (wt%)	33.1
C5 - C12 (wt%)	22.7
C13 + (wt%)	4.8

Time-on-Stream Plot for C0.053 - Run #12a



Schulz-Flory Plot for Co.053 - Run #12a
Time on Stream (hrs)

hrs.



Co.053 - Run #12b

Co wt%	NM wt %	Promotor wt%		Support
20	Ru 0.50			Al ₂ O ₃

SUMMARY REACTION DATA

Reaction Conditions:

P = 1.0 atm

T = 220 °C

H₂/CO = 2

weight of catalyst = 0.210 g

WHSV = 12.24 1/hr

time on stream = 3.5 hrs

CO₂ (g/g cat/hr) = 0.021CO₂ (% of CO) = 0.1

O/P = 5.07

CO conversion (%)	1.4
rate (g CH ₂ /g cat/hr)	0.08
alpha	0.78
C1 (wt%)	20.0
C2 - C4 (wt%)	21.8
C5 - C12 (wt%)	38.8
C13 + (wt%)	19.5

Performance of Co.053

Dates: 03/29/95 - 03/30/95 Run #12b

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.2 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	0.5	3.5	0.5	6.5	9.5	12.5
reaction temperature, °C	220	220	220	220	220	220
pressure, atm	1.0	1.0	1.0	1.0	1.0	1.0
flow, cc/min	90.0	90.0	90.0	90.0	90.0	90.0

C1 - C15 product distribution, weight %

C1	23.55	24.31	32.10	31.31	31.24	30.83
C2	6.72	6.77	5.47	5.26	5.24	5.17
C3	9.97	9.94	13.05	12.13	12.17	12.12
C4	9.69	9.74	13.48	12.14	12.15	12.09
C5	9.81	9.52	10.70	11.16	11.22	11.30
C6	7.26	7.91	7.82	8.12	8.23	8.47
C7	6.74	6.44	6.09	6.47	6.48	6.54
C8	5.34	5.16	4.09	4.37	4.33	4.38
C9	4.36	4.18	2.78	3.00	2.97	2.96
C10	3.55	3.43	1.83	1.89	1.88	1.95
C11	2.84	2.82	1.37	1.46	1.44	1.47
C12	2.54	2.28	0.72	0.95	0.91	0.93
C13	2.39	2.10	0.35	0.72	0.58	0.59
C14	2.72	2.52	0.12	0.72	0.55	0.56
C15	2.51	2.87	0.04	0.30	0.62	0.64
alpha chain growth probability	0.77	0.78	0.52	0.62	0.66	0.66

C1 - C50 estimated total product distribution, weight %

C1	20.2	20.0	32.6	31.2	30.0	29.6
C2 - C4	22.6	21.8	32.5	29.4	28.4	28.2
C5 - C12	40.0	38.8	34.6	37.4	37.6	38.1
C13 - C50	17.3	19.5	0.3	2.0	4.0	4.1

CO conversion, %	1.4	1.4	9.0	8.8	8.8	8.5
rate, g CH ₂ /g cat/hr	0.07	0.08	0.48	0.47	0.47	0.45
CO ₂ formation, %	0.1	0.1	0.2	0.2	0.2	0.2

Performance of Co.053

Dates: 03/29/95 - 03/30/95 Run #12b

flow rate = 90.0 cc/min, loading= 0.2 g, WHSV = 12.2 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	15.5	18.5	21.5
reaction temperature, °C	220	220	220
pressure, atm	1.0	1.0	1.0
flow, cc/min	90.0	90.0	90.0

C1 - C15 product distribution, weight %

C1	30.84	30.69	30.26
C2	5.15	5.11	5.40
C3	12.12	12.13	12.19
C4	12.10	12.10	12.25
C5	11.23	11.30	11.23
C6	8.40	8.50	8.47
C7	6.52	6.57	6.49
C8	4.39	4.42	4.41
C9	3.02	3.02	3.05
C10	1.97	1.99	2.08
C11	1.48	1.52	1.55
C12	0.92	0.87	0.88
C13	0.68	0.63	0.60
C14	0.58	0.54	0.58
C15	0.62	0.60	0.55
alpha chain growth probability	0.66	0.66	0.65

C1 - C50 estimated total product distribution, weight %

C1	29.7	29.6	29.3
C2 - C4	28.2	28.3	28.9
C5 - C12	38.1	38.3	38.2
C13 - C50	4.0	3.9	3.6

CO conversion, %	8.4	8.4	8.3
rate, g CH ₂ /g cat/hr	0.45	0.45	0.44
CO ₂ formation, %	0.2	0.2	0.2

Co.053 - Run #13

Co wt%	NM wt %	Promotor wt%		Support
20	Ru 0.50			Al ₂ O ₃

SUMMARY REACTION DATA

Reaction Conditions:

P = 1.0 atm

T = 220 °C

H₂/CO = 2

weight of catalyst = 0.210 g

WHSV = 12.24 1/hr

time on stream = 21.5 hrs

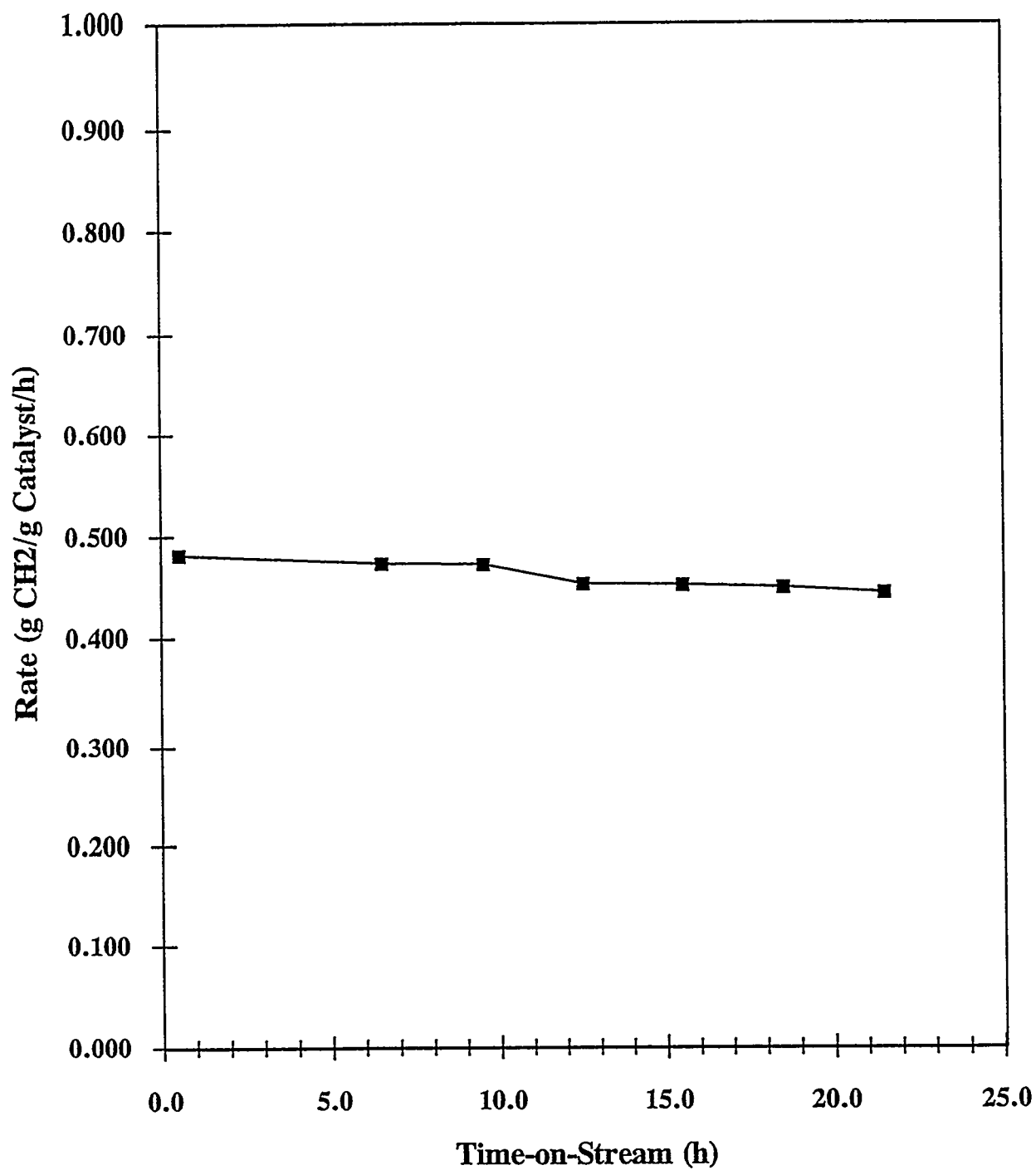
CO₂ (g/g cat/hr) = 0.037CO₂ (% of CO) = 0.2

O/P = 0.88

CO conversion (%)	8.3
rate (g CH ₂ /g cat/hr)	0.44
alpha	0.65
C1 (wt%)	29.3
C2 - C4 (wt%)	28.9
C5 - C12 (wt%)	38.2
C13 + (wt%)	3.6

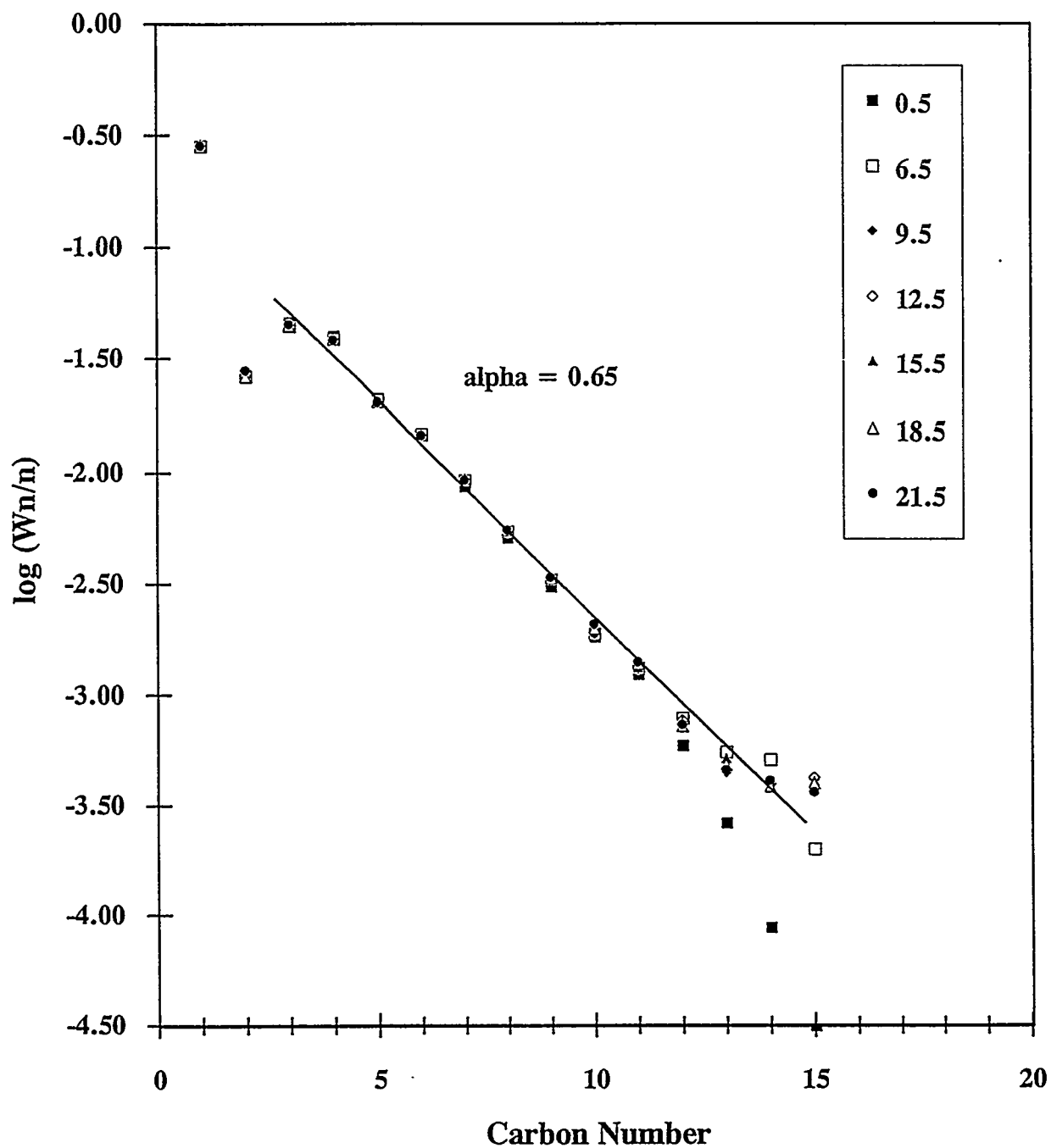
* calcined and reduced insitu after run 12

Time-on-Stream Plot for C0.053 - Run #13



Schulz-Flory Plot for Co.053 - Run #13
Time on Stream (hrs)

hrs.



Co.053 - Run #14

Co wt%	NM wt %	Promotor wt%		Support
20	Ru 0.50			Al ₂ O ₃

SUMMARY REACTION DATA

Reaction Conditions:

P = 1.0 atm

T = 220 °C

H₂/CO = 2

weight of catalyst = 0.201 g

WHSV = 12.78 1/hr

time on stream = 19.5 hrs

CO₂ (g/g cat/hr) = 0.025

CO₂ (% of CO) = 0.1

O/P = 0.85

CO conversion (%)	6.7
rate (g CH ₂ /g cat/hr)	0.37
alpha	0.74
C1 (wt%)	24.8
C2 - C4 (wt%)	24.4
C5 - C12 (wt%)	37.3
C13 + (wt%)	13.6

* Catalyst calcined (24 hr, 300 °C) and reduced (10 hr, 350 °C)
after reaction at E1

Performance of Co.053

Dates: 04/17/95 - 04/18/95 Run #14

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.8 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	1.5	4.5	7.5	10.5	13.5	16.5
reaction temperature, °C	220	220	220	220	220	220
pressure, atm	1.0	1.0	1.0	1.0	1.0	1.0
flow, cc/min	90.0	90.0	90.0	90.0	90.0	90.0

C1 - C15 product distribution, weight %

C1	29.35	28.82	29.92	29.95	29.06	29.68
C2	4.95	5.17	5.29	5.11	4.88	4.96
C3	12.23	12.16	12.51	12.45	12.07	12.24
C4	12.13	12.12	12.53	12.29	11.90	12.01
C5	11.23	11.15	11.49	11.47	11.16	11.19
C6	8.04	8.15	8.52	8.30	8.10	8.01
C7	6.42	6.33	6.54	6.46	6.38	6.38
C8	4.26	4.23	4.38	4.34	4.26	4.25
C9	2.90	2.89	2.97	2.79	2.94	2.90
C10	1.85	1.88	2.09	2.30	2.10	1.89
C11	1.43	1.44	1.62	1.57	1.60	1.38
C12	1.10	1.19	0.87	0.90	1.05	0.98
C13	1.75	2.10	0.54	0.62	0.94	0.87
C14	1.26	1.24	0.39	0.60	2.42	2.21
C15	1.11	1.13	0.33	0.84	1.16	1.03
alpha chain growth probability	0.70	0.70	0.62	0.68	0.70	0.69

C1 - C50 estimated total product distribution, weight %

C1	27.4	27.0	29.6	28.2	27.1	27.9
C2 - C4	27.4	27.5	30.0	28.1	26.9	27.5
C5 - C12	38.0	38.1	38.3	38.3	38.4	38.0
C13 - C50	7.2	7.3	2.2	5.4	7.5	6.7

CO conversion, %	6.8	6.4	5.7	5.9	6.1	6.0
rate, g CH ₂ /g cat/hr	0.38	0.36	0.32	0.33	0.34	0.33
CO ₂ formation, %	0.1	0.1	0.1	0.1	0.2	0.1

Performance of Co.053

Dates: 04/17/95 - 04/18/95 Run #14

flow rate = 90.0 cc/min, loading= 0.2 g, WHSV = 12.8 l/hr, H₂/CO ratio in feed = 2

time on stream, hr	19.5
reaction temperature, °C	220
pressure, atm	1.0
flow, cc/min	90.0

C1 - C15 product distribution, weight %

C1	29.27
C2	4.88
C3	12.06
C4	11.82
C5	11.09
C6	8.20
C7	6.26
C8	4.19
C9	2.84
C10	2.02
C11	1.55
C12	0.91
C13	0.82
C14	1.93
C15	2.15
alpha chain growth probability	0.74

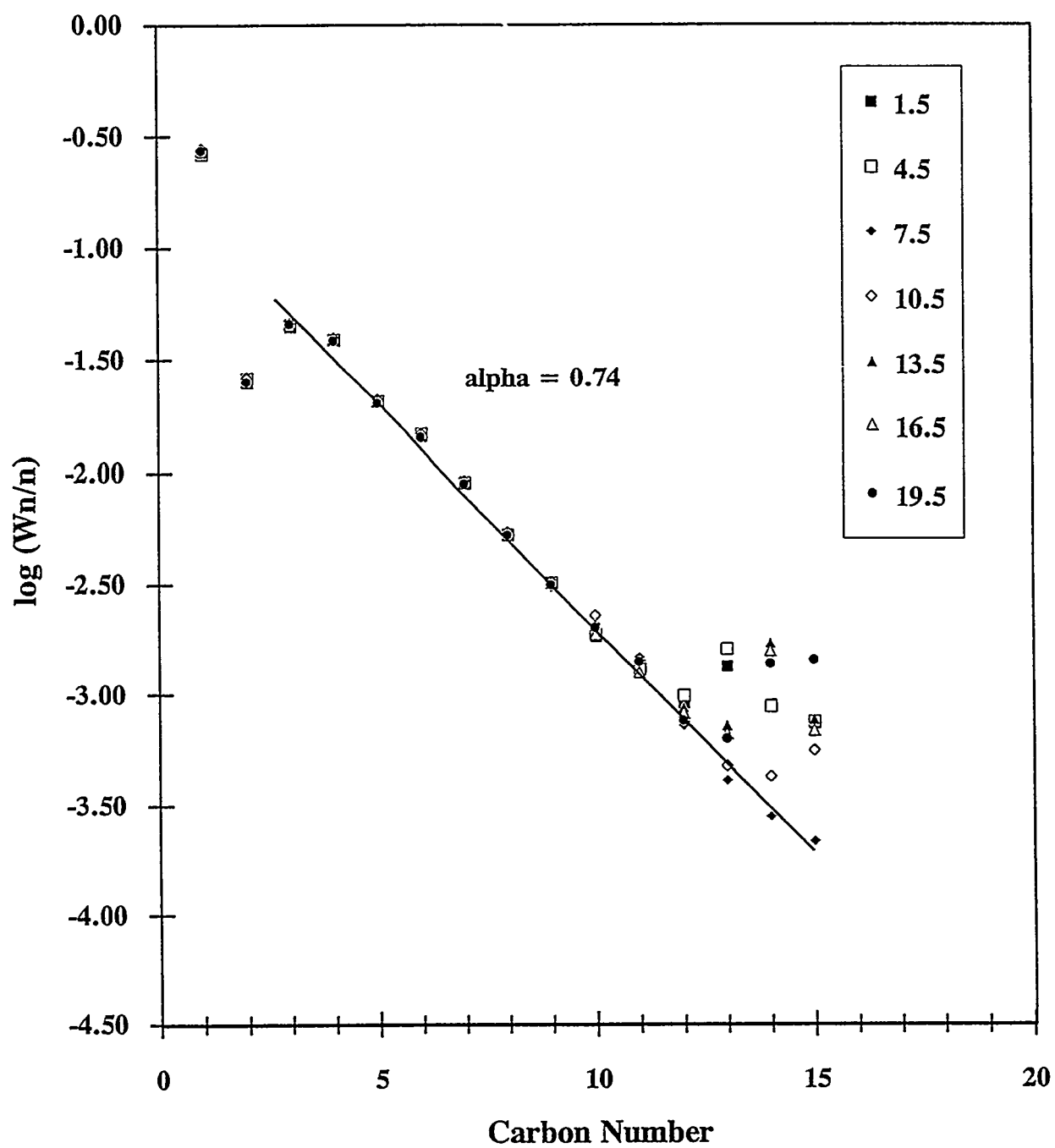
C1 - C50 estimated total product distribution, weight %

C1	24.8
C2 - C4	24.4
C5 - C12	37.3
C13 - C50	13.6

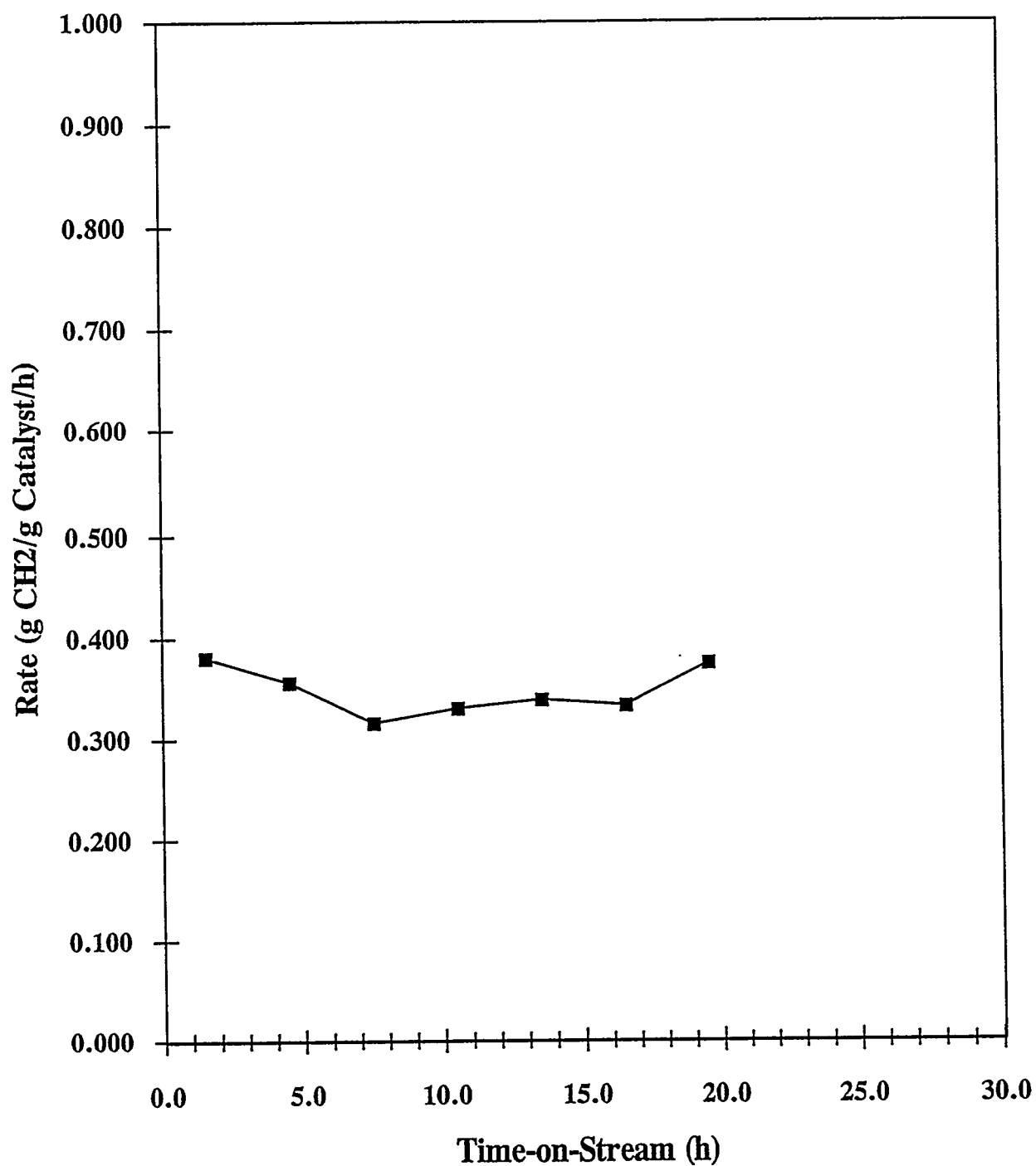
CO conversion, %	6.7
rate, g CH ₂ /g cat/hr	0.37
CO ₂ formation, %	0.1

Schulz-Flory Plot for Co.053 - Run #14
Time on Stream (hrs)

hrs.



Time-on-Stream Plot for Co.053 - Run #14



Co.061 - Run #1

Co wt%	NM wt %	Promotor wt%		Support
30	Ru 0.50			Al ₂ O ₃

SUMMARY REACTION DATA

Reaction Conditions:

P = 1.0 atm

T = 220 °C

H₂/CO = 2

weight of catalyst = 0.190 g

WHSV = 13.51 1/hr

time on stream = 24.5 hrs

CO₂ (g/g cat/hr) = 0.035CO₂ (% of CO) = 0.2

O/P = 1.42

CO conversion (%)	9.4
rate (g CH ₂ /g cat/hr)	0.56
alpha	0.67
C1 (wt%)	29.2
C2 - C4 (wt%)	27.8
C5 - C12 (wt%)	38.9
C13 + (wt%)	4.1

Performance of Co.061

Dates: 02/23/95 - 02/24/95 Run #1

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 13.5 l/hr, H₂/CO ratio in feed = 2

time on stream, hr	0.5	3.5	6.5	9.5	12.5	15.5
reaction temperature, °C	220	220	220	220	220	220
pressure, atm	1.0	1.0	1.0	1.0	1.0	1.0
flow, cc/min	90.0	90.0	90.0	90.0	90.0	90.0

C1 - C15 product distribution, weight %

C1	34.49	32.44	30.59	30.88	28.87	30.32
C2	5.63	5.42	5.21	4.99	4.85	4.82
C3	12.61	12.85	12.44	12.36	11.76	12.33
C4	12.06	12.22	12.15	11.90	11.42	11.96
C5	10.40	10.61	10.92	10.93	10.17	10.91
C6	4.56	7.70	8.04	8.06	7.52	8.27
C7	6.02	6.19	6.58	6.59	6.20	6.67
C8	4.08	4.18	4.51	4.55	4.31	4.64
C9	2.75	2.76	3.08	3.10	2.98	3.21
C10	1.74	1.75	2.04	2.18	2.18	2.14
C11	1.33	1.31	1.72	1.76	1.66	1.75
C12	0.92	0.91	1.01	1.06	6.39	1.14
C13	0.80	0.63	0.71	0.71	0.70	0.78
C14	1.03	0.53	0.50	0.51	0.50	0.56
C15	1.59	0.51	0.52	0.42	0.47	0.50
alpha chain growth probability	0.72	0.65	0.65	0.64	0.65	0.65

C1 - C50 estimated total product distribution, weight %

C1	30.4	31.5	29.8	30.4	29.9	29.7
C2 - C4	26.7	29.6	29.0	28.8	29.0	28.5
C5 - C12	32.8	35.6	37.8	38.0	37.9	38.5
C13 - C50	10.1	3.3	3.4	2.8	3.2	3.3

CO conversion, %	15.9	12.1	10.3	9.7	9.8	9.3
rate, g CH ₂ /g cat/hr	0.94	0.71	0.61	0.57	0.58	0.55
CO ₂ formation, %	0.3	0.3	0.2	0.3	0.2	0.2

Performance of Co.061

Dates: 02/23/95 - 02/24/95 Run #1

flow rate = 90.0 cc/min, loading= 0.2 g, WHSV = 13.5 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	18.5	21.5	24.5
reaction temperature, °C	220	220	220
pressure, atm	1.0	1.0	1.0
flow, cc/min	90.0	90.0	90.0

C1 - C15 product distribution, weight %

C1	31.22	30.51	30.16
C2	4.92	4.83	4.78
C3	12.28	12.20	12.16
C4	11.74	11.59	11.71
C5	10.75	10.82	10.89
C6	8.12	8.31	8.32
C7	6.55	6.68	6.75
C8	4.54	4.67	4.73
C9	3.10	3.25	3.28
C10	2.28	2.22	2.16
C11	1.75	1.83	1.77
C12	1.05	1.11	1.18
C13	0.74	0.81	0.82
C14	0.50	0.62	0.66
C15	0.46	0.55	0.63
alpha chain growth probability	0.65	0.66	0.67

C1 - C50 estimated total product distribution, weight %

C1	30.6	29.8	29.2
C2 - C4	28.4	27.9	27.8
C5 - C12	37.9	38.7	38.9
C13 - C50	3.0	3.6	4.1

CO conversion, %	9.6	9.5	9.4
rate, g CH ₂ /g cat/hr	0.57	0.56	0.56
CO ₂ formation, %	0.2	0.2	0.2
