

Performance of Co.053

Dates: 03/13/95 - 03/14/95 Run #10

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.5 l/hr, H₂/CO ratio in feed = 2

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

C1 - C15 product distribution, weight %

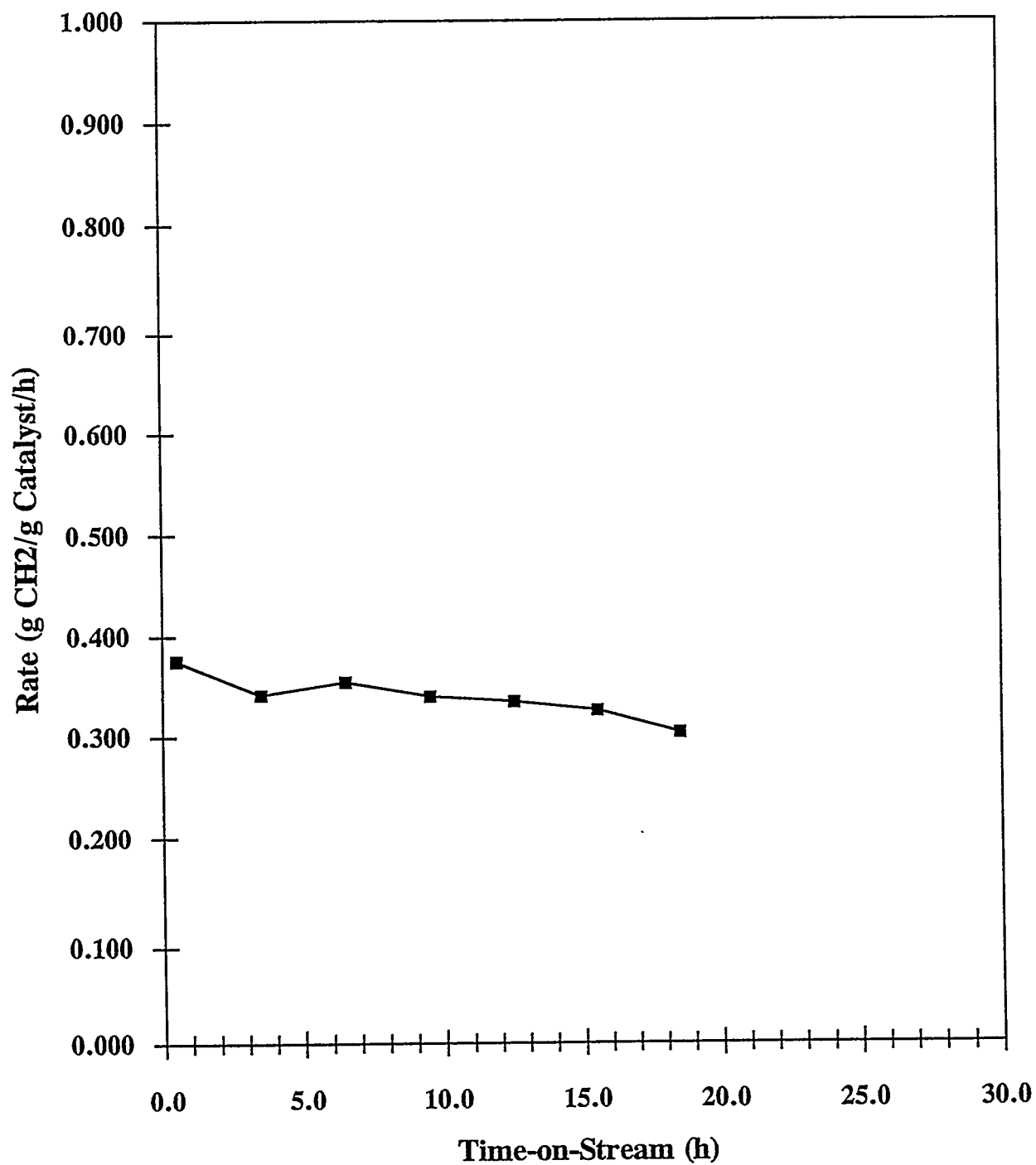
C1	28.62
C2	4.84
C3	12.13
C4	12.25
C5	11.92
C6	5.23
C7	7.48
C8	5.39
C9	4.00
C10	2.77
C11	2.13
C12	1.37
C13	0.97
C14	0.70
C15	0.21
alpha chain growth probability	0.60

C1 - C50 estimated total product distribution, weight %

C1	29.2
C2 - C4	29.8
C5 - C12	39.5
C13 - C50	1.5

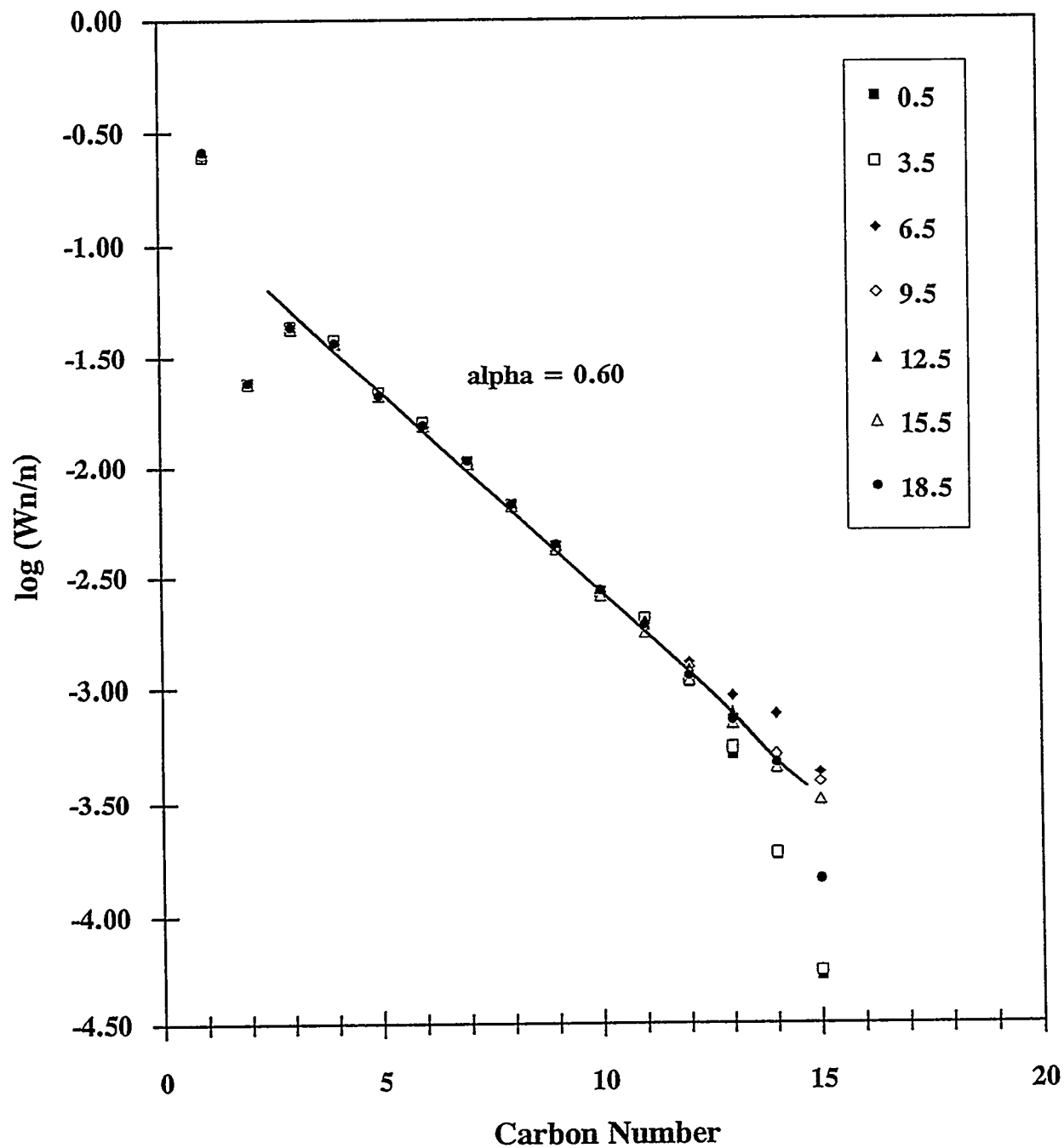
CO conversion, %	5.6
rate, g CH ₂ /g cat/hr	0.30
CO ₂ formation, %	0.0

Time-on-Stream Plot for C0.053 - Run #10



Schulz-Flory Plot for Co.053 - Run #10
Time on Stream (hrs)

hrs.



Co.053 - Run #10a

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 = 240 °C

H₂/CO = 2

weight of catalyst = 0.206 g

WHSV = 12.48 1/hr

time on stream = 42.5 hrs

CO₂ (g/g cat/hr) = 0.046CO₂ (% of CO) = 0.2

O/P = 1.10

CO conversion (%)	11.9
rate (g CH ₂ /g cat/hr)	0.65
alpha	0.59
C1 (wt%)	42.7
C2 - C4 (wt%)	31.6
C5 - C12 (wt%)	24.7
C13 + (wt%)	1.0

Performance of Co.053

Dates: 03/14/95 - 03/15/95 Run #10a

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.5 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	21.5	24.5	27.5	30.5	33.5	36.5
reaction temperature, °C	240	240	240	240	240	240
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	47.60	42.79	44.77	44.59	45.47	44.49
C2	7.40	12.85	6.74	6.65	6.72	6.59
C3	13.11	12.60	13.65	13.70	13.66	13.83
C4	11.34	10.76	11.59	11.47	11.34	11.46
C5	8.01	7.93	8.61	8.68	8.45	8.58
C6	4.68	4.79	5.29	5.35	5.07	5.27
C7	3.22	3.34	3.72	3.73	3.70	3.74
C8	1.91	1.96	2.19	2.27	2.21	2.34
C9	1.10	1.15	1.31	1.33	1.32	1.40
C10	0.56	0.66	0.75	0.78	0.72	0.88
C11	0.39	0.53	0.60	0.61	0.52	0.62
C12	0.22	0.25	0.30	0.31	0.32	0.34
C13	0.14	0.14	0.18	0.22	0.23	0.21
C14	0.15	0.12	0.14	0.17	0.16	0.14
C15	0.15	0.13	0.15	0.15	0.12	0.12
alpha chain growth probability	0.59	0.58	0.59	0.59	0.57	0.58

C1 - C50 estimated total product distribution, weight %

C1	46.9	42.3	44.3	44.1	45.1	44.2
C2 - C4	31.4	35.8	31.6	31.5	31.5	31.6
C5 - C12	20.7	21.0	23.1	23.4	22.6	23.4
C13 - C50	1.0	0.9	1.0	1.0	0.8	0.8

CO conversion, %	16.3	15.5	13.7	13.0	12.9	12.4
rate, g CH ₂ /g cat/hr	0.89	0.85	0.75	0.71	0.71	0.67
CO ₂ formation, %	0.4	0.4	0.4	0.3	0.3	0.3

Performance of Co.053

Dates: 03/14/95 - 03/15/95 Run #10a

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.5 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	39.5	42.5
reaction temperature, °C	240	240
pressure, atm	1.0	1.0
flow, cc/min	90.0	90.0

C1 - C15 product distribution, weight %

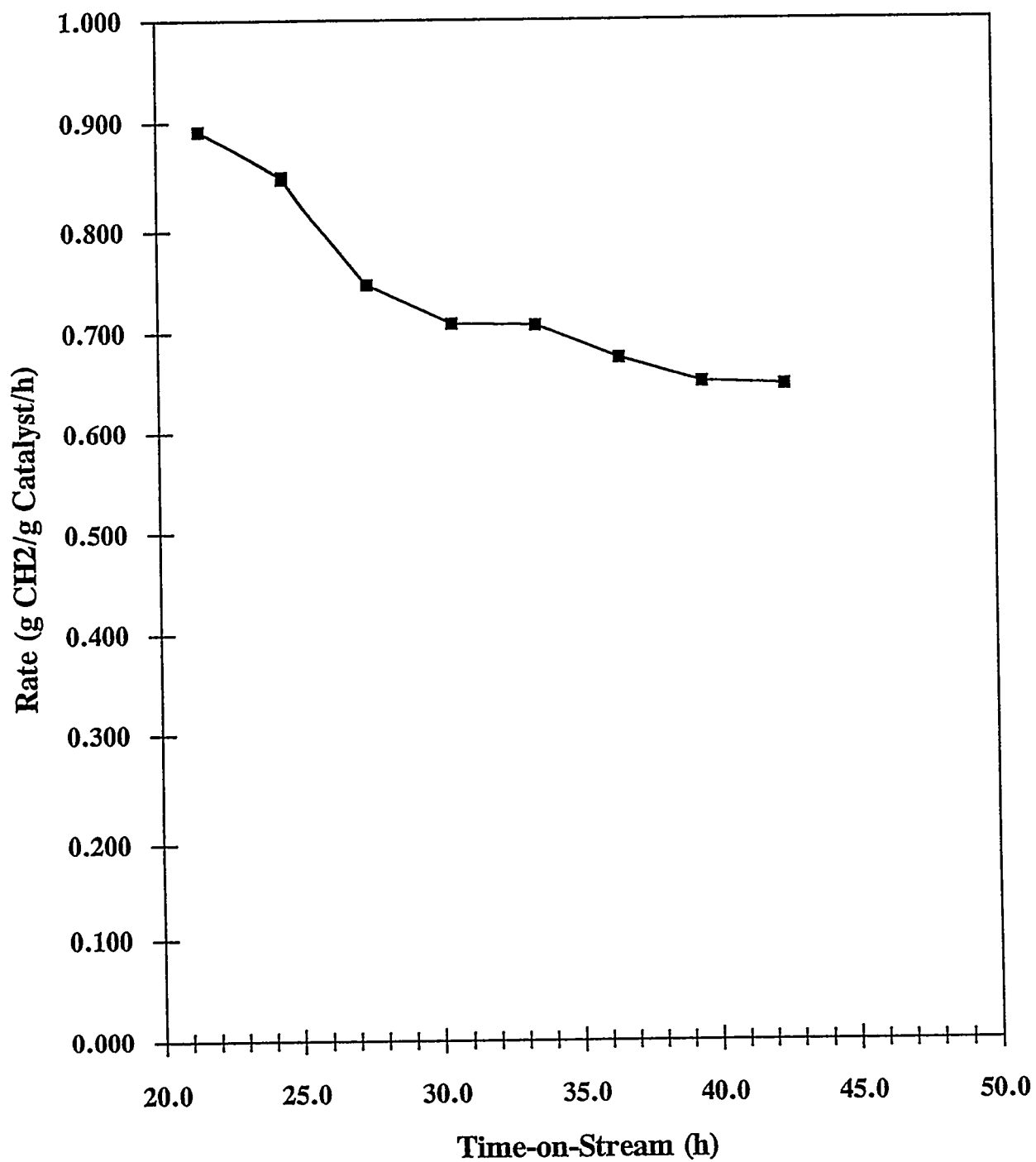
C1	44.12	43.22
C2	6.53	6.42
C3	13.84	13.98
C4	11.41	11.54
C5	8.73	8.93
C6	5.46	5.52
C7	3.86	4.05
C8	2.37	2.50
C9	1.43	1.52
C10	0.83	0.88
C11	0.55	0.58
C12	0.35	0.34
C13	0.24	0.22
C14	0.15	0.16
C15	0.13	0.16
alpha chain growth probability	0.58	0.59

C1 - C50 estimated total product distribution, weight %

C1	43.8	42.7
C2 - C4	31.5	31.6
C5 - C12	23.8	24.7
C13 - C50	0.8	1.0

CO conversion, %	11.9	11.9
rate, g CH ₂ /g cat/hr	0.65	0.65
CO ₂ formation, %	0.3	0.2

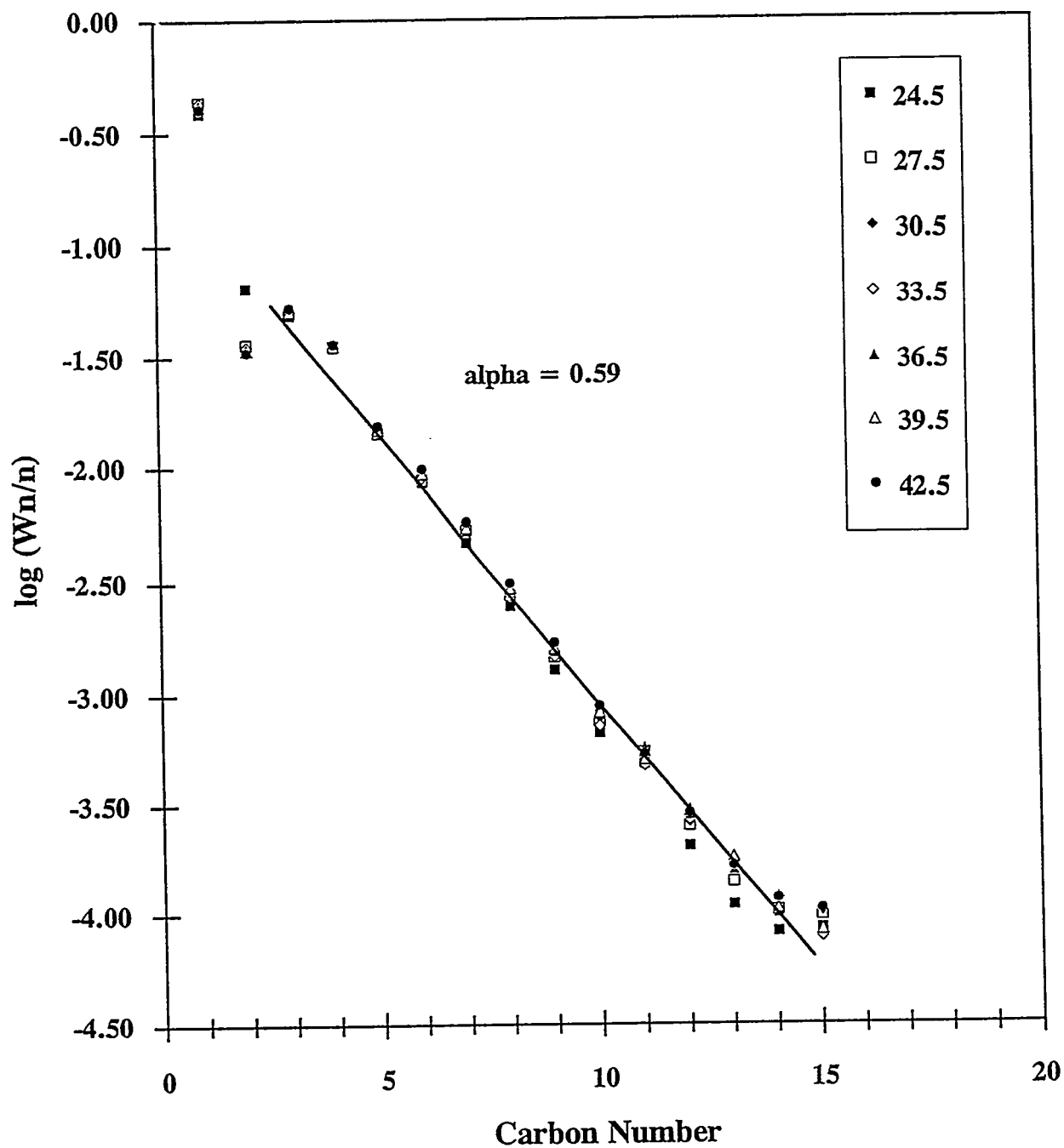
Time-on-Stream Plot for Co.053 - Run #10a



Schulz-Flory Plot for Co.053 - Run #10a

Time on Stream (hrs)

hrs.



Co.053 - Run #10b

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 = 260 °C

H₂/CO = 2

weight of catalyst = 0.206 g

WHSV = 12.48 1/hr

time on stream = 66.5 hrs

CO₂ (g/g cat/hr) = 0.070CO₂ (% of CO) = 0.4

O/P = 3.65

CO conversion (%)	7.5
rate (g CH ₂ /g cat/hr)	0.41
alpha	0.62
C1 (wt%)	46.9
C2 - C4 (wt%)	30.7
C5 - C12 (wt%)	20.8
C13 + (wt%)	1.6

Performance of Co.053

Dates: 03/15/95 - 03/16/95 Run #10b

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.5 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	45.5	48.5	51.5	54.5	57.5	60.5
reaction temperature, °C	260	260	260	260	260	260
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	49.93	49.85	48.31	48.69	48.52	48.51
C2	7.23	7.24	6.96	7.06	7.14	7.22
C3	14.61	14.77	14.50	14.54	14.45	14.34
C4	10.28	10.00	9.75	9.71	9.70	9.58
C5	6.87	6.79	6.89	7.08	7.10	7.06
C6	3.91	3.88	4.18	4.26	4.34	4.32
C7	2.69	2.72	3.32	3.05	3.03	3.11
C8	1.67	1.70	2.11	1.90	1.89	1.96
C9	1.03	1.07	1.32	1.21	1.25	1.29
C10	0.63	0.67	0.81	0.83	0.85	0.83
C11	0.43	0.46	0.55	0.59	0.59	0.59
C12	0.28	0.29	0.45	0.44	0.43	0.45
C13	0.18	0.20	0.27	0.28	0.29	0.30
C14	0.13	0.16	0.24	0.21	0.23	0.23
C15	0.14	0.19	0.34	0.17	0.19	0.21
alpha chain growth probability	0.59	0.61	0.64	0.60	0.61	0.61

C1 - C50 estimated total product distribution, weight %

C1	49.3	49.0	46.9	48.2	48.0	47.8
C2 - C4	31.7	31.5	30.3	31.0	30.9	30.7
C5 - C12	18.0	18.2	20.5	19.7	19.9	20.1
C13 - C50	0.9	1.3	2.2	1.1	1.2	1.4

CO conversion, %	14.1	12.5	11.5	9.6	8.9	8.5
rate, g CH ₂ /g cat/hr	0.77	0.68	0.63	0.52	0.49	0.46
CO ₂ formation, %	0.8	0.6	0.6	0.5	0.5	0.5

Performance of Co.053

Dates: 03/15/95 - 03/16/95 Run #10b

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.5 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	63.5	66.5
reaction temperature, °C	260	260
pressure, atm	1.0	1.0
flow, cc/min	90.0	90.0

C1 - C15 product distribution, weight %

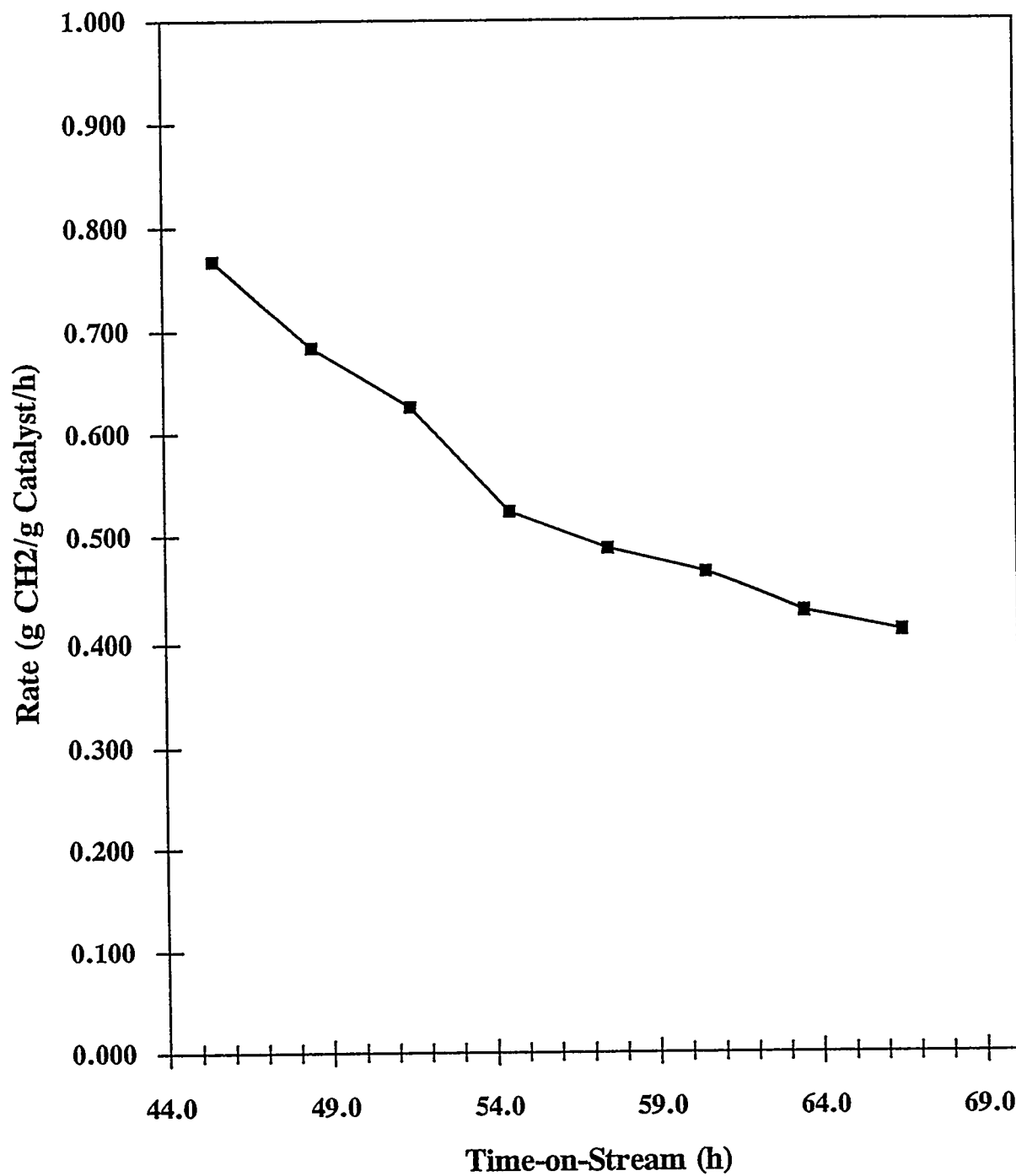
C1	48.65	47.77
C2	7.41	7.42
C3	14.50	14.23
C4	9.79	9.62
C5	7.24	7.23
C6	3.17	4.45
C7	3.13	3.16
C8	2.00	2.05
C9	1.33	1.32
C10	0.90	0.91
C11	0.62	0.65
C12	0.47	0.43
C13	0.30	0.28
C14	0.24	0.24
C15	0.25	0.25
alpha chain growth probability	0.62	0.62

C1 - C50 estimated total product distribution, weight %

C1	47.8	46.9
C2 - C4	31.2	30.7
C5 - C12	19.4	20.8
C13 - C50	1.6	1.6

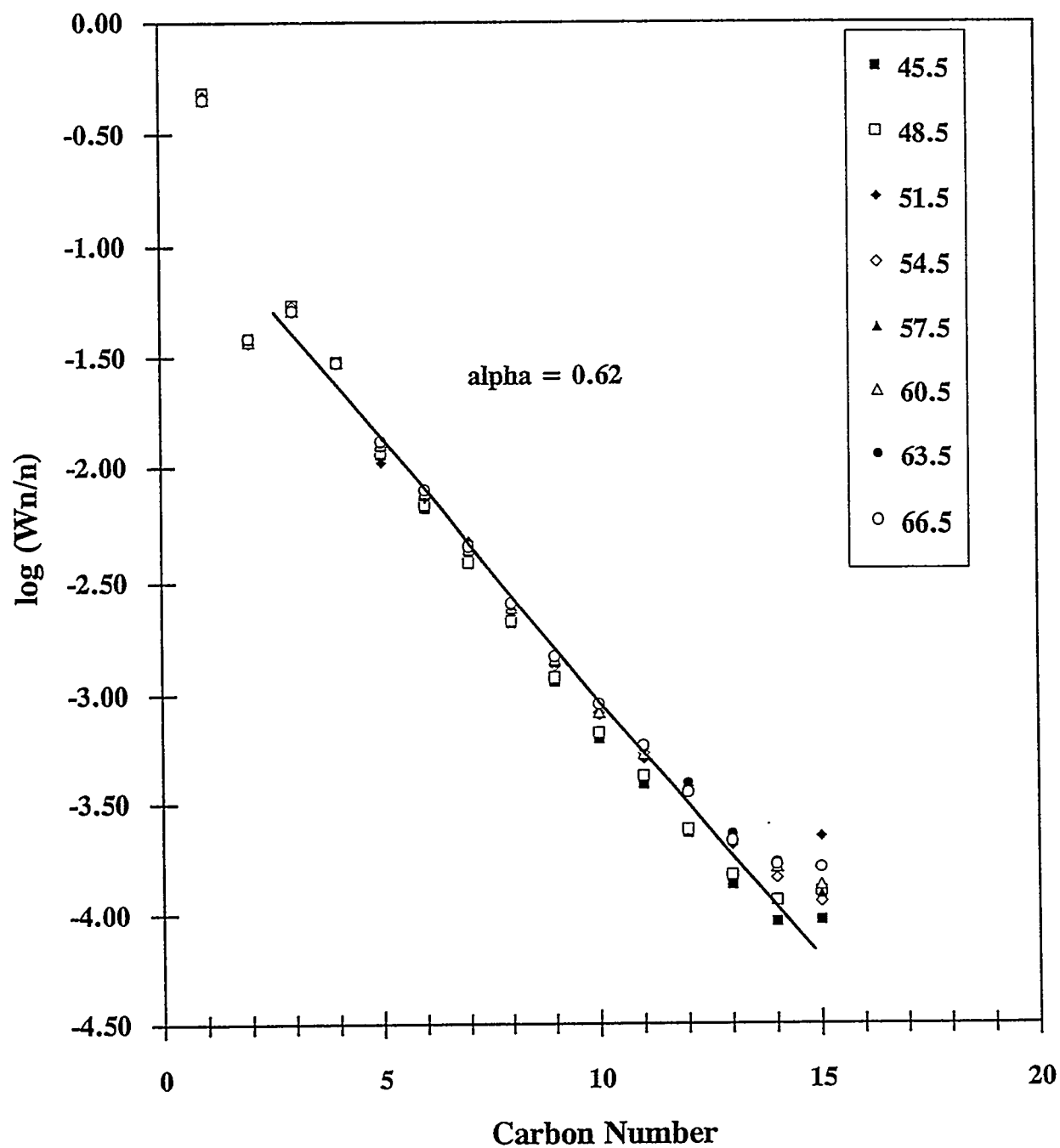
CO conversion, %	7.8	7.5
rate, g CH ₂ /g cat/hr	0.43	0.41
CO ₂ formation, %	0.5	0.4

Time-on-Stream Plot for Co.053 - Run #10b



Schulz-Flory Plot for Co.053 - Run #10b
Time on Stream (hrs)

hrs.



Co.053 - Run #10c

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 = 0.206 g

WHSV = 12.48 1/hr

time on stream = 93.5 hrs

CO₂ (g/g cat/hr) = 0.054CO₂ (% of CO) = 0.3

O/P = 10.05

CO conversion (%)	3.0
rate (g CH ₂ /g cat/hr)	0.16
alpha	0.69
C1 (wt%)	38.8
C2 - C4 (wt%)	34.3
C5 - C12 (wt%)	22.6
C13 + (wt%)	4.3

Performance of Co.053

Dates: 03/16/95 - 03/17/95 Run #10c

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.5 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	69.5	72.5	75.5	78.5	81.5	90.5
reaction temperature, °C	280	280	280	280	280	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	54.52	48.59	46.06	44.18	43.09	40.72
C2	8.83	9.64	10.35	10.85	11.41	12.63
C3	15.50	14.86	14.38	14.04	13.98	13.86
C4	8.66	8.94	8.90	8.83	8.84	8.84
C5	5.43	6.25	6.54	6.62	6.66	6.79
C6	1.33	3.84	4.26	4.66	4.45	4.50
C7	1.93	2.57	2.91	3.15	3.28	3.50
C8	1.28	1.70	2.01	2.24	2.33	2.48
C9	0.81	1.18	1.34	1.50	1.61	1.76
C10	0.49	0.77	0.98	1.13	1.24	1.36
C11	0.35	0.56	0.72	0.83	0.92	1.02
C12	0.26	0.38	0.53	0.63	0.69	0.73
C13	0.20	0.23	0.39	0.49	0.56	0.59
C14	0.19	0.23	0.32	0.52	0.46	0.61
C15	0.23	0.24	0.32	0.33	0.48	0.61
alpha chain growth probability	0.63	0.63	0.64	0.65	0.67	0.68

C1 - C50 estimated total product distribution, weight %

C1	53.4	47.7	45.1	43.4	41.8	39.1
C2 - C4	32.3	32.8	32.9	33.1	33.2	33.9
C5 - C12	12.8	17.9	19.9	21.3	21.9	23.0
C13 - C50	1.5	1.6	2.1	2.2	3.1	4.0

CO conversion, %	13.0	8.5	6.5	5.4	4.7	3.3
rate, g CH ₂ /g cat/hr	0.71	0.46	0.36	0.30	0.26	0.18
CO ₂ formation, %	1.5	0.7	0.8	0.5	0.4	0.3

Performance of Co.053

Dates: 03/16/95 - 03/17/95 Run #10c

flow rate = 90.0 cc/min, loading = 0.2 g, WHSV = 12.5 1/hr, H₂/CO ratio in feed = 2

time on stream, hr	93.5
reaction temperature, °C	280
pressure, atm	1.0
flow, cc/min	90.0

C1 - C15 product distribution, weight %

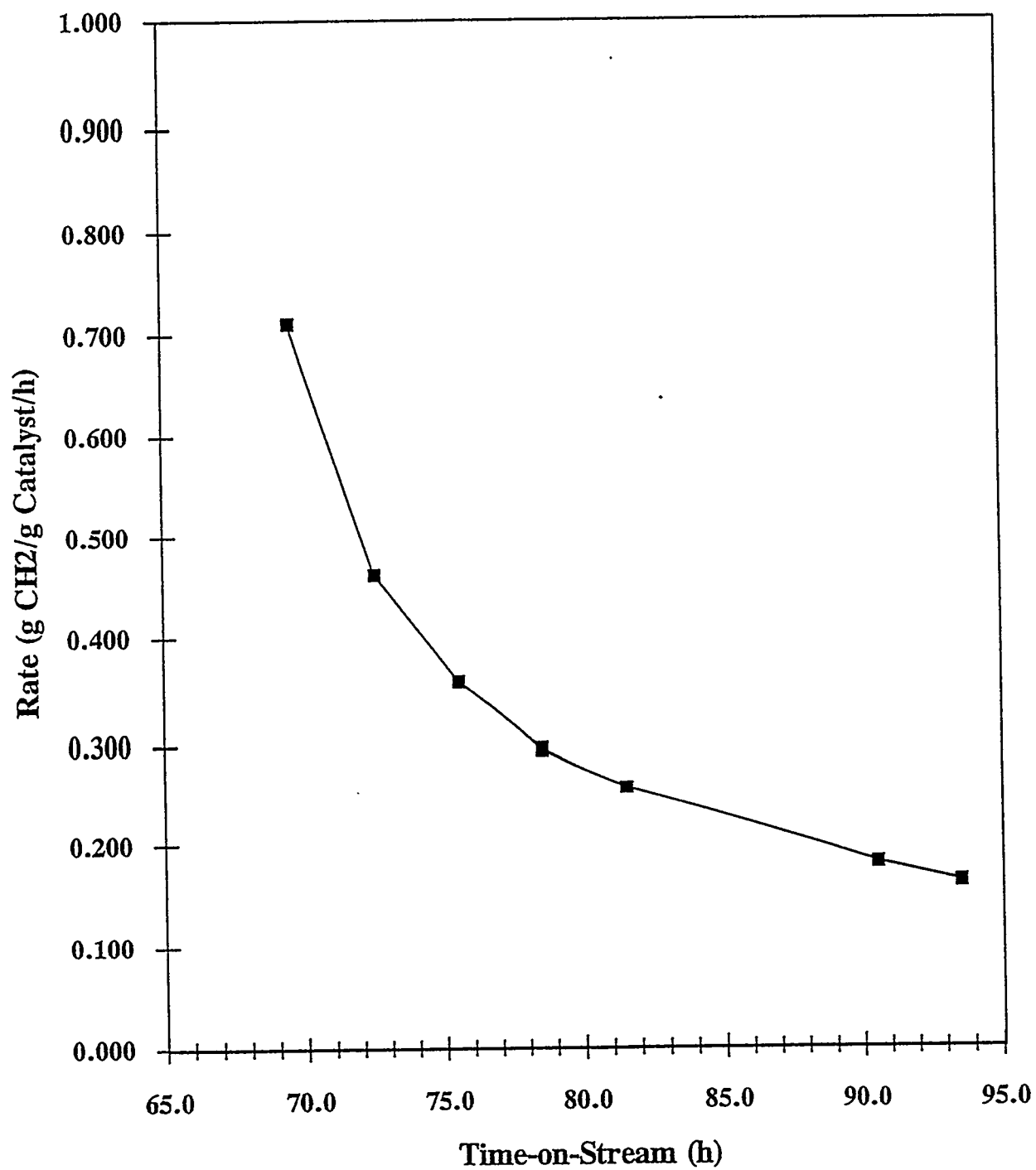
C1	40.51
C2	13.00
C3	13.96
C4	8.84
C5	6.75
C6	4.14
C7	3.40
C8	2.48
C9	1.81
C10	1.32
C11	1.03
C12	0.80
C13	0.61
C14	0.70
C15	0.66
alpha chain growth probability	0.69

C1 - C50 estimated total product distribution, weight %

C1	38.8
C2 - C4	34.3
C5 - C12	22.6
C13 - C50	4.3

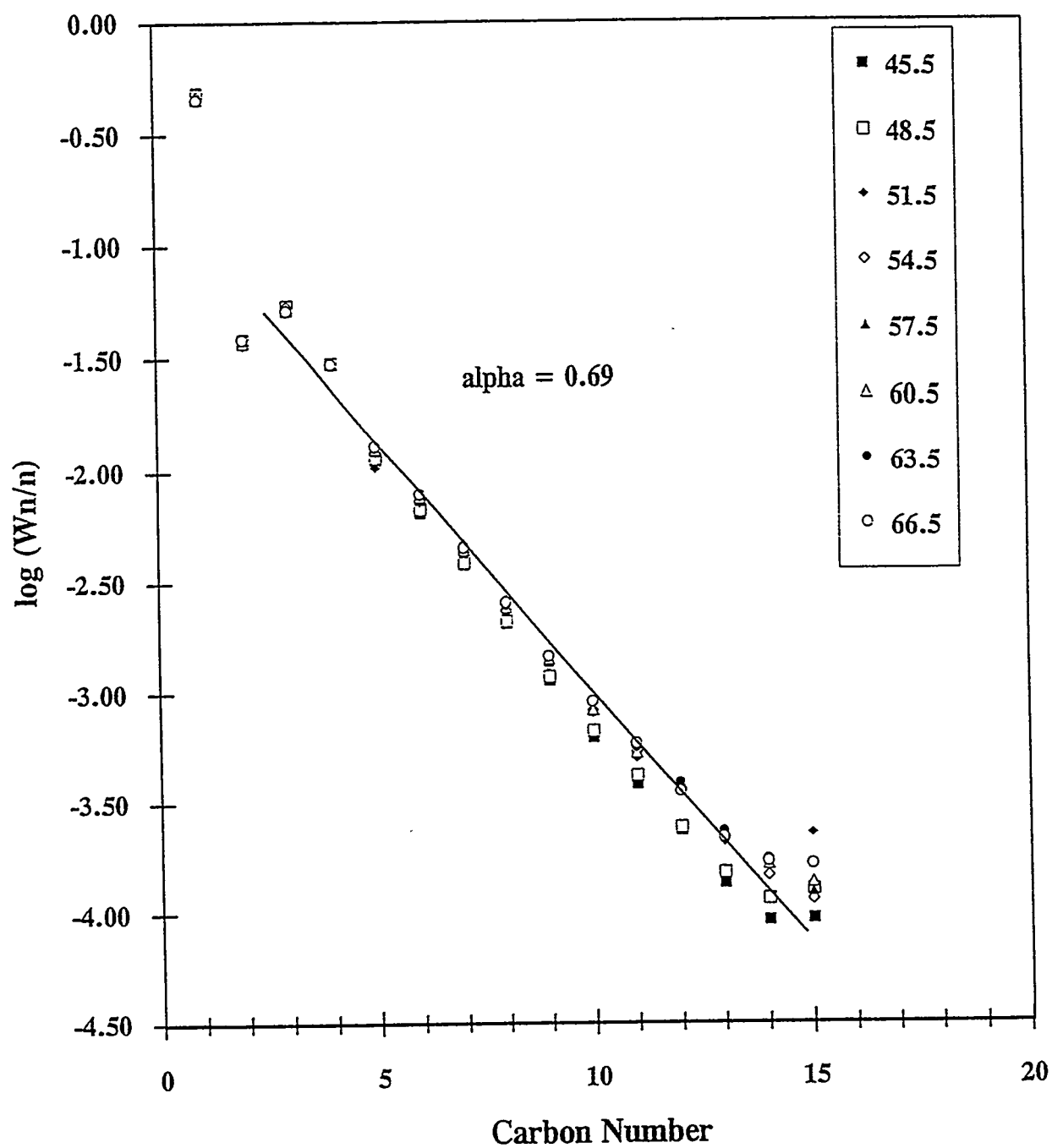
CO conversion, %	3.0
rate, g CH ₂ /g cat/hr	0.16
CO ₂ formation, %	0.3

Time-on-Stream Plot for Co.053 - Run #10c



Schulz-Flory Plot for Co.053 - Run #10c
Time on Stream (hrs)

hrs.



Co.053 - Run #11

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 = 0.211 g

WHSV = 12.21 1/hr

time on stream = 21.5 hrs

CO₂ (g/g cat/hr) = 0.022CO₂ (% of CO) = 0.1

O/P = 1.55

CO conversion (%)	5.4
rate (g CH ₂ /g cat/hr)	0.29
alpha	0.64
C1 (wt%)	26.9
C2 - C4 (wt%)	28.0
C5 - C12 (wt%)	42.3
C13 + (wt%)	2.8

Performance of Co.053

Dates: 03/20/95 - 03/21/95 Run #11

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	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	23.59	25.70	26.80	24.33	27.21	26.25
C2	4.12	4.56	4.64	4.22	5.07	4.52
C3	10.57	11.08	11.40	10.20	11.43	10.88
C4	10.99	11.45	10.79	10.29	11.57	11.12
C5	10.88	11.17	11.49	10.35	11.16	10.82
C6	10.04	8.79	9.00	8.21	8.82	8.44
C7	7.01	7.74	7.33	6.74	7.20	7.34
C8	5.18	5.65	5.35	4.94	5.31	5.80
C9	3.84	4.08	3.87	3.52	3.87	4.83
C10	3.19	2.84	2.78	2.55	2.73	3.53
C11	4.61	2.23	2.29	2.09	2.24	2.64
C12	3.99	1.61	1.58	1.46	1.41	1.58
C13	1.39	1.20	1.17	2.28	0.98	1.07
C14	0.43	1.26	1.07	6.46	0.62	0.88
C15	0.19	0.64	0.43	2.35	0.39	0.30
alpha chain growth probability	0.60	0.67	0.64	0.76	0.64	0.63

C1 - C50 estimated total product distribution, weight %

C1	25.5	25.3	26.9	21.5	27.2	26.8
C2 - C4	27.8	26.7	27.0	21.9	28.1	27.1
C5 - C12	45.3	43.7	43.2	40.6	42.1	44.1
C13 - C50	1.4	4.3	2.9	16.0	2.6	2.0

CO conversion, %	6.6	6.5	6.1	7.2	5.7	5.6
rate, g CH ₂ /g cat/hr	0.35	0.35	0.32	0.39	0.30	0.30
CO ₂ formation, %	0.2	0.1	0.2	0.1	0.1	0.1

Performance of Co.053

Dates: 03/20/95 - 03/21/95 Run #11

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	18.5	21.5
reaction temperature, °C	220	220
pressure, atm	1.0	1.0
flow, cc/min	90.0	90.0

C1 - C15 product distribution, weight %

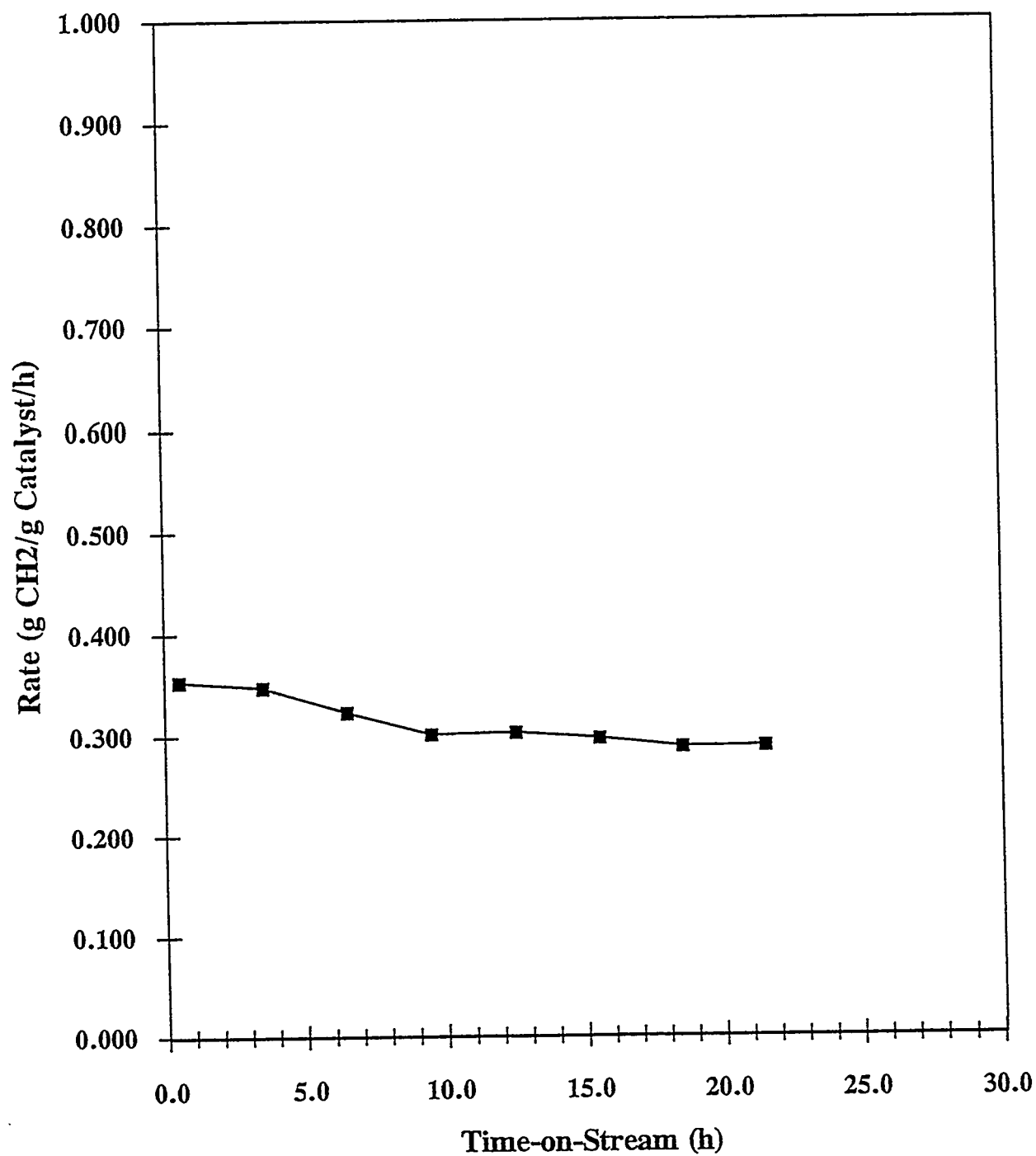
C1	27.36	26.75
C2	4.70	5.35
C3	11.31	11.12
C4	11.30	11.40
C5	11.21	11.08
C6	8.31	8.88
C7	7.30	7.15
C8	5.35	5.27
C9	3.88	3.90
C10	2.76	2.75
C11	2.28	2.19
C12	1.55	1.49
C13	1.16	1.12
C14	1.11	1.14
C15	0.42	0.42
alpha chain growth probability	0.64	0.64

C1 - C50 estimated total product distribution, weight %

C1	27.5	26.9
C2 - C4	27.5	28.0
C5 - C12	42.1	42.3
C13 - C50	2.8	2.8

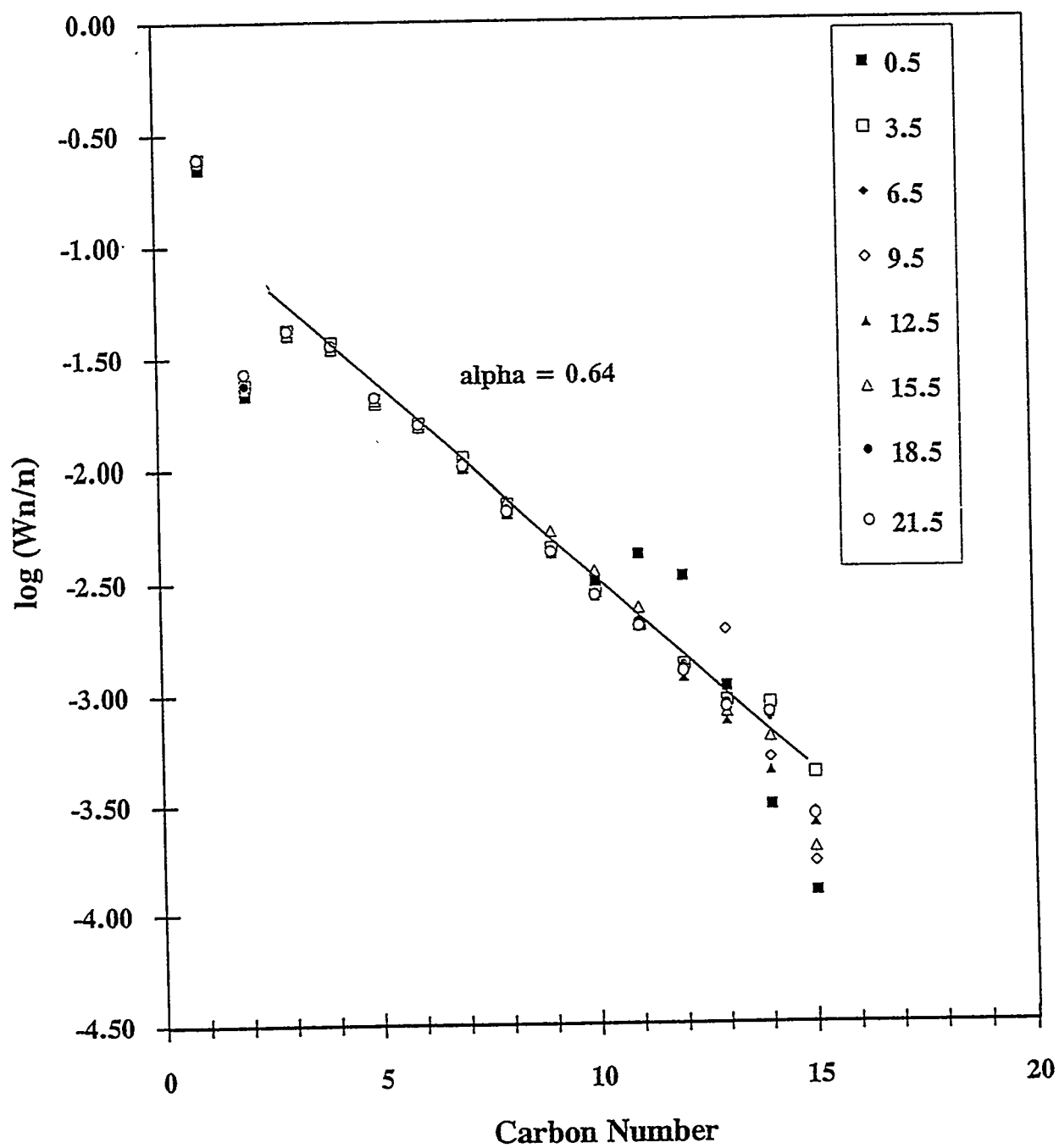
CO conversion, %	5.4	5.4
rate, g CH ₂ /g cat/hr	0.29	0.29
CO ₂ formation, %	0.1	0.1

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



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

hrs.



Co.053 - Run #11a

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 = 0.211 g

WHSV = 12.21 1/hr

time on stream = 48.5 hrs

CO₂ (g/g cat/hr) = 0.060CO₂ (% of CO) = 0.3

O/P = 9.14

CO conversion (%)	3.8
rate (g CH ₂ /g cat/hr)	0.20
alpha	0.69
C1 (wt%)	38.7
C2 - C4 (wt%)	32.8
C5 - C12 (wt%)	23.8
C13 + (wt%)	4.6

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 l/hr, H₂/CO ratio in feed = 2

time on stream, hr	27.5	30.5	33.5	36.5	39.5	42.5
reaction temperature, °C	280	280	280	280	280	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	55.79	50.17	45.26	43.76	42.75	42.10
C2	8.24	9.19	9.60	10.24	10.73	11.16
C3	14.60	15.42	14.40	14.20	14.08	14.02
C4	8.46	9.36	9.03	9.04	9.06	9.07
C5	5.06	6.47	6.61	6.83	6.95	6.98
C6	2.75	3.93	4.11	4.47	4.65	4.54
C7	1.77	2.66	2.96	3.24	3.34	3.39
C8	1.17	0.68	2.05	2.23	2.36	2.43
C9	0.73	1.08	1.47	2.63	1.61	1.65
C10	0.43	0.24	1.05	0.81	1.24	1.23
C11	0.34	0.24	1.04	0.57	0.89	0.88
C12	0.23	0.46	0.60	0.48	0.64	0.67
C13	0.17	0.07	0.86	0.58	0.53	0.57
C14	0.16	0.02	0.77	0.42	0.70	0.74
C15	0.12	0.01	0.19	0.50	0.48	0.57
alpha chain growth probability	0.60	0.48	0.61	0.67	0.67	0.68

C1 - C50 estimated total product distribution, weight %

C1	55.2	50.4	45.5	42.1	41.5	40.5
C2 - C4	31.0	34.1	33.2	32.2	32.9	33.0
C5 - C12	13.0	15.4	20.0	22.5	22.5	22.8
C13 - C50	0.8	0.1	1.3	3.2	3.1	3.7

CO conversion, %	16.1	9.1	7.3	6.2	5.3	4.6
rate, g CH ₂ /g cat/hr	0.86	0.49	0.39	0.33	0.28	0.25
CO ₂ formation, %	2.3	1.5	0.7	0.5	0.5	0.4