

TABLE 26
COMPARISON WITH LAPORTE SBCR RUN AF-R6.1F

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	12.4	87.6	100
Density, g/cm ³	3.100	0.868	0.738
Volume % Solids	2.95	97.05	100.00
Viscosity, g/cm/s	-	0.0225	0.0282
Surface Tension, N/m	-	16.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	809.8
Slurry Level, fraction	0.90
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.41
Catalyst Weight, kg	128.8
Cat. Loading, kg/m ³	91.5

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	4.0
Feed Rate, m ³ /hr	38.8
nm ³ /hr	271.3
SV, m ³ /hr/m ³	26.0
nm ³ /hr/m ³	192.8
nm ³ /h/kg Fe	3.91
Corr. factor for kLa	0.605
H ₂ Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.1-F		
	Plant	MODEL 1	MODEL 2
H ₂ Conversion, %	45.4	48.2	47.2
U _g , cm/sec		2.8	2.9
Gas hold-up, eps-g	0.136	0.106	0.107
kLa (uncorr), 1/s		0.302	0.305
kLa (corr), 1/s		0.183	0.184
kr, epsl, 1/s		0.028	0.028
KR(=kr,epsl.R.T./He)		0.005	0.005
KM(=kLa.R.T./He)		0.031	0.032
K(=KR.KM/(KR+KM))		0.004	0.004
H ₂ +CO Conversion, %	42.8	56.5	54.2
CO Conversion, %	52.5	61.8	59.1
STY, nm ³ /h/m ³		108.9	104.5
STY, nm ³ /h/kg Fe		2.21	2.12
Mass Transfer Res., %		13.11	13.00
CO Conv., gmole/kg Fe/h	52.7	63.29	60.71
CH ₂ produced, g/kg Fe/h		470.53	451.36
g/nm ³ syngas		120.20	115.30

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

TABLE 27
COMPARISON WITH LAPORTE SCCR RUN AF-R6.1G

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids In Slurry	12.45	87.55	100
Density, g/cm ³	3.100	0.668	0.739
Volume % Solids	2.97	97.03	100.00
Viscosity, g/cm/s	-	0.0225	0.0282
Surface Tension, N/m	-	18.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	609.6
Slurry Level, fraction	0.90
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.41
Catalyst Weight, kg	129.4
Cat. Loading, kg/m ³	91.2

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	4.3
Feed Rate, am ³ /hr	39.4
nm ³ /hr	292.2
SV, am ³ /hr/m ³	28.0
nm ³ /hr/m ³	207.6
nm ³ /h/kg Fe	4.20
Corr. factor for kLa	0.605
H2 Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.1-G		
	Model	MODEL 1	MODEL 2
H2 Conversion, %	41.6	46.7	45.1
Ug, cm/sec		3.1	3.2
Gas hold-up, eps-g	0.137	0.112	0.113
kLa (uncorr), 1/s		0.320	0.320
kLa (corr), 1/s		0.193	0.195
kr, epsi, 1/s		0.028	0.028
KR(=kr,epsil.R.T/He)		0.005	0.005
KM(=kLa.R.T/He)		0.033	0.034
K(=KR.KM/(KR+KM))		0.004	0.004
H2+CO Conversion, %	44.5	53.6	51.7
CO Conversion, %	43.6	58.5	56.4
STY, nm ³ /h/m ³		111.3	107.4
STY, nm ³ /h/kg Fe		2.25	2.17
Mass Transfer Res., %		12.52	12.43
CO Conv., gmole/kg Fe/h	50.0	64.41	62.14
CH2 produced, g/kg Fe/h		478.84	462.00
g/nm ³ syngas		114.09	110.08

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

**TABLE 28
COMPARISON WITH LAFORTE SBCR RUN AF-R6.1H**

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	11.8	88.4	100
Density, g/cm ³	3.100	0.686	0.733
Volume % Solids	2.74	97.26	100.00
Viscosity, g/cm/s	-	0.0225	0.0277
Surface Tension, N/m	-	18.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	609.8
Slurry Level, fraction	0.90
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.41
Catalyst Weight, kg	119.7
Cat. Loading, kg/m ³	85.0

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	4.3
Feed Rate, am ³ /hr	39.4
nm ³ /hr	292.2
SV, am ³ /hr/m ³	28.0
nm ³ /hr/m ³	207.6
nm ³ /h/kg Fe	4.54
Corr. factor for kLa	0.607
H2 Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.1-H		
	Plant	MODEL 1	MODEL 2
H2 Conversion, %	38.4	44.2	42.7
Ug, cm/sec		3.2	3.2
Gas hold-up, eps-g	0.143	0.113	0.114
kLa (uncorr), 1/s		0.323	0.326
kLa (corr), 1/s		0.196	0.198
kr, epsl, 1/s		0.026	0.026
KR(=kr,epsl.R.T/He)		0.004	0.004
KM(=kLa.R.T/He)		0.034	0.034
K(=KR.KM/(KR+KM))		0.004	0.004
H2+CO Conversion, %	40.9	50.8	49.1
CO Conversion, %	42.5	55.3	53.5
STY, nm ³ /h/m ³		105.4	101.9
STY, nm ³ /h/kg Fe		2.30	2.23
Mass Transfer Res., %		11.53	11.48
CO Conv., gmole/kg Fe/h	49.5	65.01	53.72
CH2 produced, g/kg Fe/h		490.01	473.73
g/nm ³ syngas		107.98	104.39

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

TABLE 29
COMPARISON WITH LAPORTE SBCR RUN AF-R6.2A

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	10.49	89.51	100
Density, g/cm ³	3.100	0.666	0.726
Volume % Solids	2.46	97.54	100.00
Viscosity, g/cm/s	-	0.0225	0.0271
Surface Tension, N/m	-	16.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	609.6
Slurry Level, fraction	0.90
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.41
Catalyst Weight, kg	107.2
Cat. Loading, kg/m ³	76.2

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	9.2
Feed Rate, m ³ /hr	76.0
nm ³ /hr	563.8
SV, m ³ /hr/m ³	54.0
nm ³ /hr/m ³	400.4
nm ³ /hr/kg Fe	9.77
Corr. factor for kLa	0.611
H2 Diffusivity, cm ² /s	0.00057

RUN	AF-R6.2-A		
	Plant	MODEL 1	MODEL 2
H2 Conversion, %	22.3	25.2	25.0
Ug, cm/sec		7.1	7.1
Gas hold-up, eps-g	0.265	0.178	0.178
kLa (uncorr), 1/s		0.531	0.531
kLa (corr), 1/s		0.324	0.324
kr, epsl, 1/s		0.025	0.025
KR(=kr, epsl, R.T/He)		0.004	0.004
KM(=kLa, R.T/He)		0.056	0.056
K(=KR, KM/(KR+KM))		0.004	0.004
H2+CO Conversion, %	21.1	26.6	26.4
CO Conversion, %	20.2	27.6	27.4
STY, nm ³ /hr/m ³		106.5	105.7
STY, nm ³ /hr/kg Fe		2.60	2.58
Mass Transfer Res., %		7.25	7.25
CO Conv., gmole/kg Fe/hr	49.9	70.72	70.19
-CH2 produced, g/kg Fe/hr		515.87	512.00
g/nm ³ syngas		52.80	52.40

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

TABLE 30
COMPARISON WITH LAPORTE SBCR RUN AF-R6.2B

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	9.45	90.55	100
Density, g/cm ³	3.100	0.656	0.720
Volume % Solids	2.19	97.81	100.00
Viscosity, g/cm/s	-	0.0225	0.0266
Surface Tension, N/m	-	18.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	609.6
Slurry Level, fraction	0.90
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.41
Catalyst Weight, kg	95.7
Cat. Loading, kg/m ³	68.0

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	8.2
Feed Rate, am ³ /hr	76.0
nm ³ /hr	563.6
SV, am ³ /hr/m ³	54.0
nm ³ /hr/m ³	400.4
nm ³ /h/kg Fe	10.94
Corr. factor for kLa	0.813
H ₂ Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.2-B		
	Plant	MODEL 1	MODEL 2
H ₂ Conversion, %	15.4	22.9	22.7
U _g , cm/sec		7.2	7.2
Gas hold-up, eps-g	0.25	0.179	0.179
kLa (uncorr), 1/s		0.535	0.535
kLa (corr), 1/s		0.328	0.328
kr, epsl, 1/s		0.023	0.023
KR(=kr, epsl, R.T./H ₀)		0.004	0.004
KM(=kLa, R.T./H ₀)		0.058	0.056
K(=KR, KM/(KR+KM))		0.004	0.004
H ₂ +CO Conversion, %	18.2	24.2	24.0
CO Conversion, %	17.3	25.1	24.9
STY, nm ³ /h/m ³		96.8	96.0
STY, nm ³ /h/kg Fe		2.65	2.62
Mass Transfer Res., %		6.46	6.45
CO Conv., gmole/kg Fe/h	46.9	71.98	71.41
CH ₂ produced, g/kg Fe/h		525.01	520.89
g/nm ³ syngas		47.98	47.60

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

**TABLE 31
COMPARISON WITH LAPORTE SBCR RUN AF-R6.3A**

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	2.44	91.56	100
Density, g/cm ³	3.100	0.866	0.714
Volume % Solids	1.94	98.06	100.00
Viscosity, g/cm/s	-	0.0225	0.0261
Surface Tension, N/m	-	16.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	509.6
Slurry Level, fraction	0.90
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.41
Catalyst Weight, kg	64.8
Cat. Loading, kg/m ³	60.2

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	2859
Inlet Gas Vel., cm/s	4.3
Feed Rate, m ³ /hr	39.4
nm ³ /hr	564.4
SV, m ³ /hr/m ³	28.0
nm ³ /hr/m ³	401.0
nm ³ /h/kg Fe	12.38
Corr. factor for kLa	0.615
H2 Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.3-A		
	Plant	MODEL 1	MODEL 2
H2 Conversion, %	32.0	27.7	26.9
Ug, cm/sec		3.6	3.7
Gas hold-up, eps-g	0.208	0.121	0.122
kLa (uncom), 1/s		0.350	0.351
kLa (com), 1/s		0.215	0.216
kr, epsl, 1/s		0.014	0.014
KR (=kr, epsl, R.T./He)		0.002	0.002
KM (=kLa, R.T./He)		0.037	0.037
K (=KR, KM/(KR+KM))		0.002	0.002
H2+CO Conversion, %	30.2	29.5	28.7
CO Conversion, %	28.8	30.7	29.9
STY, nm ³ /h/m ³		118.2	115.0
STY, nm ³ /h/kg Fe		3.65	3.55
Mass Transfer Res., %		6.28	6.27
CO Conv., gmole/kg Fe/h	68.4	99.81	97.05
CH2 produced, g/kg Fe/h		574.98	850.83
g/nm ³ syngas		70.70	68.75

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

TABLE 32
COMPARISON WITH LAPORTE SBCR RUN AF-R6.3B

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	7.99	92.01	100
Density, g/cm ³	3.100	0.866	0.711
Volume % Solids	1.83	28.17	100.00
Viscosity, g/cm/s	-	0.0225	0.0259
Surface Tension, N/m	-	18.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LAPORTE
ID of Rx, cm	57.2
L of Rx, cm	809.5
Slurry Level, fraction	0.90
Rx X-section, m ²	0.22
Slurry Volume, m ³	1.41
Catalyst Weight, kg	79.9
Cat. Loading, kg/m ³	56.8

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	2859
Inlet Gas Vel., cm/s	4.3
Feed Rate, am ³ /hr	39.4
nm ³ /hr	564.4
SV, am ³ /hr/m ³	28.0
nm ³ /hr/m ³	401.5
nm ³ /hr/kg Fe	13.14
Corr. factor for kLa	0.615
H2 Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.3-B		
	Plant	MODEL 1	MODEL 2
H2 Conversion, %	30.1	26.3	25.6
Ug, cm/sec		3.7	3.7
Gas hold-up, eps-g	0.221	0.122	0.122
kLa (uncorr), 1/s		0.351	0.352
kLa (corr), 1/s		0.216	0.217
kr, epsl, 1/s		0.014	0.014
KR(=kr,epsl,R.T.Hs)		0.002	0.002
KM(=kLa.R.T/Hs)		0.037	0.037
K(=KR.KM/(KR+KM))		0.002	0.002
H2+CO Conversion, %	27.3	26.0	27.3
CO Conversion, %	26.1	29.2	28.4
STY, nm ³ /h/m ³		112.4	109.5
STY, nm ³ /h/kg Fe		3.62	3.58
Mass Transfer Res., %		5.92	5.90
CO Conv., gmole/kg Fe/h	65.2	100.56	98.03
-CH2 produced, g/kg Fe/h		881.84	859.44
g/nm ³ syngas		67.13	65.42

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

**TABLE 33
COMPARISON WITH LAPORTE SBCR RUN AF-R6.4A**

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	7.43	92.57	100
Density, g/cm ³	3.100	0.686	0.708
Volume % Solids	1.70	98.30	100.00
Viscosity, g/cm/s	-	0.0225	0.0256
Surface Tension, N/m	-	16.5	-
Part Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	609.6
Slurry Level, fraction	0.91
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.42
Catalyst Weight, kg	74.6
Cat. Loading, kg/m ³	52.6

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	4.0
Resc Rate, am ³ /hr	36.6
nm ³ /hr	271.3
SV, am ³ /hr/m ³	25.7
nm ³ /hr/m ³	190.5
nm ³ /h/kg Fe	6.73
Corr. factor for kLa	0.615
H2 Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.4-A		
	Plant	MODEL 1	MODEL 2
H2 Conversion, %	28.3	17.7	17.4
Ug, cm/sec		3.6	3.6
Gas hold-up, eps-g	0.157	0.120	0.120
kLa (uncorr), 1/s		0.346	0.346
kLa (corr), 1/s		0.213	0.213
kr, eps-l, 1/s		0.008	0.008
KR (= kr, eps-l, P.T./He)		0.001	0.001
KM (= kLa, R.T./He)		0.037	0.037
K (= KR.KM/(KR+KM))		0.001	0.001
H2 + CO Conversion, %	28.8	19.4	19.0
CO Conversion, %	29.2	20.5	20.1
STY, nm ³ /h/m ³		36.8	38.2
STY, nm ³ /h/kg Fe		1.30	1.25
Mass Transfer Res., %		3.59	3.59
CO Conv., gmole/kg Fe/h	49.7	36.20	35.57
CH2 produced, g/kg Fe/h		284.85	279.38
g/nm ³ syngas		42.30	41.49

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

TABLE 34
COMPARISON WITH LAPORTE SBCR RUN AF-R6.4B

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	7.17	92.83	100
Density, g/cm ³	3.100	0.868	0.706
Volume % Solids	1.63	98.37	100.00
Viscosity, g/cm/s	-	0.0225	0.0255
Surface Tension, N/m	-	18.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	809.6
Slurry Level, fraction	0.90
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.41
Catalyst Weight, kg	71.2
Cat. Loading, kg/m ³	50.8

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	4.0
Feed Rate, cm ³ /hr	35.6
nm ³ /hr	271.3
SV, cm ³ /hr/m ³	26.0
nm ³ /hr/m ³	192.8
nm ³ /h/kg Fe	7.08
Corr. factor for kLa	0.618
H ₂ Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.4-B		
	Plant	MODEL 1	MODEL 2
H ₂ Conversion, %	28.3	16.8	16.6
U _g , cm/sec		3.6	3.6
Gas hold-up, eps-g	0.157	0.121	0.121
kLa (uncorr), 1/s		0.347	0.347
kLa (corr), 1/s		0.214	0.214
kr, epsl, 1/s		0.008	0.008
KR (=kr, epsl, R.T./He)		0.001	0.001
KM (=kLa, R.T./He)		0.037	0.037
X (=KR, KM / (KR + KM))		0.001	0.001
H ₂ + CO Conversion, %	23.8	18.4	18.1
CO Conversion, %	29.2	19.5	19.2
STY, nm ³ /h/m ³		35.4	35.0
STY, nm ³ /h/kg Fe		1.30	1.28
Mass Transfer Res., %		3.45	3.45
CO Conv., gmole/kg Fe/h	49.2	36.18	35.73
CH ₂ produced, g/kg Fe/h		224.21	250.69
g/nm ³ syngas		40.15	39.66

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

FIGURE A-1
SUMMARY DATA FOR RUHRCHEMIE CATALYST - RUN 31

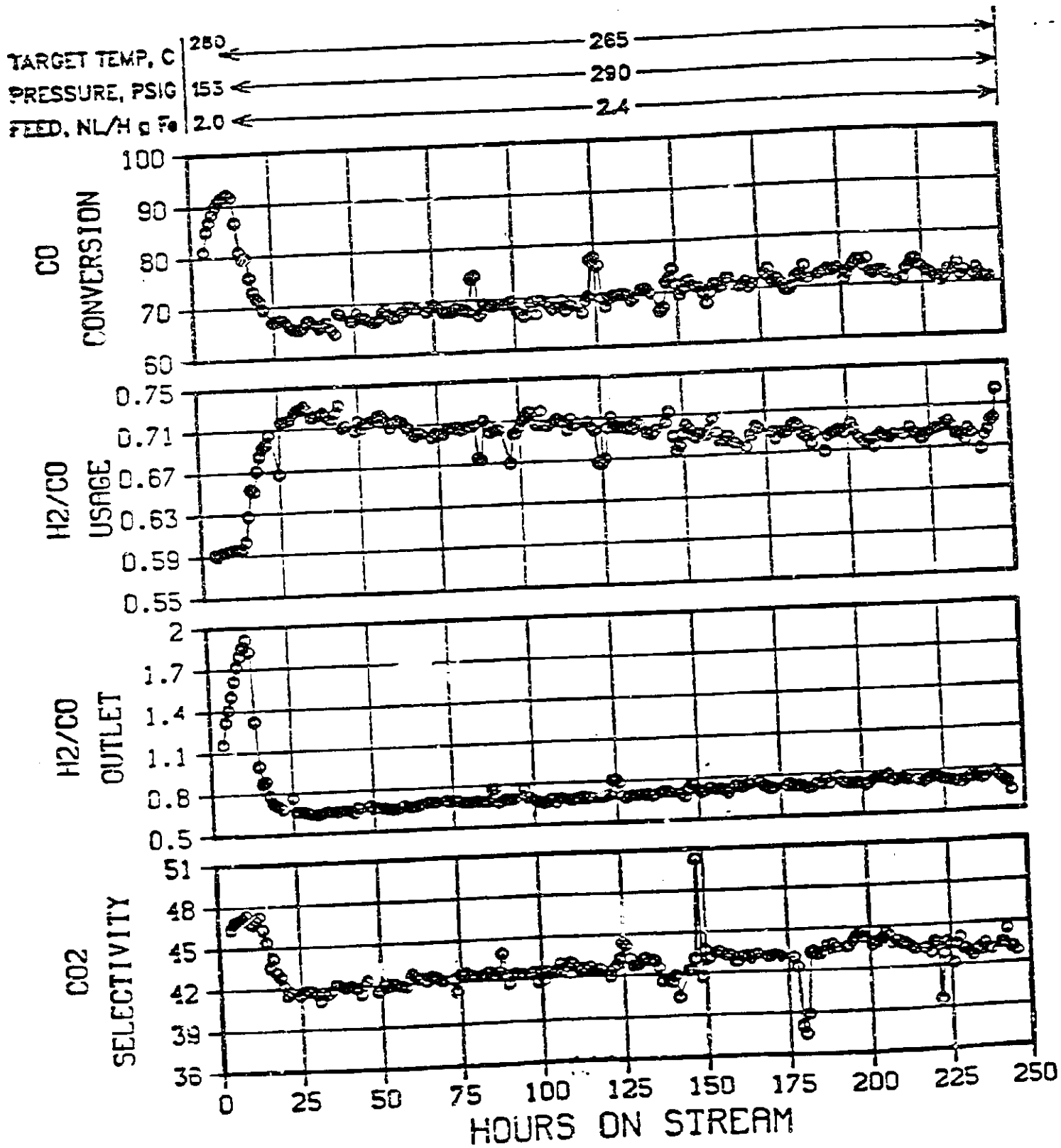


FIGURE A-2
SUMMARY DATA FOR RUERCHEMIE CATALYST - RUN 3i

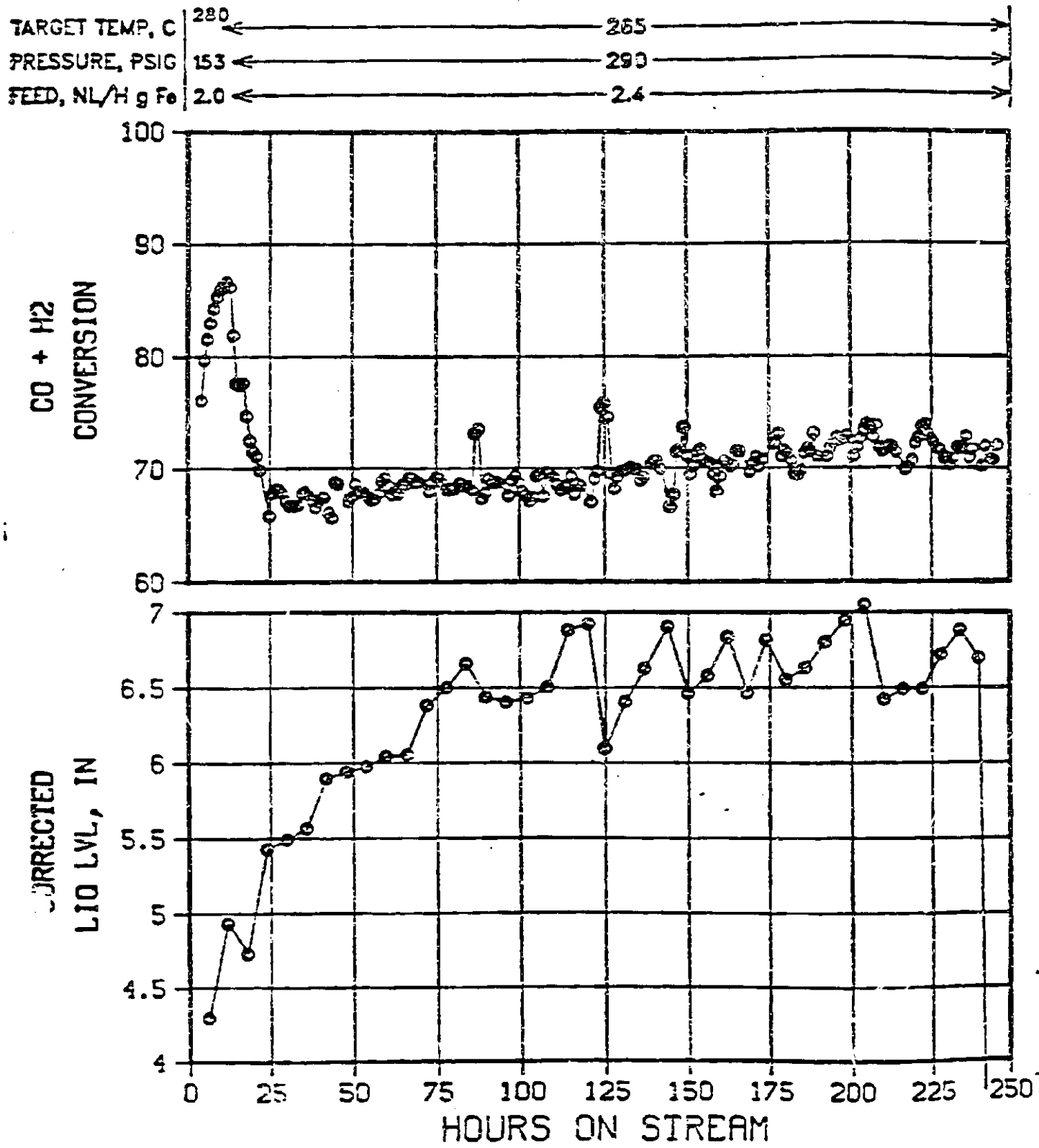


FIGURE A-3
SUMMARY DATA FOR RUHRCHEMIE CATALYST - RUN 31

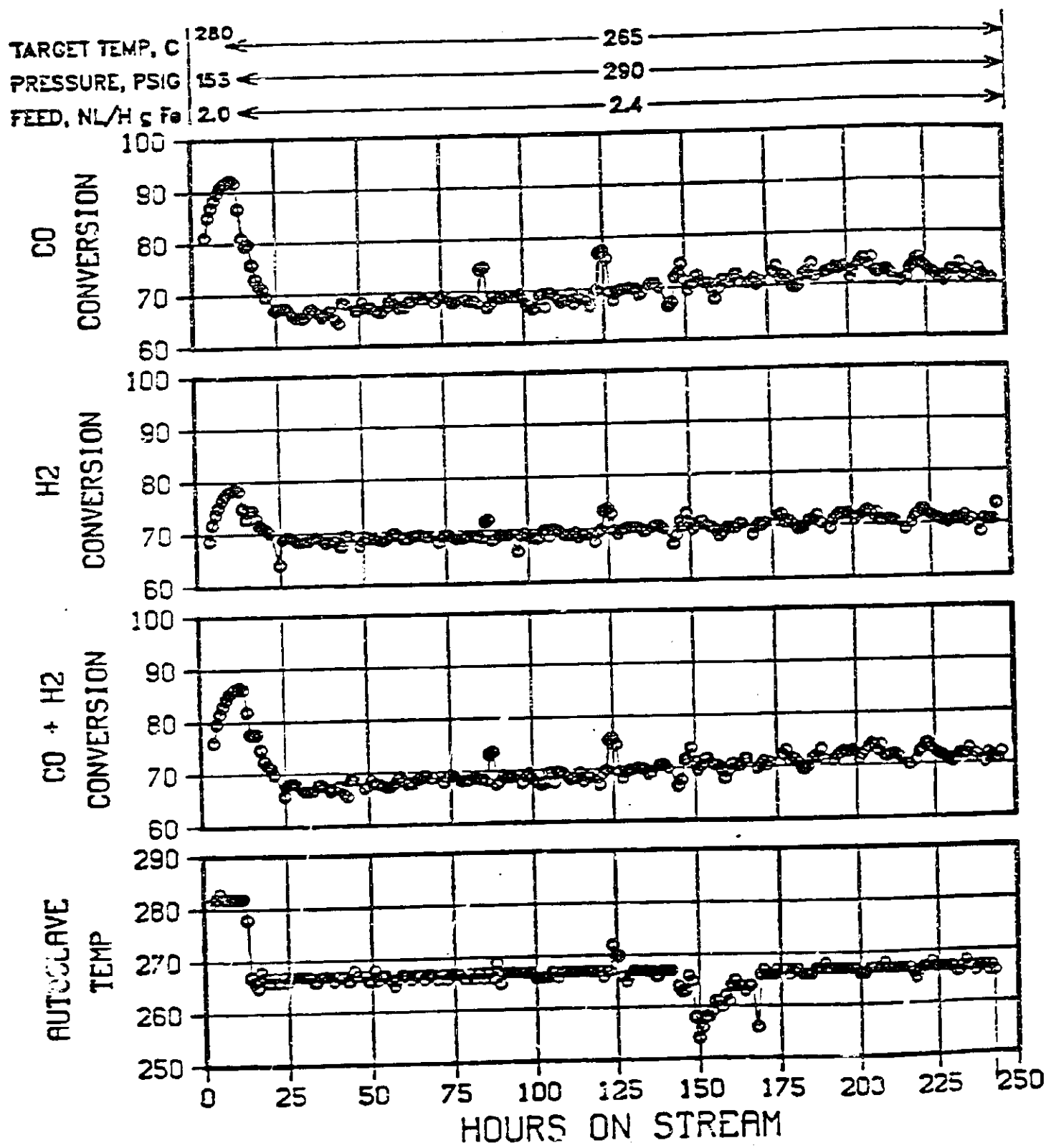


FIGURE A-4
SUMMARY DATA FOR RUHRCHEMIE CATALYST - RUN 31

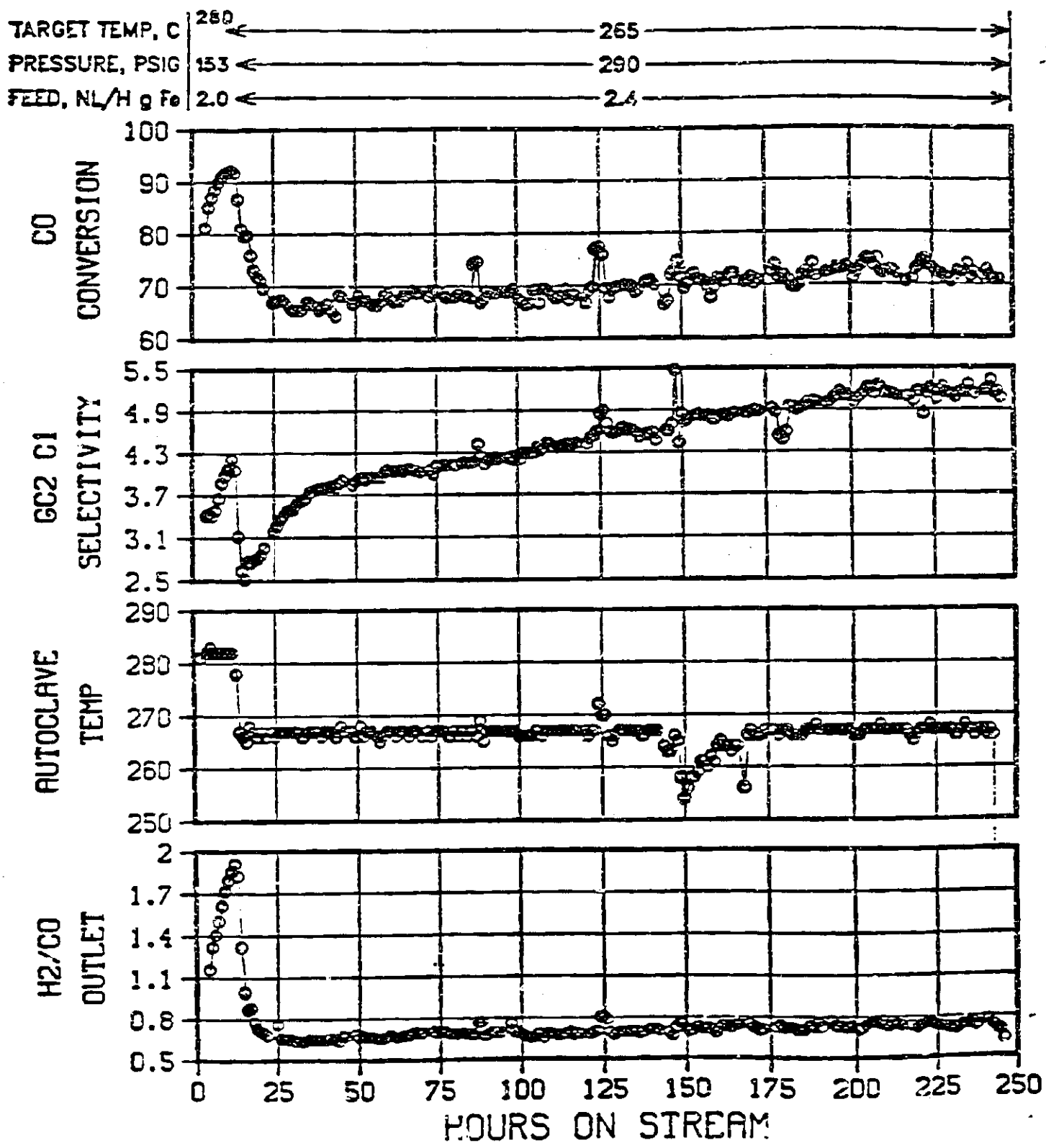


FIGURE A-5
SUMMARY DATA FOR RUHRCHEMIE CATALYST - RUN 31

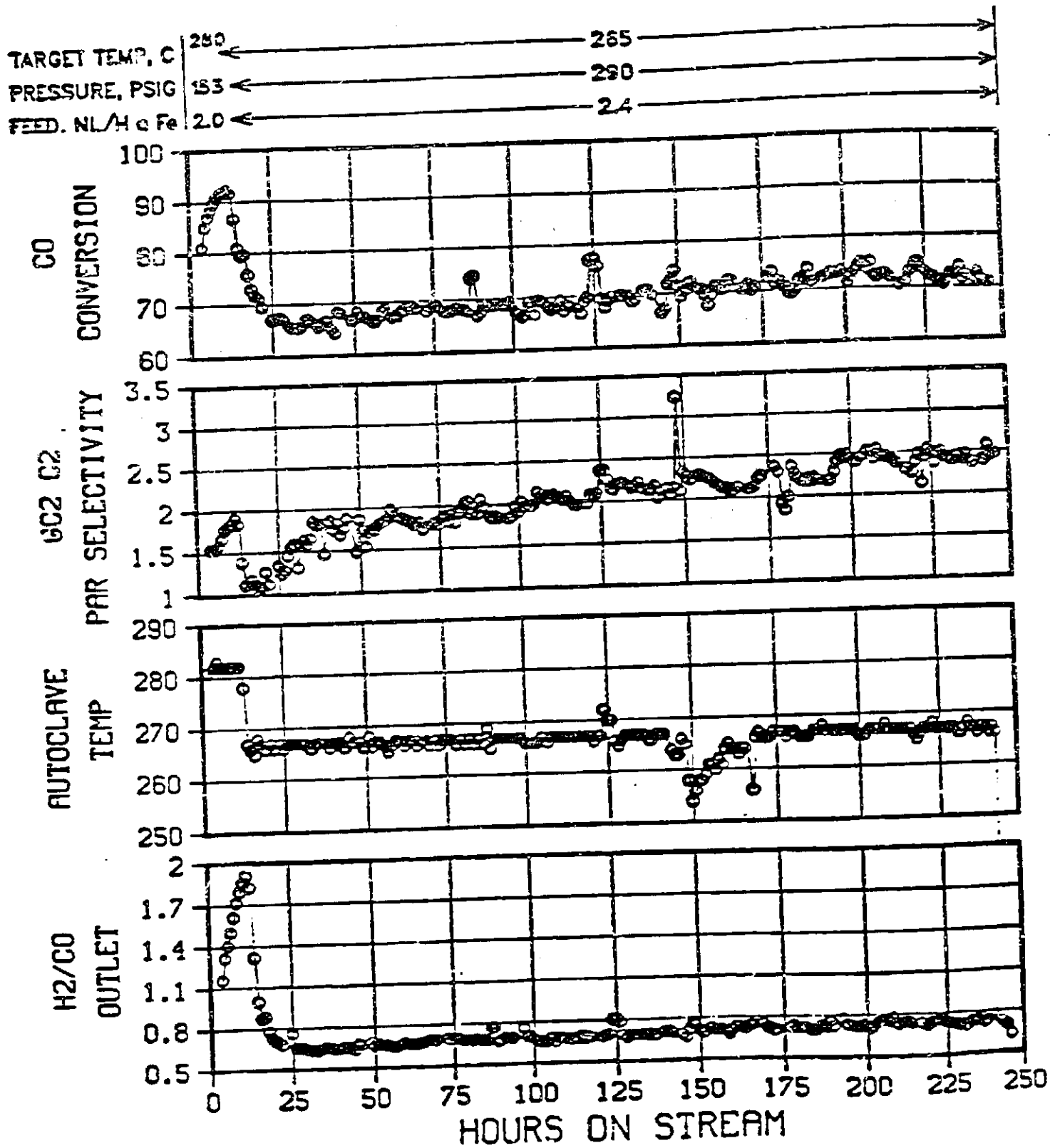


FIGURE A-6
SUMMARY DATA FOR RUHRCHEMIE CATALYST - RUN 31

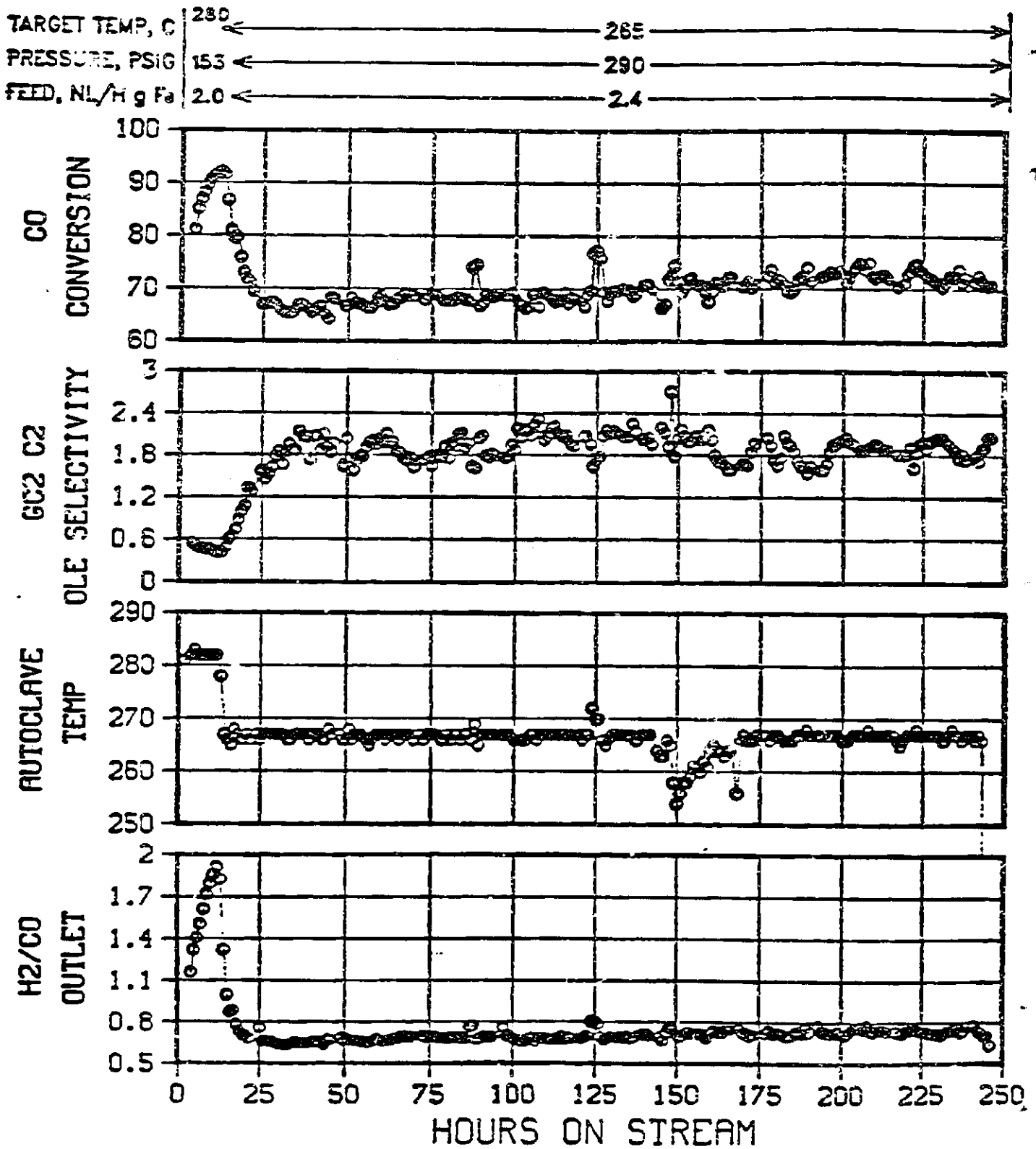


FIGURE A-7
SUMMARY DATA FOR RUHRCHEMIE CATALYST - RUN 31

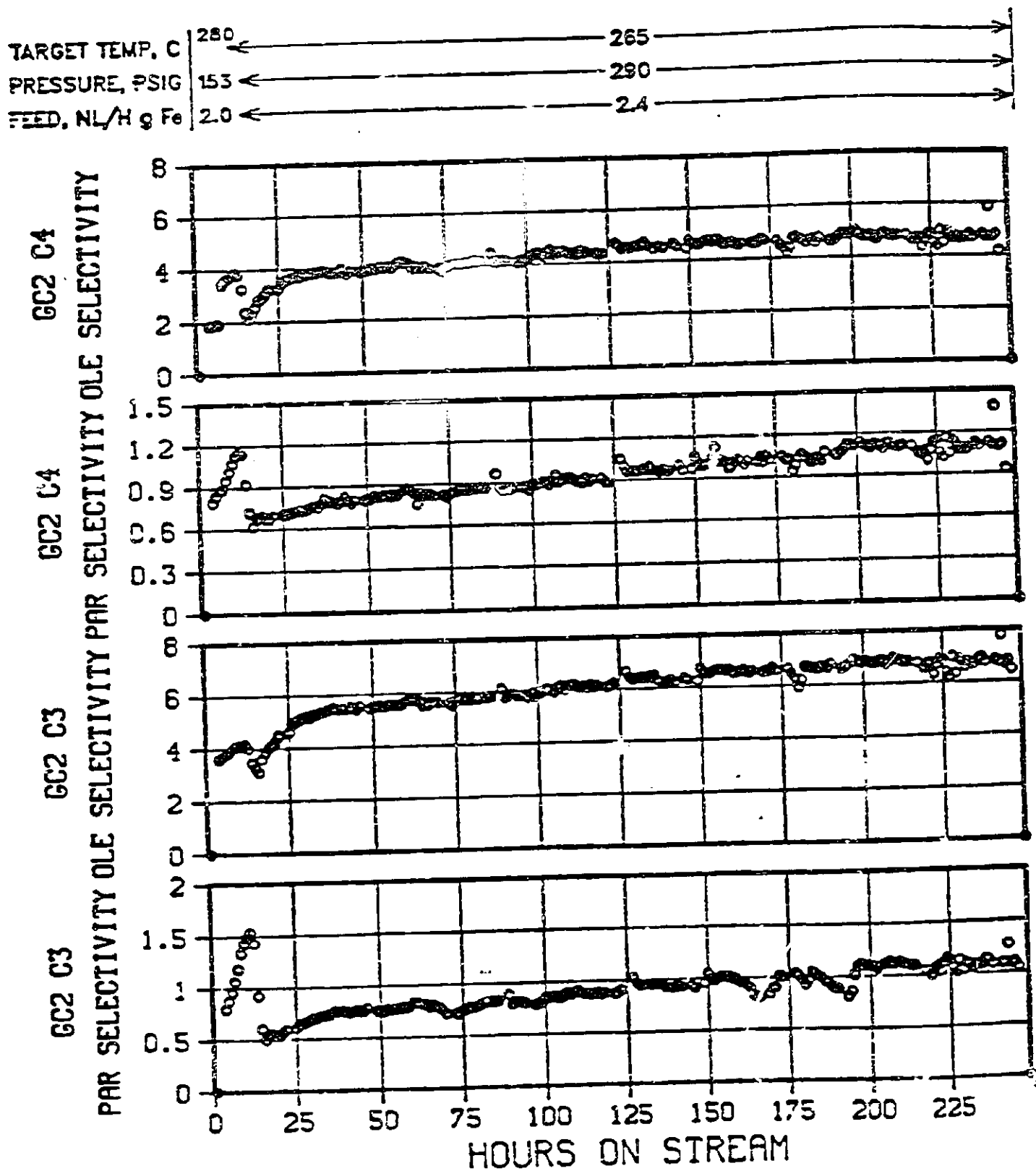


FIGURE A-8
SUMMARY DATA FOR UCI-"O" CATALYST - RUN 44

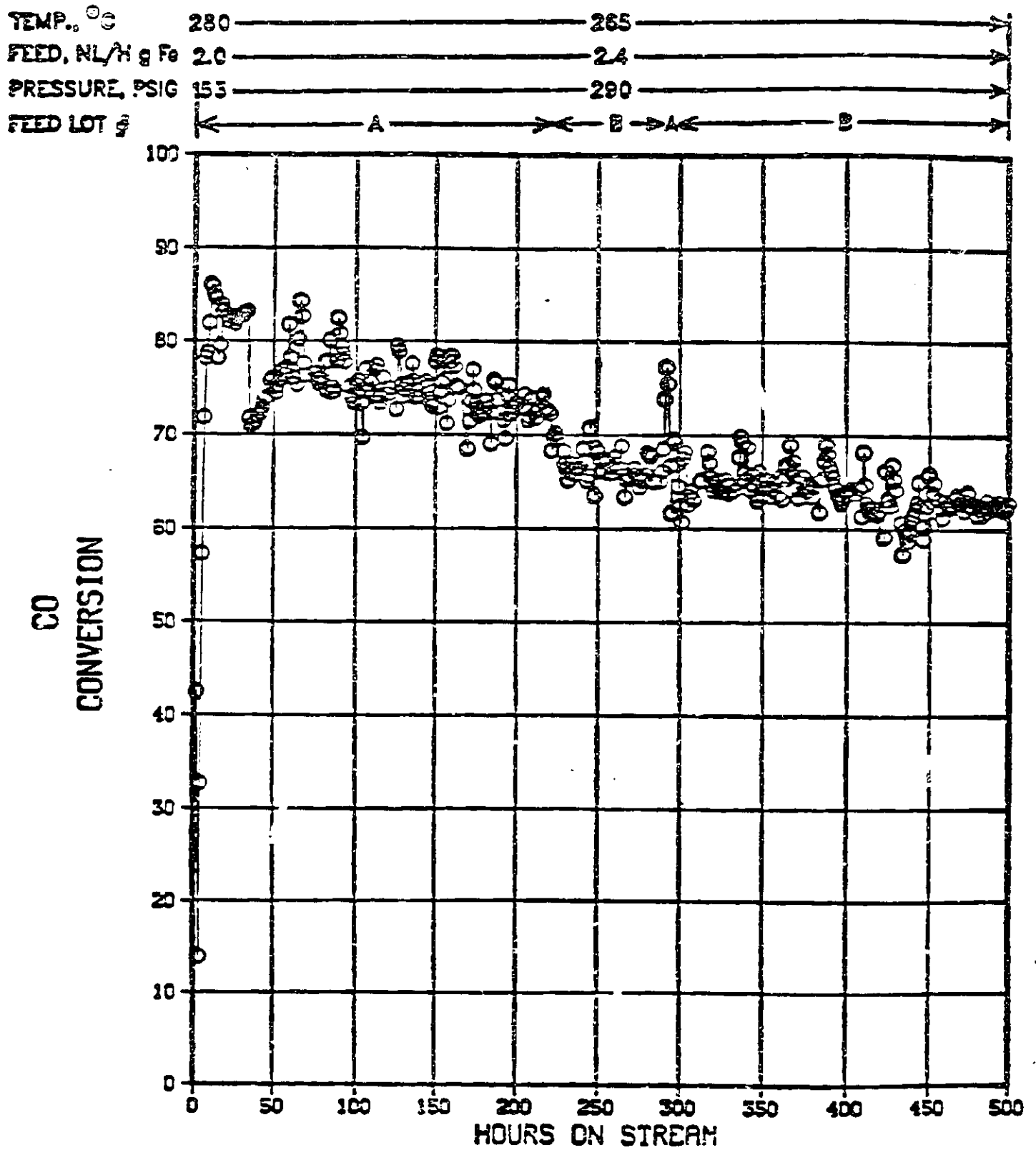


FIGURE A-9
SUMMARY DATA FOR UCI-"O" CATALYST - RUN 44

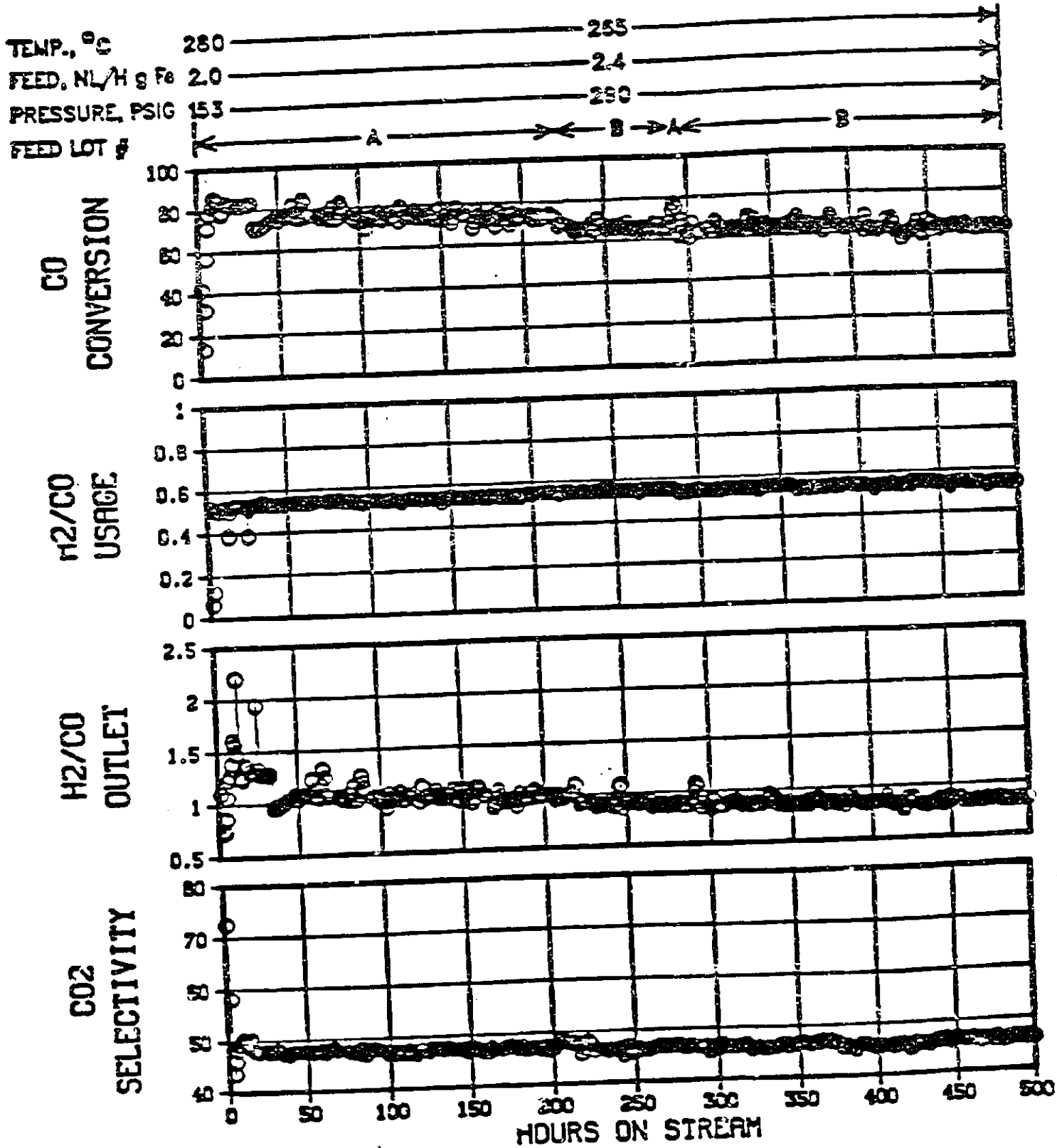


FIGURE A-10
SUMMARY DATA FOR UCI-"O" CATALYST - RUN 44

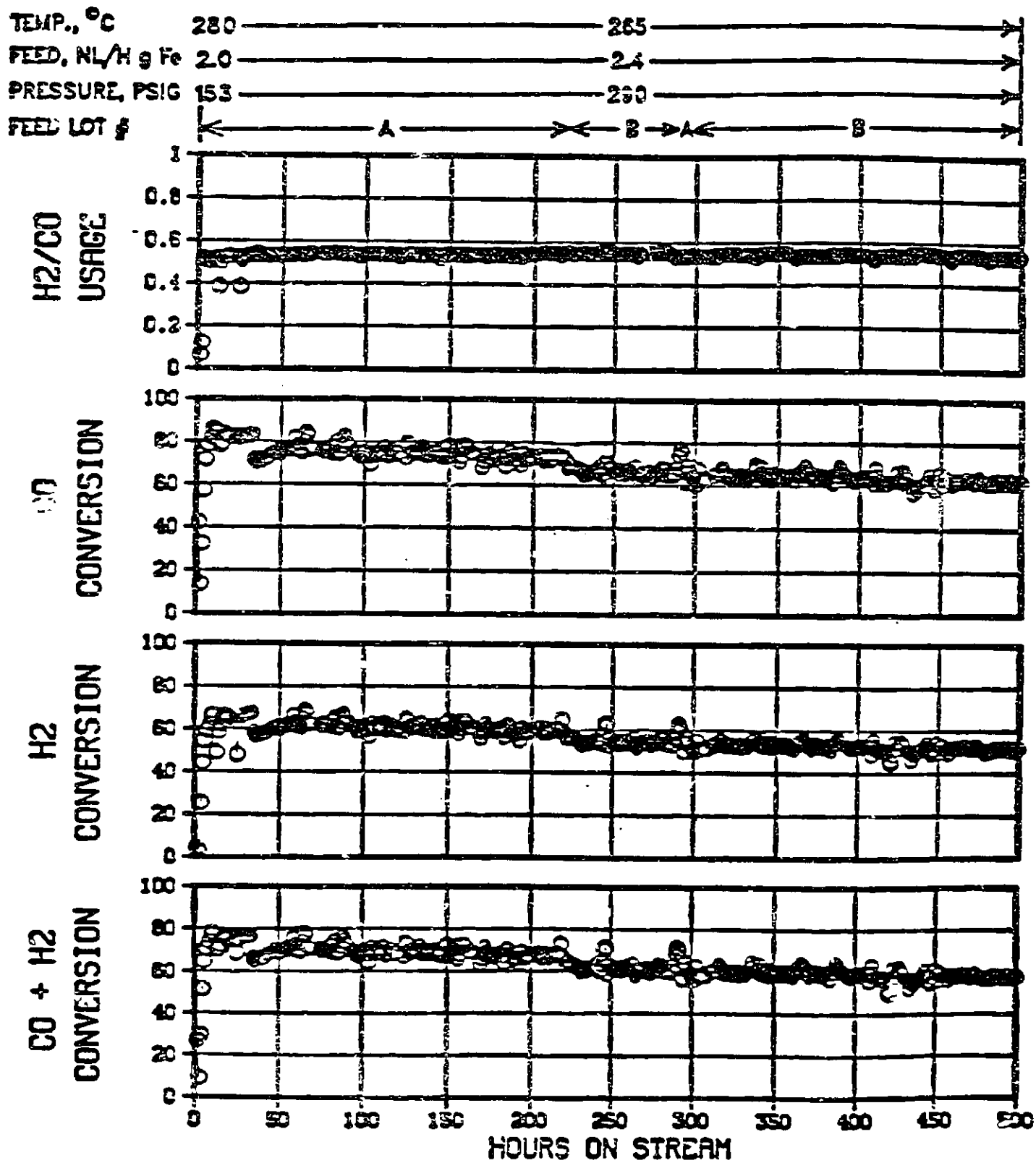


FIGURE A-11
 SUMMARY DATA FOR UCI-"O" CATALYST - RUN 44

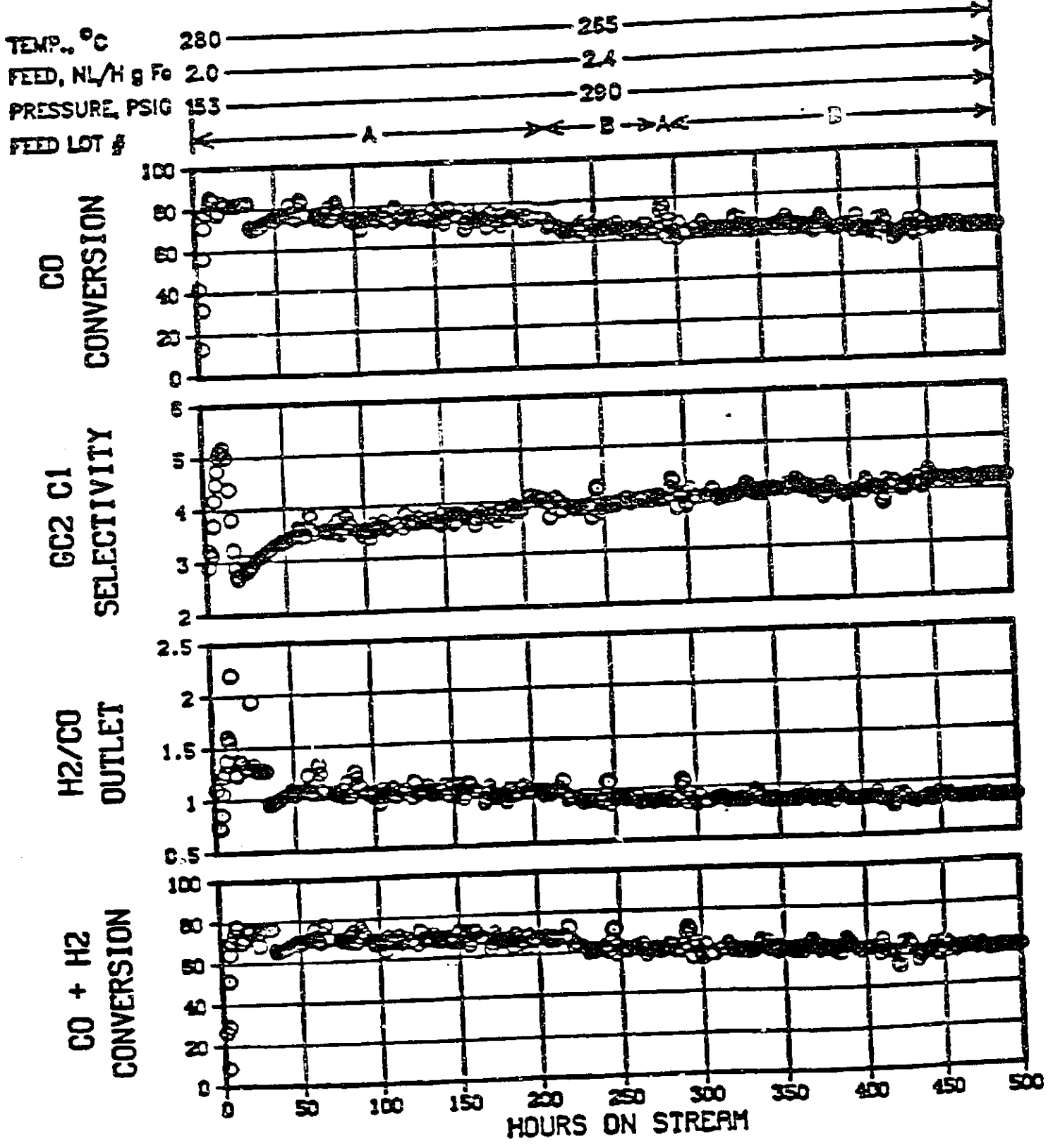


FIGURE A-12
SUMMARY DATA FOR UCI-"O" CATALYST - RUN 44

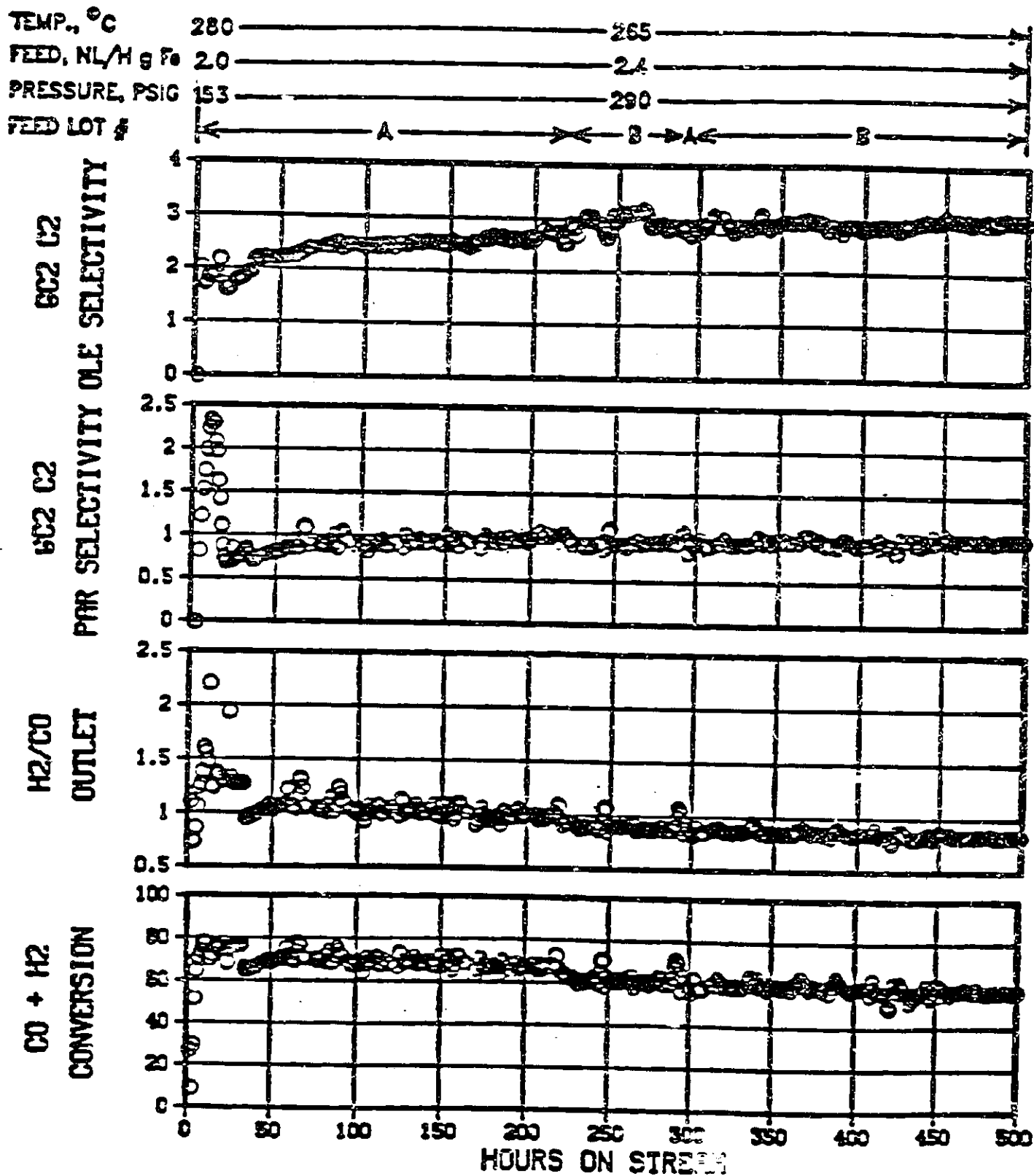


FIGURE A-13
SUMMARY DATA FOR UCI-"O" CATALYST - RUN 44

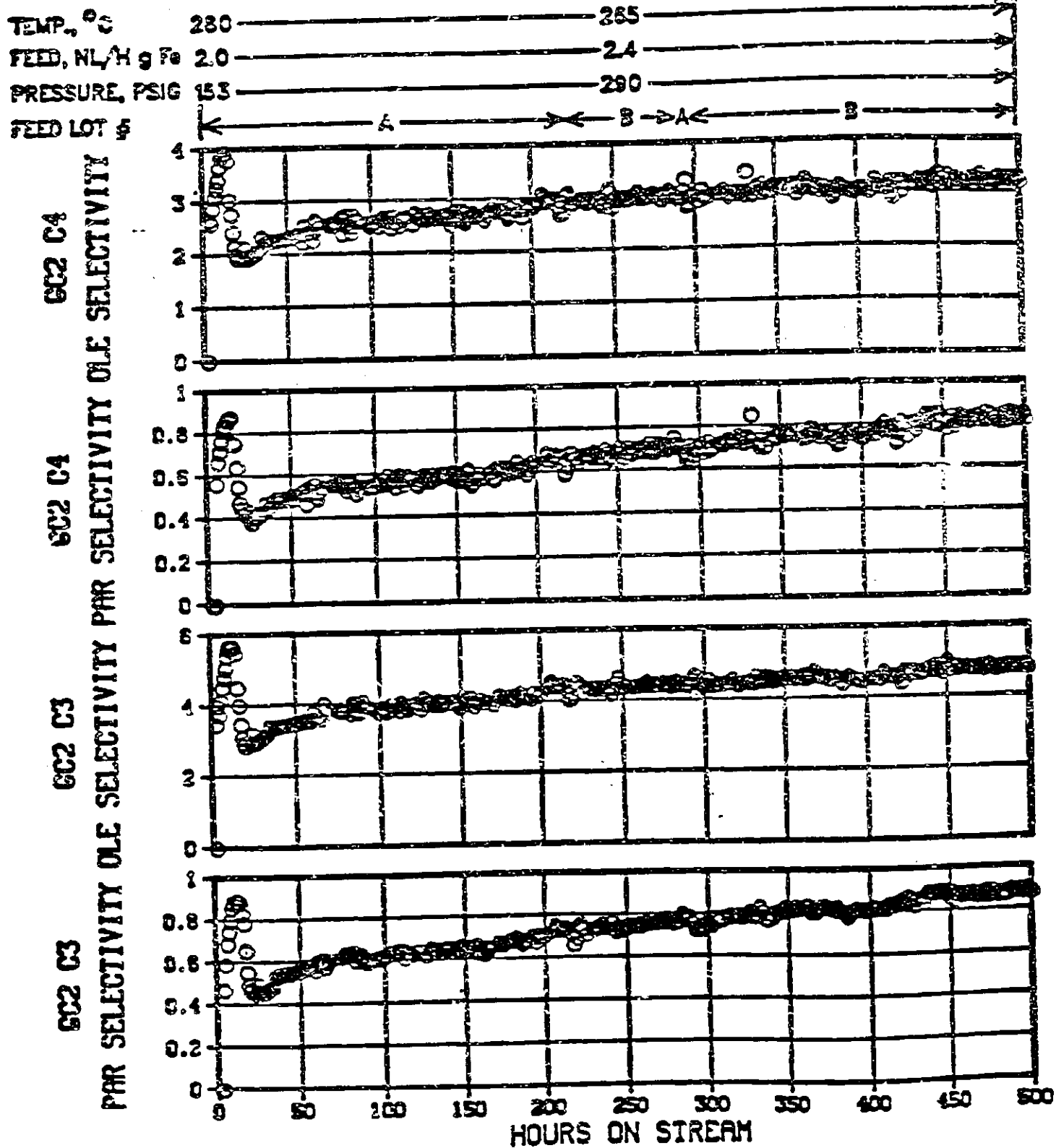


FIGURE A-14
SUMMARY DATA FOR UCI-"O" CATALYST - RUN 44

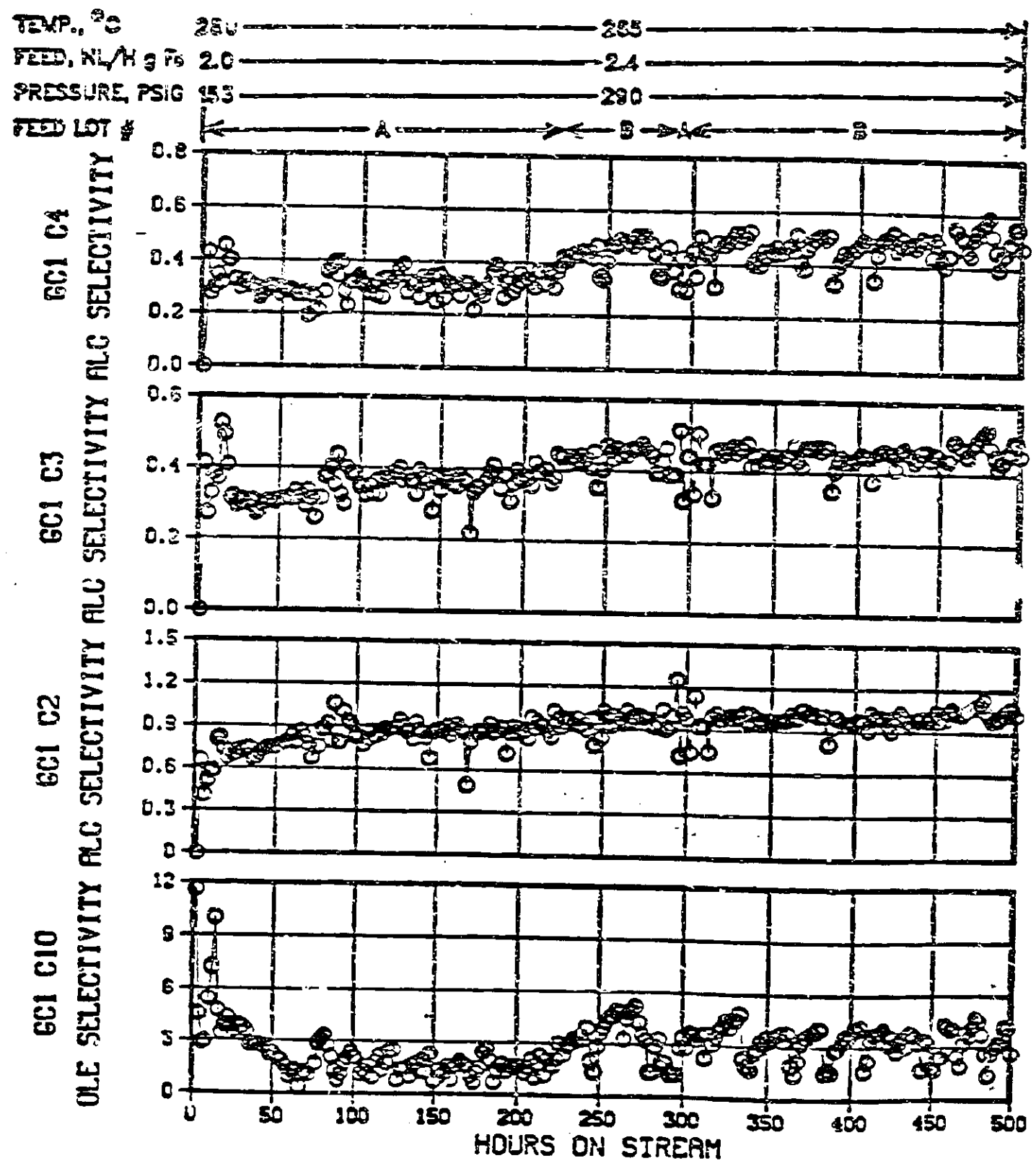


FIGURE A-15
SUMMARY DATA FOR UCI-"O" CATALYST - RUN 48

ARGET TEMP, C	280	←———— 265 ———→	←———— 285 ———→
PRESSURE, psig	153	←———— 290 ———→	
FEED, NL/H g Fe	2.0	←———— 2.4 ———→	

TEMP SPIKE *

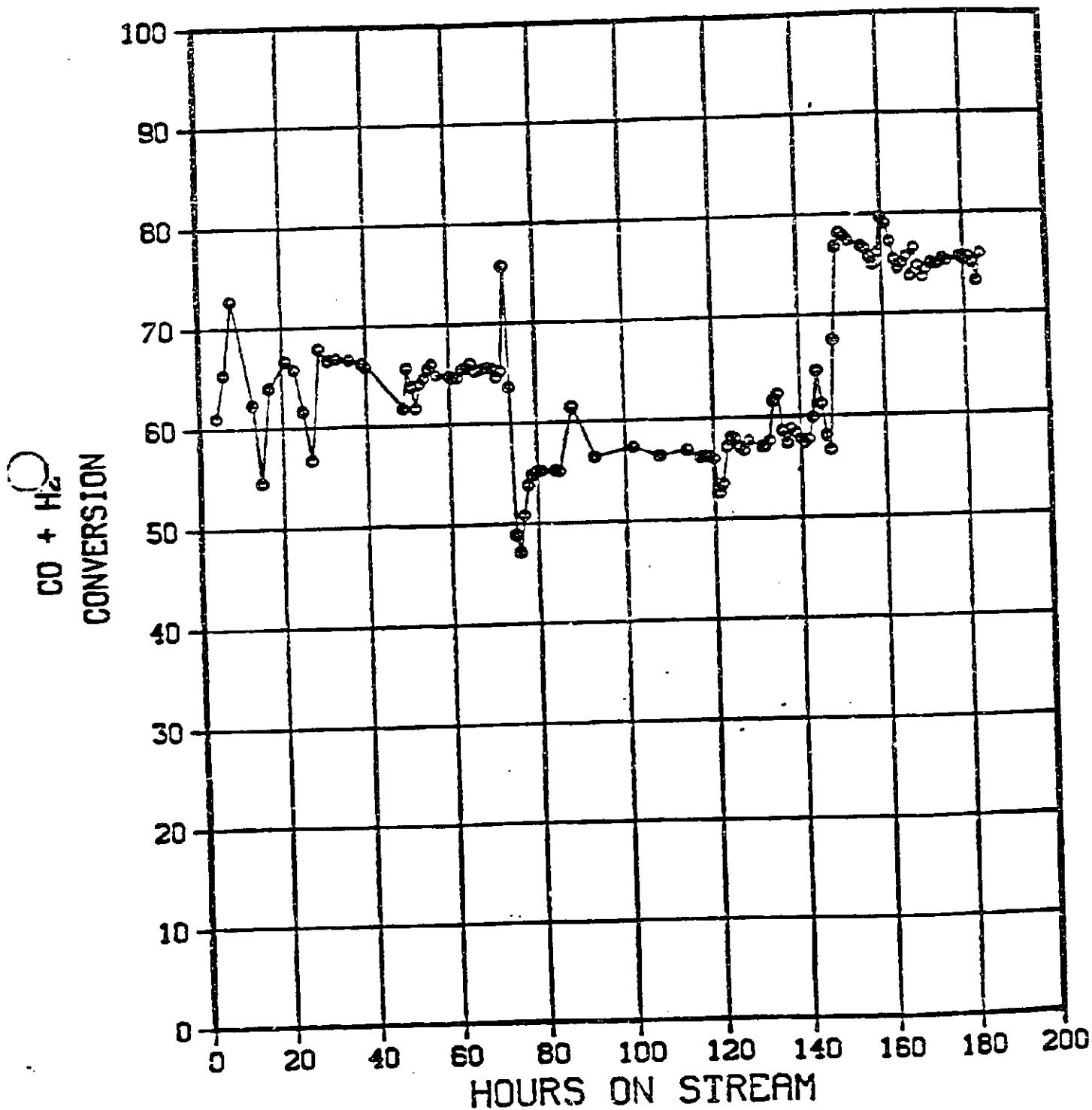


FIGURE A-16
SUMMARY DATA FOR UCI-"O" CATALYST - RUN 48

