

APPENDIX A. CATALYST TESTING: SUMMARY OF RUNS
REPORTED DURING THIS QUARTER

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J. G. Miller, L. F. Elek, C-L Yang and K. N. Beale

This report is organized around the eight catalyst tests conducted from January through March 1986, the sixth quarter of this contract.

A list of the catalysts tested, a description of their preparation, and a brief statement of each test's objective, are shown in Table A1, except for the single blank run (Run 52). All of the catalysts tested involved cobalt oxide and additive X₁₁ intimately contacted with one of three supports: Molecular Sieve TC-121 (Run 50), Molecular Sieve TC-123 (Runs 51, 53, 54, 55 and 56), and γ -alumina (Run 49). The five TC-123 supported catalysts were used to study the effects of the additional promoter I₉ (Runs 51, 55 and 56), the additional promoter X₁₃ (Run 54), and the co-mixing with extrudates of a water gas shift catalyst.

An abbreviated table of results for these catalyst runs is shown in Table A2. The conversion, weight percent CH₄, weight percent C₅⁺, and specific activity, as well as a qualitative estimate of stability, are listed for each catalyst. A more complete report of results and analyses of these runs will be presented in the Seventh Quarterly Report.

Because of the large error inherent in its computation

(based on an alpha that is determined solely from the C₃-C₆ compounds found in the off-gas), the methane factor will no longer be presented for the preliminary data given in monthly reports and in Appendix A (i.e., this Appendix) of the Quarterly Reports.

Table A1. Description of most of the catalysts tested during the sixth quarter.

Run Catalyst	Catalyst preparation	Objective of test
49 Co/X ₁₁ /γ-Al ₂ O ₃ (12561-04)	The X ₁₁ promoted cobalt oxide catalyst was formulated similarly to Catalyst 45, except that the TC-123 was replaced by γ-alumina. Theoretical pct Co=8.2, pct X ₁₁ =1.6.	To help determine the effects of the TC-123 support on catalyst performance.
50 Co/X ₁₁ /TC-121 (11617-08)	The X ₁₁ promoted cobalt oxide catalyst was formulated similarly to Catalyst 45, except that TC-123 was replaced with a new Molecular Sieve, TC-121. Theoretical pct Co=8.2, pct X ₁₁ =1.6.	To test the use of TC-121 as the catalyst support.
51 Co/X ₉ /X ₁₁ /TC-123 (12570-03)	The X ₁₁ promoted cobalt oxide catalyst was formulated similarly to Catalyst 45, except that an additional promoter, X ₉ , was added. Theoretical pct Co=8.2, pct X ₉ =1.1, pct X ₁₁ =1.6.	To screen the effect of adding the X ₉ promoter to an X ₁₁ promoted system.
52 Blank (12561-03)	Quartz chips.	To test the reactor for inherent catalytic activity.
53 Co/X ₁₁ /TC-123 + K/Ni/Mo-γ-alu- mina (12561-05)	The X ₁₁ promoted cobalt oxide catalyst was formulated similarly to Catalyst 45. 1/8" extrudates of this were combined with 1/8" extrudates of K/Ni/Mo-γ-alumina, which occupied 30% of the total catalyst volume. Theoretical pct Co=5.7, pct X ₁₁ =1.1.	To test the addition of a water gas shift component to a Co/X ₁₁ /TC-123 catalyst.
54 Co/X ₁₁ /X ₁₃ /TC-123 (11617-09)	The X ₁₁ promoted cobalt oxide catalyst was formulated similarly to Catalyst 45, except that an additional promoter, X ₁₃ , was added. Theoretical pct Co=8.1, pct X ₁₁ =1.6, pct X ₁₃ =0.7.	To screen the effect of adding the promoter X ₁₃ to an X ₁₁ promoted system.

continued

Table A1, continued.

Run Catalyst	Catalyst preparation	Objective of test
55 Co/X ₉ /X ₁₁ /TC-123 (12570-04)	The X ₉ , X ₁₁ promoted cobalt oxide catalyst was formulated similarly to Catalyst 51, except that an extra calcination step was incorporated into the formulation procedure. Theoretical pct Co=8.0, pct X ₉ =1.1, pct X ₁₁ =1.6	To repeat the results of Run 51 as well as to screen the effects of the added calcination step.
56 Co/X ₉ /X ₁₁ /TC-123 (12561-06)	The X ₉ , X ₁₁ promoted cobalt oxide catalyst was formulated similarly to Catalyst 55 except that the concentration of the X ₁₁ additive was reduced. Theoretical pct Co=8.0, pct X ₉ =1.1, pct X ₁₁ =1.0.	To further screen the X ₁₁ promoter effects.

Table A2. Preliminary catalyst test results for most of the runs made during the sixth quarter.

Run	Catalyst	Hours on stream	Total conver- sion (CO+H ₂)	CH ₄ wt %	C ₅ ⁺ wt %	Spe- cific acti- vity	Stability
49	✓ Co/X ₁₁ - γ-Al ₂ O ₃ (12561-04)	66.0	48.7	6.9	82.3	3.22	Excellent ¹
		138.0	45.0	7.1	82.5	3.40	
		162.0	62.3	8.1	81.0	3.35	Fair ²
		258.0	58.2	10.0	76.5	2.86	
		283.0	73.6	14.8	70.7	1.18	Fair ³
		331.0	69.0	16.5	67.6	0.95	
50	Co/X ₁₁ /TC-121 (11617-08)	48.5	34.3	10.2	77.3	1.28	Fair ¹
		166.0	31.8	9.9	78.3	1.10	
51	✓ Co/X ₉ /X ₁₁ /TC-123 (12570-03)	45.5	46.0	4.0	89.6	3.09	Excellent ¹
		166.5	44.5	3.5	89.2	2.99	
		214.5	56.6	6.8	83.2	1.86	Excellent ²
		331.0	55.5	6.8	83.2	1.91	
		358.0	77.8	11.9	77.5	1.44	*Good ³
		478.5	75.9	9.2	81.9	1.16	
52	Blank (quartz chips) ✓ (12561-03)	24.0	- - - - - no activity - - - - -				
53	Co/X ₁₁ /TC-123 + K/Ni/Mo- γ-alumina w (12561-05)	19.2	50.5	7.0	77.3	2.63	— ¹
		43.7	45.4	6.1	78.2	2.55	
		68.2	62.4	4.5	85.2	1.52	— ⁴
		91.2	75.3	17.4	69.0	0.94	Fair ³
		163.7	72.3	16.4	69.9	0.85	

*Estimate of stability questionable due to mechanical problems.

continued

Reactor conditions:

1. 240C, 300 psig, 1:1 H₂:CO, 300 GHSV.
2. 260C, " " " "
3. " 500 psig, 1.5:1 H₂:CO, " "
4. " " 1:1 H₂:CO, " "

12561-04 (50)

12561-05 (50)

12561-06 (50)

12561-07 (50)

12561-08 (50)

Table A2, continued.

Run	Catalyst	Hours on stream	Total conver- sion (CO+H ₂)	CH ₄ wt %	C ₅ ⁺ wt %	Spe- cific acti- vity	Stability
54	Co/X ₁₁ /X ₁₃ /TC-123 (11617-09) 1.5/1 2cc 240	27.8	55.2	4.4	84.0	5.23	Excellent ¹
		122.8	51.3	4.5	82.8	4.05	
		147.3	65.7	16.5	68.2	3.18	Excellent ⁵
		170.3	67.6	14.9	71.0	3.27	
		183.3	85.2	28.9?	47.8	1.65	— ³
		216.8	71.9	5.3	84.8	2.58	Fair ⁴
		266.3	65.6	5.0	84.9	1.95	
		289.3	72.8	8.9	79.9	1.71	Fair ⁶
		506.8	65.4	4.8	86.5	1.76	
55	Co/X ₉ /X ₁₁ /TC-123 (12570-04) 1.5/1 3cc 240	24.5	35.8	6.8	79.9	1.70	— ¹
		48.5	40.7	3.5	88.8	2.70	
		71.5	75.4	9.3	80.3	1.39	Good ³
		886.5	68.5	9.3	81.0	0.78	
56	Co/X ₉ /X ₁₁ /TC-123 (12561-06)	48.0	48.7	5.5	85.3	3.03	Excellent ¹
		192.5	47.7	4.6	86.2	3.13	
		216.5	79.8	14.3	73.9	1.34	Fair ³
		360.5	76.1	12.9	76.0	1.04	

Reactor conditions:

1. 240C, 300 psig, 1:1 H₂:CO, 300 GHSV.
3. " 500 psig, 1.5:1 H₂:CO, "
4. " " 1:1 H₂:CO, "
5. 240C, 300 psig, 1.5:1 H₂:CO, "
6. 260C, 500 psig, 1.2:1 H₂:CO, "