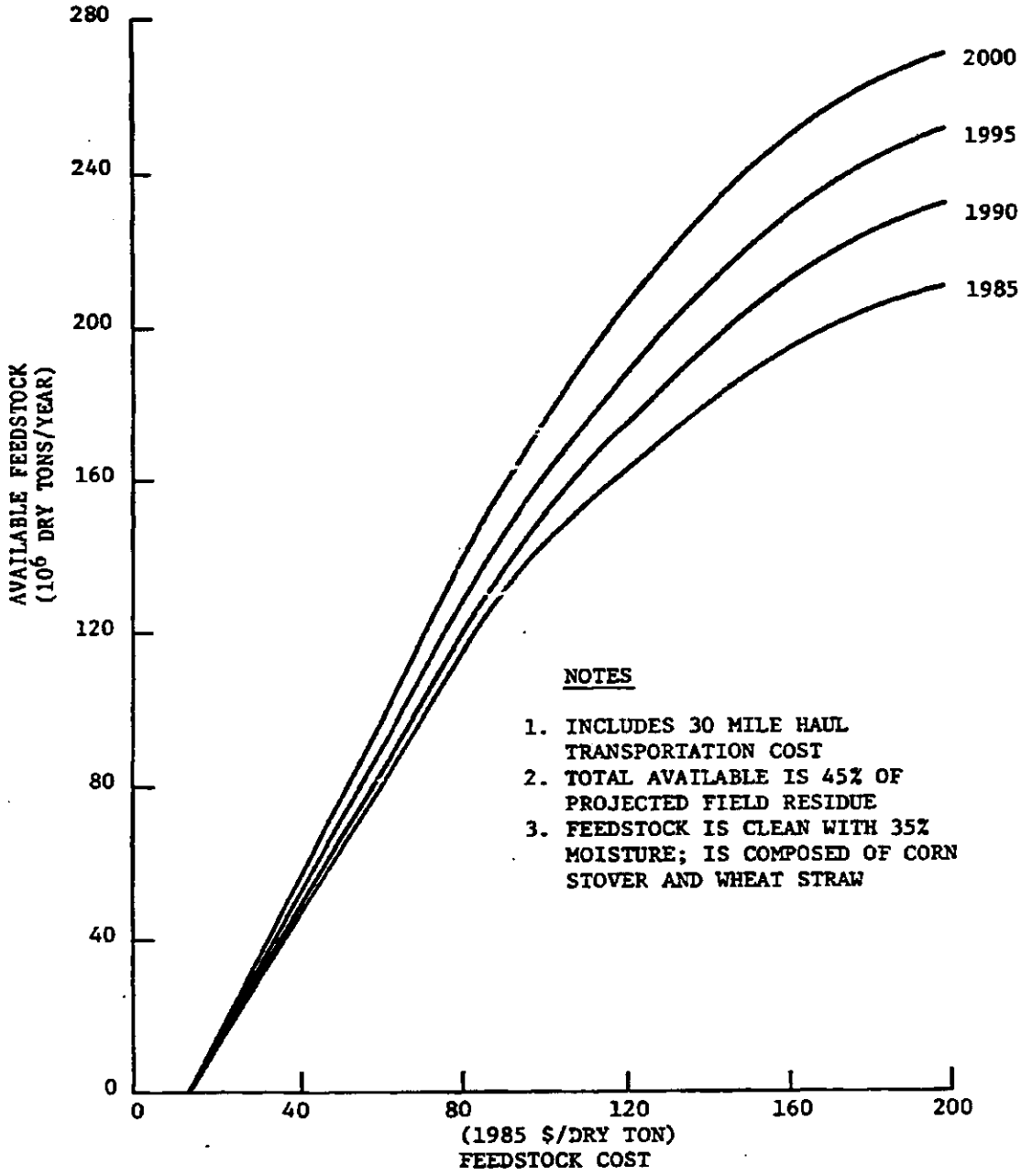
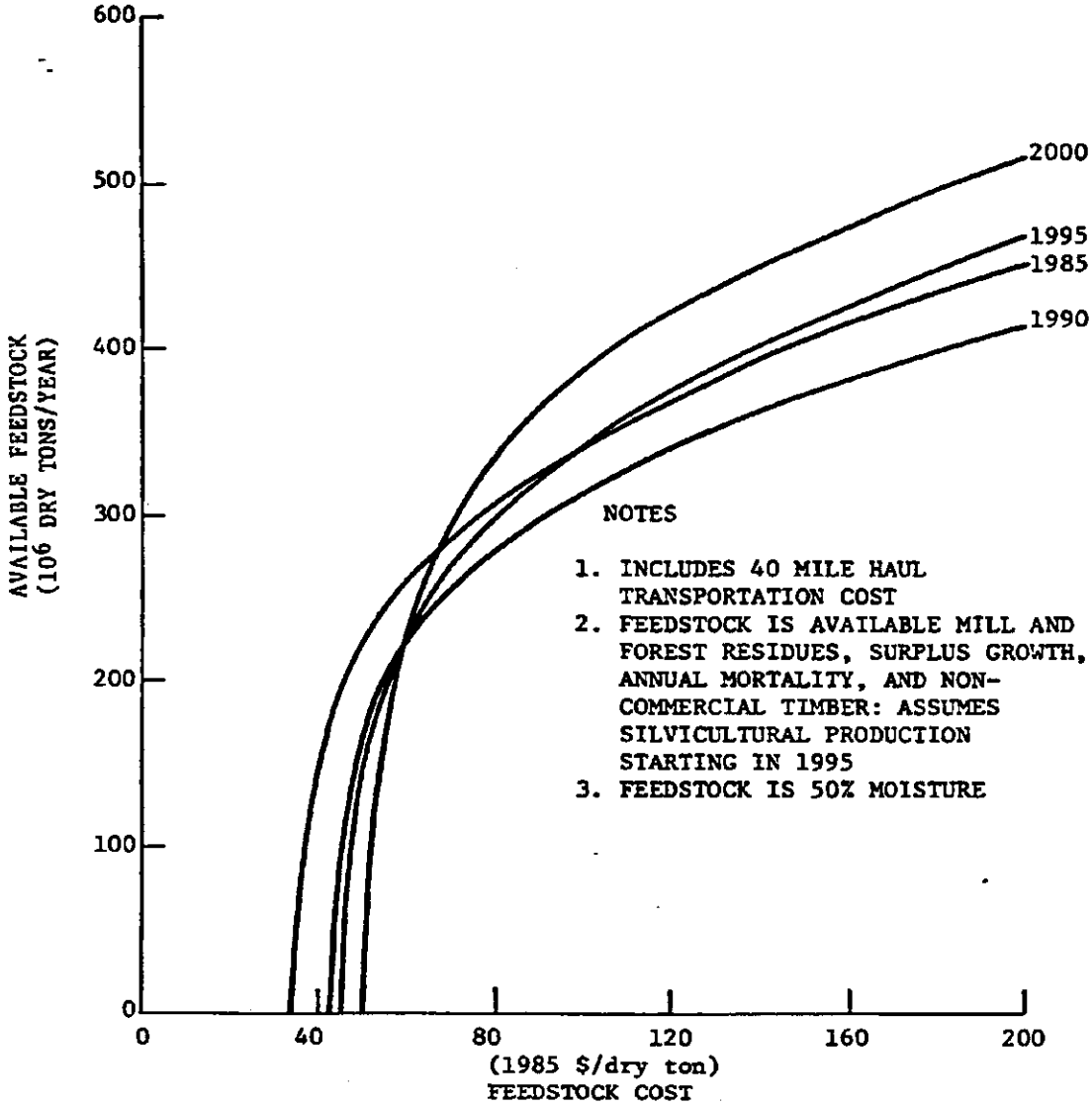


Source: References 1 and 30

Figure II.3. Supply Curve--Agricultural Residues, Delivered



Source: Reference 1

Figure II.4. Supply Curve--Wood Residue, Delivered

III. PROCESS FEEDSTOCK COST CEILING ANALYSIS

Mittelhauser Corporation performed an economic analysis of 500 TPD and 1000 TPD ASU process plants (Reference 3) using costs derived from pilot plant estimates by Kuester (Reference 14) and plant performance parameters provided by Argonne National Laboratory. The product yield assumed in the Mittelhauser Corporation analysis was 80 gallons per dry ton feedstock. A 90 percent plant factor was also assumed. Feedstock moisture content was not defined, and no cost or credit was included for supplementary gas fuel or byproduct gas sale. The Mittelhauser economic analysis used the leveled cost method to compute the product selling price required to provide a 15 percent return on investment. To the scaled-up capital costs from Kuester (Reference 14) were added contingency, working capital, and start-up expenses. Sensitivity analyses were performed on capital requirement, feedstock cost, product yield, tax credit, and cost of capital inputs.

The present study uses most cost elements and the same basic leveled cost structure as Reference 3. Product value, however, is treated as an input, consistent with the assumption that the product will be fully substitutable with commercial diesel oil (Reference 21) or No. 2 heating oil (which have essentially equal refiner's prices). Reversing the Mittelhauser leveled cost analysis, the feedstock cost consistent with a 15 percent ROI is computed, using projected fuel prices as input parameters.

In the leveled cost analysis, the total capital requirement is distributed annually over the plant lifetime using a capital recovery factor determined by the required ROI. Other elements (operating and maintenance, income taxes, and revenues) are estimated on an annual basis. The leveled cost analysis captures the time value of money (via the capital recovery factor), but omits the effect of differing price escalation rates among the various cost and income elements. To capture some of this effect, the leveled cost analysis is performed for plant operation start dates in 1985, 1990, and 1995. Except for items such as fuel costs which are specified for 1985 according to the best currently available information, the individual cost elements from the Mittelhauser report are inflated separately to 1985, 1990, and 1995 using nominal price escalation rates (Reference 2). With the price escalation rates used in this analysis, the leveled cost method is conservative in that a more realistic net present value analysis would give higher feedstock cost ceiling results. The leveled cost approach is retained for this reason (future price escalators are uncertain) and for comparability with the previous work.

Tables III-1, III-2, and III-3 display, for illustration, some of the detailed capital cost estimates developed for the 1985, 1990, and 1995 plant starts, respectively. These tables show the total capital requirement for a 1000 TPD (dry feedstock equivalent) capacity plant. Working capital and start-up expenses are varied with product yield and feedstock moisture as noted in the tables. Plant installed costs are varied with feedstock moisture content by scaling the volume of the combustor-pyrolyzer system for the added water throughput as follows:

TABLE III-1. CAPITAL COST ESTIMATION, 1985 START

Dry Feed Capacity: 1000 TPD
Operation Start Date: 1985 (Constant dollar base year)
Plant Factor: 90%

COSTS-MILLIONS OF BASE YEAR DOLLARS

	Feedstock Moisture Content											
	20%				35%				50%			
	Yield (gal/dry ton)				Yield (gal/dry ton)				Yield (gal/dry ton)			
	40	60	80	100	40	60	80	100	40	60	80	100
Installed Costs[a]	31.90	31.90	31.90	31.90	33.15	33.15	33.15	33.15	35.05	35.05	35.05	35.05
Construction Indirects at 41%	13.08	13.08	13.08	13.08	13.59	13.59	13.59	13.59	14.37	14.37	14.37	14.37
Engineering at 8%	2.55	2.55	2.55	2.55	2.65	2.65	2.65	2.65	2.80	2.80	2.80	2.80
Installed Facilities	47.53	47.53	47.53	47.53	49.39	49.39	49.39	49.39	52.32	52.32	52.32	52.32
Project Contingency at 15%	7.13	7.13	7.13	7.13	7.41	7.41	7.41	7.41	7.85	7.85	7.85	7.85
Capital Investment	54.66	54.66	54.66	54.66	56.80	56.80	56.80	56.80	60.17	60.17	60.17	60.17
Land at 3.8% of Installed Costs	1.21	1.21	1.21	1.21	1.26	1.26	1.26	1.26	1.33	1.33	1.33	1.33
Total Investment	55.87	55.87	55.87	55.87	58.06	58.06	58.06	58.06	61.50	61.50	61.50	61.50
Working Capital[b]	.65	.91	1.20	1.49	.99	1.27	1.56	1.85	1.55	1.84	2.13	2.43
Interest Expenses During Construction[c]	4.71	4.71	4.71	4.71	4.89	4.89	4.89	4.89	5.18	5.18	5.18	5.18
Less Investment Tax Credit[d]	(5.59)	(5.59)	(5.59)	(5.59)	(5.81)	(5.81)	(5.81)	(5.81)	(6.15)	(6.15)	(6.15)	(6.15)
NET CAPITAL REQUIREMENT	55.65	55.90	56.19	56.48	58.13	58.41	58.70	58.99	62.08	62.37	62.66	62.96
Start-up Expenses[e]	1.52	1.84	2.18	2.54	1.94	2.28	2.63	2.99	2.62	2.97	3.33	3.68
TOTAL CAPITAL REQUIREMENT	57.16	57.74	58.37	59.02	60.07	60.69	61.33	61.98	64.70	65.34	65.99	66.64

NOTES:
a. At 9% price escalation per year.
b. Working capital at 45 days net cash operating expenses, 15 days' feed at $20.00/ton.
c. At 15%, net of 48.16% income tax reduction.
d. Assumed continued at 10% of total investment.
e. Start-up estimated at two month's operating expenses, including feedstock supply at $20.00/ton (1985).

SOURCE: Mittelhauser Corporation, op. cit., and EIA, "Annual Report to Congress, 1979."

TABLE III-2. CAPITAL COST ESTIMATION, 1990 START

Dry Feed Capacity: 1000 TPD
Operation Start Date: 1990 (Constant dollar base year)
Plant Factor: 90%

COSTS-MILLIONS OF BASE YEAR DOLLARS

	Feedstock Moisture Content											
	20% Yield (gal/dry ton)				35% Yield (gal/dry ton)				50% Yield (gal/dry ton)			
	40	60	80	100	40	60	80	100	40	60	80	100
Installed Costs[a]	49.08	49.08	49.08	49.08	51.00	51.00	51.00	51.00	53.93	53.93	53.93	53.93
Construction Indirects at 41%	20.12	20.12	20.12	20.12	20.91	20.91	20.91	20.91	22.11	22.11	22.11	22.11
Engineering at 8%	3.93	3.93	3.93	3.93	4.08	4.08	4.08	4.08	4.31	4.31	4.31	4.31
Installed Facilities	73.13	73.13	73.13	73.13	75.99	75.99	75.99	75.99	80.35	80.35	80.35	80.35
Project Contingency at 15%	10.97	10.97	10.97	10.97	11.40	11.40	11.40	11.40	12.05	12.05	12.05	12.05
Capital Investment	84.10	84.10	84.10	84.10	87.39	87.39	87.39	87.39	92.40	92.40	92.40	92.40
Land at 3.8% of Installed Costs	1.86	1.86	1.86	1.86	1.94	1.94	1.94	1.94	2.05	2.05	2.05	2.05
Total Investment	85.96	95.96	85.96	85.96	89.33	89.33	89.33	89.33	94.45	94.45	94.45	94.45
Working Capital[b]	.92	1.40	1.92	2.46	1.54	2.05	2.58	3.12	2.56	3.09	3.62	4.16
Interest Expenses During Construction[c]	7.25	7.25	7.25	7.25	7.53	7.53	7.53	7.53	7.96	7.96	7.96	7.96
Less Investment Tax Credit[d]	(8.60)	(8.60)	(8.60)	(8.60)	(8.93)	(8.93)	(8.93)	(8.93)	(9.44)	(9.44)	(9.44)	(9.44)
NET CAPITAL REQUIREMENT	85.53	86.01	86.53	87.07	89.44	89.98	90.51	91.05	95.53	96.06	96.59	97.13
Start-up Expenses[e]	2.22	2.81	3.44	4.10	2.98	3.60	4.24	4.90	4.21	4.87	5.51	6.17
TOTAL CAPITAL REQUIREMENT	87.75	88.82	89.97	91.17	92.45	93.58	94.75	95.95	99.74	100.93	102.10	103.30

NOTES:
a. At 9% price escalation per year.
b. Working capital at 45 days net cash operating expenses, 15 days' feed at $20.00/ton.
c. At 15%, net of 48.16% income tax reduction.
d. Assumed continued at 10% of total investment.
e. Start-up estimated at two month's operating expenses, including feedstock supply at $20.00/ton (1985).

SOURCE: Mittelhauser Corporation, op. cit., and EIA, "Annual Report to Congress, 1979."

TABLE III-3. CAPITAL COST ESTIMATION, 1995 START

Dry Feed Capacity: 1000 TPD
Operation Start Date: 1995 (Constant dollar base year)
Plant Factor: 90%

COSTS-MILLIONS OF BASE YEAR DOLLARS

	Feedstock Moisture Content											
	20% Yield (gal/dry ton)				35% Yield (gal/dry ton)				50% Yield (gal/dry ton)			
	40	60	80	100	40	60	80	100	40	60	80	100
Installed Costs[a]	75.75	75.52	75.52	75.52	78.48	78.48	78.48	78.48	82.98	82.98	82.98	82.98
Construction Indirects at 41%	30.96	30.96	30.96	30.96	32.18	32.18	32.18	32.18	34.02	34.02	34.02	34.02
Engineering at 8%	6.04	6.04	6.04	6.04	6.28	6.28	6.28	6.28	6.64	6.64	6.64	6.64
Installed Facilities	112.52	112.52	112.52	112.52	116.94	116.94	116.94	116.94	123.64	123.64	123.64	123.64
Project Contingency at 15%	16.88	16.88	16.88	16.88	17.54	17.54	17.54	17.54	18.55	18.55	18.55	18.55
Capital Investment	129.40	129.40	129.40	129.40	134.48	134.48	134.48	134.48	142.19	142.19	142.19	142.19
Land at 3.8% of Installed Costs	2.87	2.87	2.87	2.87	2.99	2.98	2.98	2.98	3.15	3.15	3.15	3.15
Total Investment	132.27	132.27	132.27	132.27	137.46	137.46	137.46	137.46	145.34	145.34	145.34	145.34
Working Capital[b]	1.22	2.11	3.06	4.05	2.35	3.29	4.27	5.25	4.20	5.19	6.17	7.15
Interest Expenses During Construction[c]	11.15	11.15	11.15	11.15	11.59	11.59	11.59	11.59	12.25	12.25	12.25	12.25
Less Investment Tax Credit[d]	(13.23)	(13.23)	(13.23)	(13.23)	(13.75)	(13.75)	(13.75)	(13.75)	(14.53)	(14.53)	(14.53)	(14.53)
NET CAPITAL REQUIREMENT	131.41	132.30	133.25	134.24	137.65	138.59	139.57	140.55	147.26	148.25	149.23	150.21
Start-up Expenses[e]	3.15	4.23	5.39	6.59	4.53	5.67	6.85	8.06	6.78	7.98	9.17	10.37
TOTAL CAPITAL REQUIREMENT	134.56	136.53	138.64	140.83	142.18	144.26	146.43	148.61	154.04	156.23	158.40	160.58

NOTES:
a. At 9% price escalation per year.
b. Working capital at 45 days net cash operating expenses, 15 days' feed at $20.00/ton.
c. At 15%, net of 48.16% income tax reduction.
d. Assumed continued at 10% of total investment.
e. Start-up estimated at two month's operating expenses, including feedstock supply at $20.00/ton (1985).

SOURCE: Mittelhauser Corporation, op. cit., and EIA, "Annual Report to Congress, 1979."

	Feedstock Moisture Content			
	0%	20%	35%	50%
Equipment Volume Scale Up (ESU)	1.0	1.12	1.24	1.34

Finally, the dry basis installed cost is scaled up for feedstock moisture content according to the following convention (Reference 13):

Installed Cost = MIF x DBC, where

DBC = dry basis cost
MIF = moisture increase cost factor, and

$$MIF = (2/3) \times (ESU)^{0.6} + 1/3$$

Plant operating costs, revenues, and the derivation of the feedstock delivered cost ceiling for the 1000 TPD plant are shown for illustration in Tables III-4, III-5, and III-6. The main difference between these O&M costs and those used by Mittelhauser in Reference 3 is that a cost is included for purchased gas supplemental fuel (or a by-product gas credit is included as appropriate).

The overall system energy balance is based on the mass balance given by J.L. Kuester in the Arizona State University process flow sheet (Reference 14). The pyrolyzer steady state energy demands were calculated on a dry feed basis. Pyrolysis gas recycle is the fluidizing medium for the pyrolyzer. Off-gas from the Fischer-Tropsch reactor and char from the pyrolyzer cyclone separator are considered as fuel for the combustor (References 10 and 19). The various heat values, composition and amounts available of the Fischer-Tropsch off-gas are predicated on values from the aforementioned process flow sheet. A 500 TPD plant mass balance used for this purpose is shown in Figure III.1. Assumed system temperatures are shown in Figure III.2. Because of the relatively good efficiency associated with fluidized bed heat transfer, an overall system efficiency of 80 percent is used. Once the dry feed system energy requirements were calculated, increases in moisture content resulted in increased energy requirements by the amount of extra heat needed to heat and vaporize the excess water. Additionally, as the Fischer-Tropsch product yield increased, the amount of by-product off-gas decreases although the combustor-pyrolyzer system demands remain relatively constant. A break even point is reached below which make-up gas must be purchased (see Figure III.3). Annual by-product gas for the 500 TPD, 90 percent plant factor case is displayed in Table III-7.

In Tables III-4, III-5, and III-6, annual feedstock cost is equal to annual gross revenues less income taxes, annualized capital costs, and net annual O&M costs. Feedstock costs are expressed in 1985 dollars per

TABLE III-4. O&M COST ESTIMATION AND FEEDSTOCK COST CEILING, 1985 START

Dry Feed Capacity: 1000 TPD
Operation Start Date: 1985 (Constant dollar base year)
Plant Factor: 90%

ANNUAL COSTS --- THOUSANDS OF BASE YEAR DOLLARS

	Feedstock Moisture Content											
	20% Yield (gal/dry ton)				35% Yield (gal/dry ton)				50% Yield (gal/dry ton)			
	40	60	80	100	40	60	80	100	40	60	80	100
Payroll[a]	1360	1360	1360	1360	1396	1396	1396	1396	1396	1396	1936	1396
Operating Supplies at 15% Oper. Payroll	89	89	89	89	94	94	94	94	94	94	94	94
Maintenance Supplies at 2.25% Capital Investment	1230	1230	1230	1230	1278	1278	1278	1278	1354	1354	1354	1354
Total Supplies[a]	1319	1319	1319	1319	1372	1372	1372	1372	1448	1448	1448	1448
Electricity[b]	442	442	442	442	457	457	457	457	478	478	478	478
Purchased Gas Fuel (By-Product Credit)[c]	(2340)	(416)	1652	3792	0	2030	4146	6286	3878	6016	8132	10272
Outside Services[d]	93	93	93	93	93	93	93	93	93	93	93	93
Local Taxes and Insurance at 3% Total Investment[e]	1676	1676	1676	1676	1742	1742	1742	1742	1845	1845	1845	1845
TOTAL ANNUAL O&M EXPENSES EXCLUDING FEEDSTOCK	2550	4474	6542	8682	5060	7090	9206	11346	9138	11276	13392	15532
Annual Capital Cost (CRF=.16)	9146	9238	9339	9443	9611	9710	9813	9917	10352	10454	10558	10662
Income Tax at 48.16%[h]	5668	5739	5817	5897	5973	6049	6129	6209	6460	6538	6618	6699
Gross Revenue[f]	18790	28186	37580	46976	18790	28186	37580	46976	18790	28186	37580	46976
Feedstock Cost at 0.160 CRF[g]	1426	8735	15882	22954	(1854)	5337	12432	19504	(7160)	(82)	7012	14083
1985 Feedstock Cost in dollars/dry ton	4.34	26.59	48.35	69.87	(5.64)	16.25	37.84	59.37	(21.80)	(0.25)	21.35	42.87

NOTES: a. Escalated at 9.0% per year.
b. Escalated at 8.6% per year, base price 6.13 cents/kWh in 1985.
c. Escalated at 12.9% per year, base price $5.96/10^6 Btu in 1985 for purchased fuel; $5.36/10^6 Btu in 1985 for excess by-product gas credit.
d. Escalated at 8.0% per year (assumed rate of general inflation).
e. Fixed annual expense.
f. Sale of product at refiner's price, distillate fuel oil; escalated at 10.5% per year, base price $1.43/gal in 1985.
g. 15% ROI, 20 year investment life; feedstock cost assumed to escalate at 8.0% per year.
h. Income Taxes = 48.16/51.84 x (Annual Capital Recovery - 1/20 (Capital Investment + Startup + Interest Expense)

SOURCE: Mittelhauser Corporation, February 15, 1980, op. cit. and DOE/EIA, "Annual Report to Congress, 1979."

TABLE III-5. O&M COST ESTIMATION AND FEEDSTOCK COST CEILING, 1990 START

Dry Feed Capacity: 1000 TPD
Operation Start Date: 1990 (Constant dollar base year)
Plant Factor: 90%

ANNUAL COSTS --- THOUSANDS OF BASE YEAR DOLLARS

	Feedstock Moisture Content											
	20% Yield (gal/dry ton)				35% Yield (gal/dry ton)				50% Yield (gal/dry ton)			
	40	60	80	100	40	60	80	100	40	60	80	100
Payroll[a]	2092	2092	2092	2092	2148	2148	2148	2148	2148	2148	2148	2148
Operating Supplies at 15% Oper. Payroll	314	314	314	314	322	322	322	322	322	322	322	322
Maintenance Supplies at 2.25% Capital Investment	1892	1892	1892	1892	1966	1966	1966	1966	2083	2083	2083	2083
Total Supplies[a]	2206	2206	2206	2206	2288	2288	2288	2288	2405	2405	2405	2405
Electricity[b]	678	678	678	678	690	690	690	690	722	722	722	722
Purchased Gas Fuel (By-Product Credit)[c]	(4292)	(763)	3030	6956	0	3724	7605	11530	7113	11035	14916	18842
Outside Services[d]	137	137	137	137	137	137	137	137	137	137	137	137
Local Taxes and Insurance at 3% Total Investment[e]	2578	2578	2578	2578	2680	2680	2680	2680	2833	2833	2833	2833
TOTAL ANNUAL O&M EXPENSES EXCLUDING FEEDSTOCK	3399	6928	10721	14647	7943	11667	15548	19473	15358	19280	23161	27087
Annual Capital Cost (CRF=.16)	14040	14211	14395	14587	14792	14973	15160	15352	15958	16149	16336	16528
Income Tax at 48.16%[h]	8697	8828	8970	9117	9194	9334	9478	9625	9968	10115	10259	10406
Gross Revenue[f]	30956	46435	61911	77390	30956	46435	61911	77390	30956	46435	61911	77390
Feedstock Cost at 0.160 CRF[g]	4820	16468	27825	39039	(973)	10461	21725	32940	(10328)	891	12155	23369
1990 Feedstock Cost in dollars/dry ton	14.67	50.13	84.70	118.84	(2.96)	31.84	66.13	100.27	(31.44)	2.71	37.00	71.14
1990 Feedstock Cost in 1985 dollars/dry ton	9.98	34.12	57.65	80.88	(2.01)	21.67	45.01	68.24	(21.40)	1.84	25.18	48.42

NOTES: a. Escalated at 9.0% per year.
b. Escalated at 8.6% per year, base price 6.13 cents/kWh in 1985.
c. Escalated at 12.9% per year, base price $5.96/10^6 Btu in 1985 for purchased fuel; $5.36/10^6 Btu in 1985 for excess by-product gas credit.
d. Escalated at 8.0% per year (assumed rate of general inflation).
e. Fixed annual expense.
f. Sale of product at refiner's price, distillate fuel oil; escalated at 10.5% per year, base price $1.43/gal in 1985.
g. 15% ROI, 20 year investment life; feedstock cost assumed to escalate at 8.0% per year.
h. Income Taxes = 48.16/51.84 x (Annual Capital Recovery - 1/20 (Capital Investment + Startup + Interest Expense)

SOURCE: Hittelhauser Corporation, February 15, 1980, op. cit. and DOE/EIA, "Annual Report to Congress, 1979."

TABLE III-6. O&M COST ESTIMATION AND FEEDSTOCK COST CEILING, 1995 START

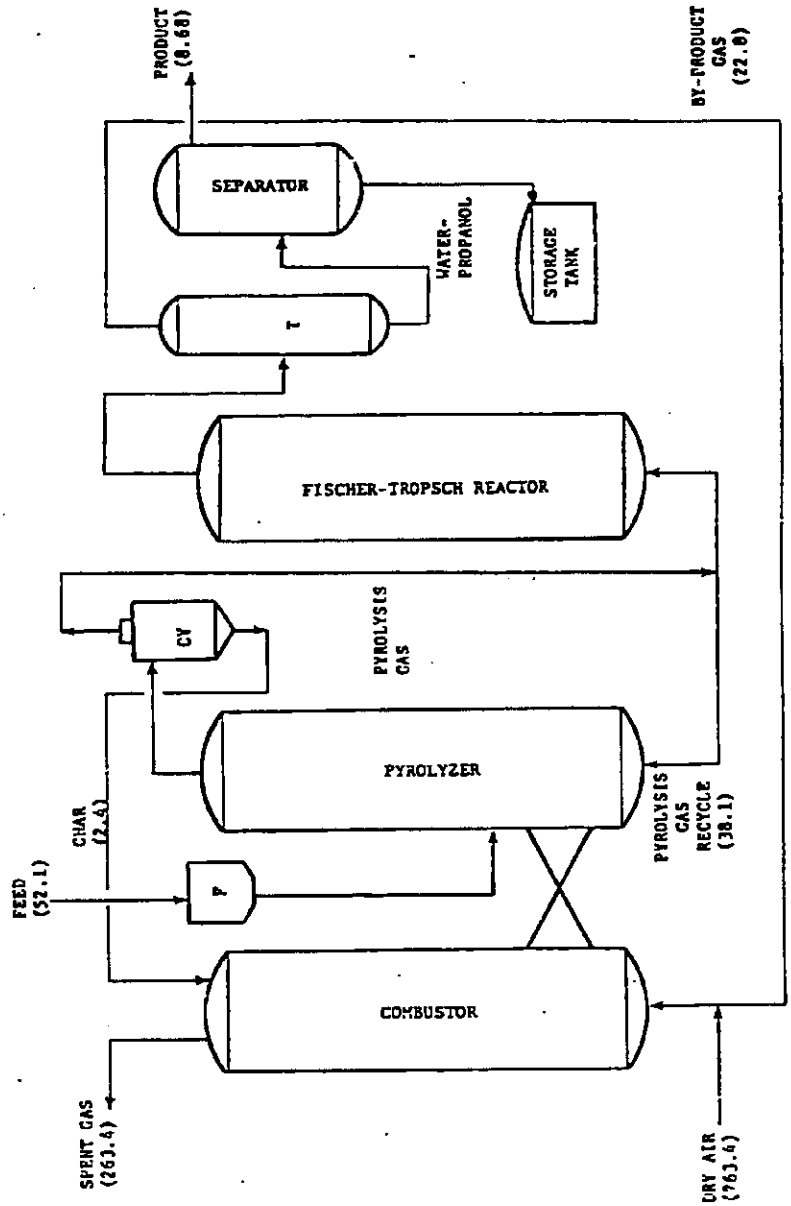
Dry Feed Capacity: 1000 TPD
Operation Start Date: 1995 (Constant dollar base year)
Plant Factor: 90%

ANNUAL COSTS --- THOUSANDS OF BASE YEAR DOLLARS

	Feedstock Moisture Content											
	20% Yield (gal/dry ton)				35% Yield (gal/dry ton)				50% Yield (gal/dry ton)			
	40	60	80	100	40	60	80	100	40	60	80	100
Payroll[a]	3220	3220	3220	3220	3305	3305	3305	3305	3005	3305	3305	3305
Operating Supplies at 15% Oper. Payroll	483	483	483	483	496	496	496	496	496	496	496	496
Maintenance Supplies at 2.25% Capital Investment	2911	2911	2911	2911	3026	3026	3026	3026	3199	3199	3199	3199
Total Supplies[a]	3394	3394	3394	3394	3522	3527	3522	3522	3695	3695	3695	3695
Electricity[b]	1007	1007	1007	1007	1043	1043	1043	1043	1091	1091	1091	1091
Purchased Gas Fuel (By-Product Credit)[c]	(7873)	(1400)	5558	12759	0	6830	13950	21150	13048	20242	27361	34562
Outside Services[d]	201	201	201	201	201	201	201	201	201	201	201	201
Local Taxes and Insurance at 3% Total Investment[e]	3968	3968	3968	3968	4124	4124	4124	4124	4360	4360	4360	4360
TOTAL ANNUAL O&M EXPENSES EXCLUDING FEEDSTOCK	3917	10390	17348	24549	12195	19025	26145	33345	25700	32894	40013	47214
Annual Capital Cost (CRF=.16)	21530	21845	22182	22533	22749	23182	23429	23778	24646	24997	25344	25693
Income Tax at 48.16%[h]	13327	13569	13828	14099	14139	14488	14662	14931	15408	15678	15945	16214
Gross Revenue[f]	50998	76499	101995	127497	50998	76499	101995	127497	50998	76499	101995	127497
Feedstock Cost at 0.160 CRF[g]	12224	30685	48637	66316	1915	19804	37759	55443	(14756)	2930	20693	38376
1995 Feedstock Cost in dollars/dry ton	37.21	93.44	148.06	201.87	5.83	60.29	114.94	168.78	(44.92)	8.92	62.99	116.82
1995 Feedstock Cost in 1985 dollars/dry ton	17.23	43.28	68.58	93.50	2.70	27.93	53.24	78.18	(20.81)	4.13	29.18	54.11

NOTES: a. Escalated at 9.0% per year.
b. Escalated at 8.6% per year, base price 6.13 cents/kWh in 1985.
c. Escalated at 12.9% per year, base price $5.96/10^6 Btu in 1985 for purchased fuel; $5.36/10^6 Btu in 1985 for excess by-product gas credit.
d. Escalated at 8.0% per year (assumed rate of general inflation).
e. Fixed annual expense.
f. Sale of product at refiner's price, distillate fuel oil; escalated at 10.5% per year, base price $1.43/gal in 1985.
g. 15% ROI, 20 year investment life; feedstock cost assumed to escalate at 8.0% per year.
h. Income Taxes = 48.16/51.84 x (Annual Capital Recovery - 1/20 (Capital Investment + Startup + Interest Expense)

SOURCE: Mittelhauser Corporation, February 15, 1980, op. cit. and DOE/EIA, "Annual Report to Congress, 1979."



Flows in 10^3 lb/hour

Figure III.1. Typical Mass Balance, 500 TPD Plant, 20 Percent Moisture Feed

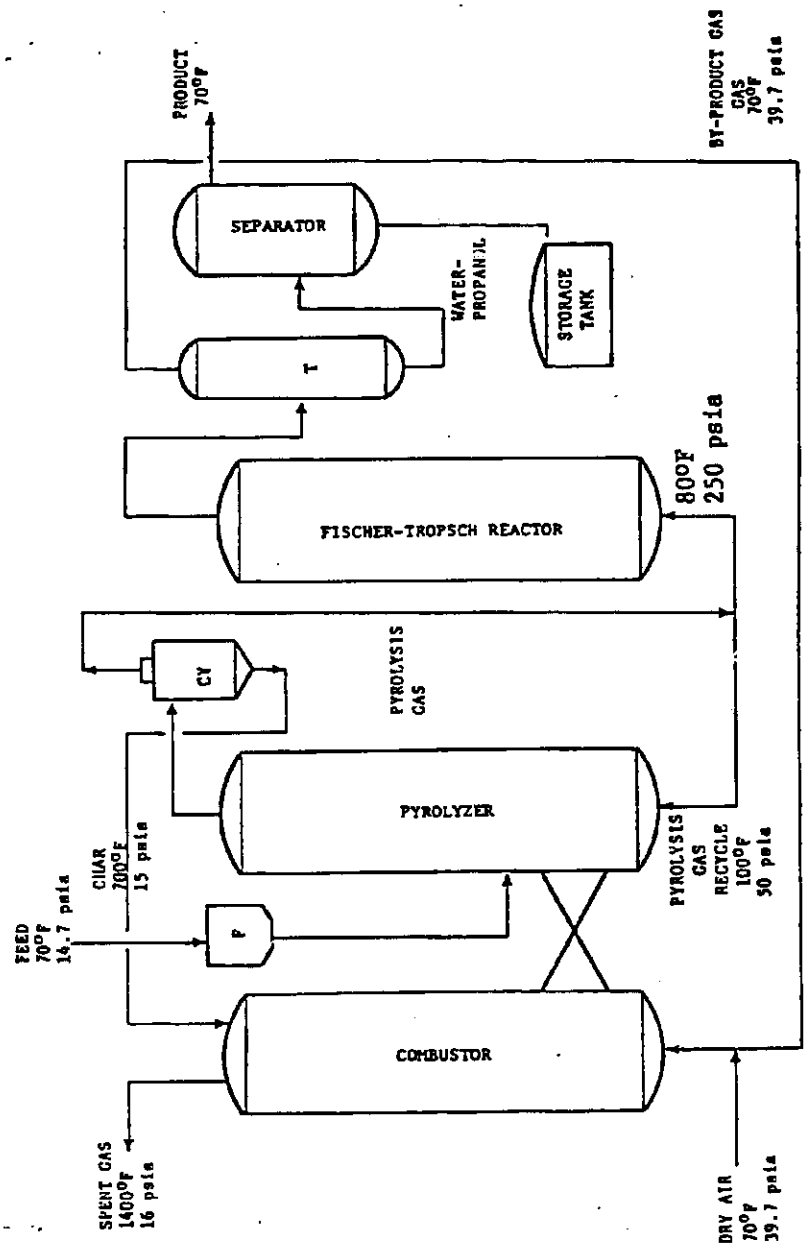


Figure III.2. Process Temperatures and Pressures, 500 TPD Plant, 20 Percent Moisture Feed

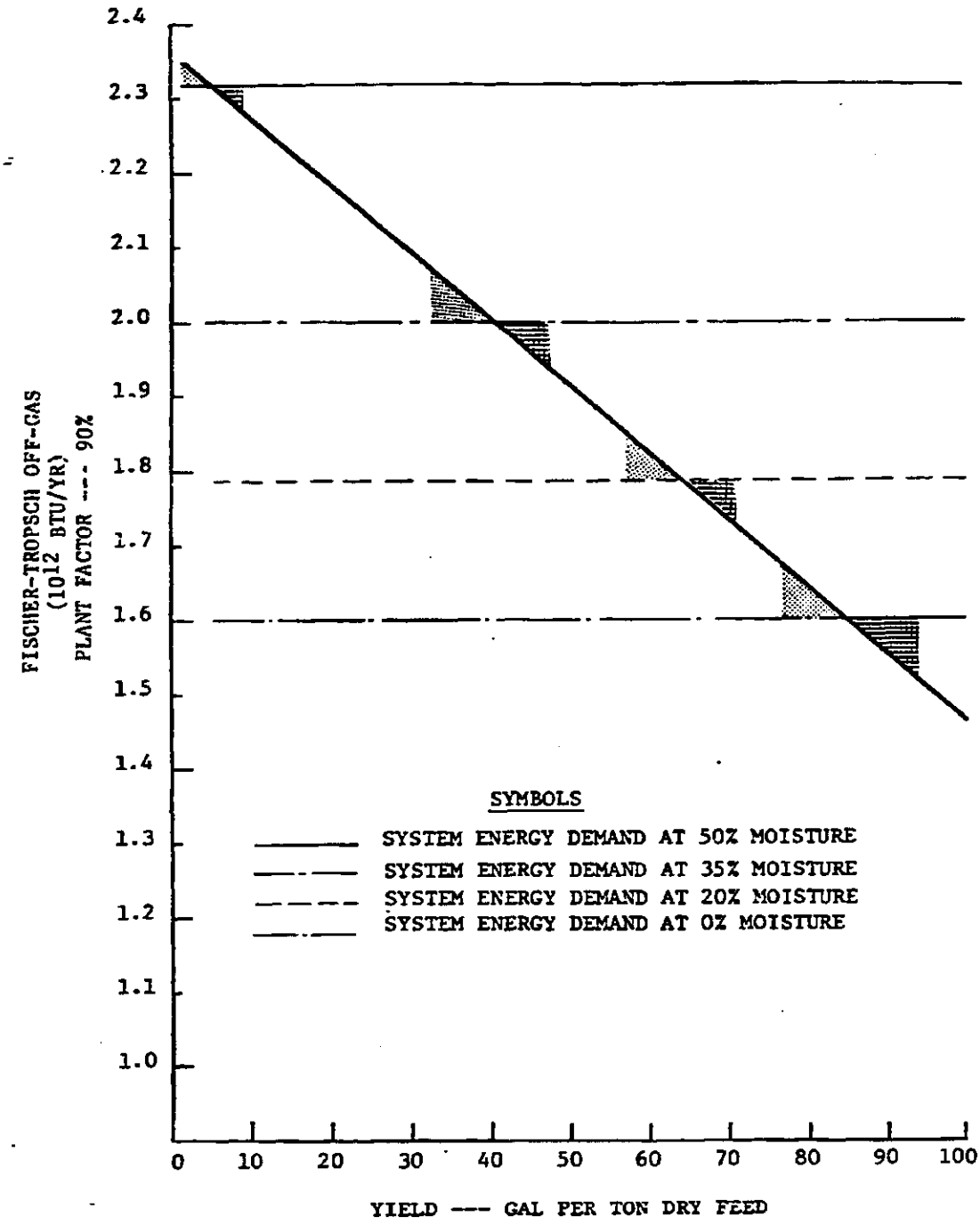


Figure III.3. Pyrolytic Conversion of Cellulose to Fuel--500 TPD System Energy Requirements

TABLE III-7 SURPLUS HIGH BTU GAS*
(10^{11} BTU/YR)

	MOISTURE CONTENT			
	0%	20%	35%	50%
YIELD (gal/dry ton)				
40	3.99	2.18	0	(3.25)
60	2.18	.39	(1.70)	(5.05)
80	.40	(1.39)	(3.48)	(6.82)
100	(1.38)	(3.18)	(5.27)	(8.62)

*500 TPD plant capacity, 90 percent plant factor

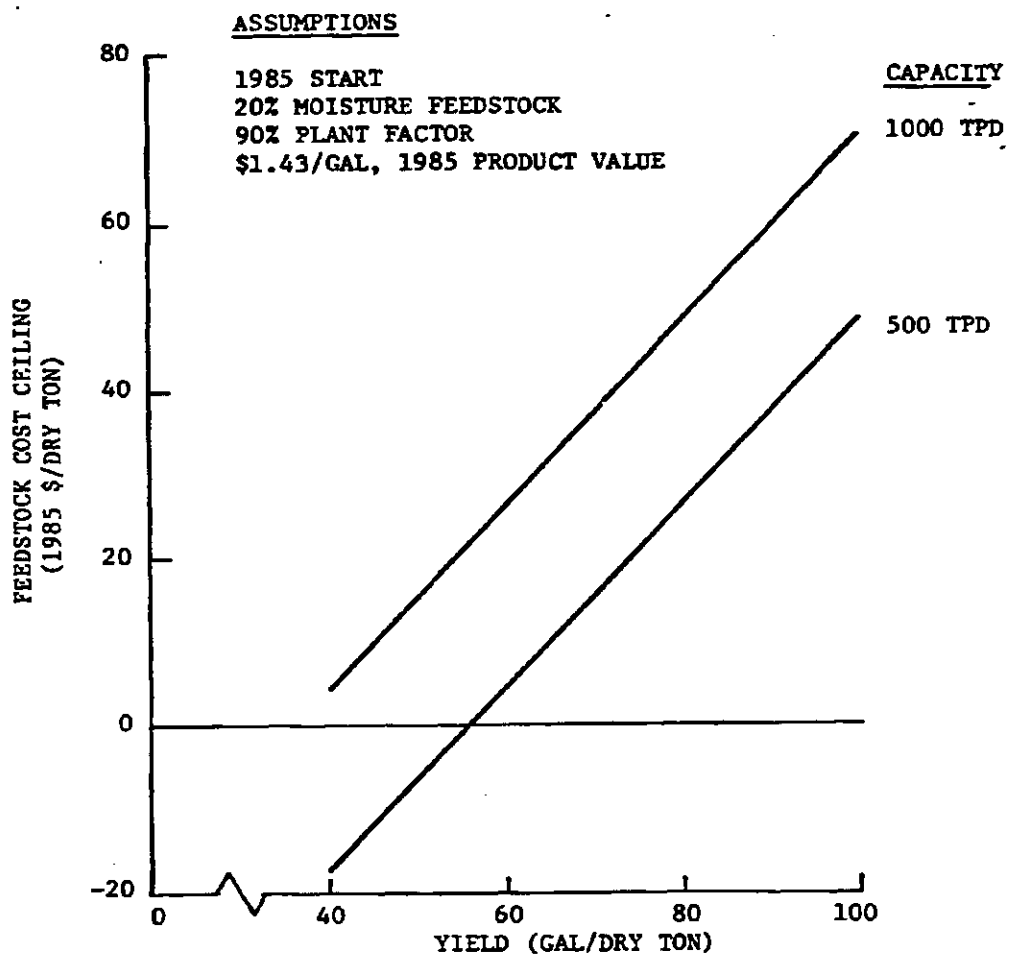


Figure LII.4. Effects of Plant Capacity and Yield on Feedstock Cost Ceiling

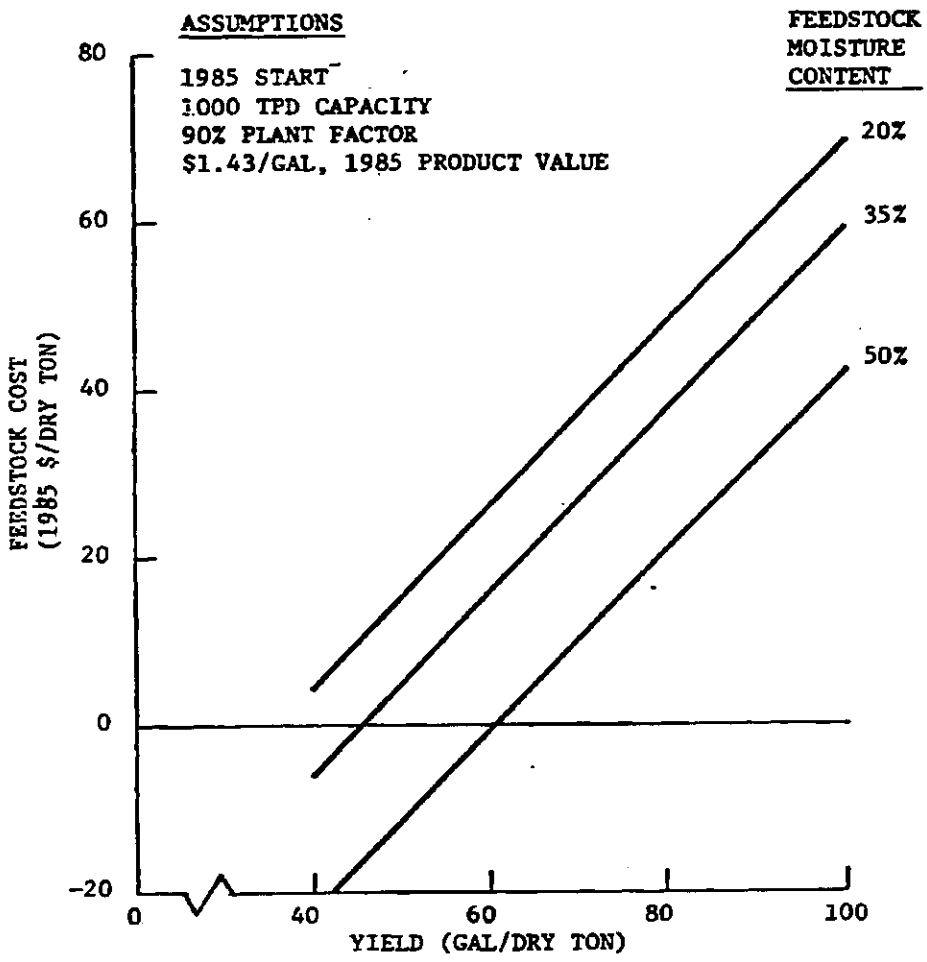


Figure III.5. Effects of Feedstock Moisture Content and Plant Yield on Feedstock Cost Ceiling

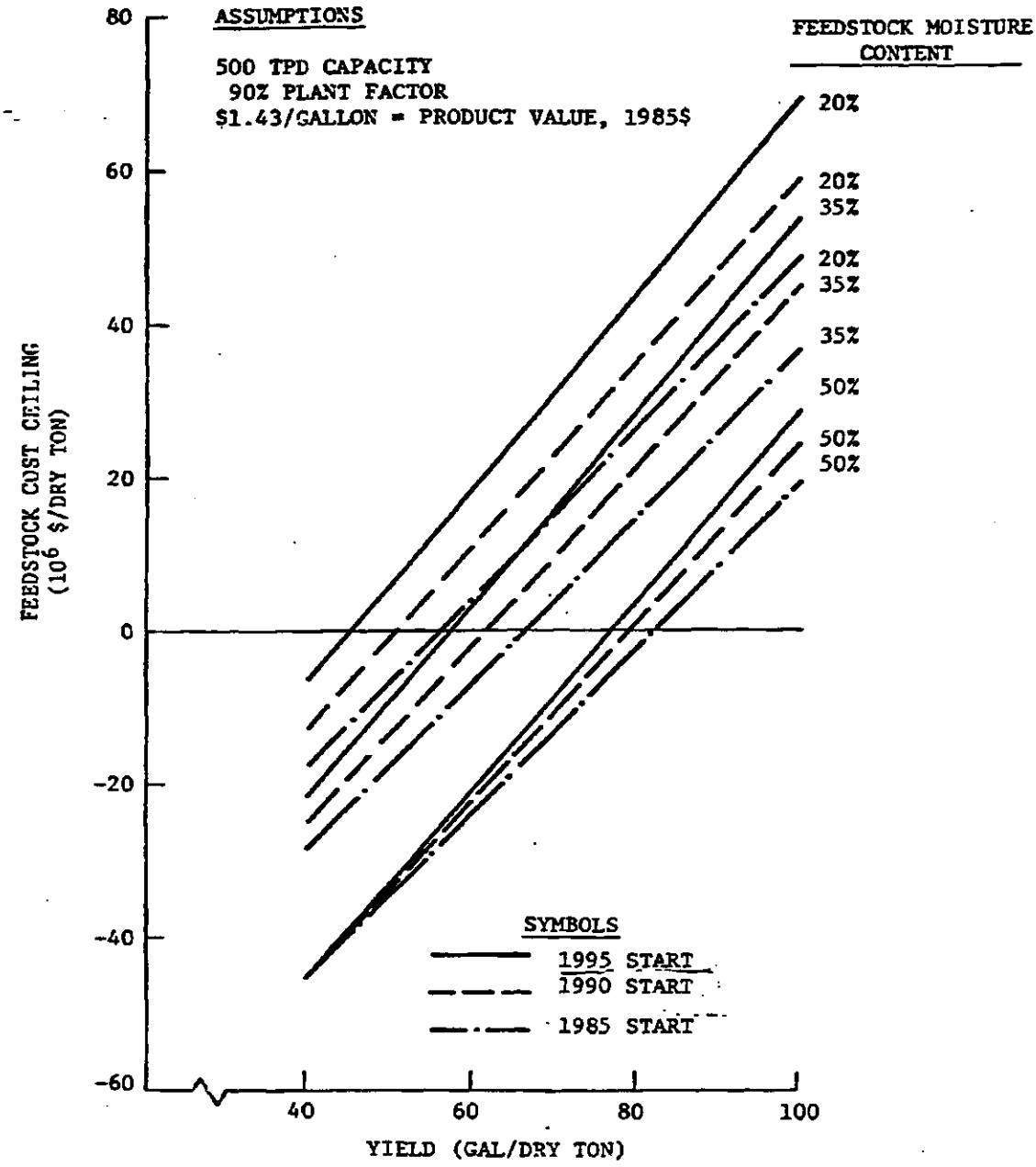


Figure III.6. Effect of Plant Start Year on Feedstock Cost Ceiling

dry ton for subsequent use with the feedstock supply curves discussed in the previous chapter. The computer feedstock costs are cost ceilings in that they are the maximum unit costs consistent with at least the assumed 15-percent ROI requirement.

Figures III.4, III.5, and III.6 illustrate the effects of changes in plant capacity, plant yield, operation start date, and feedstock moisture on the feedstock cost ceiling.

As indicated by Figure III.4, the size of plants which can be feasibly supplied with feedstock is an important commercialization factor. Particularly when considered in light of the steeply rising feedstock supply curves presented in Chapter II, this capital cost sensitivity suggests that fairly sharp plant performance thresholds exist. Below these threshold performance levels the process economics would not support the aquisition of sufficient feedstock quantities for a nationally significant petroleum savings impact. Above these performance levels (depending principally on petroleum fuel prices) the process economics would make available large quantities of cellulosic feedstocks and the feasibility of larger plants would be enhanced.

The plant economy is also sensitive to feedstock moisture content, as illustrated in Figure III.5. Figure III.6 indicates the gradual improvement in plant economics projected for operation starts in 1985, 1990, and 1995. This improvement is due to the higher nominal price escalator assigned to the product revenue stream (10.5 percent) as compared to the assumed capital cost nominal inflator (9.0 percent) and the assumed 8.0 percent general inflation rate. Purchased gas fuel cost (or by-product gas revenue) is assigned a 12.9 percent nominal price inflator, which limits the degree of improvement in plant economy over time for higher feedstock moisture contents. Nominal price inflators are consistent with mid-term "high" fuel price projections published by DOE in the EIA "Annual Report to Congress, 1979" (Reference 2).

The 1985 base prices for product, by-product gas, supplementary gas, and electricity noted in Tables III-4, III-5, and III-6 are also consistent with the mid-term DOE/EIA "high" price projections from Reference 2.

Record high increases in oil and gas prices in recent weeks indicate that the 1979 EIA price projections are too low. For example, the refiner's price for No. 2 heating oil currently runs 12 cents per gallon under the residential retail price (Reference 2). In the Baltimore, Maryland area the retail price paid for home heating oil in February, 1981 was $1.29 per gallon. At a 10.5 percent nominal price inflator, this would indicate a 1985 refiner's price of $1.75 per gallon. Accordingly, the $1.43 1985 base price for product oil and other fuel prices used in Tables III-4, III-5, and III-6 obtained from Reference 2 (called "high" projections in this 1979 document) are together used as the "low" fuel price scenario for this study. A middle fuel price scenario is defined in terms of assumed 1985 fuel prices consistent with a 1985 product value of $1.75 per gallon. Subsequent to 1985, the nominal fuel price escalators noted in Tables III-4,

III-5, and III-6 are retained in all price scenarios. The high fuel price scenario defined for this study is consistent with a $2.00 per gallon 1985 product value.

Plant feedstock cost ceilings are tabulated for 1985, 1990, and 1995 operation starts in Tables III-8, III-9, and III-10. These results are expressed in 1985 dollars. This analysis indicates that the ASU process will probably become commercially feasible for 20 and 35 percent moisture feedstocks if performance levels approaching those assumed in the earlier economic analysis by Mittelhauser Corporation are attained (i.e., 80 gallon per ton yield and 90 percent plant factor). Plant feasibility at these performance levels for 50 percent moisture feedstocks is less clearly indicated, since minimum wood feedstock delivery costs are projected at over $30 per ton in 1985. Nonetheless, the high fuel price scenario results indicate marginal wood conversion feasibility by 1985 and clear-cut feasibility by 1990 (see Figure II.4, Chapter II).

At a more methodical approach to analyzing the feedstock cost ceiling results, minimum feasible plant performance levels are associated with each fuel price scenario in Table III-11. The minimum feasibility criterion used in this procedure is a 20 percent moisture (RDF) feedstock 1985 cost ceiling of $8 per ton. This feedstock cost corresponds with approximately 10 million tons of RDF availability in 1985 (see Figure II.2 discussed in the previous chapter).

The analysis shown in Table III-11 suggests that the present ASU/DOE project commercial plant performance goals of 80 gallons per ton product yield and 90 percent plant factor (as reflected in the earlier economic study by Mittelhauser Corporation) are unnecessarily high. It is evident from examination of these results that a 60 gallons per ton yield would probably suffice for commercialization of the ASU process to an extent adequate to justify DOE support of the project. For example, at 60 GPT, 1000 TPD capacity, 70 percent plant factor RDF conversion plants should be feasible if the 1985 product value is at least $1.43 per gallon in 1985 dollars.

Reviewing previous discussions, these results are based on an assumption of product equivalence with commercial distillate fuel oil and an assumption that the pilot plant costs proposed by ASU are correct. The analysis includes as-delivered feedstock moisture content in the plant energy balance, capital costs, and operating costs.

It is possible that the feedstock supply curves (Chapter II) used in this analysis are too optimistic. This could occur, for example, if steeply rising fuel prices drive delivered feedstock costs up unexpectedly or if average transportation distances are greater than estimated. Such a feedstock cost increment can be hypothesized for RDF as follows:

(1) The 0.7×10^6 Btu/dry ton imbedded energy associated with RDF could conceivably add $2.50/dry ton to the projected 1985 feedstock cost if the cost of this imbedded energy is increased by $0.50 per gallon of oil equivalent and if fully borne by the feedstock purchaser.

TABLE III-8. FEEDSTOCK COST CEILING PROJECTIONS, 1985 START

Operation Start Date = 1985

TPD CAPACITY	PLANT FACTOR %	1985 PRODUCT VALUE, $/GAL	1985 GAS COST, $/$10^6$ Btu	Feedstock Cost Ceiling--1985 Dollars Per Dry Ton											
				Feedstock Moisture Content:				20%				35%			
				Yield (Gal/Dry Ton):	40	60	80	100	40	60	80	100	40	60	80	100
500	50	1.43	5.96		(83.08)	(61.33)	(39.93)	(18.87)	(96.84)	(75.38)	(54.20)	(33.19)	(118.08)	(96.93)	(75.85)	(54.78)
500	50	1.75	7.30		(68.72)	(42.17)	(15.78)	10.47	(84.07)	(57.61)	(31.63)	5.54	(107.95)	(81.89)	(55.87)	(29.85)
500	50	2.00	8.34		(57.44)	(27.12)	3.2	33.52	(74.04)	(43.64)	(13.89)	16.18	(99.99)	(70.08)	(40.17)	(10.26)
500	70	1.43	5.96		(41.75)	(18.93)	2.72	24.07	(52.83)	(31.08)	(9.64)	11.67	(71.37)	(49.96)	(28.56)	(7.22)
500	70	1.75	7.30		(26.95)	0.22	26.88	53.41	(40.06)	(13.31)	12.94	39.32	(61.24)	(36.83)	(8.54)	17.72
500	70	2.00	8.34		(15.33)	15.27	45.87	76.47	(30.03)	0.65	30.69	61.05	(53.28)	(22.95)	7.19	37.32
500	90	1.43	5.96		(17.56)	4.63	26.42	47.93	(28.37)	(6.48)	15.12	35.99	(45.41)	(23.85)	(2.29)	19.22
500	90	1.75	7.30		(3.21)	24.06	50.84	77.27	(15.61)	11.29	37.84	63.64	(35.29)	(8.79)	17.72	44.16
500	90	2.00	8.34		8.07	39.33	70.02	100.33	(5.58)	25.25	55.70	85.37	(27.33)	3.04	33.44	63.76
1000	50	1.43	5.96		(43.64)	(21.79)	(0.47)	20.92	(55.92)	(34.45)	(13.30)	7.78	(75.55)	(54.44)	(33.29)	(12.22)
1000	50	1.75	7.30		(28.52)	(1.32)	25.25	54.55	(42.47)	(12.52)	10.64	36.91	(64.87)	(38.57)	(12.21)	14.06
1000	50	2.00	8.34		(18.01)	12.91	43.13	77.92	(33.12)	(2.72)	27.27	57.15	(57.45)	(27.54)	2.44	32.32
1000	70	1.43	5.96		(12.80)	9.58	30.91	52.28	(23.60)	(1.59)	19.58	40.95	(40.99)	(19.33)	1.83	23.22
1000	70	1.75	7.30		2.24	29.30	56.63	83.20	(9.20)	16.97	43.52	70.08	(30.32)	(3.62)	22.92	49.48
1000	70	2.00	8.34		12.69	43.00	74.51	104.68	0.80	29.87	60.15	90.32	(22.90)	7.30	35.57	67.73
1000	90	1.43	5.96		4.34	26.59	48.35	69.87	(5.64)	16.25	37.84	59.37	(21.80)	(0.25)	21.35	42.47
1000	90	1.75	7.30		19.47	47.06	74.07	100.79	7.81	34.97	61.78	88.50	(11.12	15.62	42.43	69.15
1000	90	2.00	8.34		29.98	61.29	91.94	122.27	17.16	47.98	78.41	108.74	(3.70)	26.65	57.08	87.41

TPD CAPACITY	PLANT FACTOR %	1985 PRODUCT VALUE, $/GAL	1985 GAS COST, $/$10^6$ Btu	Feedstock Cost Ceiling--1985 Dollars Per Dry Ton											
				Feedstock Moisture Content:				50%							
				Yield (Gal/Dry Ton):	40	60	80	100								
500	50	1.43	5.96		(118.08)	(96.93)	(75.85)	(54.78)								
500	50	1.75	7.30		(107.95)	(81.89)	(55.87)	(29.85)								
500	50	2.00	8.34		(99.99)	(70.08)	(40.17)	(10.26)								
500	70	1.43	5.96		(71.37)	(49.96)	(28.56)	(7.22)								
500	70	1.75	7.30		(61.24)	(36.83)	(8.54)	17.72								
500	70	2.00	8.34		(53.28)	(22.95)	7.19	37.32								
500	90	1.43	5.96		(45.41)	(23.85)	(2.29)	19.22								
500	90	1.75	7.30		(35.29)	(8.79)	17.72	44.16								
500	90	2.00	8.34		(27.33)	3.04	33.44	63.76								
1000	50	1.43	5.96		(75.55)	(54.44)	(33.29)	(12.22)								
1000	50	1.75	7.30		(64.87)	(38.57)	(12.21)	14.06								
1000	50	2.00	8.34		(57.45)	(27.54)	2.44	32.32								
1000	70	1.43	5.96		(40.99)	(19.33)	1.83	23.22								
1000	70	1.75	7.30		(30.32)	(3.62)	22.92	49.48								
1000	70	2.00	8.34		(22.90)	7.30	35.57	67.73								
1000	90	1.43	5.96		(21.80)	(0.25)	21.35	42.47								
1000	90	1.75	7.30		(11.12	15.62	42.43	69.15								
1000	90	2.00	8.34		(3.70)	26.65	57.08	87.41								