7.1.1 BGC-Kolbel All Liquids Case

The Fischer-Tropsch indirect liquefaction process produces pipeline gas in addition to gasoline, diesel and other liquid products. In the Sasol-U.S. base case 64% of the thermal value of the products is in SNG. In the base case most of this SNG is derived from the primary methane produced in the dry-bottom Lurgi gasifier. Additional methane is produced from the Synthol F-T synthesis. If the objective of a coal liquefaction facility is the production of liquids, especially transportation fuels, then this methane will have to be reformed back to synthesis gas and reintroduced into the F-T synthesis reactors. There is a considerable efficiency penalty to be taken in reforming methane and synthesizing liquids from the resultant CO and H_2. Data from the Mobil report show that only 61% of the original energy contained in the SNG is retained in the resulting liquid products. Thus any gasifier system that produces less primary methane and more synthesis gas will have an efficiency advantage over one producing large quantities of gasifier methane. Also any synthesis unit that produces less methane than the Synthol reactor will similarly enjoy an efficiency advantage if an all liquid output is required.

Certain plant modifications must be made to produce an all-liquid product. The pipeline gas train units can be deleted. This means elimination of the methanation unit, carbon dioxide removal and SNG drying units (refer to Appendix B). For methane and C_2 reforming an autothermal reformer is installed. This unit operates by partial oxidation of the methane and ethane and thus additional plant oxygen is required. To provide this oxygen additional steam capacity is needed.

Table VII-4 shows the finished products from the combination of the BGC-Lurgi-Kolbel system for an all-liquids output plant. Sixty-one percent of the energy contained in the SNG from the mixed output case is now contained in the liquid products. The details of this procedure are given in Appendix B.

Table VII-4 illustrates the efficiency penalty involved in reforming C_1 and C_2 hydrocarbons. The SASOL-U.S. base case has the highest penalty to pay because of the large primary methane make from the gasifier and the F-T generated C_1 and C_2 hydrocarbons. Relative to the Synthol-BGC case, the Kolbel-BGC system takes less of an efficiency penalty because of the low weight % of C_1 and C_2 hydrocarbons generated in the Kolbel system. The Kolbel system has an 8% increase in total liquids over the Synthol system and an increase of four efficiency points. The 10% increase in thermal efficiency over the SASOL-U.S. case is very significant.

Liquid yields of finished products are very high for both the BGC-Kolbel and Synthol cases. Yields of 2.3 barrels/ton of dry coal are approaching the yields obtained from direct liquefaction processes for example H-Coal and EDS. Again, it is emphasized that the liquid products are finished useable refinery outputs and not low API gravity syncrudes.

TABLE VII-4

PRODUCTS AFTER DOWNSTREAM PROCESSING
(All Liquids Case)

	BGC (KOLBEL)	BGC (F-T)	SASOL (US)
Gasoline (B/SD)	39,945	31,514	28,090
C_3 LPG (B/SD)	4,055	2,738	2,436
C_4 LPG (B/SD)	-	361	321
Diesel (B/SD)	5,025	5,706	5,078
Fuel Oil (B/SD)	523	1,538	1,369
Alcohol (B/SD)	813	4,524	4,026
Total Liquids (B/SD)	50,361	46,381	41,320
FOE* (B/SD)	41,506	37,776	33,652
Efficiency, percent**	52.5	47.9	42.7
B Liquid Fuels/Ton Dry Coal	2.52	2.32	2.06
B Liquid Fuels C_4^+/Ton Dry Coal	2.31	2.18	1.94

*Fuel oil equivalent = HHV/6.0 x 10^6

**Product HHV/Coal HHV x 100

7.1.2 Impact of BGC-Kolbel on Construction Costs

For the mixed output case, Table VII-5 shows the impact of combining the BGC gasifier with the Kolbel synthesis relative to the BGC-Synthol combination. The details of this cost analysis are in Appendix C. The savings on synthesis gas preparation is due predominantly to the small shift requirement when using Kolbel synthesis. The H_2/CO ratio of the synthesis gas from the BGC Lurgi is 0.5 and for Synthol a 2.54 ratio is required. This means shifting the total gas stream. Since Kolbel can accept a H_2/CO of only 0.67, only a small portion of the gas need be shifted. In addition, the water in the gas for the Kolbel case is condensed on cooling resulting in less volumetric flow through the Rectisol unit. For the Synthol case, the water is used in the shift and the flow through the gas purification unit is much higher.

The saving in the by-product recovery stream attributed to the Kolbel system is entirely due to a smaller sulfur recovery system. This unit size is based on volumetric flow of acid gas which again, because of the very small shift upstream, has generated a relatively small quantity of carbon dioxide.

TABLE VII-5

BGC/KOLBEL IMPACT ON CONSTRUCTION COST
(Mixed Output Case)
(MM $1977)

	Δ Relative to BGC/F-T	
REFERENCE CONSTRUCTION COST (BGC/F-T)		1,104.3
Synthesis Gas Preparation Including Shift	-31.8	
By-Product Recovery	-31.9	
Synthesis	+20.8	
SNG Preparation	- 5.8	
F-T Liquid Product Upgrading	+27.2	
Oxygen Plant	+ 1.3	
Steam Plant	-11.4	
Waste Water Treatment	- 4.8	
TOTAL CHANGE		-36.4
BGC-KOLBEL CONSTRUCTION COST		1,067.9
CAPITAL COST (1.59 x Construc. Cost)		1,698.0

The Fischer-Tropsch synthesis section is more expensive for the Kolbel combination. No construction cost figures are currently available for the fabrication of large liquid slurry reactors of the Kolbel type. Preliminary estimates price the reactor 20 percent higher than the F-T Synthol system for a comparable flow of reactive species. This may be over penalizing the Kolbel system since the reactor is of relatively simple design. However, doubling the cost of the reactor only results in a construction cost change of 7 percent for the total plant. The higher cost of the synthesis units for Kolbel are slightly offset by a lower catalyst preparation cost. It is expected that less catalyst will be required in a bubble column slurry reactor that is operating at a slurry concentration of approximately 80 g/liter.

The SNG preparation is less expensive for the Kolbel combination because of the lower C_1 and C_2 hydrocarbon make in the Kolbel synthesis. The units are scaled on total SNG production.

The F-T liquid product upgrading is more expensive for the Kolbel combination than for the BGC-Synthol. This is because the Kolbel system produces 39 percent more liquids that have to be refined through the various downstream processing units. The cost of the units is based on capacity as described in Appendix C. The generation of large quantities of carbon dioxide within the Kolbel unit necessitates the introduction of another Rectisol unit for CO_2 removal in the Kolbel purge gas stream. This unit will also separate C_3 and C_4 hydrocarbons thus the hydrocarbon recovery unit in the purge gas stream for the Synthol case can be eliminated.

A slight increase in the size of the oxygen plant for this case results in a slight cost increase. This is because slightly more coal is sent to the gasifier and less to the steam plant than for the BGC-Synthol combination.

The savings in the steam plant are a gain because it is not necessary for the raw gas to be extensively shifted to comply with the Kolbel input requirements. Waste water treatment is less than BGC-Synthol because the by-product of the synthesis is primarily carbon dioxide and not water. In the Synthol case, 25 lbs/hr of water are produced for each bbl/day of product. This lower waste water effluent may have implications for a more environmentally acceptable process.

Table VII-6 shows the impact of the BGC-Kolbel system on construction costs for a plant producing an all-liquid output. The details of the cost analysis are given in Appendix C.

The increase in synthesis cost is due to increased throughput to the Kolbel reactors. C_1 and C_2 hydrocarbons are reformed to produce more synthesis gas which is recycled to the F-T reactors. The cost of the autothermal reformer is scaled from the unit in the MRDC report on the basis of total SNG produced in the mixed output case. A cost savings results from elimination of the methanation and SNG preparation units. The extra cost of F-T liquids refining is associated with the 31 percent more liquids produced from the reforming process.

TABLE VII-6

BGC/KOLBEL IMPACT ON CONSTRUCTION COST
(All Liquid Output)
(MM $1977)

	Δ Relative to Mixed Output Case	
REFERENCE CONSTRUCTION COST (BGC-KOLBEL MIXED OUTPUT		1,067.9
Synthesis	+31.8	
Add Autothermal Reformer	+26.5	
Delete SNG Preparation and Methanator	-15.9	
F-T Liquid Product Upgrading	+31.0	
Oxygen Plant	+26.0	
Steam Plant	+13.9	
Waste Water Treatment	- 0.8	
TOTAL CHANGE		+112.5
BGC-KOLBEL CONSTRUCTION COST		1,180.4
CAPITAL COST		1,877.0

The autothermal reformer requires oxygen to partially combust the C_1 and C_2 hydrocarbons. This extra oxygen requirement is met by a corresponding increase in the steam facility. Fuel for extra steam is supplied by slipstreaming 10 percent of the feed to the autothermal reformer.

The results of the cost analysis for both mixed product and all liquid output cases show the BGC-Kolbel system to be potentially less expensive than either BGC-Synthol or the dry-bottom-Synthol base case. Plant modifications for all liquids output require approximately 10 percent higher construction costs than a mixed output plant.

7.1.3 Impact of BGC-Kolbel on Product Cost

Table VII-7 shows the costs of gasoline for BGC-Kolbel combination plants producing mixed products and all liquids. For comparison the gasoline costs for the BGC-Synthol combination are also shown. The basis of the two forms of costing have already been discussed in Section 4.0. Details of the analysis are given in Appendix D. On a mixed output basis selling all products on the basis of their thermal value, the gasoline price would be 80 cents per gallon. For the all-liquid case because of higher capital plant cost and lower thermal output the gasoline price would rise to 1.00 $/gallon. This is still 19% cheaper than an equivalent analysis using the BGC-Synthol combination.

On a market basis the cost differentials between BGC-Synthol and BGC-Kolbel are more pronounced because of the larger quantity

TABLE VII-7

GASOLINE COSTS FOR BGC-KOLBEL COMBINATION
(MM $1977)

	Mixed Output		All Liquid	
	BGC-Kolbel	BGC-Synthol	BGC-Kolbel	BGC-Synthol
THERMAL BASIS				
$/MM Btu	6.68	6.91	8.39	9.99
Gasoline ($/Gallon)	0.80	0.83	1.00	1.19
"MARKET" BASIS				
Gasoline ($/Gallon)	0.84	0.92	1.03	1.24

of SNG produced in the Synthol plant that has to be sold for less than the thermal basis cost. For an all-liquids plant this cost differential is further increased because of the inefficiency penalty incurred under reforming this SNG to produce more liquids. The BGC-Kolbel gasoline price is 20% less than the corresponding BGC-Synthol price.

The market price costs of gasoline for the SASOL-U.S. base case are $1.33 and $1.51 per gallon for mixed product and all liquid cases respectively. Thus, substitution of both gasifier and synthesis unit could achieve a considerable cost saving for the price of the gasoline product. For the all liquids case a savings of 47% could possibly be realized over the SASOL-U.S. base case by selection of improved gasifiers and more gasoline selective synthesis procedures.

7.2 Process Evaluation for Combination of a Texaco Gasifier with a Kolbel Synthesis Unit

As has been mentioned in Section 5.3, waste heat recovery in the Texaco gasifier produces enough steam to run the oxygen plant. This, combined with the fact that the coal is conveyed to the gasifier burners in a water slurry thus obviating the addition of steam, means that no coal need be diverted to a steam plant. Total plant input of 27.792 tons/SD is sent directly to the gasifiers.

The total number of lb moles/hr of synthesis gas and methane from the Texaco is shown below (see Section 5):

H_2	50,100	lb-moles/hr
CO	73,675	
CH_4	150	
TOTAL	123,925	

TOTAL Synthesis Gas 123,775 lb-moles/hr

This total quantity of synthesis gas is 28% higher than the quantity produced from the BGC-Lurgi. The increase results from the gasification of the total plant coal and the low primary methane make of the Texaco gasifier. Texaco produces no gasifier naphthas, phenols, tars, etc. and only a minimal quantity of methane.

Table VII-8 shows the refined product distribution obtained from the combination of Texaco with Kolbel synthesis. For comparison, the Texaco-Synthol results are tabulated. Details of this analysis are described in Appendix B.

The results shown are for a plant producing an all liquid output for optimization of gasoline. Only an all-liquids case is considered because the SNG produced in a mixed output case would only amount to 11% of the total plant output. The methane and C_2 produced are autothermally reformed to produce more synthesis gas. The Kolbel combination produces 28% more gasoline than the Synthol system and a considerably smaller quantity of alcohols. The higher thermal efficiency for the Kolbel case is associated with the need to reform less methane and C_2 hydrocarbons. Again total C_4^+ liquid per ton of dry coal is high and comparable to the BGC-Kolbel case

TABLE VII-8

PRODUCTS AFTER DOWNSTREAM PROCESSING

(ALL LIQUIDS CASE)

	TEXACO-KOLBEL	TEXACO-SYNTHOL
Gasoline (B/SD)	40,407	31,445
C_3 LPG (B/SD)	4,277	2,876
C_4 LPG (B/SD)	-	382
Diesel (B/SD)	5,298	6,004
Fuel Oil (B/SD)	552	1,617
Alcohol (B/SD)	856	4,737
TOTAL Liquids (B/SD)	51,390	47,061
FOE (B/SD)	42,332	38,308
Efficiency %	53.7	48.6
Liquid Fuels/Ton Dry Coal (B)	2.57 (2.39)*	2.35 (2.19)
Liquid Fuels C_4^+/Ton Dry Coal (B)	2.35 (2.19)	2.21 (2.05)

*Numbers in parentheses are B/Ton of total coal to plant including coal used for drying.

previously described. The numbers in parentheses refer to liquids per ton of total dry coal to the plant. This includes 2100 tons/day used for coal drying.

7.2.1 Impact of Texaco-Kolbel on Construction Costs

Table VII-9 shows the changes in construction cost incurred by substitution of the Kolbel synthesis system for the Synthol. The H_2/CO ratio of the raw output gas from the Texaco is exactly the right ratio for input to the Kolbel synthesis unit. Thus no shift is required for this gas. This elimination of shift represents a savings of 30 million dollars. As no shift stream is required, no separate shifted gas waste heat boiler is necessary. This again represents another cost saving. By product recovery is cheaper by another 30 million because no extra carbon dioxide is produced by shift reaction.

The Kolbel synthesis reactors are again considered to be 20% higher in cost than the Synthol for a comparable molar flux of reactive species. The overall savings of 8.6 million dollars is due to lower catalyst preparation costs and not lower synthesis costs. The details of this cost analysis are in Appendix C. The savings in the reformer result from the smaller quantity of C_1 and C_2 hydrocarbons produced in the Kolbel system. The reformer is scaled to the total SNG produced in a mixed output case, and although such a case is not formally considered in the analysis, reference to Appendix B shows that only 29 MM SCF/D of SNG would be produced if the plant were to operate in a mixed output mode.

TABLE VII-9

TEXACO/KOLBEL IMPACT ON CONSTRUCTION COST
(All Liquids Product Case)
(MM $1977)

	Δ Relative to Texaco-Synthol	
REFERENCE CONSTRUCTION COST (TEXACO-SYNTHOL)		1,289
Delete Raw Gas Shift	-30.0	
Delete Shifted Gas Cooling	-14.9	
Synthesis and Catalyst Preparation	- 8.6	
Autothermal Reformer	-11.3	
F-T Liquid Product Upgrading	+ 4.5	
Oxygen Plant	- 3.9	
Waste Water Treatment	- 9.7	
TOTAL CHANGE		112.9
TEXACO-KOLBEL CONSTRUCTION COST		1,176.1
CAPITAL COST		1,870.0

The cost of refining the F-T generated liquids is slightly higher for the Kolbel combination as 9% more total liquids are produced than for the Synthol case. The cost of the total liquids refinery is based on scaling the ratio of the capacities to the 0.7 power.

The lower cost of the oxygen plant is directly related to the smaller autothermal reforming unit required in the Kolbel case.

It appears that only nominal waste water treatment facilities would be necessary for a coal liquids plant based on a Texaco-Kolbel combination to prevent excess contaminant build up. Since the by-product of the Kolbel synthesis is carbon dioxide and not water, the remaining sources of waste water in the plant are used for slurry make up water for feeding coal into the gasifiers. Waste water evolved during the coal drying operation is vented to the atmosphere.

The total savings in construction cost introduced by using the Kolbel synthesis amounts to 10% over that of the Texaco-Synthol combination. The bottom line capital cost figure of 1870 MM dollars is obtained by multiplying the construction cost by 1.59 as previously discussed.

7.2.2 Impact of Texaco-Kolbel on Product Cost

Table VII-10 shows the gasoline costs associated with the combination of the Texaco gasifier with the Kolbel synthesis (see Appendix D). Results for the Texaco-Synthol combination are shown for comparison. The higher costs for the Synthol system on the thermal basis are related to higher capital costs for the system combined

TABLE VII-10

GASOLINE COSTS FOR TEXACO-KOLBEL COMBINATION
(All Liquid Output)
(MM $1977)

	Texaco-Kolbel	Texaco-Synthol
THERMAL BASIS		
$/MM Btu	8.25	9.91
Gasoline ($/Gallon)	0.99	1.19
"MARKET" BASIS		
Gasoline ($/Gallon)	1.01	1.23

with the lower total thermal output. On the market basis, since less SNG need be reformed to liquids in the Kolbel case, gasoline costs are 20% below the costs associated with the Synthol system. In absolute values the gasoline cost for the all liquid Texaco-Kolbel plant is slightly cheaper than that of the all liquids case using a BGC-Kolbel combination (refer to Table VII-7).

7.3 Process Evaluation for Combination of a Shell-Koppers Gasifier with a Kolbel Synthesis Unit

As with the case of the Texaco gasifier, waste heat recovery for the Shell-Koppers case produces sufficient steam to run the oxygen plant. The S-K gasifier needs a minimal quantity of steam and this can also be readily supplied by the waste heat recovery system. Additional coal is needed to provide thermal energy for a coal dryer as was the case also with Texaco. The amount of coal fed to the Shell-Koppers gasifier is the same as for the Texaco case, i.e., 27,792 tons/SD of as received coal.

The Shell-Koppers gasifier produces no primary methane or gasifier naphtha. The off gas is composed of hydrogen and carbon monoxide with small quantities of impurities and carbon dioxide. The total number of lb-moles of synthesis gas from Shell-Koppers is shown below: (See Appendix B for details).

H_2	54,451
CO	81,269
TOTAL	135,720 lb-moles/hr

This gas has been shifted from the original H_2/CO ratio of 0.48 to the ratio of 0.67 required for the Kolbel synthesis in this analysis.

Table VII-11 shows the refined product distribution obtained from the Shell-Koppers/Kolbel combination. For comparison, the output from the Shell-Koppers/Synthol system is also tabulated. Details of this analysis are given in Appendix B.

The results shown in Table VII-11 are for an all-liquids output plant, the objective being the optimization of gasoline. The very high thermal efficiency for the Kolbel case illustrates again the efficiency advantage inherent in producing small quantities of C_1 and C_2 hydrocarbons when all-liquid products are required. The combination of a gasifier (Shell-Koppers) that itself produces no primary methane with a synthesis system producing only small amounts of C_1 and C_2 hydrocarbons represents a high efficiency process when optimizing a plant output for gasoline. The fewer light gases that need to be reformed the greater the efficiency of the overall plant.

Liquid yields of refined C_4^+ liquids from this combination are high and approach the syncrude yields expected from direct coal liquefaction facilities. The figure of 2.39 B/ton dry coal includes the coal used for drying the gasifier coal to 5% moisture.

Table VII-12 shows the product spectrum obtained from a combination of Shell-Koppers with Kolbel synthesis for a plant producing a mixed output of liquids and SNG. The thermal output of SNG for

TABLE VII-11

PRODUCTS AFTER DOWNSTREAM PROCESSING
(All Liquids Case)

	Shell-Koppers/Kolbel	Shell-Koppers/Synthol
Gasoline (B/SD)	44,166	34,455
C_3 LPG (B/SD)	4,675	3,157
C_4 LPG (B/SD)	-	417
Diesel (B/SD)	5,792	6,579
Fuel Oil (B/SD)	604	1,774
Alcohols (B/SD)	936	5,204
TOTAL Liquids (B/SD)	56,173	51,586
FOE (B/SD)	46,272	41,996
Efficiency %	58.7	53.3
Liquid Fuels/Ton Dry Coal (B)	2.81 (2.61)*	2.58 (2.40)
Liquid Fuels C_4^+/Ton Dry COal (B)	2.57 (2.39)	2.42 (2.25)

*Numbers in parentheses are B/ton of total coal to plant including coal used for drying.

TABLE VII-12

PRODUCTS AFTER DOWNSTREAM PROCESSING
(Mixed Output Case)

	Shell-Koppers/Kolbel	Shell-Koppers/Synthol
SNG (MM SCF/SD)	31.21	112.5
Gasoline (B/SD)	41,127	25,040
C_3 LPG (B/SD)	4,353	2,294
C_4 LPG (B/SD)	-	303
Diesel (B/SD)	5,393	4,781
Fuel Oil (B/SD)	562	1,289
Alcohols (B/SD)	872	3,782
Total Liquids (B/SD)	52,307	37,489
FOE (B/SD)	48,308	49,332
Efficiency %	61.3	62.6
Liquid Fuels/Ton Dry Coal (B)	2.61 (2.43)*	1.87 (1.74)
Liquid Fuels C_4^+/Ton Dry Coal (B)	2.40 (2.23)	1.76 (1.63)

*Numbers in parentheses are B/ton of total coal to plant including coal used for drying.

the Kolbel coupling is only 10.8% of the total HHV product output. This compares to 38% for the thermal output of SNG from the S-K/Synthol combination. This illustrates that even though the gasifier itself may not produce methane, the F-T synthesis units can still yield considerable quantities of SNG as product. For the Kolbel case it is probably preferable to reform the small amount of SNG produced and only market liquid fuels. A similar situation arises when the Kolbel synthesis is coupled with the Texaco gasifier.

7.3.1 Impact of Shell-Koppers/Kolbel on Construction Costs

Table VII-13 shows the impact of combining Shell-Koppers gasification with Kolbel synthesis on the plant construction costs for a mixed output case relative to the Shell-Koppers/Synthol case. Costs of synthesis gas preparation are much lower in the Kolbel case because of the smaller shift requirements. The greatest savings is in the smaller Rectisol capacity required, as very little carbon dioxide is produced in shifting from 0.48 to 0.67. In the Synthol case, the shift requirement is from 0.48 to 2.54.

The savings in by-product recovery is again directly related to the shift requirement. The small quantity of acid gas produced allows for a much smaller capacity sulfur recovery unit to be used. The synthesis section is more expensive, but this is modified by a less expensive SNG preparation section because of the smaller quantity of SNG produced with Kolbel.

Upgrading of the raw products is more costly with Kolbel because of increased liquids production.

The waste water produced using the Kolbel system is again much less than Synthol as the by-product of synthesis is carbon dioxide.

The total change between S-K/Synthol and S-K/Kolbel is a construction cost savings of 67 MM$. The detailed cost analysis for this case is given in Appendix C.

Table VII-14 shows the construction cost change brought about by modifying the Shell-Koppers/Kolbel mixed output plant to a plant producing an all-liquid product. The cost of conversion, approximately 30 MM$, is comparatively low because of the small quantity of SNG that needs to be autothermally reformed. The increase in cost of the liquids upgrading is directly related to the extra liquids produced by autothermal reforming. Details of the cost analysis are again given in Appendix C.

7.3.2 Impact of Shell-Koppers/Kolbel on Product Cost

Table VII-15 shows the gasoline costs associated with the combination of the Shell-Koppers gasifier with Kolbel synthesis (see Appendix D). Results for the combination of Shell-Koppers with Synthol are shown for comparison. The market basis cost of 94 cents a gallon for gasoline is the least expensive of all the gasifier-synthesis combinations and represents a savings of 61% in comparison to the Base Case Lurgi dry-bottom/Synthol combination. Table D-1 in Appendix D lists all the gasoline product costs from all gasifier/synthesis combinations considered in this report.

TABLE VII-13

SHELL-KOPPERS/KOLBEL IMPACT ON CONSTRUCTION COST
(Mixed Product Case)
(MM $1977)

	△ Relative to Shell-Koppers/Synthol	
REFERENCE CONSTRUCTION COST (SHELL-KOPPERS/SYNTHOL)		1,231.4
Synthesis Gas Preparation Including Shift	-52.2	
By-Product Recovery	-48.8	
Synthesis	+24.0	
SNG Preparation	-10.7	
F-T Liquid Product Upgrading	+33.1	
Waste Water Treatment	-13.0	
TOTAL CHANGE		-67.6
SHELL-KOPPERS/KOLBEL CONSTRUCTION COST		1,163.8
CAPITAL COST		1,850.0

TABLE VII-14

SHELL-KOPPERS/KOLBEL IMPACT ON CONSTRUCTION COST
(All Liquids Output)
(MM $1977)

	Δ Relative to Mixed Output Case	
REFERENCE CONSTRUCTION COST (SHELL-KOPPERS/ KOLBEL MIXED OUTPUT)		1,163.8
Synthesis	+ 9.9	
Delete SNG Preparation and Methanator	- 7.3	
Add Autothermal Reformer	+12.2	
F-T Liquid Product Upgrading	+ 9.5	
Oxygen Plant	+ 5.4	
TOTAL CHANGE		+29.7
SHELL-KOPPERS/KOLBEL CONSTRUCTION COST (ALL LIQUID)		1,193.5
CAPITAL COST		1,898.0

TABLE VII-15

GASOLINE COSTS FOR SHELL-KOPPERS/KOLBEL COMBINATION
(All Liquid Output)
(MM $1977)

	S-K/Kolbel	S-K/Synthol
THERMAL BASIS		
$/MM Btu	7.65	9.41
Gasoline ($/Gallon)	0.92	1.13
MARKET BASIS		
Gasoline ($/Gallon)	0.94	1.16