CONTENTS

			Page	
Prefac	eface			
1	INTROI	DUCTION	1	
	1.1	Overall Refinery Flow	2	
2.	REFINERY PRODUCTS		5	
	2.1	Low-Boiling Products	6	
	2.2	Gasoline Gasoline Specifications	8	
	2.3 2.4	Gasoline Specifications Distillate Fuels	10 11	
	2.5	Jet Fuel	12	
	2.6	Automotive Diesel Fuels	13	
	2.7	Railroad Diesel Fuels	13	
	2.8	Heating Oils	13	
	2.9	Residual Fuel Oils	14	
	Notes		14	
3.	REFINE	ERY FEEDSTOCKS	16	
	3.1	Crude Oil Properties	17	
	3.2	Composition of Petroleum	19	
	3.3 3.4	Crudes Suitable for Asphalt Manufacture Crude Distillation curves	22 23	
	2.4 Problem		23 29	
	Notes	S.	30	
4.	CRUDE DISTILLATION		31	
	4.1	Atmospheric topping Unit	31	
	4.2	Vacuum Distillation	42	
	4.3	Auxiliary Equipment	44	
	4.4	Crude Distillation Unit Products	45	
	4.5	Case-Study Problems : crude Units	46	
	4.6 4.7	Statement of the Problem General Procedure	47 47	
	Problem		50	
	Notes		51	
5.	DELAYED COKING 52			
	5.1	Process Description	53	
	5.2	Coke Removal	54	
	5.3	Properties and Uses of Petroleum Coke	55	
	5.4	Operation Vi. 14. Grow D. Level C. Live	56	
	5.5 5.6	Yields from Delayed Coking Case-Study Problem : Delayed Coker	57 61	
	Problem		63	
	Notes		64	
6.	CATALYTIC REFORMING AND ISOMERIZATION			
٠.	6.1	Feed Preparation	65 70	
	6.2	Catalytic Reforming Processes	70	
	6.3	Reforming Catalyst	74	
	6.4	Reactor Design	74	

	6.5 6.6 6.7 6.8 6.9 Problen Notes	Yields and Costs Isomerization Capital and Operating Costs Isomerization Yields and Costs Case – Study Problem: Naphtha Hydrotreater and Catalytic Reforming	75 75 79 79 81 84 85
7.	CATAI 7.1 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9 7.10 7.11 7.12 7.13 Problen Notes	Fluidized-Bed Catalytic Cracking Moving-Bed Catalytic Cracking Cracking Reactions Cracking of Paraffins Olefin Cracking Cracking of naphthenic Hydrocarbons Aromatic hydrocarbon Cracking Cracking Catalysts Process Variables Heat Recovery Yield Estimation Capital and Operating Costs Case-Study Problem: Catalytic Cracker	86 87 90 95 96 97 97 97 97 98 100 100 108 112
8.	HYDRO 8.1 8.2 8.3 8.4 Problen Notes	OTREATING Hydrotreating Catalysts Reactions Process Variables Construction and Operating Costs	114 114 116 117 117 118 120
9.	CATAI 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 9.9 Problem Notes	Hydrocracking Reactions Feed Preparation The Hydrocracking Process Hydrocracking Catalyst Moving-Bed Hydrocracking Processes Process Variables Hydrocracking Yields Investment and Operating Costs Case-Study Problem: Hydrocracker	121 122 124 125 126 128 130 131 137 139 140
10.	ALKYI 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 10.10 Problem Notes	ATION Alkylation Reactions Process Variables Alkylation Feedstocks Alkylation Products Catalysts Hydrofluoric Acid Processes Sulfuric Acid Alkylation Processes Comparison of Processes Alkylation Yields and Costs Case-Study Problem: Alkylation	142 142 144 146 146 147 148 151 154 156 159 160

11.	PRODUCT BLENDING			
	11.1	Reid Vapor Pressure (RVP)	162 163	
	11.2	Octane Blending	167	
	11.3	Blending for Other Properties	169	
	11.4	Case-Study Problem : Gasoline Blending	170	
	Problem		177	
	Notes		178	
12.	SUPPORTING PROCESSES		179	
	12.1	Hydrogen Manufacture	179	
	12.2	Gas Processing Unit	182	
	12.3	Acid Gas Removal	185	
	12.4	Sulfur Recovery Processes	190	
	12.5	Ecological Considerations in Petroleum Refining	198	
	12.6	Control of Atmospheric Pollution from Refineries	199	
	12.7	Control of Noise Level in Refineries	200	
	12.8	Case-Study Problems: Gas Recovery Unit, Amine Unit, and Sulfur Recovery unit	200	
	12.9	Cast-Study Problem: Hydrogen Unit	202	
	12.10	efinery Gas Processing unit	202	
	12.11	Amine Gas Treating Unit	203	
	12.12	Sulfur Recovery Plant	204	
	Problem	ns en	205	
	Notes		206	
13.	COST E	ESTIMATION	207	
	13.1	Rule-of-Thumb Estimates	207	
	13.2	Cost-Curve Estimates	208	
	13.3	Major Equipment Factor Estimates	208	
	13.4	Definitive Estimates	209	
	13.5	Summary form for Cost Estimates	209	
	13.6	Storage Facilities	209	
	13.7	Land and Storage Requirements	210	
	13.8	Steam Systems	211	
	13.9	Cooling Water Systems	211	
	13.10	Other Utility Systems	211	
	13.11	Application of Estimation Techniques	214	
	13.12	Statement of Problem	214	
	Notes		226	
14.	ECONOMIC EVALUATION			
	14.1	Definitions	228	
	14.2	Return on Original Investment	229	
	14.3	Payout Time	230	
	14.4	Discounted Cash Flow Rate of Return	230	
	14.5	Case-Study Problem: Economic Evaluation	233	
	14.6	Case-Study Problem : Economic Solution	238	
	Problem	OS CONTRACTOR OF THE PROPERTY	240	
	Notes		240	
	NDIXES		212	
A		ons of Refining Terms	243	
В		l Properties	255	
C	Catalyst		267	
D		reau of Mines Routine Analyses of Selected Crude Oils	271	
E		ic Evaluation Example Problem	287	
F	Photogr		293	
G	Y ield ar	nd Cost Data Figures	307	
Index			361	