CHAPTER NINETEEN

Refinery Operating Cost

Petroleum refining is a capital-intensive business. A grassroots refinery of average complexity processing 100 mb crude per day may cost a billion dollars to build. For a refinery to be economically viable, its operating cost must be minimized. Joint-ownership refineries are built and operated with these objectives in view. Large throughput refineries can be built with initial investment spread over the resources of two companies instead of one. As many operating cost elements, such as depreciation, insurance, and personnel, cost remain constant with refinery throughput, operating cost per barrel crude processed is reduced, thereby increasing refinery profit for the participants. This chapter discusses the equitable sharing of operating costs of the refinery (allocation of operating costs) between the participants.

A refinery operating cost can be classified under the following heads:

Personnel cost. This includes salaries and wages of regular employees, employee benefits, contract maintenance labor, and other contracted services.

Maintenance cost. This includes maintenance materials, contract maintenance labor, and equipment rental.

Insurance. Insurance is needed for the fixed assets of the refinery and its hydrocarbon inventory.

Depreciation. Depreciation must be assessed on refinery assets: plant machinery, storage tanks, marine terminal, and the like.

General and administrative costs. This includes all office and other administrative expenses.

Chemicals and additives. These are the compounds used in processing petroleum and final blending, such as antioxidants, antistatic additives and anti-icing agents, pour point depressants, anticorrosion agents, dyes, water treatment chemicals, and so forth.

Catalysts. Proprietary catalysts used in various process units.

Royalties. Royalties are paid either in a lump sum or running royalty purchased for know-how.

Purchased utilities. This may include electric power, steam, water, and so on.

Purchased refinery fuel. This may include natural gas purchased by the refinery for use as refinery fuel and feedstock for hydrogen production.

ALLOCATION OF OPERATING COST

In a jointly-operated refinery, the individual operating expenses under different cost headings, as just described, can be allocated to the participants by one of the following methods: the system costing method, the theoretical sales realization valuation (TSRV) method, or on an actual usage basis.

SYSTEM COSTING METHOD

In the system costing method, costs are allocated to a participant in the ratio of its equity in the refinery All operating expenses involved in processing feedstocks in the refinery and related general and administrative services are allocated in this manner. The portion of current operating expenses related to major maintenance and repair items, such as unit shutdowns, emergency repairs, and large expenditure on replacements and renewals, which do not extend the life of fixed assets, are segregated. These are spread over a 12-month period by including in the operating expenses for each operating period, a monthly amount equal to 1/12th the estimated amount of such expenses, ensuring a 12-month period to recover the actual expenditure.

THEORETICAL SALES REALIZATION VALUATION METHOD

In the TSRV method, the total expense is allocated to the participants in the ratio of TSRV of its product. The following example illustrates the methodology involved.

EXAMPLE 19-1

The total operating expenses of a marine terminal of a refinery during a month were $1.3 million. We want to allocate these expenses to the participants using the TSRV method. The product shipments during the month from the terminal were as follows:

PRODUCT	AOC'S SHIPMENTS, bbl	BOC'S SHIPMENTS, bbl
NAPHTHA	817,149	511,711
GASOLINE	412,477	78,417
KEROSENE	632,858	101,675
DIESEL	1,900,245	460,552
FUEL OIL	1,706,555	376,461
ASPHALT	29,221	50,832
TOTAL	5,498,505	1,579,648

The first step in allocating the cost by the TSRV method is to estimate the value of the product shipped by both the participants. This is done by multiplying the shipment volumes by per unit cost of the product as follows. The cost used here is the average mean of Platts (MOP) published prices of the products during the month:

PRODUCT	MOP PRICE, $/bbl	AOC SHIPMENTS, $ millions	BOC SHIPMENTS, $ millions
NAPHTHA	18.681	15.265	6.373
GASOLINE	25.761	10.626	1.347
KEROSENE	27.252	17.247	1.847
DIESEL	23.234	44.149	7.133
FUEL OIL	13.422	22.905	3.369
ASPHALT	15.000	0.438	0.508
TOTAL		110.631	20.577

Total value of the product shipped over marine terminal = $131.208 million

Value of the product shipped by participant AOC = $110.631 million

Value of the product shipped by participant BOC = $20.577 million

Total value of the product shipped = \$131.208 million

Participant AOC's product share = 84.0%

Participant BOC's product share = 16.0%

Total operating expenses of the marine terminal = \$1.31 million

Participant AOC's share of operating cost (84%) = \$1.092 million

Participant BOC's share of operating cost (16.0%) = \$0.121 million

COST ALLOCATION FOR ACTUAL USAGE

The following cost items are allocated to the participants as per their actual usage:

1. The cost of the chemicals and additives, such as antiknock compounds, pour point depressants, and antistatic dissipaters. It is possible to accurately estimate the quantity of antiknock compound, pour point depressants, and other additives used in the final blending of their products from shipment and quality data records.
2. All operating expenses involved in receiving crude oil and other feedstocks in each operating period are segregated and allocated to the participants on the basis of that received by each in the period. For example, if a participant brings in a crude or another feedstock for processing in its share of refining capacity, all expenses related to receiving the crude is allocated to that participant. If a crude is brought in by pipeline for processing by both the participants, the pipeline-related expense is allocated to the participants in the ratio of the crude received.
3. All operating expenses involved in the manufacture and shipping of solid products, such as asphalt and sulfur, in each operating period are segregated and allocated to the participants on the basis of their respective shares of shipment of such products.

UNUSED CAPACITY CHARGE

After each operating period, the refinery establishes the amount of total crude distillation capacity available to each participant during the

operating period but not used by that participant. The per-barrel charge to be applied to payable unused capacity is calculated as follows. If we let

$$\text{Total operating expenses during a month} = A \text{ (million \$)}$$
$$\text{Total available refinery crude distillation capacity during month} = B \text{ (mb)}$$
$$\text{Per barrel capacity charge} = A/B$$

Suppose the participants' equity in refinery is 60/40. The capacity available to participants during the month is

$$\text{AOC} = 0.6B \text{ mb}$$
$$\text{BOC} = 0.4B \text{ mb}$$

If one participant, say, BOC, utilizes only 95% of its available capacity,

$$\text{BOC's unused capacity} = 0.4 \times 0.05B \text{ mb}$$
$$= 0.02\text{B mb}$$
$$\text{Unused capacity charge payable by BOC} = \$[(A/B) \times (0.02B)] \text{ million}$$

The unused capacity charges are deducted from the total operating expenses of the refinery before allocating these expenses to the participants. An example of monthly allocation of various cost elements in an actual refinery is shown in Table 19-1. In the table the total monthly operating expenses are shown in column 4. The basis of allocation of each operating expense is indicated in column 1.

We see that

- Personnel, maintenance, insurance for the refinery plant and machinery, depreciation, royalties, catalyst costs, and so forth are allocated on the basis of participant equity in the refinery.
- Insurance for the hydrocarbon inventory in the refinery's tanks is on the basis of average inventory held by each participant.
- Natural gas import costs are allocated to the participants in the ratio of their usage in the allocation LPs.

Table 19-1
Monthly Allocation of Various Cost Elements

EXPENSE	BASIS OF ALLOCATION (1)	AOC ALLOCATION, $ (2)	BOC ALLOCATION, $ (3)	TOTAL EXPENSE, $ (4)
PERSONNEL	EQUITY	1,710,000	1,140,000	2,850,000
MAINTENANCE	EQUITY	958,500	639,000	1,597,500
INSURANCE				
ASSETS	EQUITY	112,500	75,000	187,500
INVENTORY	INV. RATIO	12,375	10,951	23,326
TAXES/LICENCES	EQUITY	4,926	3,284	8,211
DEPRECIATION	EQUITY	143,100	95,400	238,500
NATURAL GAS	USAGE	751,511	499,185	1,250,696
CHEMICALS/ADDITIVES	USAGE	69,438	103,273	172711
CATALYSTS	EQUITY	180,000	120,000	300,000
ROYALTIES	EQUITY	682	454	1,136
UTILITIES	CRUDE RUN	225,000	150,000	375,000
CRUDE RECEIVING PIPELINE	CRUDE RECEIPTS	2,932	3,058	5,990
MARINE TERMINAL	TSRV	624,268	633,639	1,257,907
ASPHALT PRODUCTION	PRODUCTION	756	504	1,260
ASPHALT DRUM FILLING	PRODUCTION	1,260	840	2,100
SULFUR PLANT	TOTAL CRUDE RUN	4,927	3,284	8,211
TOTAL		4,802,175	3,477,873	8,280,048

- Chemical and additive costs is allocated to the participants on the basis of actual usage. For example, the cost of anti-icing additives used for blending jet fuel by one participant can be estimated from the volume of jet fuel blended and the additive dosage rate. For additives and chemicals whose use by an individual participant cannot be identified is allocated in the ratio of the crude run of the participant.
- Utilities costs are allocated on the basis of the participant's crude run.
- If crude is received by way of a pipeline for use of more than one participant, all pipeline expenses are allocated to the participants in the ratio of their crude run in the refinery. If crude or feedstock is received by refinery for exclusive use of one participant, all expenses relating to that import are allocated to the receiving participant.
- All expenses relating to product export from the refinery marine terminal are allocated by the TSRV method. In this method, the value of total product exported by each participant is estimated and the total operating expenses of the terminal is allocated in that ratio. An example of the methodology involved is shown in Example 19-1.
- Asphalt production and drumming is a noncontinuous activity in many refineries. Special operating costs, such as drum filling, are segregated from other unit operating costs and allocated to participants in the ratio of the product shipped. Similarly, sulfur plant special costs, such as prilling plant costs, are allocated to participants in the ratio of their sulfur shipped.

REVENUES FROM LEASING EXCESS TANKAGE CAPACITY

A situation can arise in which the refinery has excess storage capacity available over that required for operation of the refinery at its maximum crude throughput. In such situation, the refinery can lease its surplus tankage capacity on a long-term lease to other companies for storage of its products and earn some extra profit. Any profit from such an operation is split between the participants in the ratio of their equity in the refinery.

EXAMPLE 19-2

A jointly owned company is awarded a tender from the Defense Department to store 1 million bbl petroleum products for a period of 5 years. The products comprise the following:

PRODUCTS	VOLUME, bbl
KEROSENE/JET FUEL	350,000
AUTOMOTIVE DIESEL	300,000
FUEL OIL	350,000
TOTAL STORED	1,000,000

The business is offered to the refinery, at $5.00/bbl/year. The refinery, however, has to use one storage tank of 500 mb capacity built exclusively for participant BOC, in addition to its own excess tankage capacity, to meet the storage capacity required for this business. The equity of the participants in the refinery is 60 and 40%. The participants agree to share revenues from this venture 50:50. Estimate net revenue of each participant from this business.

Total revenue from leasing tankage capacity = 1 million × 5 = $5 million/year. The revenue sharing of $5 million per year will be 50:50, as follows, for the 5-year period of the contract.

YEAR	AOC REVENUE, $ million	BOC REVENUE, $ million
1	2.5	2.5
2	2.5	2.5
3	2.5	2.5
4	2.5	2.5
5	2.5	2.5
TOTAL	12.5	12.5

To provide the required storage capacity, participant BOC leases its exclusively owned tank of 500 mb capacity to the refinery for this business at $5.0 bbl/year for a period of 5 years. As the equity of participants in the refinery is 60:40 for AOC and BOC, the revenue of the participants will be as follows:

$$\text{Capacity of participant BOC tank leased to the refinery} = 500\,\text{mb}$$

$$\text{Annual lease charge payable to the participant BOC} = \$500{,}000 \times 5 = \$2.5\,\text{million}$$

This lease cost is shared between the participants in their equity ratio (60/40 here), as follows:

	LEASE COST, $ million		
YEAR	TO AOC	TO BOC	TOTAL
1	1.5	1.0	2.5
2	1.5	1.0	2.5
3	1.5	1.0	2.5
4	1.5	1.0	2.5
5	1.5	1.0	2.5
TOTAL	7.5	5.0	12.5

Revenue to BOC from leasing the tank to refinery, because of its ownership of the leased tank, is as follows:

YEAR	REVENUE TO BOC, $ million
1	2.5
2	2.5
3	2.5
4	2.5
5	2.5
TOTAL	12.5

The net profit to each participant from storage tender and participant BOC leasing its tank can be determined as follows:

$$\text{Participant AOC} = \$2.5 - \$1.5 = \$1.0\,\text{million/year}$$

$$\text{Participant BOC} = \$2.5 - \$1.0 + \$2.5 = \$4.0\,\text{million/year}.$$

	CUMULATIVE REVENUE, $ million	
YEAR	AOC	BOC
1	1.0	4.0
2	1.0	4.0
3	1.0	4.0
4	1.0	4.0
5	1.0	4.0
TOTAL	5.0	20.0

We see that the total revenue of the participants remains constant at $25 million, after 5 years of business. However, the split of this revenue between the participants has changed from 50:50 without BOC tank leasing to the refinery, to 20/80 in participant BOC favor as a result of tank leasing.