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Accounts of an Oil Company

H. G. Humphreys

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By H. G. Humphreys

Probably the most interesting problems to the accountant are those that arise in the finding of costs of refined products. In later paragraphs these "costs" will be discussed in three divisions: (a) refinery department, (b) lubricating department, (c) natural gasoline department.

As a preliminary, that may make for clearer understanding of the accounts later to be introduced, I shall touch briefly on some of the procedures and terms used in the oil-refining business.

Petroleum refining

Petroleum consists of about 84 per cent. by weight of carbon with 12 per cent. of hydrogen, and varying proportions of sulphur, nitrogen and oxygen.

In the first operation, the crude oil is fractionally distilled so as to separate it at normal boiling points into wet gas, gasoline, kerosene, gas oil, fuel oil, etc. Some of the products are later purified by chemical treatment.

The cracking process, wherein gas oils and fuel oils form the main charging stock, consists in distilling the oils at a higher temperature than the normal boiling point of the constituents to be decomposed (cracked). This is usually brought about by a distillation under pressure. Wet gas, pressure distillate and heavy bottoms—the latter being mostly of the consistency of fuel oil—are produced in the cracking process. Pressure distillate is from 25 to 50 per cent. of the charge. The pressure distillate is further processed and is found to contain ordinarily about 95 per cent. of gasoline and 5 per cent. residuum. The latter can be recharged to the cracking still. An innovation that has awakened much interest is the hydrogenation process. As we understand it, this new process will occupy the "clean up" position in the batting order. After the other processes have had their innings and taken out all the lighter products within their power, leaving only the heavy ends, hydrogenation gets into action by introducing hydrogen into the heavy residues and converting them into lighter hydrocarbon products, such as gasoline, etc.

It might be mentioned at this point that a modern refinery is capable of recovering from 60 per cent. to 80 per cent. gasoline from a barrel of high grade crude oil. With the addition of the hydrogenation process the percentage of gasoline yield would be tremendously increased. This prospect, considered with the complete capture of available casinghead gas and other wet gas, for conversion into gasoline, would seem to insure an ample gasoline supply were the present crude oil production much less than it actually is. However, with bottled drinking water at present commanding a higher price than gasoline, we shall have to wait a while before we see hydrogenation in extensive use.

Gravity and volume corrections

It is easy to look at a clock and read the time, but it is not easy to explain in technical terms why the hands go around their course so accurately. It is also easy to read temperature as registered on a thermometer or gravity as registered on a hydrometer. But the measure of oils and products, generally speaking, must be corrected both in respect of gravity and temperature as read, so that the resulting figures will represent correct degrees of gravity and corrected volume, as though the oil measured were actually taken at 60 degrees Fahrenheit. They whose duty it is to make these corrections develop in course of time an intuitive facility in determining correct results.

To obtain complete information on this subject, one should read the various publications issued by the United States bureau of standards, the American Society for Testing Materials, the American Petroleum Institute, as well as the books that are issued by the makers of hydrometers.

For present purposes I shall merely illustrate the factors involved in these computations.

The following abridged table shows the comparison of the specific gravity scale, API gravity scale and Baumé gravity scale for fluid lighter than water, under which practically all petroleum and its fluid products fall:

	Specfic gravity	API gravity	Baumé gravity
*Distilled water (standard of comparison—at 60° F. and 760 MM. barometric pressure)	*1.0000	10	10
	.9340	20	19.90
	.8762	30	29.78
	.8498	35	34.82

$$\text{Degrees API} = \frac{141.5}{\text{Spec. grav.}} - 131.5$$

$$\text{Degrees Baumé} = \frac{140}{\text{Spec. grav.}} - 130$$

Specific gravity	API gravity	Baumé gravity
.8251	40	39.72
.7796	50	49.58
.7389	60	59.48
.7165	66	65.40
.6690	80	79.27
.6388	90	89.17
.6112	100	99.07

For liquids heavier than water, the Baumé gravity scale is used. The following is an abridged table:

$$\text{Degrees Baumé} = 145 - \frac{145}{\text{Spec. grav.}}$$

	Specific gravity	API gravity	Baumé gravity
*Distilled Water (standard of comparison at 60° F. and 760 MM. barometric pressure)	*1.0000	(No API scale for heavy liquids)	0.000
	1.0069		1.000
	1.0140		2.000
	1.0211		3.000
	1.0284		4.000
	1.0357		5.000
	1.5263		50.000
	1.9333		70.000

A brief example of a gravity temperature correction table is appended:

Observed temperature degrees Fahr.	Hydrometer—Observed degrees of gravity (tenths omitted)				
	30	40	60	70	80
	Observed degrees corrected to degrees at 60° F.				
30	32.0	42.4	63.6	74.3	84.9
40	31.3	41.6	62.4	72.8	83.2
60	30.0	40.0	60.0	70.0	80.0
70	29.3	39.2	58.9	68.6	78.4
80	28.7	38.4	57.8	67.4	76.9

A complete table would give each degree of temperature from 0 to 125 and each observed degree of gravity from 10 to 99, with a rule for interpolating corrections in respect of tenths of observed degrees of gravity.

The table given below will serve to illustrate the method of determining the correct volume at 60° F. of a given volume of oil measured at a different temperature:

At 60° F.				Observed temperature—degrees Fahr.				
				30	40	60	70	80
*Coefficient of expansion		Grav. group	Grav.	Volume correction Multiply measured volume by				
*Applicable to certain gravity groups.	0.0004.....	1	30	1.0120	1.0080	1.0000	0.9960	0.9921
	0.0005.....	2	40	1.0149	1.0099	1.0000	0.9951	0.9901
	0.0006.....	3	60	1.0181	1.0121	1.0000	0.9939	0.9879
	0.0007.....	4	70	1.0211	1.0141	1.0000	0.9929	0.9858
	0.0008.....	5	80	1.0240	1.0160	1.0000	0.9919	0.9838

A complete table would give each degree of observed temperature from 0 to 203. Among other tables used is that which gives API gravity equivalent of specific gravity with corresponding weight in pounds per U. S. gallon.

Casinghead (wet) gas

Casinghead gas is a valuable contribution to the petroleum market. Approximately 30 per cent. of this gas, by volume, is converted into various grades of natural gasoline, some of which may be used as a special motor fuel and some combined with refinery gasoline to form a motor fuel for ordinary consumption. Since so much gasoline is obtainable from wet gas, it is apparent that this as well as gasoline from crude oil must be considered in determining the minimum gasoline production commensurate with current demand for that commodity.

The lighter components of the gasoline extracted from wet gas yield butane, propane, solvents, etc., etc. Butane is a gas supplied chiefly to small towns for light and fuel; propane is the liquid gas which is supplied in cylinders for heating purposes; solvents are used as a compounding medium in the manufacture of rubber, vegetable compounds, etc.

The remaining 70 per cent. is dry gas which may be used as fuel or burned into carbon black.

There has been a deplorable waste of casinghead gas, or gas produced with the oil from oil wells.

Casinghead gas is usually bought under contract. "Seller"

is the owner or lessee of an oil and gas producing property. "Buyer" is the owner of a natural gasoline plant.

Delivery is made at seller's vapor-tight flow tanks and/or gas traps and/or casingheads of the oil wells. By agreement, buyer may install equipment for saving vapors, which are considered casinghead gas.

Buyer may decline casinghead gas below a given gasoline content and also flush production of such gas in excess of his plant capacity to absorb.

Buyer usually returns free to seller residue dry gas for the operation of seller's property, but not in excess, however, of the dry gas returnable as determined in accordance with the standard table of the Natural Gas Association of America, which shows the percentage of casinghead gas returnable as residue after deducting the volume consumed in gasoline extraction and plant operation. The richer the casinghead gas in gasoline content, the smaller the percentage of dry gas. For example:

Gasoline content of wet gas per M. cu. ft. gallons	Residue gas returnable per cent.
.75	85.75
1.75	75.50
2.75	65.75
15.00	10.80

Seller pays for dry gas delivered him by buyer in excess of the quantity to which he is entitled as measured according to the standard table. And, as often happens, should buyer sell unutilized dry gas, he pays to seller 50 per cent. of the amount realized from such sale. The 50 per cent. of realization is calculated on the proportion which the volume of surplus residue gas available for sale from casinghead gas delivered by seller bears to the total volume of surplus residue gas available for sale from casinghead gas delivered to buyer's plant from all sources within the period involved.

The gasoline content is determined by a field compression test in accordance with the official code, specifications and procedure of the N. G. A. A. for such purposes. Tests are made quarterly or at the demand of either party on notice, as provided.

The casinghead gas delivered is usually measured by an orifice meter which is furnished, installed and kept in repair by buyer. Meters are tested on the demand of either party. A registration

within 3 per cent. of correct is considered correct. On request, buyer sends seller meter charts for perusal and return.

Buyer pays seller a price per thousand cubic feet computed according to the following standard price schedule:

Realized average price per gal. of gasoline—cents	Gallons per M. cubic feet		
	Less than .75	.75 to 1.74 incl.	1.75 and over
	Per cent. of the average value of gasoline		
2 or less	5%	10%	15%
2⅛ to 3⅞	10%	15%	20%
4 to 5⅞	15%	20%	25%
6 and over	20%	25%	33⅓%

Provision is made for the termination of the contract when the supply of casinghead gas declines to an unprofitable volume.

Tests

Accountants who are desirous of learning something concerning tests might obtain a booklet from a laboratory concern that specializes in testing petroleum products. In a plant that turns out quality products the physical and chemical tests are many and bewildering.

The distillation test is the most important in determining the quality of gasoline, since it shows how it will perform in an internal combustion engine. Here is found the point at which the lightest elements of gasoline begin to boil—the initial boiling point; also the highest temperature reached in distilling the gasoline—the end point. The intermediate performance of gasoline under this test is important in determining the degree of constancy in vaporization compared with specification requirements.

With the "doctor" test it is found whether the gasoline is sweet or sour.

The percentage of bottom sediment and water in crude and fuel oil (oil being lighter than water) is determined by a centrifugal test which throws the heavy elements to the bottom of the testing flask.

Viscosity is the term which denotes the body or cohesiveness of a liquid—the resistance which it offers to flow, like molasses.

Flash point is the temperature at which there is enough gas

given off of the volatile liquid to cause a small flash to shoot across the surface of the liquid, on passing a small flame over the liquid as the temperature increases.

Fire point is the temperature at which the oil will burn without extinguishing. Furthermore, there is the cold test to determine the temperature at which the oil ceases to flow; the test to determine the temperature at which wax will melt; the test to learn how long an illuminating oil will burn (a good kerosene will burn 18 hours steadily without clouding the chimney or forming incrustations on the wick); the corrosion test to determine whether or not the gasoline will corrode carburetor and cylinders; the calorific test, especially for fuel oil, to learn the heating value—B T U per pound—the heat required to raise one pound of water one degree from 32 degrees Fahrenheit; the sulphur test for fuel oil; the penetration test on asphalts and greases by which is learned the point at which the latter becomes an oil, at least for excise-tax purposes; and so on.

Octane numbers

The following is given by permission of the copyright owner, so to speak:

In the internal combustion engine automotive engineers try to approach the even gradual increase of power such as found in steam engine performance. The power produced by steam is by expansion, while in an internal-combustion engine the power is produced by explosion.

Internal-combustion engine performance approaches the desired objective by being fed a slow burning (exploding) fuel. Refiners accomplish this by high heat treating, or adding some material such as ethyl, which lowers the hydrogen carbon ratio. Reduction of hydrogen content makes a slower burning fuel. We speak of it as being more refractory.

Automotive engineers try to develop an engine which has less weight per horse power, which means lower cost. They also want a fuel which will perform without knocking. Knocking indicates a loss of power and is detrimental to smooth performance. Reducing the size of the engine is primarily a sacrifice of power, which has been compensated by the introduction of high compression ratios (7–1, 8–1, etc.). The ability of the fuel to withstand high compression without prematurely breaking down (knocking)

is determined by a testing engine which measures the burning qualities of the fuel.

A reference fuel is made by mixing normal heptane and iso-octane which have known constant characteristics. The properties of normal heptane are such that it is a bad knocking fuel; iso-octane resists knocking. These two fuels are blended so as to give the same degree of knock as the fuel to be tested. The comparison is made by alternately using the heptane-octane mixture and the fuel being tested. The percentage of normal heptane added to iso-octane to give the same knocking rate as the fuel under investigation is what is known as the octane number. Seventy octane would be a mixture of 30 per cent. normal heptane and 70 per cent. iso-octane.

The testing engine goes to compression ratios which are much higher than those of commercial automotive engines and make the fuel knock—otherwise there would be no yardstick.

Costs

Refinery department

On succeeding pages will be found the following described statements and memoranda:

1. Summary of income
2. Daily plant records
3. Plant expense
4. Cost of deliveries
5. Account of stocks
6. Market prices
7. Operations by processes
8. Processing summary

The figures given in the statements are intended for illustrative purposes only and do not represent true values in any sense.

Let us consider these costs under three heads: (1) in which only partial information as to stocks is available; (2) where there is a daily control of stocks; (3) where stocks are controlled and costs apportioned over processes.

It is probably true that many of the small refineries are in class 1. In such cases, one would probably learn that the primary purpose of the management was to keep the men profitably employed; "Why keep unnecessary books?" However, a monthly statement is called for and the accountant will, at least, be able to obtain sufficient information to make up an account like state-

ment 1—summary of income given herewith, except that it will be necessary for him to combine the gallonage of refining loss and stock variation. He might go further and build up a statement by products as in columns 8 to 19 of statement 5 herewith, thus:

	Products	
	Gallons	Cost
Closing inventory	X	X
Deliveries	X	X
Total	X	X
Deduct:		
Opening inventory	X	X
Purchased products	X	X
Total	X	X
Plant yield and cost	X	*X
Add:		
Processing and storage loss	X	
Crude oil run	X	X
Operating and maintenance		X
Depreciation		X
Direct departmental expense		X
Production cost, as above		*X

This being a monthly statement, to trace an excessive gallonage loss might entail considerable work, possibly with no success.

In case 2 there is a complete set of stock records, as described in memorandum (2) daily plant records. Processing figures are carefully audited and figures of transfers between products are acknowledged by the plant superintendent. Losses from processing and stock variations are developed separately under this system and are ascertained daily. The figures given in statement (1) summary of income have, for present purposes, been developed according to this system, which is believed to be fully explained in the accompanying statements and memoranda 2 to 6 inclusive. In column 15 of statement 5 the dollar values of opening inventory and purchases plus costs for the period have been combined and apportioned in ratio to average market prices for the period, as given in statement 6. Some will contend that the prices for such

apportionment should be the average for a six-months' period. Others will contend that the costs should be apportioned on different bases—one for crude oil, one for direct expenses, one for utility and general expense and opening inventory as previously valued.

Since no two refineries are alike and crude oil is of varying quality and the manufacturing policy is necessarily based on conditions as they are, the accountant must use his best judgment with his individual problem. Whatever change he would desire could be accomplished by a breakdown of the costs as given in column 15 of statement 5. But the managing director comes into the picture and says that all the figures are very pretty; they account for the stocks and they develop an acceptable valuation of products for balance-sheet purposes—but they are of no value otherwise. Let us tackle case 3.

All the figures necessary for case 3 are furnished in case 2. The first thing to find out is whether the concern has a specific objective or merely produces more or less haphazardly. Let us assume that the policy is to produce as much kerosene as is necessary to meet current demand and as much gasoline as possible; regarding the inevitable lower ends as by-products. We first make proper arrangements for charging direct expense to each respective process and to apportion utility and general expense equitably over processes. The monthly figures of "consumed," "produced" and "processing loss" are available from the records as described under process unit No. X given in statement—memorandum 2. These figures are entered in statement 7, as well as the cost of crude oil consumed and the expenses of each process. Now we are to value the by-products that have been consumed and the by-products produced from each process as per statement 7. On consulting the managing director he requests development of a set of figures that will tell him as to each process how much the market value of products consumed plus expenses was increased by the resulting products priced at market value. This is his yardstick of economic efficiency. Statement 7 gives the result and statement 8 is a summary of statement 7. It will be seen that the applied principle works out thus as to costs:

Market value of commodities consumed.....
Actual expenses.....

Total.....

Less: by-products at market prices	
Cost of main products apportioned in ratio to respective market prices	

Why operate a process if the market value of consumed material plus expenses exceeds the production at market value?

The stock ledger would contain the opening inventory of each account. Entries for the month would be the production and consumption as per statement 8. Purchases would be recorded at cost. Transfers between products would first absorb opening inventory value and the remainder would be valued as per the month's cost, respectively. Stock variations would be posted in quantities only. The total at this point would be ascertained as to each stock account—gallons, per gallon, dollars. This "per gallon" figure would be applied to deliveries and closing inventory and the balance of each product account would be carried forward unchanged. For balance-sheet purposes the value per gallon would be the cost record figure or market, whichever was the lower; the adjustment would not affect cost of deliveries per cost record but would be given effect in the general profit-and-loss account.

Refinery Department

(1) *Summary of Income*

(In the financial statement combining all departments, depreciation would be shown in the last deduction position)

	Price	Gallons	Dollars	Statement reference
Direct wholesale sales:				
Ethyl gasoline	.07	8,500	$ 595.00	
No. 2 "	.05	8,000	400.00	
No. 3 "	.04	7,500	300.00	
		24,000		
Kerosene	.03	400	12.00	
Distillate	.025	300	7.50	
Fuel oil	.012	10,000	120.00	
		34,700	$1,434.50	
Deduct—outage allowances		100	6.00	
Total sales		34,600	$1,428.50	
Cost of sales:				
Crude oil plus pipage (1,000 barrels)		42,000	$ 840.00	
Refining loss (43 barrels)		(1,806)		
Operating and maintenance			512.35	
Depreciation			185.35	
Direct departmental expense			10.00	

	Price	Gallons	Dollars	Statement reference
Production costs (957 barrels)		40,194	$1,547.70	8
Opening inventory at cost		108,562	2,510.00	
Storage variation (28 barrels)		(1,176)		
Purchased products at cost		46,620	168.00	
Costs to be accounted for		194,200	$4,225.70	5
Deduct: transfers at cost—				
To marketing department		24,000	$ 857.50	4
To operations		26,000	207.35	4
Closing inventory at cost		109,500	2,210.25	5
Total deductions		159,500	$3,275.10	
Cost of sales		34,700	$ 950.60	4
Shipping and transportation expense			20.00	
Proportion of selling expense			100.00	
Proportion of general expense			10.00	
Total costs and expenses			$1,080.60	
Net income for the department			$ 347.90	

Ratios:	Per cent	Per gallon	Per gallon gasoline
Cost of sales	66.55	$.0274	....
Shipping and transportation	1.40	.0006	....
Selling expense	7.00	.0029	$.0042
General expense	.70	.0003	....
Net income	24.35	.0100	....
Sales	100.00	$.0412	

(2) *Daily Plant Records*

Of primary importance is a complete record of stocks by individual commodities for each day and for the month to date. The following will illustrate the ordinary method of control:

Stocks on hand, 7 A. M. previous day:	Barrels
Received in plant—	
Crude oil	do
Purchased products	do
Total	do
Deduct: deliveries, per loading report	do
Plant consumption	do
Total deductions	do
To be accounted for, 7 A. M. today	do

By means of pumping reports and miscellaneous plant data, the plant office compiles a performance analysis each day for entry into a record such as described below (process unit No. X), the

record containing a separate sheet for each process. The column for "processing loss" develops a difference in each case which should compare favorably with the standard variation allowance; large discrepancies would be investigated and corrected, or explained under "remarks." At the same time, figures are developed to represent transfers from product to product within the plant for the day. With this information in hand, together with stock movements to and from the plant, the plant accountant is now ready to compile his daily report (for the day and month to date) in substantially the form of statement (5) account of stocks given herein—barrels only.

At the close of the month, the plant office would fill in all the figures, as to average gravity, percentage, barrels and gallons, in forms (7) operations by processes and (8) processing summary.

The storage variations (statement 5 column 6) are due chiefly to temperature variations. All stocks are corrected to 60° F. at the close of each month. Receipts and deliveries are likewise corrected as they occur.

PROCESS UNIT NO. X

Performance for the month ended 7 A. M. February 1, 19—

Horizontal classification:
- Cycle no.—
- Hours on stream
- 24 hours to 7 A. M. (vertical—2nd day to 1st of following month)
- Consumed—
  - Column for each commodity—barrels, per cent. of total, gravity
  - Total barrels
- Produced—
  - Column for each product—barrels, per cent. of total, gravity
  - Processing loss—barrels
  - Total barrels (as above)
- Laboratory memo.—gasoline content of product, etc.
- Remarks

Foot of sheet:
- Totals—consumed and produced—barrels, per cent. of total and average gravity
- Cycle record—day, hour, minute

Cycle No.—	Time on charge—hours and minutes
Charge started	Time on stream—hours and minutes
Stream started	Time idle— hours and minutes
Stream ended	Remarks
Cycle ended	

(This form would probably cover any process; but many processes would not require such an elaborate form.)

(3) *Plant Expense*

Classification	*Dollars*
Fuel	$287.35
Operating labor	150.00
Chemicals and supplies	50.00
Repair labor	5.00
Repair material	5.00
Superintendence	5.00
Insurance	5.00
Taxes	5.00
Direct departmental expense	10.00
Depreciation	185.35
	$707.70

The above is assumed to be the total column of the expense analysis. The actual analysis would be divided into three groups: (a) processing (b) utilities (c) general plant. Processing would consist of direct classified expenses to each process. The direct expense to each utility would be classified. Each general plant account would likewise be separately charged according to classification.

After full discussion with plant superintendent and assistants, bases would be determined whereby utilities expense and general plant expense would be equitably apportioned over processes, each of the latter accounts ultimately bearing its direct expense plus its share of overhead.

Auxiliaries (14 column) would be maintained, having a separate classified sheet of performance (where applicable) and expenses for each subdivision of (a) (b) and (c). Obviously, inordinate variations would be readily detected.

Large plants equalize monthly charges for repairs through the medium of a reserve account to which actual expenses are charged, the balance being adjusted at the end of the year, according to conditions then known.

(4) *Cost of Deliveries*

(Prices as per statement 5—column 14)

Products	Prices	Total		Direct wholesale sales		Transfers to marketing dept.		Used in operations	
		Gallons	Dollars	Gallons	Dollars	Gallons	Dollars	Gallons	Dollars
1. Gasoline	$.046	17,000	$ 782.00	8,500	$391.00	8,500	$391.00		
2. "	.033	16,000	528.00	8,000	264.00	8,000	264.00		
3. "	.027	15,000	405.00	7,500	202.50	7,500	202.50		
8. Kerosene	.020	400	8.00	400	8.00				
13. Residue gas	.008	21,000	167.35					21,000	$167.35
14. Distillate	.017	300	5.10	300	5.10				
17. Fuel oil	.008	15,000	120.00	10,000	80.00			5,000	40.00
		84,700	$2,015.45	34,700	$950.60	24,000	$857.50	26,000	$207.35

(5) *Account of Stocks—Sheet 1–2*

Products	Processing		Transfers—product to product		Total	Storage variations over (short)	Net plant yield		Opening inventory	Purchases
	Produced barrels	Consumed barrels	To barrels	From barrels	Barrels	barrels	Barrels	Gallons	Gallons	Gallons
1. Ethyl gasoline	300				300	(12)	288	12,096	14,204	
2. Gasoline	400	300	250		350	10	360	15,120	5,280	
3. Gasoline	300		250		550	(10)	540	22,680	3,720	
4. Light gasoline	312			500	(188)	(10)	(198)	(8,316)	2,916	8,400
5. Raw gasoline	250	250							9,200	
6. Raw gasoline	232	232							9,200	
7. Raw light gasoline	530	530							9,400	
8. Kerosene	90			80	10		10	420	80	
9. Kerosene distillate	100	100	80		80		80	3,360	1,340	
10. Treated pressure distillate	250	250							2,000	
11. Pressure distillate	250	250							5,000	
12. Wet gas	120	980			(860)		(860)	(36,120)		36,120
13. Residue gas	500				500		500	21,000		
14. Distillate (furnace oil)	10	20		50	(60)		(60)	(2,520)	2,920	
15. Gas oil	250	50		50	150	(10)	140	5,880	4,520	
16. Topped crude	380	50		50	280	(10)	270	11,340	7,560	
17. Fuel oil	440	150		50	240	10	250	10,500	5,400	
18. Recracking stocks	135	750	200		(415)	4	(411)	(17,262)	24,862	2,100
19. Pitch	20				20		20	840	960	
	4,869	3,912	780	780	957	(28)	929	39,018	108,562	46,620
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

	Column	Gallons
Closing inventory	18	109,500
Deliveries	16	84,700
Total	11	194,200
Deduct—purchases	10	46,620
Opening inventory	9	108,562
Total		155,182
Net plant yield (8)	8	39,018

Purchases	Gallons	Dollars
Light gasoline	8,400	$168.00
Wet gas—gallon equivalent	36,120	No Cost
Recovered from various sources other than cracking stills (See process 111)		
Recracking stocks	2,100	No Cost
Slop oil recovered		
Total, per statement (1)	46,620	$168.00

(5) *Account of Stocks—Sheet 2–2*

Products	Opening inventory plus purchases and net plant yield valued at average market prices for the period			Apportionment of costs in ratio to market as per column 13		Cost of deliveries		Closing inventory	
	Gallons	Per gallon	Dollars	Per gallon	Dollars	Gallons	Dollars	Gallons	Dollars
1. Ethyl gasoline	26,300	$.070	$1,841.00	$.046	$1,222.60	17,000	$ 782.00	9,300	$ 440.60
2. Gasoline	20,400	.050	1,020.00	.033	677.37	16,000	528.00	4,400	149.37
3. Gasoline	26,400	.040	1,056.00	.027	701.29	15,000	405.00	11,400	296.29
4. Gasoline for blending	3,000	.035	105.00	.023	69.73			3,000	69.73
5. Raw gasoline	9,200	.030	276.00	.020	183.29			9,200	183.29
6. Raw gasoline	9,200	.030	276.00	.020	183.29			9,200	183.29
7. Raw light gasoline	9,400	.030	282.00	.020	187.27			9,400	187.27
8. Kerosene	500	.030	15.00	.020	9.96	400	8.00	100	1.96
9. Kerosene distillate	4,700	.028	131.60	.019	87.39			4,700	87.39
10. Treated pressure distillate	2,000	.030	60.00	.020	39.85			2,000	39.85
11. Pressure distillate	5,000	.029	145.00	.019	96.29			5,000	96.29
12. Wet gas		.010							
13. Residue gas	21,000	.012	252.00	.008	167.35	21,000	167.35		
14. Distillate (furnace oil)	400	.025	10.00	.017	6.64	300	5.10	100	1.54
15. Gas oil	10,400	.020	208.00	.013	138.13			10,400	138.13
16. Topped crude	18,900	.018	340.20	.012	225.93			18,900	225.93
17. Fuel oil	15,900	.012	190.80	.008	126.71	15,000	120.00	900	6.71
18. Recracking stocks	9,700	.015	145.50	.010	96.63			9,700	96.63
19. Pitch	1,800	.005	9.00	.003	5.98			1,800	5.98
	194,200		$6,363.10		$4,225.70	84,700	$2,015.45	109,500	$2,210.25
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)

Cost—Column 15

Production costs	$1,547.70
Purchases	168.00
Opening inventory	2,510.00
Total per statement (1)	$4,225.70

Apportionment of Costs

1. Items of 11 times items of 12 equals items of 13
2. Total of 15 divided by total of 13 equals reciprocal (.66409)
3. Reciprocal (.66409) times items of 13 equals items of 15
4. Items of 15 divided by items of 11 equals items of 14
5. Items of 14 times items of 16 equals items of 17
6. Items of 14 times items of 18 equals items of 19

(6) *Market Prices—Average of Quoted Prices for the "Period"*

(Used as realization in statement 1 and to value products in statement 7)

	Number	Product	Per gallon	Per barrel
Main products	1	Ethyl gasoline	$.070	$2.94
	2	Gasoline	.050	2.10
	3	Gasoline	.040	1.68
	4	Light gasoline	.035	1.47
	5	Raw gasoline	.030	1.26
	6	Raw gasoline	.030	1.26
	7	Raw light gasoline	.030	1.26
	8	Kerosene	.030	1.26
	9	Kerosene distillate	.028	1.176
	10	Treated pressure distillate	.030	1.26
	11	Pressure distillate	.029	1.218
By-products	12	Wet gas	.010	.42
	13	Residue gas	.012	.504
	14	Distillate (furnace oil)	.025	1.05
	15	Gas oil	.020	.84
	16	Topped Crude	.018	.756
	17	Fuel oil	.012	.504
	18	Recracking stocks	.015	.63
	19	Pitch	.005	.21

(7) *Operations by Processes I to VII—Sheet 1–3*

	Product	Average gravity	Per cent.	Barrels	Gallons	Per barrel	Per gallon	Market value	Allocated value
I. Topping process									
Consumed:									
Crude oil including pipage		38.9	100	1,000	42,000	$ .840	$.020	$840.00	
Expenses						.042	.001	42.00	
			100	1,000	42,000			$882.00	
By-products:									
Gas oil	15	33.6	25	250	10,500	.840	.020	$210.00	
Topped crude	16	20.2	38	380	15,960	.756	.018	287.28	
			63	630	26,460			$497.28	$497.28
Main products:									
Kerosene distillate	9	42.5	10	100	4,200	1.176	.028	117.60	
						1.046	.025		104.58
Raw gasoline	5	60.3	25	250	10,500	1.260	.030	315.00	
						1.121	.027		280.14
Loss			2	20	840				
			100	1,000	42,000			$929.88	$882.00
II. Cracking process									
Consumed:									
Gas oil	15	33.3	5	50	2,100	.840	.020	$42.00	
Fuel oil	17	12.0	15	150	6,300	.504	.012	75.60	
Topped crude	16	20.6	5	50	2,100	.756	.018	37.80	
Recracking stocks	18	22.0	75	750	31,500	.630	.015	472.50	
Expenses						.126	.003	126.00	
			100	1,000	42,000			$753.90	
By-products:									
Recracking stocks	18	23.0	12	120	5,040	.630	.015	75.60	
Fuel oil	17	10.0	44	440	18,480	.504	.012	221.76	
Wet gas	12		12	120	5,040	.420	.010	50.40	
Pitch	19		2	20	840	.210	.005	4.20	
			70	700	29,400			$351.96	$351.96
Main products:									
Raw light gasoline	7	75.6	3	30	1,260	1.260	.030	37.80	
						1.479	.035		44.39
Pressure distillate	11	50.4	25	250	10,500	1.218	.029	304.50	
						1.430	.034		357.55
Loss			2	20	840				
			100	1,000	42,000			$694.26	$753.90

(7) *Operations by Processes I to VII—Sheet 2–3*

	Product	Average gravity	Per cent.	Barrels	Gallons	Per barrel	Per gallon	Market value	Allocated value
III. Gasoline extraction process									
Consumed:									
Wet gas	12		98	980	41,160	$ .420	$.010	$411.60	
Distillate	14	42.5	2	20	840	1.050	.025	21.00	
Expenses						.21	.005	210.00	
			100	1,000	42,000			$642.60	
By-product:									
Residue gas utilized	13		50	500	21,000	.504	.012	$252.00	$252.00
Main product:									
Raw light gasoline	7	83.7	50	500	21,000	1.260 .781	.030 .019	630.00	390.60
			100	1,000	42,000			$882.00	$642.60

NOTE.—Barrelage of raw light gasoline is actually measured.

Barrelage of residue gas is determined by reducing the number of cubic feet recovered and utilized, according to BTU value, into barrels of fuel oil and so valued and charged to expense.

Distillate consumed is correctly ascertained.

The remainder—980 barrels (41,160 gallons) of wet gas, equivalent of X cubic feet of wet gas saved, is entered to balance.

This wet gas was obtained—

From cracking stills	5,040 gals.
From indeterminate sources around the plant	36,120 gals.
Total	41,160 gals.

A more detailed accounting for wet gas will be found in the later memorandum on natural gasoline plants.

IV. Treating process (intermediate)									
Treated:									
Pressure distillate	11	50.8	100	250	10,500	$1.430	$.034		$357.55
Expenses						.040	.001		10.00
			100	250	10,500	$1.470	$.035		$367.55
Main product:									
Treated pressure distillate	10	50.6	100	250	10,500	$1.470	$.035		$367.55

(7) *Operations by Processes I to VII—Sheet 3–3*

	Product	Average gravity	Per cent.	Barrels	Gallons	Per barrel	Per gallon	Market value	Allocated value
V. Rerunning process									
Rerun:									
Treated pressure distillate	10	50.6	100	250	10,500	$1.470	$.035		$ 367.55
Expenses						.084	.002		21.00
			100	250	10,500				$ 388.55
By-product:									
Recracking stocks	18	29.8	6	15	630	.630	.015		$ 9.45
Main product:									
Raw gasoline	6	51.8	93	232	9,744	1.633	.039		379.10
Loss			1	3	126				
			100	250	10,500				$ 388.55
VI. Treating process (finishing)									
Treating:									
Raw gasoline	5	60.3		250	10,500	1.121	.027		$ 280.14
Raw gasoline	6	51.8		232	9,744	1.633	.039		379.10
Raw light gasoline	7	75.6		30	1,260	1.479	.035		44.39
Raw light gasoline	7	83.7		500	21,000	.781	.019		390.60
Kerosene distillate	9	42.5		100	4,200	1.046	.025		104.58
Expenses						.042	.001		46.70
				1,112	46,704				$1,245.51
By-product:									
Distillate	14	40.5		10	420	1.050	.025	$ 10.50	$ 10.50
Main products—costs apportioned in ratio to market									
Kerosene	8	42.5		90	3,780	1.260	.030	113.40	
						.812	.019		73.10
Gasoline	2	58.2		400	16,800	2.100	.050	840.00	
						1.354	.032		541.33
"	3	60.9		300	12,600	1.680	.040	504.00	
						1.083	.026		324.91
"	4	83.5		312	13,104	1.470	.035	458.64	
						.948	.023		295.67
				1,112	46,704			$1,926.54	$1,245.51
Note: In actual practice there is a small treating loss.									
VII. Ethylizing process									
Ethylized:									
Gasoline	2			300	12,600	1.354	.032		$406.00
Expenses						.840	.020		252.00
				300	12,600	2.194	.052		$658.00
Main product:									
Ethyl gasoline	1			300	12,600	2.194	.052		$658.00

(8) *Processing Summary*

(Recapitulation of statement 7)
gallonage omitted

Consumed					Main products	Produced			
	Barrels	Cost per barrel	Dollars			Barrels	Per barrel	Dollars	
				1.	Ethyl gasoline	300	2.194	$ 658.00	VII
VII	300	$1.354	$ 406.00	2.	Gasoline	400	1.354	541.33	VI
				3.	Gasoline	300	1.083	324.91	VI
				4.	Light gasoline	312	.948	295.67	VI
VI	250	1.121	280.14	5.	Raw gasoline	250	1.121	280.14	I
VI	232	1.633	379.10	6.	Raw gasoline	232	1.633	379.10	V
VI	30	1.479	44.39	7.	Raw light gasoline	30	1.479	44.39	II
VI	500	.781	390.60			500	.781	390.60	III
				8.	Kerosene	90	.812	73.10	VI
VI	100	1.046	104.58	9.	Kerosene distillate	100	1.046	104.58	I
V	250	1.470	367.55	10.	Treated pressure distillate	250	1.470	367.55	IV
IV	250	1.430	357.55	11.	Pressure distillate	250	1.430	357.55	II
	1,912		$2,329.91			3,014		$3,816.92	
					By-products				
III	980	.420	$ 411.60	12.	Wet gas	120	.420	$ 50.40	II
				13.	Residue gas	500	.504	252.00	III
III	20	1.050	21.00	14.	Distillate (furnace oil)	10	1.050	10.50	VI
II	50	.840	42.00	15.	Gas oil	250	.840	210.00	I
II	50	.756	37.80	16.	Topped crude	380	.756	287.28	I
II	150	.504	75.60	17.	Fuel oil	440	.504	221.76	II
II	750	.630	472.50	18.	Recracking stocks	120	.630	75.60	II
						15	.630	9.45	V
				19.	Pitch	20	.210	4.20	II
	2,000		$1,060.50			1,855		$1,121.19	
	3,912		$3,390.41			4,869		$4,938.11	

Barrels carried to statement 5, columns 1 and 2

	Barrels	Dollars
Produced	4,869	$4,938.11
Consumed	3,912	3,390.41
Production cost	957	$1,547.70
Processing loss	43	
Crude oil run	1,000	$840.00
Expenses		707.70
Total cost as per statement 1		$1,547.70

In the event of changes in the price of crude oil followed by corresponding changes in the price structure of refined products, it is desirable to know the approximate effect of such changes, and therefore prospective statements are often made, in somewhat the following form, containing the latest market quotations.

PROSPECTIVE GASOLINE SINGLE-PRODUCT COST

	Per cent	Barrels	Per barrel	Dollars
Crude oil.....(market)	100	1,000	$1.00	$1,000.00
Pipage.....(cost)			.10	100.00
Operating expense.....(do)			.12	120.00
Depreciation.....(do)			.02	20.00
Direct departmental expense.....(do)			.01	10.00
Total cost.....	100	1,000	$1.25	$1,250.00
Deduct: by-products—				
Kerosene.....(market)	5	50	1.68	$ 84.00
Gas oil.....(do)	10	100	1.26	126.00
Fuel oil.....(do)	25	250	.84	210.00
Loss.....	5	50		
Total by-products at market.....	45	450	.933	$ 420.00
Balance being gasoline single-product cost.....	55	550	$1.51	$ 830.00
		Gallons	Per gallon	
Balance—gallon basis.....	55	23,100	$ .036	$ 830.00

PROSPECTIVE REALIZATION ON GASOLINE PRODUCTION
From 1,000 barrels (42,000 gallons) of crude oil

	Gallons	Per gallon	Dollars
Sales No. 1 gasoline.....(market)	7,500	$ .08	$ 600.00
Sales No. 2 gasoline.....(do)	8,500	.06	510.00
Sales No. 3 gasoline.....(do)	10,000	.04	400.00
Total sales.....	26,000		$1,510.00
Cost of gasoline produced from 42,000 gallons of crude oil run...	23,100	.036	$ 830.00
Cost of gasoline purchased.....	2,900	.025	72.50
Cost of ethylizing (7,500 gallons @ .02).....			150.00
Transportation expense.....(42,000 gallons)		.001	42.00
Proportion of selling expense.....(do do)		.003	126.00
Proportion of general expense.....(do do)		.001	42.00
Total costs and expenses.....	26,000		$1,262.50
Net realization per 1,000 barrels (42,000 gallons) of crude oil run			$ 247.50

The auxiliary records, designed in this case to give figures for the month and for the half year and year to the close of the

month, form a source from which to ascertain various percentage and per-barrel rates.

Thus, the following described data would be derived for use in prospective statements:

Per cent.—The ultimate yield of products from crude oil run to stills (net plant yield).

Costs per barrel—actual costs divided by crude oil run to stills.

Transportation expense
Proportion of selling expense
Proportion of general expense
} Actual expenses divided by crude oil run to stills.

These figures are trustworthy only when computed on the results of a period of six months or more. Even then, the figures might be subject to some adjustment, as in the event of a major addition to plant or changes in the processing routine.

[Discussion of lubricating and natural gasoline departments will be taken up in the next paper.—H. G. H.]