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Accounts of an Oil Company

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VI

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Discussion of the subject of costs of refined products was opened in article V of this series, published in the August issue of The Journal of Accountancy, in which (a) refinery department was the topic. This particular discussion is conducted in the succeeding paragraphs under the heads of (b) lubricating department and (c) natural gasoline department.

Lubricating Department

The operations of the lubricating department usually are such that it would be more appropriate if it were called "compounding department."

In the refinery department various commodities are produced from one original charging stock—crude oil. In the lubricating department many commodities are also produced, but by means of compounding various combinations of base oils and other ingredients, according to formulas. Ordinarily, most of the component or base oils are produced in the refinery department. However, some of the component oils as well as various animal and vegetable ingredients are purchased from outside sources.

As a rule the operations of a compounding plant are planned so as to avoid lost motion. Stocks are so arranged that a physical inventory may be readily taken. All movements of oils, greases and containers, by steps, from commencement to completion of the finished products are reported daily by the plant to the cost division. The control of stocks is of paramount importance. While as a matter of necessity the lubricants in warehouses and stations are represented by a considerable figure in the company's frozen assets, the plant stocks might be held at a volume that would yield a high rate of turnover per annum. Individual costs of products are necessary and, in order that they may be dependable, they must tie into the books of account.

It is not practicable to develop actual individual costs in time to be of any value to the management; therefore, they must be predetermined in whole or in part. The system described in the following paragraphs comprises an individual predetermined cost of each product sold (or delivered) by product code, subdivided by container code.

As the result of close study of the entire subject, having regard for expectancy as to volume of business and price structure under present and future conditions, costs are predetermined for the following:

(a) Materials entering into each compounded product.

(b) Rate per gallon of compounding expense to be applied to each product uniformly.

(c) Each container and container-combination (cases and cans).

(d) Filling and handling (receiving, cleaning, shipping) each container and container-combination, including bulk (tank cars) and returnable containers (drums).

The record of these predetermined costs is arranged so that the unit cost of a particular product in bulk or in a particular kind of container may be readily ascertained. These unit costs, at the close of the month, are entered in a column in the sales analysis next to the corresponding unit price realized from sales, thus affording a valuable means of comparison, not only as between results by products and by periods, but also as between the unit prices realized for a given product in various containers and the respective costs. Every merchandiser likes to sell most of that article from which he enjoys the biggest margin of profit. Such an article usually has to be sold, while the salesman merely takes orders for the article from which there is a lean margin of profit.

The expense classification varies according to the size and character of the plant. In large plants the expense is broken down into fine detail and charged as directly as may be to the various operating divisions, the indirect expense then being equitably apportioned to divisions under monthly agreement between the superintendent and controller. Expenses are about 10 per cent. of the total cost of the finished product. For present purposes, I shall assume that there are two divisions (a) compounding, (b) filling and handling, each having certain direct expenses, the balance being apportioned between the two.

As the products are compounded according to formulas it will be understood that predetermined costs of (a) compounded stocks are based entirely on market conditions. This is also true of (b) containers. The compounding expense rate is the product of expected gallonage into total normal compounding costs. The filling and handling rates, however, require to be graded. This is done in somewhat the following manner:

Containers and combinations	How many	Predetermined rates	Predetermined costs
1	100	.2	$ 20
2	150	1.0	150
3	200	1.4	280
4	250	1.6	400
etc.			
Total			$850

The control of stocks and costs is broadly illustrated in the table on the following page.

The subsidiary ledgers to accounts 1 and 3 contain a separate account for each kind of stock. Compounded-stocks account includes oils and greases in filled containers. The subsidiary ledgers to accounts 2 and 4 contain a separate account for each size of container or case-container combination. Entries to accounts 5 and 6 are made in monthly totals. All ledger sheets of accounts 3 to 6, inclusive, have separate columns for actual costs and for costs applied, the latter being closed into the former at the close of the year.

Quantities of components compounded are ascertained from the plant compounding reports (or register). These are recapitulated with respect to each product (quantity ratios of each being checked against its formula) and are then valued at the respective average unit prices as per component-stocks-ledger accounts. Similarly, containers filled are recapitulated from plant reports and valued at the respective average unit prices given in the empty-containers-ledger account.

The costs as applied are developed in the sales and cost of sales analysis—later described.

A physical inventory of all plant stocks is taken as at 7 A.M. on the first day of each month. The difference between the quantity balance of each ledger account and the respective quantity inventoried, if substantial, is investigated and corrected. Minor differences—quantities only—may be recorded in the ledger or may be ignored until the end of the year.

After the completion of each month's accounts, unit costs of all "actual" and "applied" ledger balances are carefully compared and considered. Adjustments found necessary are effected

LEDGER ACCOUNTS (QUANTITY, UNIT COST AND AMOUNT—WHERE APPLICABLE)

	1 Component stocks	2 Empty containers	3 Compounded stocks	4 Filled containers (containers only)	5 Compounding expense	6 Filling and handling expense
1. Opening inventory and unapplied expense	x	x	x	x	x	x
2. Purchases	x	x				
3. Expenses					x	x
4. Stocks compounded	–		x			
5. Containers filled		–		x		
6. Stock variations (x or –)						
7. Actual costs	x	x	x	x	x	x
8. Deduct: costs applied to deliveries	0	0	–	–	–	–
9. Closing inventory and unapplied expense	x	x	x	x	x	x

by revising the rates of "applied" costs affected so as to absorb the amount of adjustment during the remainder of the year. At the close of the year all "applied" balances are closed into the respective "actual" columns, adjusted if necessary, and the inventory balances are then carried down in accordance with the predetermined schedule for the succeeding year.

The sales are analyzed and all costs recapitulated for accounting purposes, as follows:

I. *Sales and unit cost of sales*

Product No. 1) Each divided as between (a) external sales and (b)
do 2) internal sales—transfers, plant consumption, etc.
do 3) All sales are recorded at sales and cost value.
etc.)

Container code	Cases	Gallons	Dollars	Unit price Sales	Unit price Cost
1					
2	(Unit costs are taken from the unit cost records previously described)				
3					
etc.					
Total					

II. *Cost of compounded stocks applied*

Product	Total gallons	Applied cost	Amount
1			
2			
3			
etc.			
Total			

III. *Cost of containers applied*

Container code	How many	Applied cost	Amount
Total 1			
do 2	(returnable container costs omitted)		
do 3			
etc.			
Total			

IV. *Compounding expense applied*

Total gallons,—all products—as per II, times applied rate of compounding expense. Total

V. *Filling and handling expense applied*

Container code	How many	Applied rate	Amount
Total 1			
do 2	(Including containers III plus tank car and drum gallonage)		
do 3			
etc.			
Total			

VI. *Journal entry—applied cost of sales*
Cost of sales Dr
To * Cost of compounding stocks applied
* Cost of containers applied
Compounding expense applied
Filling and handling expense applied

*With details for subsidiary accounts.

Natural Gasoline Department

From present signs one seems justified in assuming that a greater degree of circumspection than has hitherto prevailed is to be exercised in the conservation of natural resources. This prospect, coupled with the expansion of the field of utilization of the components of casinghead gas in recent years, promises to produce deserved recognition of the economic importance of this branch of the petroleum industry.

Natural gasoline plants, for reasons of safety and economy, are erected at or near to the oil properties which produce casinghead gas. Many of the large oil companies own chains of natural gasoline plants. The accounts and operating statistics of these enterprises form a valuable source of information for the guidance of the management, not only in conducting current operations with due economy, but in determining the advisability of engaging in new projects.

Thus, should the characteristics of X—a new gas field which the company is surveying—resemble the initial characteristics of A—a natural gasoline enterprise which has been profitably operated by the company for a number of years—the historical record of the latter would be scrutinized, particularly for pitfalls to be avoided. Further considerations would be the location of the new producing property and the prospects of the market for natural gasoline. Assuming contracts to have been entered into for the purchase of casinghead gas from X property, a conservative tabulation, by years, would now be made of the prospective outlay and earnings, so as to fix the probable pay-out date—the date at which earnings would equal outlay for plant and expenses, plus loss of interest. With this forecast completed and thoroughly checked, the size and type of initial plant would be decided. The plant would then be constructed in an amazingly short period and operations commenced under the best predetermined policy growing out of the study of all relative data. As operations proceeded, actual results would be compared from time to time with the figures contained in the prospective tabulation mentioned.

Natural gas may be classified, according to natural gasoline content, as follows:

Dry gas	0 to 0.1	gallons of gasoline per M cubic feet
Lean gas	0.1 to 0.5	
Wet gas	over 0.5	

Casinghead (wet) gas purchases are usually measured by means of an orifice meter consisting of an orifice disc and recording mechanism, which records on charts certain variables in pressure which, with the orifice disc coefficient, form the basis for determining the flow of gas in cubic feet per hour.

A disc, through the center of which is drilled an orifice, is flanged in the gas line between two tapped outlets, one of which is under upstream flow pressure and the other under downstream flow pressure. The fluctuating flow pressure (either at the upstream or the downstream tap, depending upon the type of connection set-up) is directly communicated to the chart by the mechanical recording device contained in the meter. The two outlets mentioned are connected to a U tube containing mercury, from which is also communicated to the chart the fluctuating difference between upstream and downstream pressures, expressed in inches of water (one inch of mercury being equal to thirteen and six-tenths inches of water in weight).

Typical factors and definitions follow:

(*a*) The quantity purchased is expressed in cubic feet per 24 hours. (See example following.)

(*b*) "Differential pressure" (excess of upstream over downstream pressure) is recorded on the chart in inches of water.

(*c*) "Static pressure" in pounds per square inch absolute equals gauged pressure of flow (recorded on the chart in pounds per square inch) plus atmospheric pressure (mid-continent average being 14.4 pounds per square inch).

(*d*) Pressure extension is the square root of (*b*) x (*c*).

(*e*) "Hourly orifice coefficient" is the quantity which flows per hour when the "differential" is one inch of water and the flow pressure is one pound per square inch absolute.

(*f*) (*e*) x (*d*) equals cubic feet per hour before adjustment for temperature, pressure base and specific gravity.

(*g*) Correction factors for temperature are taken from tables.

(*h*) Correction factors for pressure base and specific gravity combined are also taken from tables.

The following example explains the computation of a gas purchase:

Flange connections.
Diameter of pipe, 6 inches.
Diameter of orifice, 3 inches.
Average differential pressure, 6 inches ⎫ per chart
Average gauged flow pressure, 10 pounds ⎭
Flowing temperature, 90 degrees Fahr.
Contract pressure base, 4 oz. above an assumed atmospheric pressure of 14.4 lbs. per square inch.
Specific gravity of gas, .95.

$$a = e\sqrt{b \times c} \times g \times h \times 24$$

$$\sqrt{b \times c} = \sqrt{6 \times (10 + 14.4)} = 12.1$$

$$\begin{pmatrix}\text{quantity}\\ \text{per}\\ \text{24 hours}\end{pmatrix} \overset{*}{=} \begin{pmatrix}\text{orifice}\\ 1913.6\\ \text{coefficient}\end{pmatrix} \times \begin{pmatrix}\text{pressure}\\ 12.1\\ \text{extension}\end{pmatrix} \times \begin{pmatrix}\text{temperature}\\ .9723\\ \text{correction}\end{pmatrix} \times \begin{pmatrix}\text{pressure base \&}\\ 1.0085\\ \text{grav. correction}\end{pmatrix} \times \begin{pmatrix}\text{hours}\\ 24\\ \text{per day}\end{pmatrix} = \begin{pmatrix}\text{M. cubic}\\ 545\\ \text{feet}\end{pmatrix}$$

* Each orifice in place has its fixed coefficient as determined by actual experiment on the specified arrangement of connections.

Thus the chart becomes a faithful messenger carrying to the office certain basic information for determining the quantity of casinghead gas purchased. Accuracy in computation is effected by the use of a delicate instrument which, by following the fluctuations of the two lines given on the chart, develops the average pressure per hour represented by each of the lines. The cash outlay on account of one of these charts may vary from 10 cents or less to 1,000 dollars or more.

A description of a contract form, such as is generally used in the purchase of casinghead gas, was given in the August issue of THE JOURNAL OF ACCOUNTANCY, pages 112 to 114.

There are at least three methods of producing natural gasoline, namely, the compression process, mineral-oil-absorption process and charcoal-absorption process. A description of these methods will be found in *Petroleum Industry of the Southwest* by Charles B. Eliot, domestic commerce series—No. 44, published by the United States government printing office,—a book that is replete with interesting data concerning the industry.

The greater numbers of natural gasoline sales are made to refiners for blending purposes. Formerly, the grade classification under which natural gasoline was sold only broadly described the different commodities, so that the purchaser did not know exactly what he was buying. It became apparent that a new classification would have to be devised which would more definitely describe the characteristics of the various grades of natural gasoline.

Accordingly, the Natural Gasoline Association of America sponsored a new set of specifications for commercial purposes, which have been generally adopted, viz:

1. Reid vapor pressure—10 to 34 pounds per square inch absolute.
2. Percentage evaporated at 140° F.—25 to 85.
3. Percentage evaporated at 275° F.—not less than 90.
4. End point—not higher than 375° F.
5. Corrosion—non-corrosive.
6. Doctor test—negative, "sweet".
7. Color—Not less than plus 25 (Saybolt).

A circular giving further particulars of these specifications and of the testing procedure may be obtained from the Natural Gasoline Association of America at Tulsa, Oklahoma. The following is a list of some of the new grades:

Vapor pressure	Percentage evaporated at 140° Fahr.	Used in trading
10–14	25–40	14–25
10–14	40–55	14–40
10–14	55–70	14–55
14–18	25–40	18–25
14–18	40–55	18–40
14–18	55–70	18–55
18–22	40–55	22–40
18–22	55–70	22–55
18–22	70–85	22–70
22–26	55–70	26–55
22–26	70–85	26–70

In the common parlance of the trade, these grades are known as 14 lb. material, 18 lb. material, etc., the vapor pressure being the chief factor with which the ordinary purchaser is concerned.

And so progress has been made. After all, this business consists of exchanging merchandise for money, and these grade specifications were intended as yardsticks, not only for measuring the physical qualities of each grade, but also for measuring their proportionate money value. The laboratory did not quite succeed (politicians certainly could not do as well) and the law of supply and demand had its way, as usual. It was found that a range of four pounds vapor pressure was too wide for trading purposes, and now we find in actual practice an apportionment of value according to vapor pressure, approximately, as follows (with possible further modifications in the making):

Vapor pressure (pounds)	Apportionment value (percentage)	Example (cents)	
26	100	3.00	base price
22	112	3.36	
20	118	3.54	
18	125	3.75	
16	134	4.02	
15	138	4.14	
14	143	4.29	
12	154	4.62	
11	160	4.80	

The life of a gasoline plant depends upon the continued supply of a sufficient volume of gas and gasoline content to operate the plant profitably. While the supply of gas diminishes, the gasoline content per M cubic feet will be found to increase. The gasoline ratio in the foregoing statement is higher than the average, which is probably about 1.5 gallons per M cubic feet. A gasoline plant may be connected to ten or less wells. Others are connected to a hundred wells or more.

Depreciation is usually computed at a fixed rate per annum on cost of investment divided by years. Thus, should the rate be ten per cent., at the end of ten years the capital expenditures made in the first year, less retirements, would be entirely covered by reserve, nine-tenths of the second year's expenditures would be covered by reserve, and so on. In the absence of complete information as to gas reserves, this is probably the best method. However, if it be known at the close of the first year (as in the case above cited) that the gas received at the plant was 4 billion cubic feet, which yielded 4,800,000 gallons of gasoline, the company's engineers might make a conservative estimate of the ultimate gas recovery and natural gasoline content, and this information might be used as a basis for reserve for depreciation. The estimate would be reviewed at least once a year, particularly if the projection should prove out of line with actual experience in the second year. Such an estimate is assumed to have been made in the case of the summary above presented and with an expected total investment of (say) $350,000 we learn that the probable gasoline yield will be 71,720,000 gallons, conservatively stated. On that

COMPARATIVE SUMMARY BROADLY ILLUSTRATING THE MAIN ACCOUNTING FACTORS IN THE OPERATION OF A NATURAL GASOLINE PLANT

	Actual operations					Estimated	
	First year	Second year	Third year	Fourth year	Fifth year	Sixth to twentieth year	Total twenty years
Casinghead gas purchases—M cubic feet	4,000,000	3,000,000	2,000,000	1,500,000	1,200,000	8,300,000	20,000,000
Gasoline content per M cubic feet—gallons	1.20	1.60	3.30	4.40	4.80	5.20	3.59
Gallons—net plant production	*4,800,000	4,800,000	6,600,000	6,600,000	5,760,000	43,160,000	71,720,000
do add opening inventory		200,000	300,000	200,000	300,000		
do deduct closing inventory	(200,000)	(300,000)	(200,000)	(300,000)	(200,000)		
do sales	4,600,000	4,700,000	6,700,000	6,500,000	5,860,000		
Cost of production							
Casinghead gas—valued as per contracts	$ 40,000	$ 45,000	$ 65,000	$ 70,000	$ 60,000		
Operating expenses	40,000	45,000	50,000	50,000	50,000		
Repairs and maintenance	10,000	12,000	15,000	20,000	25,000		
Departmental general expense—proportion	6,000	6,000	6,000	6,000	6,000		
Depreciation	24,000	24,000	33,000	33,000	28,800		
Total cost of production (See quantities above*)	$120,000	$132,000	$169,000	$179,000	$169,800		
Opening inventory, average cost		5,000	8,220	5,140	8,130		
Closing inventory, average cost	(5,000)	(8,220)	(5,140)	(8,130)	(5,880)		
Cost of sales	$115,000	$128,780	$172,080	$176,010	$172,050		
Trading account							
Gross sales—gasoline and other products	$120,000	$135,000	$195,000	$210,000	$180,000		
Deduct: outages and allowances	2,000	2,000	3,000	4,000	3,000		
Net sales—gasoline and other products	$118,000	$133,000	$192,000	$206,000	$177,000		
Sales of residue gas	30,000	25,000	20,000	15,000	15,000		
Miscellaneous sales (services, etc.)	5,000	5,000	6,000	6,000	6,000		
Total sales	$153,000	$163,000	$218,000	$227,000	$198,000		
Cost of sales	115,000	128,780	172,080	176,010	172,050		
Gross profit	$ 38,000	$ 34,220	$ 45,920	$ 50,990	$ 25,950		
Transportation expense	$ 6,000	$ 6,000	$ 9,000	$ 9,000	$ 9,000		
Proportion of selling expense	8,000	8,000	10,000	10,000	10,000		
Proportion of general expense	6,000	6,000	6,000	6,000	6,000		
Total deductions	$ 20,000	$ 20,000	$ 25,000	$ 25,000	$ 25,000		
Net profit	$ 18,000	$ 14,220	$ 20,920	$ 25,990	$ 950		

basis we are justified in allowing depreciation at the rate of one-half cent per gallon of gasoline production, pending correction of reserves. Some persons will doubtless contend that the reserve should be accumulated in ratio to the decline of estimated gas recovery (20 billion cubic feet). By this latter method, the depreciation allowance would have been 117/200 instead of 2856/7172 of the investment ($350,000) as shown in the summary. This is a moot question which may never be solved to the satisfaction of all concerned.

A method for spreading cost of production over individual products is given on pages 127 to 130 of the JOURNAL OF ACCOUNTANCY for August, 1933.

In addition to extracting the various grades of gasoline, a modern plant also manufactures certain special products—butane, propane, solvents, etc., in a separate division of the plant. The individual "costs" of these special products may be determined by making a complete separation of their operating costs (including taxes, insurance, depreciation, etc.) on the cost records and charging, at market, the gasoline delivered from the main plant to the special division, less "slop" returned. The net cost of gasoline, etc., consumed, plus operating costs, would then be apportioned over special products in proportion to the market value of the latter. The costs of this special division would include an on-cost for capitalized expenditures for research and demonstration. The total cost of these special products would then be deducted from the entire cost of production for the period and the remainder less amount of residue and miscellaneous sales, would be apportioned over grades of gasoline produced in proportion to their realizable values.