

Valuation Factors of Casing-head Gas Industry

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THE utilization of casing-head gas in the manufacture of casing-head gasoline by both the absorption and the compression method is a most important factor in the conservation of our natural resources. Any industry connected with the oil business, in general, possesses particular attraction for a large number of people not conversant with its basic principles, for the reason that the large fortunes made in the production and utilization of petroleum and its products have been given undue prominence. The general impression of the public that enormous profits are to be realized in the casing-head gas industry with minimum expenditures of both capital and effort has, in a large measure, accounted for the phenomenal expansion of the industry in recent years and, likewise, has resulted in many mistakes and loss of investment funds. It is true that many installations have been very profitable, but such instances are always the result of careful planning, experienced judgment and conservative estimates.

The inception and subsequent activity in the manufacture of casing-head gasoline, enabling the business to assume an important position in the petroleum industry, are of comparatively recent origin, as its greatest growth, particularly in Oklahoma, occurred during the years 1917 and 1918. Much information must yet be secured and systematized concerning the methods of manufacture of gasoline from high-yield casing-head gas, and a large field is still open for the application of accumulated experience and good engineering practice in devising better methods of extracting gasoline from casing-head gas of the poorer grades.

The absorption process is coming into general use as a most efficient system of treating casing-head gas, and even so-called dry gas. In fact, there is a decided tendency toward the universal adoption of the absorption process as against compression methods. However, a general discussion of the relative merits of these two systems is not within the scope of this article.

A few of the facts that must be given consideration in arriving at a fair and impartial estimate of the actual investment value of the casing-head gas business are the quantity of gas available, the quality and

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composition of the gas, accessibility of plant to railroads and water supply, efficiency of operation of oil leases connected to plants, plant efficiency, estimates of production and marketing costs, contract for purchase of gas, and market price of casing-head gas.

QUANTITY OF GAS AVAILABLE

The most important factors are the quantity of casing-head gas available and the conditions that will have a material bearing on its future supply, such as location of field, depth of oil wells, initial rock pressure, thickness and porosity of oil sands, relative position of oil and gas strata in the sand, grade of oil, life of oil wells, location and rapidity of water infiltration, vacuum carried, and regularity of its application. More mistakes have been made in the estimation of the available supply of gas than in any other feature of the business. It is at once appreciated that as close a determination as possible of the marketable quantity of casing head gas is of extreme importance. When volume tests are made, it should be remembered that orifice tests of built-up pressure of casing-head gas on individual wells do not necessarily indicate the performance of these wells under vacuum conditions. The application of the vacuum frequently increases the volume of both oil and casing-head gas temporarily, but the effects of the continuous operation of wells under a vacuum cannot be clearly defined, as it is an open question as to when and under what conditions a vacuum should be applied to oil wells in order to produce the maximum extraction of both oil and casing-head gas.

The exploitation of casing-head gas is quite different from ordinary mining operations, as available sources of supply are not susceptible to exact measurements, like ore in a mine, for example, which may be developed by shafts and drifts, blocked out by raises and winzes, sampled and assayed, and the mineral content closely estimated. Casing-head gas, technically speaking, is not in place, cannot be stored, and, therefore, must be treated and disposed of at once after being brought to the surface. Many casing-head gasoline plants have been designed and erected for the treatment of a certain estimated quantity of gas, which after two or three months have found that the supply of gas has decreased more than 50 per cent., necessitating the dismantling and removal of several units of the equipment, or having on hand surplus machinery, which imposes a considerable handicap on the profitable operation of the business. In the case of many plants in Oklahoma, if conservative engineering estimates had been made at the beginning of operations, a smaller plant would have been installed and additions made thereto, in case the supply of gas justified them. In this way, the equipment could have been

enlarged to meet the requirements of the gas supply instead of reversing the process.

The location of oil leases, with reference to the general producing area of the pool, is important, as investigation has shown that when leases are located on the edge of the pool the casing-head gas frequently fails to maintain its usual volume, and its richness is much less than that from wells in the main or central portion of the field. Consideration should also be given to underground conditions in estimating the possibilities of the supply of casing-head gas.

QUALITY AND COMPOSITION OF GAS

A chemical analysis of the gas should be made in order to determine its actual physical characteristics, as a basis for applying a method that will obtain a maximum yield of casing-head gasoline. Furthermore, a practical field test should always be made, so as to secure dependable information regarding the results that may reasonably be expected in the operation of a plant. A demonstration of the desirability, as well as the necessity, of applying both chemical and practical tests to casing-head gas, is clearly shown in the accompanying data, giving percentage loss due to evaporation in conducting tests to determine its correct productivity.

No. of Test	Cubic Feet Used	Gasoline Un-weathered, Cubic Centimeters	Gasoline Weathered, Cubic Centimeters	Cubic Centimeters Lost	Percentage of Evaporation	Productivity per 1000 Cu. Ft.
1	200	2,985	1,960	1,025	34.0	2.59
2	200	3,830	1,960	1,870	48.8	2.58
3	200	640	635	5	0.9	0.83
4	200	2,475	2,070	405	16.3	2.73
5	200	2,405	2,040	365	15.1	2.69
6	167	1,345	1,165	180	13.4	1.84

These tests were all made from casing-head gas from the Bartlesville sand in the Cushing Field and illustrate the variability in the composition of such gas, the higher fractions sometimes predominating and sometimes, the lower.

Conditions that may produce a considerable variation in the results of tests may be summarized as follows: (1) The time of the year taken, as climatic conditions and temperature have a bearing on the results. (2) Conditions on the lease, such as wells on the pump or off, cleaning out wells, and other lease work. (3) Point of sampling the gas and conditions under which the sample is taken. (4) Improper design of machine, such as lack of cooling surface, inefficient compression, faulty

manipulation, poor connections, and defects in mechanical equipment designed to make these tests. (5) Natural error creeping in when small quantities of gas are tested, together with incorrect meters. (6) Excessive evaporation in open-air field tests.

Because of the presence of one or more of these conditions, the results of field tests are frequently too high or too low and, in calculating the value of the gas, proper allowances should be made after a survey of all the facts. If careful attention is given to the chemical analysis of the gas and an effort is made to get a practical field test under as nearly as normal conditions as possible, the chances of error in figuring commercial yields are greatly reduced.

ACCESSIBILITY OF PLANT TO RAILROADS AND WATER SUPPLY

Plants are sometimes located unfavorably with regard to supply of casing-head gas. It is frequently a debatable question as to whether the plant should be located close to railroad facilities, with the supply of gas several miles away, or close to the supply, with railroad facilities several miles distant. The general factors relative to loading losses, cost of upkeep of field lines, and general efficiency of plant operations should be considered in selecting the location of a plant. Furthermore, a dependable water supply is always important. Numerous plants have been located where the initial expense of installing a suitable and adequate water supply and its subsequent maintenance have been excessive, thus imposing a heavy charge on the future profits of the business.

EFFICIENCY OF OPERATION OF OIL LEASES CONNECTED TO PLANTS

Serious friction may often arise between the operator of an oil lease and the manufacturer of the casing-head gasoline. This contingency is of particular importance, though it is frequently given no attention, because the close relationship between the production of oil and casing-head gas is not fully appreciated. Considerable inroads on the profits of a casing-head gasoline plant may be made by undue irregularities in the operation of oil leases, such as disconnecting wells at inopportune times, cleaning out same, admission of air into lines through leaking stuffingboxes and defective lead lines. Many difficulties of this sort may be eliminated by the incorporation of certain provisions in casing-head contracts. Practically all of the larger companies operate their own casing-head gasoline plants, or this work is done by closely affiliated or subsidiary companies, which is far more satisfactory from the standpoint of efficiency, as there will be close coöperation between the oil-producing department and the casing-head gasoline division.

PLANT EFFICIENCY

There are many methods of cooling the gas and its treatment under varying pressures; also, many systems of blending are in use, all of which have a material bearing on results. A résumé of the numerous practices will not be given at this time. However, casing-head gasoline manufacturers should be willing to coöperate in comparing the various methods employed, to the extent of giving independent investigators as much information as possible, as the collection of reliable data on the efficiency of different methods of handling the various grades of gas would benefit the entire industry and need not necessarily make public the particular trade secret of any company. Under the most careful management, there will still remain considerable variations in plant operation, and sometimes these differences will result in changes of production ranging from 15 to 20 per cent. during any one month.

Some of the causes, not associated with the efficiency of plant operation, that will produce substantial changes in monthly productions of plants are as follows:

1. Climatic conditions. An examination of the records of monthly production of casing-head gasoline plants will show changes corresponding to the seasons of the year, the production in the spring and fall months usually being greater than that of the summer and winter months.

2. Frequently, one or two of the wells will produce a different quality of gas, when considered in connection with its gasoline productivity. If the pressure on one well should be greater than on others, it will naturally force proportionately more lean gas into the plant. This will often result in a great difference in the daily production; on some days, this high pressure will put a greater quantity of gas into the plant than on others. The mixture of lean gases with the regular gas coming into the plant will reduce the productivity of the entire volume of gas in a considerably larger ratio than would be revealed if a test were made of the individual productivities and an average taken. It has been found necessary, in many plants, to cut out these lean wells in order to secure a reasonable degree of uniformity in the average daily production.

3. It is necessary, in the operation of casing-head gasoline plants, to guard against excessive amounts of air in the lines. Daily tests should be made of the gas mixture entering the plant and the presence of excessive amounts of air should be investigated and faulty conditions remedied. Air not only has a direct bearing on the output of the plant but is a source of considerable danger from explosion, when it reaches a high percentage in the mixture.

The varying monthly results of plant operation may be shown by the following tabulation:

MONTH	TOTAL GAS CONSUMED CUBIC FEET	TOTAL CONDENSATE PRODUCED GALLONS	GALLONS PER 1000 CUBIC FEET
April.....	8,727,000	30,034	3.44
May.....	9,106,000	29,382	3.23
June.....	9,389,000	18,630	1.98
July.....	9,877,000	20,741	2.10

ESTIMATES OF PRODUCTION AND MARKETING COSTS

Careful estimates should be made of the cost of labor and supplies, superintendence, insurance, taxes, yearly depletion of gas supply, depreciation of equipment, the unavoidable shipping losses, and the general hazards of the business, such as inability to find a ready market for the product, due to different specifications of purchasers as to gravity and blending material.

In reality, the marketing factor frequently becomes a question of vital concern. Most manufacturers of casing-head gasoline must now supply their own cars, specially designed at considerable expense, not only in order to comply with the Federal shipping regulations but to avoid excessive evaporation losses and leakage.

CONTRACTS FOR PURCHASE OF GAS

Contracts for the purchase of casing-head gas have gone through the various stages of development, or evolution, corresponding rather closely to the expansion of the industry. In a general way, such contracts may be divided into several distinct classes, viz.:

(a) The flat-rate contract in which there is a specified fixed rate per thousand cubic feet for the gas, extending over a period coinciding with the terms of the lease. These flat rates were made in the infancy of the industry and, compared with present conditions, are extremely low, as most of the instruments drawn for the purchase of casing-head gas in the early days show a price ranging from 3 to 5 cents per thousand cubic feet.

(b) Sliding-scale rate in which a certain price is specified for the gas, based on the Chicago tank-wagon price for casing-head gasoline, or f.o.b. loading rack price at plant, or a designated local market; that is, 3 cents per thousand cubic feet for the gas when the price of gasoline is 10 cents per thousand cubic feet, with $\frac{1}{2}$ cent increase in the price per thousand cubic feet for the gas for every 1 cent increase in the price of gasoline. These sliding-scale contracts range from 3 cents on 10-cent gasoline to 8 cents on 12-cent gasoline, with the percentage increase feature. It will be noted that no mention is made of the productivity of the casing-head gas.

(c) A fixed percentage of the gross proceeds derived from the sale of casing-head gasoline produced. Contracts of this character, varying from 25 to 50 per cent. of the gross proceeds are considered fair, as they show exactly what the plant produces and the settlement for the gas is made on such basis. Provisions are frequently incorporated in these contracts, charging up the proportionate cost of the blend and its transportation against the seller of the gas, particularly if the percentage of gross proceeds is above 40 per cent. Some difficulty is encountered, at times, in making settlements with royalty owners on the basis of plant production, but from the standpoint of the lessee, who usually owns a group of leases, the contracts are equitable.

(d) A test of the productivity of the gas and the Chicago tank-wagon price per gallon for gasoline. The price of the gas is determined by a schedule showing the yields of gasoline from the gas on a scale of $\frac{1}{2}$ -gal. units, arranged in a horizontal column, and the Chicago tank-wagon price of gasoline, in a vertical column. Several kinds of schedules are in use and are included in contracts, but the principle involved in each is the same; the schedule shown in Table 1 was suggested to the Department of the Interior by different casing-head gasoline producers and was approved by that Department.

In contracts providing for a test of the gas, it is rare that any method of procedure is prescribed for making the same. The ordinary equipment and requirements of a field test of the productivity of casing-head gas that will give reasonable satisfactory results may be specified as follows:

1. A fairly dependable testing machine usually consists of a small gasoline-engine unit, belted to a compressor, with coil racks, cooling tanks, accumulator tanks, gages, meters, pipe connections and necessary fittings, the entire equipment being portable. Coil racks should contain at least 18 ft. (5.49 m.) of $\frac{3}{8}$ -in. (9.53 mm.) galvanized-iron pipe in the form of a spiral, and all lines from the compressor to the coils and from the coils to the accumulator tank should have a natural drain so that all condensate will move to the accumulator tank by its own gravity. The testing machine should be placed and jacked up with this end in view.

2. The compressor should make 250 r.p.m., in order to do the most efficient work.

3. The casing-head gas to be tested should be taken from the discharge of the vacuum pump or from the discharge of the low side of the plant compressor at a pressure of 4 oz. at the intake of the meter.

4. All leases connected to the vacuum pump should be shut off except the lease to be tested, when such is possible, and the main line should be given time to clear itself of all mixed gases; or, a vacuum-pump unit may be installed on the testing machine, thus enabling a sample of gas

TABLE 1.—Schedule for Determining Price of Gas from Chicago Tank-wagon Quotation

Sale Price per Gallon or Less	Gallons per 1000 Cu. Ft.																							
	½	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12
Cents	Cents per 1000 Cu. Ft. of Gas																							
6	¾	2	2	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
7	¾	2	3	5	6	7	8	9	11	12	13	14	15	16	18	19	20	21	22	23	25	26	27	28
8	¾	2	3	5	7	8	9	11	12	13	15	16	17	19	20	21	23	24	25	27	28	29	31	32
9	¾	2	3	6	7	9	11	12	14	15	16	18	20	21	23	24	25	27	29	30	32	33	34	36
10	1	3	4	7	8	10	12	13	15	17	18	20	22	23	25	27	28	30	32	33	35	37	38	40
11	1	3	4	7	9	11	13	15	17	18	20	22	24	26	28	29	31	33	35	37	39	40	42	44
12	1	3	5	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
13	1	3	5	9	11	13	15	17	20	22	24	26	28	30	33	35	37	39	41	43	46	48	50	52
14	1½	4	5	9	12	14	16	19	21	24	26	28	30	33	35	37	40	42	44	47	49	51	54	56
15	1½	4	6	10	12	15	18	20	23	26	27	30	33	35	38	40	42	45	48	50	53	55	57	60
16	1½	4	6	11	13	16	19	21	24	27	29	32	35	37	40	43	45	48	51	53	56	59	61	64
17	1½	4	6	11	14	17	20	23	26	29	31	34	37	40	43	45	48	51	54	57	60	62	65	68
18	2	5	7	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72
19	2	5	7	13	16	19	22	25	29	32	35	38	41	44	48	51	54	57	60	63	67	70	73	76
20	2	5	8	13	17	20	23	27	30	33	37	40	43	47	50	53	57	60	63	67	70	73	77	80
21	2	5	8	14	17	21	25	28	32	35	38	42	46	49	53	56	59	63	67	70	74	77	81	84
22	2	6	8	15	18	22	26	29	33	37	40	44	48	51	55	59	62	66	70	73	77	81	84	88
23	2	6	9	15	19	23	27	31	35	38	42	46	50	54	58	61	65	69	73	77	81	84	88	92
24	2	6	9	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96
25	2	6	9	17	21	25	29	33	38	42	46	50	54	58	63	67	71	75	79	83	88	92	96	100
26	3	7	10	17	22	26	30	35	39	43	48	52	56	61	65	69	74	78	82	87	91	95	100	104
27	3	7	10	18	22	27	32	36	41	45	49	54	59	63	68	72	76	81	86	90	95	99	104	108
28	3	7	11	19	23	28	33	37	42	47	51	56	61	65	70	75	79	84	89	93	98	103	107	112
29	3	7	11	19	24	29	34	39	44	48	53	58	63	68	73	77	82	87	92	97	102	106	111	116
30	3	8	11	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120

to be taken from any point on the field lines under vacuum, but such a unit must be operated efficiently in order to get satisfactory results.

5. The usual vacuum should be pulled at the time of the test so that the quality of the gas tested will be similar to that ordinarily utilized in the plant in the manufacture of casing-head gasoline.

6. The temperature of the cooling coils should be between 50° and 60° F. (10° and 17° C.).

7. Scrubber tanks and lines at vacuum stations should be blown out so as to eliminate waste oil and all foreign matter before making the test.

8. Gasoline should be drawn from the accumulator tanks at atmospheric pressure. After measuring the contents, Baumé and temperature readings should be taken.

9. A cubic centimeter jar should be used when weathering; warm water is a satisfactory medium for slowly raising the temperature of gasoline to normal, or 60 degrees.

10. The pressure on the accumulator tank at the time the test is run should be the same as the pressure carried in the gasoline plant. After the sample of gasoline is weathered to 60° F., the Baumé reading should be noted.

11. In starting the test, build up the pressure of gas in the machine and the accumulator tank to 300 lb., and note any leakage in the line or connections of the machine. If no leaks appear, retain the pressure at 300 lb. and blow off the accumulator tank until all liquid is discharged, but do not let the pressure go below 250 lb., on the gage. Close the valve and start reading the meter for the test.

12. If a scrubber tank is located between the compressor and the accumulator, it should be drained of gasoline upon the completion of the test, as some gasoline will always condense in it; this gasoline should be added to the volume drawn from the accumulator, in order to get the full volume of casing-head gasoline coming from the gas that has been metered.

(e) Contracts in which the productivity of casing-head gas is determined by the results of plant production; that is, the total number of gallons of condensate produced during the month is divided by the total volume of casing-head gas utilized, which shows the average productivity in gallons per thousand cubic feet of gas. The schedule shown in Table 1, or one similar to it, may then be used in determining the price of casing-head gas per thousand cubic feet.

(f) An ascending flat scale of prices on a yearly basis. For example, 15 cents for the first year, 20 cents for the second, 25 cents for the third, and so forth, no reference being made to the productivity of the gas.

A casing-head gas contract constitutes a vital part of the investment in the business and, therefore, the terms should receive careful attention. The more important items, such as initial supply of gas, richness, and

estimated percentage of yearly decline will certainly not be overlooked, but minor considerations, such as the regularity of the vacuum carried on wells, upkeep of field lines, and return of dry gas to the lease for operating purposes frequently are not given sufficient consideration. Instances are numerous where a provision for the return of a certain amount of dry gas for lease purposes has made it necessary for the gasoline manufacturer to purchase dry gas and supply it at considerable expense to the operating company, in order to fulfill the terms of the contract.

MARKET PRICE OF CASING-HEAD GASOLINE

Market quotations for casing-head gasoline are a controlling factor in the profitable or unprofitable aspect of the casing-head gas business; it should be pointed out that casing-head gasoline is considered in a different class to straight-run gasoline. The various methods of handling this product—blending into different grades, requirements of shipping in order to make same acceptable to certain market demands, and the commercial connections enabling a company to get its output before the public—are matters of grave concern to producers of casing-head gasoline. In conclusion, therefore, the general conditions in the business make it necessary to take a long-range view, including an estimate of the probable effect of future demands and trade conditions, as related to possibilities of motor-fuel substitutes, from the standpoint of efficiency and cost of production.