USE OF NATURAL GAS IN WYOMING.

The word petroleum includes both oil and natural gas and, while oil is the principal objective in the wilcatter of today, natural gas in commercial quantities is found with equanimity by the searcher for petroleum. In the earlier history of the industry, natural gas was looked upon as a necessary evil of the oil business, but that attitude is now all changed.

Wyoming oil men knew this State contained large deposits of natural gas back when the State was a territory. Later some of the wildcatters for oil, drilled wells that produced gas instead of the expected oil and these launched the gas industry of Wyoming that has sprung into a many million dollar value within the past eight years time.

The first gas well was opened near Greybull in 1908, a year later another big gasser was brought in in the Byron Field. Phillip Miner found the Greybull gasser and J.D.Loscamp the well at Byron. The Greybull well was partially plugged and abandoned but later caught fire and burned for several years. The well at Byron was utilized to supply gas to the town of Byron, but it was not until about three years later that this was accomplished.

The Chicago, Burlington & Quincy Railroad published an account of the burning gas well at Greybull in an advertising folder that was circulated in the East. Some well known oil men of Sistersville, West Virginia, Homer Lamb and the Alvord brothers and others, became interested in the Greybull well through this folder and journeyed to Wyoming to look over the situation. The result was that these parties leased the land in the vicinity of the Greybull well and after drilling more wells, laid a pipe line to Greybull and to Basin and started a gas service to these two towns. The company was incorporated as The Big Horn Gas Co.

Since that time when gas was first used in this State in 1911, its use has been continuous and has grown until at present we burn daily as much as was used yearly in 1911 when the first line was laid. Today the gas industry and its subsidiary industry, the natural gasoline industry, constitutes one of out greatest industries that have come to our State within the past decade.

It is noteworthy to see how the two first systems have grown. The Big Horn Gas Co. is now the Wyoming Gas Co. with a great trunk line extending to the Buffalo Basin Field, another line connects the Hidden Dome Field on the east side of the Big Horn Basin and these pipe lines assure the central towns and

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cities of the Big Horn Basin area an adequate supply of natural gas for many years to come.

In 1916, the Lovell Gas & Electric Co. was incorporated and took over the Byron system, this was extended to supply the town of Lovell that has since become a city and still later the line was extended to take in the town of Cowley. At this time a distribution system of eight miles of mains supplies the 500 customers with an annual consumption of 600,000,000 feet.

The developement of the Grass Creek oil field at this period caused the building of the Greybull refinery, this plant utilized a large amount of gas for fuel and the first supply came from the Byron Field through the Illinois Pipe Line Co.'s pipe line, later this pipe line was used to carry oil from Elk Basin and Byron and another gas supply was found in the Hidden Dome Field south of Greybull about 40 miles. The Midwest Refining Co. laid a 34 mile line from Hidden Dome to Greybull in 1920 and the same line also supplied some of the gas used in the towns and cities along the route.

In 1913 the first gas was used at Salt Creek for other than drilling wells and pumping powers. Since that time the Salt Creek Field camps have all been piped so that gas is used all over that district for domestic and power purposes.

During 1917, the New York Oil Co. uncovered a large gas field in the Poison Spider district west of Casper in three separate structures and in 1920 this company laid a 12 inch line to Casper and about 60 miles of distribution system in that city for the conveying of the gas to consumers in Casper. Later this system was extended to Glenrock, about 28 miles east of Casper and also supplies the refining plants with gas along the route. In the Poison Spider district, the New York Oil Co. extended a feed line to Boone Dome and later a 75 mile pipe line was laid to the Big Sand Draw Field in Fremont County and this latter field is now supplying the New York Oil Co.'s system in central Wyoming with natural gas.

In 1921 the Producers & Refiners Corporation laid a pipe line from the Sand Draw wells to Riverton and later extended this pipe line to Hudson and Lander. In 1925 the New York Oil Co. purchased this system from the Producers and Refiners Corporation and added it to the system of the New York Oil Co. The Producers & Refiners Corporation however, retained the Big Sand Draw Field and wells, selling the gas production to the New York Oil Co. at the wells.

At the same time, the New York Oil Co. purchased the Producers & Refiners Corporation pipe line from the gas wells in the Baxter Basin Field to Rock Springs, this consisted of a 20 mile six inch pipe line and a 26 mile distribution system in Rock Springs, laid in 1924.

From 1921 on the developement of the natural gas industry in Wyoming was rapid. The Rocky Mountain Gas Co, a subsidiary of the Ohio Oil Co., laid a gas line from the Byron Field to Powell and now sells about 65,000,000 feet there per annum. The same company then laid a pipe line from the Lost Soldier Field to Rawlins, a distance of 28 miles and a distribution system of 11 miles in Rawlins, supplying 600,000,000 feet annually to consumers in this city.

The Gallatin Gas Co., another subsidary of the Ohio Oil Co. laid a pipe line from the Elk Basin Field, 66 miles long, to Billings, Montana. This line is supplying some 4,000 consumers along this line and in Billings with about one billion feet annually.

The Gallitin Gas Co. also laid an 8 inch pipe line from the Oregon Basin Field to Cody and now supplies that city with natural gas through a 15 mile line.

In 1923, the Midwest Refining Co. laid a pipe line from the Salt Creek Field to Casper, a distance of 42 miles and utilized the gas from the field at the Casper refinery. In 1921, the trunk pipe line from the Lost Soldier Field in Carbon County was laid to Casper, a distance of nearly 100 miles. This line assures the refineries of the Standard Oil Co. and the Midwest Refining Co. at Casper a supply of this fuel for many years to come, this line was laid jointly by the Midwest Refining Co. and the Producers & Refiners Corporation. The annual production of gas through this line is from 11 to 12 billion feet.

In 1922, the Thermopolis Gas Co. laid a pipe line to the Golden Eagle Dome in Hot Springs County and started supplying the city of Thermopolis with gas, a carbon black plant was also established on the Golden Eagle Dome and took its gas supply from the wells there. In two or three years the supply of gas was entirely depleted and an extension of this line was then laid to the Little Grass Creek Dome where a supply of gas was obtained for the customers in the city of Thermopolis but the carbon black plant was shut down and has not been operated since.

In 1924, the Producers & Refiners Corporation laid a pipe line from the Eight Mile Lake Dome in Carbon County to the new city of Parco, this line being

15 miles long and laid with 8 inch pipe. It supplies Parco and the Parco refinery with fuel at the rate of abour two to three billion feet annually,

In 1926, the Cities Service Co. laid a 40 mile pipe line from the Fort Collins Field in Colorado to Cheyenne city and supplied natural gas through the mains in Cheyenne that had formerly carried manufactured gas. This is the only importation pipe line in the State of Wyoming.

In 1927, the Big Horn Gas Co., operated by the Midwest Refining Co . and the Wyoming Gas Co. completed the 57 mile, 12 and 14 inch pipe line from the Little Buffalo Basin Field to a connection with the previously laid lines in the central part of the Big Horn Basin.

In 1928, the Ohio Oil Co., Prairie Oil & Gas Co. and others, proposed the laying of a large pipe line from the Baxter Basin Field in Sweetwater County to Salt Lake City, Utah, to supply the city with natural gas and all the cities and towns along the proposed route. From all indications, this pipe line will be laid in 1929.

The pipe lines now laid and carrying gas in Wyoming comprise a total of 755 miles of trunk lines with a distribution system aggregating 287 miles. In addition there are approximately some 137 miles of gathering lines in the gas fields so that a total of more than 1,000 miles of pipe lines are required to serve the gas consumers of our natural gas at this time.

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1179

At the risk of digressing from the subject there is one phase of the natural gas industry that is of interest to the industrial engineer. The industry is necessarily coupled with the public utility business and in this phase gas does not remain a commodity to be purchased and sold, but becomes a service.

In order to dispose of his product, the producer or owner of natural gas must find a market within reasonable distance of production warranting investment in transportation facilities. This market is potential rather than actual. It must be induced to replace established fuel with gas.

From the standpoint of the seller, the most desirable market is the large manufacturer or industrial consumer. This market can be supplied at a minimum overhead cost, and furnishes quick return of capital because of volume. Were it without restriction or complication the problem of the seller would merely be to take the gamble that he has a sufficient amount of gas to insure the return of his investment in the gas, together with a return of the necessary investment in transportation plus a profit through the sale of his gas at a fixed price per unit of gas sold. However, there are a number of factors to be considered.

The price to be had from the wholesale market is necessarily very low. This is natural. To create a market in the large manufacturer, it is necessary to change his methods and equipment for using fuel. In the large concern this is a matter of great expense. The only inducement is fuel at a low price over a period of time sufficient to compensate for the cost of the installation of proper equipment for that fuel. This, of course, does not permit the gas to be sold at prices commensurate with the former fuel.

This wholesale market even at an extremely low price is practically necessary to the seller of natural gas. It offers a definite revenue insuring a quick return of a part of the capital invested in production and transportation.

However, it is not to be reached without additional complication. The industrial consumers are in or near cities or towns. In fact, they largely assist in creating the community. The gas must be delivered to the consumer, hence must be carried into the town. This requires the consent of the municipality which means the securing of a franchise or license to operate. The franchise carries with it the condition that gas service must be extended to the public. In consequence the seller of natural gas becomes a

public utility, distributing gas to the public.

In becoming a public utility the gas distributer loses the right to sell the gas at prices governed by supply and demand or commensurate with the fuel value as compared to other fuels. He is only allowed to sell at prices that are presumed to return him the value of the property in use for the benefit of the public, over a period of years together with interest and to repay the costs of operation and maintenance while that investment and interest is being returned. The period of time as a rule is arbitrarily considered to be the estimated physical life of the property and equipment used. However, the rates are not governed solely by the estimated return over an arbitrary period of time. They must be such as to compare favorably with the cost of other fuels. In addition they must be further modified to secure the maximum market of consumption.

Being unable to sell the gas at prices commensurate with its heat value, or at a price governed by supply and demand, and unable to choose its customers or confine its business to any class or part of the community, the utility in the final analysis does not sell the gas. The public purchases the property at an appraised valuation which may or may not ammount to the investment by the utility. The purchase price is to be paid in partial payments over a long period of time with interest until paid providing the gas supply is not exhausted in the meantime, and, as a condition of sale, the utility must operate and maintain the property as an employee of the public until final payment has been made, the theory being that the utility shall advance the money for the properties and for everything required in the distribution of gas to the place of consumption, and that it shall be repaid the money so advanced together with interest on the money spent for properties, this repayment to extend over a period of years tentatively fixed as being the physical life of the properties, but such repayment terminable at any time that the gas supply becomes exhausted; it being theoretically presumed that the gas supply will last as long as, but no longer, than the time required in which to make final payment for the property. The partial payments are, of course, the amounts paid for gas delivered at fixed rates.

In consequence the utility is not selling gas to the public, but is delivering gas and receiving for its services the cost of delivery plus part payment and interest on the property bought by the utility and repurchased by the public.

The value of the gas has no bearing on the question except as to capital valuation. The consumer does not pay for the actual value of the gas he receives. He pays for his share of the cost of the property plus his share of the cost of delivering the gas he consumes. His cost is calculated on the basis of the amount he consumes in terms of M. cubic feet of gas. The larger the consumption the lower the rate.

With the exception of the case of the large industrial market above described, the only explanation for lowering the rate with increasing consumption is the lessening of the overhead expense per consumer. As a matter of fact it is a custom - a tradition of the gas business difficult to overcome and uneconomic.

The gas producer therefore is confronted with the problem of first making additional investments in pipeline and transportation system to his market, second a distributing system for the market and third because of the fact that he becomes a public utility, he may neither limit his market nor control the price at which he may sell his product.

This is the situation in which the gas owner finds himself when he considers the possibility of marketing his gas. Realizing the further expenditures, the difficult market, the future work, the uncertainty of repayment through distribution of the gas as a public utility, the future investments demanded by a future market, the question resolves itself down to the adequacy of the gas supply and sufficiency of the market. If the producer with a sufficient market assured can be certain that the supply will outlast the physical life of the pipelines the term on which his returns are allowed, taking into consideration the probable growth of his market during the life of those lines, he may reasonably expect his investment back with interest commensurate with the nature of the business.

At the outset the available gas supply the investments for development, and transportation, and distribution ~~of~~ system, the cost of operation, the present and future market, the rates to be charged and even the interest to be had on the investment can only be estimated.

SUPPLY

The gas owner therefore turns back to an attempt to estimate his supply. The expenditures which may reasonably be made in order to market the gas depend upon the total available supply.

In determining supply, open flow production of the initial or subsequent wells is of little value. It is a popular misconception that the open flow capacity is the measure of gas supply. While it is an indication of a supply it is of no value by itself in determining the amount available and consequently of no value in determining the length of time any proportion of the open flow may be produced.

The porosity method so called is the usual method relied upon to approximate

the initial available supply. The factors entering into this calculation are the percentage of pore space in the reservoir sandstones, the thickness of the sands, productive gas area and the number of atmospheres of gas pressure. Of these factors the determination of productive area is the most difficult. As a rule the wildcat well is drilled on top of the structure and in consequence determines but a small area. The subsequent drilling of wells down the flank of the structure is sometimes necessary in order to determine at least a minimum area of production. The thickness of the sand is shown by the log of the well for the small area immediately adjacent to the well. The rock pressure of the well can be determined by gauge. (By multiplying the production area in square feet by the thickness of the sandstone and this result by the porosity of the sandstone we have the cubic feet of pore space filled with gas. This in turn multiplied by the number of atmospheres of gas pressure gives the apparent total quantity of gas in terms of cubic feet of normal pressure.) This method at best, is a rough approximation. The porosity of the sand in any well can be fairly well determined by laboratory tests if a sufficiently large sample of the sand can be obtained. The extent of the production area and the thickness and porosity of the sand over that area can only be determined by additional drilling.

The more accurate method is that of determination of gas content by the decline in rock pressure resulting from the production of a known quantity of gas. This method however is not available until a considerable amount of the gas has been produced. In consequence the rough approximation of available gas supply must first be relied upon. If it appears that the supply will be sufficient for the estimated future market over a considerable period of years the formation of the utility is probably justified.

Next the supply must be developed by the drilling of additional wells, not only as a better determination of the amount of the content, but also to produce the gas economically. Sufficient available production should be secured so that the market will not require the taking of more than 25% of the open flow of any well. An additional factor to be considered at this time is the rock pressure at the well. Unless this pressure is sufficient to deliver the gas to the consumer, the distributor may have to add to his cost the expense of compressors to deliver the gas. A well with low rock pressure in a very porous gas sand may produce an open flow a much larger volume than a well with

high rock pressure in a much less porous gas sand.

After development of sufficient supply the distributor as the first step in becoming a public utility must secure from the State Public Service Commission a Certificate of Convenience and Public Necessity. In most states, if not all, the public utility is governed by a State Board or Commission. This is the rate making and rule making body. It determines the amount of interest the utility may receive on its investment, the amount of the investment, and the rate at which the investment may be returned. Theoretically in the determination of rates it considers the investment in the property the probable life, the cost of operating, the nature of the business, the service to the public, the necessary investments in pipelines and plant, additions from year to year, and many other factors having to do with the property and business. Actually, in practice, rates are arbitrarily fixed and reach final adjustment through the records of gain or loss by the utility.

This certificate of Convenience and Necessity is a necessary legal step required before a franchise may issue from the city or town. It is granted upon the approval of the State Commission as to the apparent supply, feasibility of the project, and responsibility of the applicants. It serves both as an assurance to the public and a safeguard to the proposed utility, in that it permits the utility to proceed to the operating point and if satisfactory service is given safeguards the investment.

Following the Certificate of Convenience from the State Commission, comes the application for franchise from the city or town. This franchise should be for a term of years in excess of the estimated physical life of the original pipelines and system. The city or town should allow the proper use of its streets, lanes and alleys. Provision as a rule is made for the supervision of the work and approval by the city, Bond for proper performance of construction work and bond for the safeguarding of the city against claims of any nature during construction and operation.

After the necessary permission to operate, the utility proceeds with the securing of a right of way for pipeline or lines. This right of way as a rule should be of sufficient width to allow for construction and repair work. It should include right of way for telephone line and for the purpose of constant inspection or line riding. As a rule in the western states such a right of way will include Government, State and privately owned lands. The Government and

State have made provision for the grant of such right of way.

The next step is that of construction of the pipeline, the important factor being the determination of size of line. This is governed by distance, proposed working pressure and maximum peak load. The distance of course, is fixed. The working pressures vary, depending on the intake pressure required to deliver the gas to the distribution system at a certain minimum pressure which in turn varies with consumption.

Generally the work of construction of the pipelines and distributing system, of drilling the necessary additional wells, and of installing the necessary appliances are all carried on at the same time in order to be able to deliver immediately upon completion of the distributing system.

The distribution system. While the transportation system or main pipeline to the market may be a high pressure pipeline of sufficient size to most economically deliver gas at the desired pressure, the distribution system is more complicated. The most satisfactory arrangement consists of a so called high pressure loop so located as to best serve as a belt line, from which the gas is fed to a number of low pressure loops each serving directly a certain district of the city. A regulator at the intake of the high pressure loop serves to maintain a constant pressure of gas in the intermediate system which in turn by means of regulators serves gas at constant low pressure to the low pressure loops. The system when first installed must be designed to carry the load not for immediate needs but for anticipated needs. It is an interlocking system of pipes so arranged that each low pressure loop not only serves its own district but is so connected that the two low pressure loops on either side may serve that same district. As an example with the main pipeline carrying a delivery pressure of 50 lbs. the intermediate system would carry a pressure of 30 lbs. and the low pressure loops a pressure of seven ounces, bringing the gas to the consumer at approximately 4 oz.

Upon completion of the system to the point of operation the State Commission upon application approves tentative rates and regulations under which the utility may operate, both subject to change from time to time to safeguard the public and the utility.

In the operation of a natural gas utility the one rule of service and safety is eternal vigilance. A large force must be employed and on duty day and night.

The utility must be constantly engaged in securing additional gas supply long in advance of the actual need. Depending as it does for existence on a supply which cannot be replenished it must continually seek new sources. Theoretically it receives its money back when the supply is exhausted. In practice however, the money so returned goes to renew the pipelines and to secure new gas deposits. In this cycle of new lines and new gas deposits occurs the necessity from time to time of renewal of franchise. To be assured of success, to make good interest on its money, and to get that money back the natural gas utility must have an almost inexhaustible supply of gas. It must provide for maintenance and constant supervision of its supply, combatting water, leakage, and accident troubles of every kind.

The flow of gas from each well must be charted daily. The flow from the wells or through booster stations must be regulated hourly depending upon the consumption load. The main pipeline through its length must be inspected daily, and kept free from leaks and water. The average loss from leakage on a high pressure pipe line may run from 5 to 30%. Regulators from each well and supply line to the main line must be charted daily. The regulator to the distributing system must be under constant inspection. In the distribution system the intermediate pressure must be kept constant. Each low pressure loop must be charted daily and regulated to a constant pressure.

The utility must maintain a department for installing and testing meters, of keeping the records of consumption of thousands of customers. It should maintain a department at the service of consumers for the inspection of appliances. A large office force is necessary for its daily business.

Above all it must at all times provide a continuous service of gas and have immediate access to emergency supplies. Not only must it depend for existence on its continuous service but in addition a cessation of operation for a comparatively short period of time might render its investment worthless except for salvage.

The danger of interruption of service safeguarded as much as humanly possible, is ever present.

In the business of serving natural gas to the public

"Uneasy lies the head that wears the crown."