

## CULM BANKS AND FUEL GAS.

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Near the mines of hard coal, great mounds of anthracite culm have accumulated. This culm or very finely divided coal continues to pile up from year to year, because its value in coal markets is not sufficiently great to cover the transportation charges. So great have the quantities of this fine coal become that it is an impediment to mining operations, and the owners would gladly see it removed without asking any compensation. While these little mountains of culm are oxidizing, unprotected from the action of rain and sun, the demand for cheaper gas in heating and industrial operations is daily increasing at cities only a few tens or a few scores of miles distant. The minds of those familiar with these facts have often turned to the idea that in some way the energy wasting in these mounds of fine coal might be gathered up in gas and transferred through pipes to distant points of use. Such plans have not yet gone beyond the interrogation point, Will it pay? and little seems to have been done in the way of an answer to this important question. The controlling factor in the problem is evidently one of transportation. Though culm cannot be handled, transported and delivered to consumers at a profit, it is possible that a gas containing a part of the coal's energy may be transmitted through a pipe to more advantage. While experience has nothing to offer on just the case in hand, some of its lessons may be drawn from similar instances. It is known that natural gas has been and is successfully transmitted through pipes over distances as great as one hundred miles. Petroleum is also economically transferred long distances through pipes, and there seems to be ample precedent for their use where available from the financial standpoint. It may be accepted without argument that culm would be valuable, were the costs of transportation eliminated, and it therefore remains to be discovered whether these costs can be so reduced in gas pipe lines as to render the energy of this now refuse coal available.

Most of the expense of gas transfer through a long pipe line arises from the items of interest and depreciation on the cost of construction, a smaller amount being due to the development of power to pump the gas. The capacity of a gas pipe line and the cost of pumping the gas depend on the weight and volume to be moved per hour or other unit of time, but the value of the gas varies directly with its heating capacity on combustion. If the energy of culm is to be cheaply transmitted in gas, it is, therefore, highly important that the kind of gas to which the energy of coal is transferred shall have as little weight and as large a heating capacity per cubic foot as possible. Since the culm now considered has no present value and its removal free of charge will be a benefit to the present owners, the efficiency of the gas-making process adopted is not nearly so important as is the quality of the gas produced. There are two well-known processes for the production of gas from anthracite coal, known as the producer and the water-gas methods respectively. Two thousand pounds of anthracite coal yield on treatment about 160,000 cubic feet of producer gas. This gas develops on combustion fully 125 heat units per cubic foot or a total of 20,000,000 heat units. Allowing 12,500 heat units per pound for the heating capacity of the coal, the energy of one ton is 25,000,000 heat units. The producer gas process therefore delivers 80 per cent of the heating power of coal. Water gas to the amount of 33,333 cubic feet may be generated with one ton of anthracite coal, and each cubic foot of gas has a capacity to develop 325 heat units. The 33,333 cubic feet of water gas therefore represent 10,833,225 heat units, or a little more than 40 per cent of the energy of the coal. Producer gas, therefore, makes available nearly twice as much of the heating power of coal as does water gas.

The water gas, however, has about two and one-half times as much heating capacity per cubic foot as that from the producer, and this has an important influence on the cost of a pipe line and on the subsequent power for pumping. Producer gas has approximately 0.84 and water gas 0.57 as much weight as air per cubic foot, or, in other words, the weight of producer gas is 65 pounds and of water gas 45 pounds per 1,000 cubic feet. To supply a heating capacity equal to that of one cubic foot of water gas, 2.6 cubic feet of producer gas are required, and the weight of this amount of producer gas is 3.75 times as much as the weight of the single cubic foot of water gas. This great difference in weight and volume for a given heating capacity is inherent in the compositions of producer and water gas. More than one-half, or 55 to 60 per cent of the producer gas, as to both weight and volume, is composed of nitrogen and inert gas that has no fuel value.

Water gas, on the other hand, contains only 2 or 3 per cent of nitrogen, while nearly 90 per cent of its weight and volume is a mixture of hydrogen and carbon monoxide, both excellent fuels. The facts just cited indicate the decided advantage of water gas over producer gas, as to the weight and volume of each that must be forced through a pipe line per unit of time, for a given heating capacity. The greater the volume and weight of gas moved past any section of

the pipe per hour, the larger and more expensive must be the pipe line, or the power required to maintain the flow. Figures for an assumed case of gas transmission, to a given distance and for a certain heating and power capacity, covering the size and approximate cost of the pipe line, will perhaps best illustrate what can be done. For the purpose of this example, the water gas above described will be employed. It may be stated that the water gas here mentioned is quite different from the so-called water gas commonly distributed in cities for purposes of illumination. The heating and illuminating power of plain water gas is usually much increased by the addition of oil gas from petroleum or naphtha before distribution for general use. Plain water gas is entirely suitable for heating and power purposes, also for illumination if incandescent gas mantles are used.

The open flame of pure water gas has very little illuminating power, but water gas from a distant works could be readily mixed with hydrocarbon gases from petroleum, if desired for purposes of illumination in open flame burners. Maps of the United States show quite a number of cities not more than fifty miles distant from the anthracite coal fields, in each of which a yearly consumption of 700,800,000 cubic feet of water gas may readily be expected. This amount of plain water gas is the equivalent in heating capacity of 350,400,000 cubic feet of coal gas or carbureted water gas, or of 9,110 tons of coal. Owing to the low efficiency of ordinary heating and cooking apparatus, where coal is used, the 700,800,000 cubic feet of plain water gas would be the practical equivalent of 20,000 to 40,000 tons of coal for general purposes. The amount of water gas just named as a yearly consumption corresponds to an average constant hourly flow from the pipe line of 80,000 cubic feet. During a year of 3,000 working hours this flow of gas would supply gas engines with a total capacity of 5,840 horse power, allowing 40 cubic feet of gas per brake horse power hour. A pipe of twelve inches internal diameter will deliver this water gas from a distance of fifty miles at the rate of 80,000 cubic feet per hour, if supplied at a pressure of 45 pounds per square inch. To pump the gas through this pipe at the rate and pressure just named requires 300 horse power. The plant to furnish this power should be located at the gas works near the coal mines, and should operate continuously during each twenty-four hours.

The yearly cost per horse power at such a plant, considering its location and the cheap fuel, may be taken at \$30 or \$9,000 as a total. Fifty miles of wrought iron or steel pipe, 12 inches in diameter, with sides 0.083 inch thick, and a safe working strength nearly four times as great as the proposed gas pressure, weighs 1,848 tons. A liberal estimate for the cost of this pipe, including the laying and connection in position, is \$200,000. Annual interest, depreciation and repairs at 15 percent on this sum, amounting to \$30,000, is a sufficient allowance for these items. The total yearly charge for the transmission of 700,800,000 cubic feet of gas is, therefore, \$39,000. This is equivalent to a cost of 5.6 cents for each 1,000 cubic feet transmitted. As the prime incentive to the transmission is the cheap or worthless fuel near the mines, the cost of the transmission should be compared with the value of the coal consumed per 1,000 cubic feet of a plain water gas produced at the ordinary city gas works. At the rate previously stated of 33,333 cubic feet of plain water gas produced per ton of coal consumed, 60 pounds of coal are required to generate 1,000 cubic feet of the gas. Of this 60 pounds, about 50 pounds must be anthracite coal for use in the gas generators, but the remaining 10 pounds may be bituminous coal for use under the boilers that supply steam to the generators. Assuming \$4 per ton as an average price for all of the coal, the 60 pounds consumed to generate 1,000 cubic feet of plain water gas costs 12 cents. As the total charge against 1,000 cubic feet of gas was found to be 5.6 cents for transmission over a distance of 50 miles from a place of free fuel, the expense for coal at \$4 per ton is more than twice as great as the charge for transmission. With anthracite coal at \$2 per ton, its cost per 1,000 cubic feet of gas generated at city works is just about equal to the charge for transmission of the same amount of gas over a distance of 50 miles.

The estimates just made are for a transmission of 50 miles, but the costs for the same quantity of gas over any other distance can be readily derived from them. All of the expenses of the transmission vary directly as the distance, provided that other factors remain constant. If the pipe line is extended to a length of 100 miles, the weight and cost of pipe is twice as great, and the required power is twice as great, for the same delivery of gas. For the line of 100 miles the cost of transmission per 1,000 cubic feet of gas is therefore 11.2 cents, or nearly the value of the coal from which the gas may be generated when it is worth four dollars per ton. If the distance of the transmission is only 25 miles, the cost per 1,000 cubic feet of gas drops to 2.8 cents and is equivalent to that of anthracite coal at one dollar per ton. Inspection of the items in the transmission estimate shows that more than three-fourths of the total are for interest, depreciation and

repairs, and about one-fourth for power. This indicates that the transmission charge could be reduced by a smaller investment in pipe line and the use of more power for pumping the gas. As the flow of gas is presumed to be continuous, gas holders must be provided at both ends of the line, but their combined capacities need be no greater than for the case of a city gas works of equal capacity. Including the cost of the plant for pumping gas, estimated at \$30,000, to that of the pipe line gives a total of \$230,000. The 80,000 cubic feet of gas delivered per hour are competent to develop 2,000 horse power during 24 hours per day, on an investment of \$115 per horse power for the transmission equipment. This supply of gas can develop heat energy that is equivalent to 7,620 kilowatts at an investment of only \$30 per heating capacity equivalent to one kilowatt.

## THE NOBEL PRIZES FOR SCIENTIFIC DISCOVERIES.

Many of our readers will be interested to know that the formal rules and regulations relating to the awarding of prizes under the Nobel bequest have now been formulated and published, and in the SUPPLEMENT for the current week we give them in full. The three corporations awarding the Nobel prizes are the Royal Academy of Science at Stockholm, the Swedish Academy at Stockholm, and the Carolin Institute of Medicine and Surgery at Stockholm. The first award will take place December 10, 1901. The prizes are assigned as follows: 1. To the person having made the most important discovery or invention in the department of physical science. 2. To the person having made the most important discovery and having produced the greatest improvement in chemistry. 3. To the author of the most important discovery in the department of physiology or medicine. 4. The author having produced the most notable literary work in the sense of idealism. 5. To the person having done the most, or the best, in the work of establishing the brotherhood of nations, for the suppression or the reduction of standing armies, as well as for the formation and the propagation of peace conferences.

For physical science and chemistry the Swedish Academy of Science will award the prize. For works in physiology or medicine, the Carolin Institute will give the prize; for literature, the Academy of Stockholm; and finally, for the work of peace, by a committee of five members elected by the Norwegian Storting. It is expressly stipulated in Dr. Nobel's will that nationality shall not be considered, so that the prizes may accrue to the most worthy without consideration as to place of birth. The matter of the estate has been satisfactorily adjusted with the Nobel heirs. Each of the annual prizes given by the will must be awarded at least once in the course of every period of five years, and the sum total of a prize thus awarded shall in no case be less than 60 per cent of the yearly revenues disposable for the distribution of the prizes; neither can it be divided into more than three prizes at the most. The limitation of the will declaring that the annual distribution of the prizes must be directed to works executed in "the course of the preceding year" must be interpreted in this sense, that the objects of the rewards shall be the most recent results of research displayed in the departments indicated by the will; older works will be considered only in the event that their importance shall have been demonstrated in recent times.

In order to be admitted to the competition, every written work must have been published by means of the printing press. Various regulations have been made relative to the division of the prizes, and as to whether the prizes may be adjudged to an institution or a society. If none of the works submitted to the competition possess the quality desired, the sum total of the prize is reserved for the following year. For admission to the competition it is necessary to be proposed in writing by a qualified person, and no attention will be paid to requests addressed by persons desiring to obtain a prize themselves. At the annual competition an annual committee considers proposals which have been offered in the course of the year immediately preceding, up to the date of February 1. Each proposal must be accompanied by writings and other documents upon which it is founded. The proposal must be drawn up in English, French, German, Latin, or in one of the Scandinavian languages.

At the solemn reunion which takes place on the anniversary of the death of the donor, December 10, the corporations will make known publicly their decision and bestow upon the laureate a check for the value of the prize, a diploma, and a gold medal bearing the effigy of the donor with an appropriate legend. The laureate is obliged, unless prevented by unforeseen circumstances, to give during the six months following each reunion a public lecture on the subject of the work crowned. This lecture will be given in Stockholm, or for the peace prize in Christiania. Decisions in regard to the prizes are without appeal. There are many other provisions, which are fully set forth in the rules and regulations as published in the SUPPLEMENT. The prizes which will be distributed in 1901 will amount in all to \$402,000, or \$80,400 for each division.