Squeezing Gasoline Out of Natural Gas

A Fuel Destined to Compete With Refinery Gasoline

By Frank P. Peterson

THE refining of petroleum oils as an art has been subject to a peculiar diversity of limitations. The infinite variety in physical characteristics of the crude oils which have been unearthed have imposed those limitations.

Crude oil may mean anything from an approach to asphaltum in character to the other extreme. An example representing the one extreme would be a dark brown or almost black substance having a pungent odor, the consistency of a thick molasses and a specific gravity of slightly more than 1.000 as compared to water. A sample representing the other extreme would have a slight discoloration, only, from a pure white, and would be comparable in general appearance to the very lightest of sewing machine oils. So much for the liquid petroleum products which Nature has deposited for us.

In the majority of instances where petroleum is found, it is accompanied by more or less extensive deposits of natural gas. There are some exceptions in which petroleum is found alone. There are a great many cases in which gas is found not accompanied by petroleum, and many instances in which it cannot be shown that there is any physical connection between deposits of gas and oil.

It is an interesting but not greatly surprising fact that gases which are found residing with petroleum oils in the earth vary in physical characteristics almost as widely as do the oils which form the great family of liquid petroleum deposits; this with reference to specific gravity and variance of the relative percentages of the different hydrocarbon compounds of which the gas is composed.

Until about two years ago natural gases were estimated commercially as methane. It is a fact that the great volume of gas being produced and transported to large consuming centers may be so classed without great deviation from strict truth. Probably as much as 90 per cent by volume of the gas composition is methane, the remainder being ethane with very slight percentages in some cases of propane.

In dealing, however, with the gases which are found directly accompanying the petroleum oils as they reside in the strata from which they are obtained, we have a very different condition and a widely different general composition of gas. It is thought, now, that the variance in gas composition in adjacent oil wells is much greater than is that of the oils. Wells located within a narrow radius and producing, so far as can be observed, oils of uniform character from the different wells will produce gases which vary very markedly in percentages of the different hydrocarbons of which they are composed.

Within the last two years, a development has been carried to the proportions of an industry allied to refining, but which becomes necessarily a part of oil field operations, and it consists in the recovery of a refined gasoline which is extracted from oil well gases at the

Like most new things "natural gas gasoline" is the product of an imagination. For years it had been noticed that gasoline collected in the pipes into which the waste gases of oil wells had been turned. This "drip" was bought up by refineries. An imaginative inventor, John Lathrop Gray, made up his mind that he would find out why the "drip" accumulated at all. He found that gasoline could be squeezed out of natural gas, and took out the only patent which comprehensively covers the process now most widely used. This article, written by one intimately connected with the industry, explains the scientific principles of recovering gasoline from oil well gases.—EDITOR.

wells. There are a few exceptions to the statement that this product can be recovered from oil well gases only, but the writer believes that without exception it can be demonstrated that any gases which yield gasoline condensates to any considerable extent, communicate to and through oil producing strata. Since this phase of the petroleum industry has reached commercial proportions amounting to the recovery of probably some 2,000 barrels daily of a product which heretofore had gone to waste, it would be interesting to look into the physical conditions which make it possible. It will be most convenient to deal with the series of hydrocarbons known as saturated paraffins. It is possible that there may also be some exceptions to this latter classification.

If we consider, however, that a triangle may graphically represent the great family of saturated petroleum hydrocarbons, we can divide such a figure into percentages which may represent to the mind's eye, very clearly, the summary of facts involved.

We shall not permit the figure, or the percentages into which we divide it, to represent wholly relative volumes, but rather to represent combined volume and composition with reference to the structures forming the great group or family of petroleum hydrocarbons.

The dark base on which the triangle rests may represent the coke residue drawn from a petroleum still after the crude has been distilled into its various fractions; the second small percentage section of the triangle will represent petroleum tar and paraffin waxes; the third section, varying greatly in volume, may represent greases and lubricants; the fourth division may be made to represent lighting oils; the fifth, to represent naphthas; the sixth, to represent gasoline fractions; the seventh, to represent refinery products known as pentane, rhigolene, and cymogene. The eighth, to represent the heavy portions of condensable natural gases with which this article attempts to deal. The ninth division may be made to represent that portion of heavy gases which is intermediate between the product commercially accepted as gasoline and the

great volume of gas product known as dry gas. The tenth and last division will be made to represent the methane portion, together with any impurities, of petroleum deposits, where gas and oil may be found in large volume. Such impurities as may be worthy of mention are carbon dioxide, free nitrogen, and some hydrogen sulphides.

To get a familiar conception of the chemical proportion of the compounds forming the triangular graphic representation, we may go to its base and look for a composition which is almost wholly carbon. The next division of the triangle will represent a product having a greater percentage of hydrogen and a lesser percentage of carbon in its make up, and when we have arrived at the third, or grease and lubricant division, we begin to find chemical compositions like $C_{24}H_{50}$ of the saturated series having the general form C_nH_{2n+2} . The sixth group will bring us to a chemical composition with which we are quite familiar, viz., C_8H_{18} , gasoline, naphtha, benzine. The seventh group will still further lower the relative carbon proportion, and we will have a range of compounds running from C_6H_{14} to C_3H_8 . The eighth division will represent our natural gas gasolines which are so closely related to the seventh group that it is not proper to designate them as different except as exceptions to this phase of the petroleum industry which we are considering now. The ninth group or division is to play an important future part in our domestic life. It represents that very considerable fraction of the greater number of oil well gases which can be liquefied by reasonable treatment and delivered in strong steel containers to isolated consumers for fuel and lighting purposes. The tenth and final division is CH_4 with the above-mentioned impurities, which exist to varying degrees in different localities, and are absent in the great majority of the important producing regions.

In getting a proper conception of this interesting matter, it must be borne in mind that the groups or divisions of petroleum products, unless subjected to extremely tedious treatment, are not sharply defined in chemical composition. This fact may be graphically represented again by the hypotenuse side of the triangle, which might represent the gradation from a hydrocarbon structure through all the minute steps from an all-carbon to an all-hydrogen composition, the hydrogen point being represented by the vortex of the triangle.

It is now easy to refer to and explain the method by which the product which is known as "natural gas gasoline" is recovered. For many years past in the operation of oil wells, where the gases escaping from them have been turned into a system of pipe lines for service, and the running of gas engines used to pump the wells, difficulty has been experienced under favorable winter weather conditions in those lines becoming filled with a liquid. Some water is frequently present, but more frequently the liquid found in the pipe lines

is seen to be gasoline. Many oil operations collect considerable quantities during the winter season of this "drip" product, which has been bought up by the refineries as an inferior grade of gasoline. It obtained its reputation of inferiority from the fact that, in many cases, having lain in rusty pipes and come in contact with oil and dirty paraffin sediments, it has been discolored and required filtering or redistillation. The oil producer has, therefore, been content to receive something like one fourth to one third the prevailing market price for gasoline for his "drip" product, even though it be water white, and of apparently high grade as compared to refinery gasoline.

The physical laws involved in the process of recovering gasoline from natural gas are supposedly very simple. They would appear to be the same as for the condensation of any liquid vapor suspended in a gaseous medium. The fact, however, develops that the suspended vapors present in natural gas being of three or four different chemical groupings complicate the matter somewhat and bring about the requirement of more extensive treatment than the first glance would perceive as necessary. Compressing and cooling of the gases containing the vapors in suspension is all that is necessary, provided the same be carried to a sufficient extent and effected under proper arrangement for the separating of the liquid to be precipitated.

Going back to about the year 1906, we find a few investigators going further into the matter than the application of vacuum to oil wells, and the recovery of the "drip" from lines connecting the pumps used to produce vacuum on the wells. They were employing air compressors to compress the gas to an extent much beyond that for which oil well vacuum pumps are designed to do duty. John Lathrop Gray obtained, apparently, the only patent which comprehensively covers the process, and the licensees under that patent seem to have found the most effective and extensive development of the industry.

The essentials of this Gray patent are the compressing and cooling of the gases, the separation of liquid products and the accomplishment of the same by the simplest and most effective means.

Gray used a simple type of separator for collecting the condensates, and an automatic trap which continually transferred the condensate to a place of storage.

The advantageous features of the method are greater than are seen at the first glance. One great difficulty in the development of the art has been to reduce the condensates to such a state of stability as will eliminate serious evaporation losses between points of production and consumption. It is now known that gasoline, either from petroleum oil or gas, will absorb considerable quantities of gas or even air, and that the absorption is a function of time, temperature and pressure.

Gray's method, therefore, of using traps to remove the condensates promptly, when precipitated, and minimizing the time of their exposure to gas under pressure, is of the utmost importance.

Just as in the case of crude petroleum oils, the new product, when produced by Gray's process, is capable of refinement to more homogeneous fractions. When to be handled as gasoline, the new product is very much improved by the removal of that portion embodied in a fraction which is too light and volatile to be stable at atmospheric pressure and the temperature conditions which must be met in use.

The recognition of new uses and increasing demand for the conservation of all fuel energy has held the promoters of the new industry to a realization of the necessity in providing means to effect the recovery and the separation into commercial fractions of the total product available. The possibility of fractionation by stage compression was early recognized by the writer, and many installations of machinery capable of ready adaptation to this method have been accomplished by the firm of manufacturers which has given the industry its greatest uplift.

The possibility of separation by stage compression

treatment of a relatively large fraction of the product suitable for any fuel purpose, but which must be handled under restraint, brings about an entirely new phase of the petroleum industry which has not yet had scarcely more than an introduction to scientific and technical notice.

The successful introduction of the new product, which has been accepted as gasoline, depended largely on market conditions. It is comparable in inflammable

prices of all petroleum products. The refiners were able to offer their product in serious competition with the new natural gas condensates to the extent of largely shutting its recognition out from the consumer.

The new product finds its best adaptation in the treatment of the refinery low grade gasoline fractions to make them suitable for motor fuels. Apparently, the new product will be sufficiently plentiful to bring the entire petroleum naphtha fraction, which is too low in gravity for successful motor fuel, into a state of volatility making it entirely satisfactory, so far as carburetion and proper fuel mixture is concerned, and when so enlivened, this particular naphtha fraction has the greatest fuel value, having a greater weight for equal carbureting characteristics than any other known fuel.

The new product in appearance and physical characteristics is so nearly identical with the refinery first fractions, when properly produced and treated, that it requires careful judgment to distinguish it. The gravities of the natural gas condensates range from 76 degrees to 100 degrees Baumé (sp. gr. 0.68 to 0.61). It mixes permanently and without stratification with any refinery product which is not technically termed an oil. It also will mix sufficiently well with kerosene or lighting oil fractions to make a good satisfactory motor fuel, though, of course, such a mixture is not suitable for the cleaning of delicate fabrics where the presence of an oil would be objectionable. The term blending has been erroneously but conveniently adopted. The term itself would indicate the bringing together of two non-miscible materials. The light condensate is perfectly miscible with any "dry" or naphtha fraction and cannot be separated or re-obtained except by fractional distillation, and then only imperfectly.

The necessity for maintaining a cheap source of motor fuel will soon bring about the practice of "blending" the new "natural gasoline" or gas condensate with a 46 to 54 gravity lighting oil. Such a product will not be recognized or given proper credit, however, until the price of motor fuels makes it necessary to resort to such a means.

The very remarkable increase in motor fuel consumption which goes on is destined, however, to bring about revolution and the adoption of any new thing which can safeguard the consumer against prohibitive fuel cost.

For the question stands unanswered today, just as it has for forty years, have we reached our maximum crude oil production?

The advance in prices of the fuel fractions for this season alone is sufficient to warn us for the coming consequences when we do reach the zenith. We may as well assume that we are going to reach it one of these days, and take a few forethoughts as to what actually can be done to conserve the petroleum resources. We do not at all fully appreciate the importance of our petroleum, nor are any of us prepared to say what could be found to substitute it, were it no longer available.

If we go back to the graphical triangular representation of petroleum, which, being hurriedly drawn, makes no claim to precision, but can be counted upon to represent facts as roughly and about as closely as a quick conception could state them, we will see how great is the division in favor of fuels. For, beginning with the fourth group, everything upward is consumed either to heat us, move us, or light us.

If we look at the combined sixth, seventh, and eighth groups, and consider them as adapted to gasoline motors, then consider the number and extent of these motors; and if we look at the tenth division, representing natural gas, and consider that Buffalo, Erie, Cleveland, Cincinnati, Pittsburgh, practically all the intervening area and much surrounding, represents possibly one half the natural gas consumption; that all these communities depending on natural gas have reasonable expectation of many years of service, we get a good comparative idea of space nine, which represents what is being wasted, what has always been wasted throughout the life of the crude oil industry.

The squeezers—direct driven straight line gas compressors, using for fuel residue gas after gasoline has been extracted.

Receiving tanks, in which the gases from oil wells are collected.

The insert shows triangle representing the great petroleum family. Taking out the 8th group which represents the heavy portions condensable to gasoline, the remaining residues are: 1st.—Petroleum Coke. 2nd.—Petroleum Tar and Wax. 3rd.—Greases and Lubricants. 4th.—Lighting Oils. 5th.—Naphtha. 6th.—Gasoline. 7th.—Refining products, Pentane, Rhigylene, Cyomogene. 9th.—Intermediate heavy gases. 10th.—Methane.

Air and water cooled coils used in the condensing system.

characteristics to the highest grade refinery gasolines, and since its bulk has reached considerable proportions, the transportation of the same has received the attention of the Bureau of Explosives, and finally the Interstate Commerce Commission with certain restrictive safeguards which have placed its utilization at a premium, and the industry has been able to thrive only under the conditions of the consumers' demand which prevailed in 1910, and which now prevail. The whole year 1911 was one of plenty and predominant low