REPORT No. 42.

A NEW PROCESS FOR THE PRODUCTION OF AIRCRAFT-ENGINE FUELS.

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INTRODUCTION.

The main object for which these experiments were conducted was the development of a new method of producing high-grade aviation gasoline. Of almost equal importance was the problem of increasing the yield over existing practice, and also of reducing the cost of production.

The experimental plant was established at Charleston, W. Va., and owes its origin to the offer made to the Government during 1917 and accepted by the National Advisory Committee for Aeronautics early in 1918 for the erection of a test laboratory.

The installation consisted of a suitable building and equipment, including a six-horsepower "Foos" gas engine, a 2-ton Brunswick ammonia compressor, high-pressure tanks, condensers, separators, pressure gauges, etc., which, together with our services, were offered to the Government without remuneration.

PRESENT METHODS.

The universal method of producing gasoline consists of boiling crude oil in a still, similar to the boiling of water in a kettle, the vapor arising from the oil being passed through a condenser, which consists of a series of pipes lying in a trough of moving water, the water playing the part of cooling the oil vapors, and thus condensing them into liquid which is removed to a cleaning outfit where it is treated with sulphuric acid to remove the unsaturated or cracked products. Sulphuric acid has a great affinity for cracked paraffins such as are produced in gasoline distillation.

The temperature at which the first drop of gasoline condenses from the distillation of crude oil differs according to the age of the oil field from which the crude oil has been obtained, and also according to the length of time it has stood uncovered since its pumping from the well. Crude oil from the Pennsylvania or West Virginia fields will start to boil at 80° F. to 100° F.; and the first drop of condensation will be found at about that temperature. This is known as the initial boiling point.

The temperature of the still is then gradually raised until it reaches the temperature at which it is desired to "cut" off the distillate. This is known as the end point or final boiling point. This latter temperature is controlled by the commercial side of the enterprise, i. e., the supply and demand for gasoline. At 302° F. as a final boiling or end point the end of the real volatile products is reached; and they are about to enter the illuminating or burning oil distillates. Most of the commercial gasolines have an end point of 450° F. This is an indication of gasoline containing a large quantity of kerosene. The higher the temperature of the end point the larger quantity of unsaturated hydrocarbons will be found before cleaning.

It is the practice to clean the gasoline and remove the unsaturated hydrocarbons by a sulphuric acid treatment, removing most of the acid, neutralizing the remaining acid held in suspension by the gasoline by the use of an alkali, and washing with water. The acid absorbs the unsaturated hydrocarbons, thereby producing sulphones which in turn are washed with water.

It is our conviction that a gasoline which has not been in touch with an acid will have decided advantages over one which has. It is also our conviction that a gasoline produced without a heat treatment, such as the distillation at present universally practiced at oil refineries, would be free from cracked or unsaturated hydrocarbons, thereby eliminating the necessity for such acid treatment. A series of experiments have lately been conducted with the following results:

EXPERIMENT NO. 1.

Extraction direct from crude oil.

	Gallons.		
Raw product, West Virginia crude oil			42° Baumé.
Raw product, quantity used in experiment			44 gallons.
Gasoline produced:			
No. 1, 69° Baumé	5		
No. 2, 58° Baumé	10		
No. 3, 55° Baumé	5		
		20	
Residue, 37° Baumé		24	
			44
Per cent volatile products			45

No. 1 is high-grade aviation gasoline.
No. 2 is automobile gasoline.

It is our opinion that a mixture of Nos. 1 and 2 would prove to be a satisfactory aviation gasoline.

All these gasolines evaporate clean and without leaving any odor.

EXPERIMENT NO. 2.

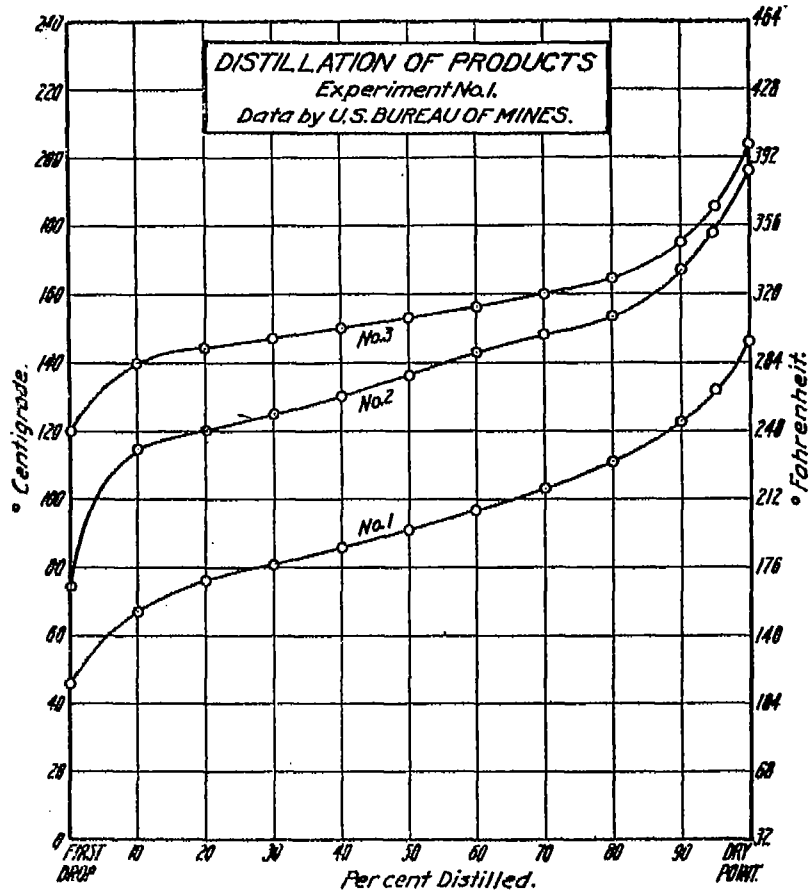
Treatment of crude benzine or first cut from West Virginia crude oil.

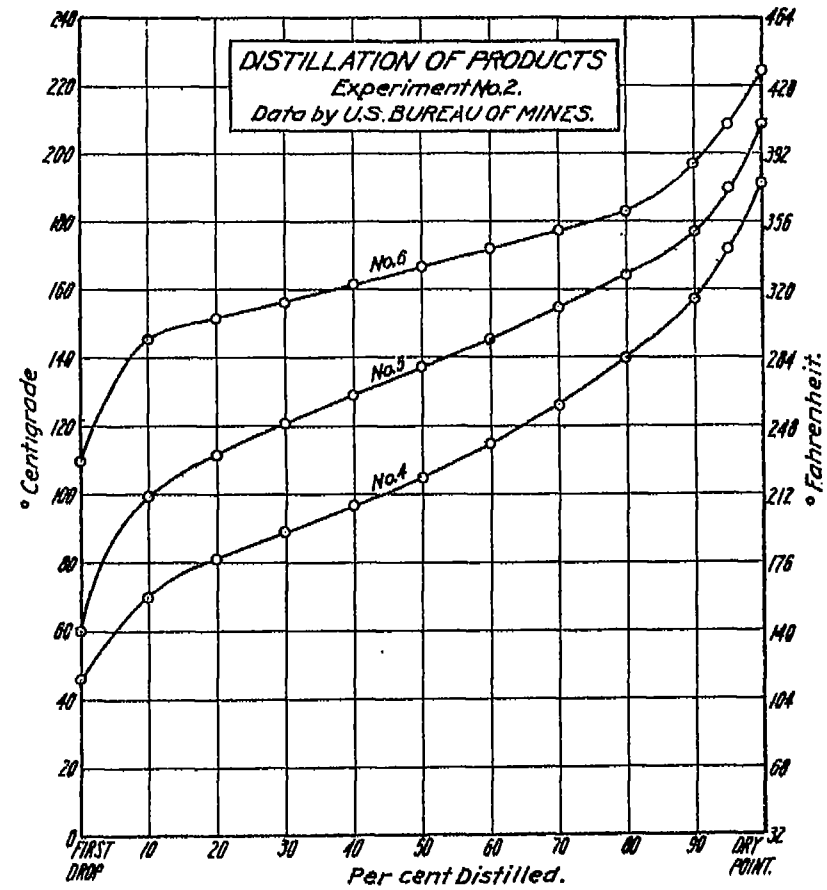
	Gallons.		
Raw product, crude benzine			62° Baumé.
Quantity used in experiment			97 gallons.
Gasoline produced:			
No. 4, 65° Baumé	51		
No. 5, 59° Baumé	36		
		87	
No. 6, residue, 53° Baumé		10	
			97 gallons.

No. 4, 65° Baumé, is aviation gasoline.
No. 5, 59° Baumé, is automobile gasoline.

TABLE I.—*Products of experiments.*

	Experiment No. 1.			Experiment No. 2.		
Product No.	1	2	3	4	5	6
Specific gravity	0.704	0.745	0.756	0.7165	0.741	0.7645
Degrees Baumé	68.9	57.9	55.2	65.4	58.9	53.1
Color	W. W.	W. W.	W. W.	W. W.	W. W.	W. W.
Odor	O. K.	O. K.	O. K.	O. K.	O. K.	O. K.
Unsaturated	1.2%	1.4%	.8%	.8%	.8%	.7%
Doctor test	+ or −	+ or −	+ or −	+ or −	+ or −	+ or −
Acidity	None.	None.	None.	None.	None.	None.
Loss	1.5%	1.0%	1.0%	1.5%	1.0%	.....


DISTILLATION OF PRODUCTS
Experiment No. 1.
Data by U.S. BUREAU OF MINES.
No. 1
No. 2
No. 3
° Centigrade.
° Fahrenheit.
Per cent Distilled.
FIRST DROP
DRY POINT.


DISTILLATION OF PRODUCTS
Experiment No. 2.
Data by U.S. BUREAU OF MINES.
No. 4
No. 5
No. 6
° Centigrade
° Fahrenheit.
Per cent Distilled.
FIRST DROP
DRY POINT.

DESCRIPTION OF PROCESS USED IN EXPERIMENTS.

Crude oil or benzine was placed in a closed tank which was supplied with heat from a gas burner sufficient to maintain the temperature at around 200° F. Natural gas at a pressure of about 100 pounds and a temperature approximately 150° F. was allowed to bubble through the oil and thereby absorb the vapors of the lower boiling point hydrocarbons contained in the crude petroleum. This charged gas, at its then reduced pressure of about 10 pounds passed to a single cylinder refrigeration machine and was compressed to about 125 pounds per square inch. During the compression stroke a small quantity of glycerine was sprayed into the cylinder by means of the high gas pressure on the delivery side of the compressor, and mixed with the gas and hydrocarbon vapors therein. The compressed gas, with its then condensed and entrained gasoline, plus the injected glycerine, passed through a settling tank where the most of the glycerine and some of the gasoline were deposited, and then through a water-cooled condenser where the most of the remaining gasoline vapors were condensed. A separator was next in line and served to remove the condensed gasoline from the gas which latter was then passed through a reheater where its temperature was raised to around 200° F. by transfer of the heat of the exhaust gases from the gas engine which operated the refrigerating machine. This reheated natural gas then again passed to the tank containing the crude material and so completed the cycle.

During the experiments a small amount of the natural gas was lost by leakage or otherwise and it was necessary to admit more to the system from time to time. The glycerine which was injected into the compressor cylinder served to aid the cold water circulating through the compressor cylinder jackets to abstract the heat of compression and maintain the temperature of the compressed gas and vapors at a low point. The amount of gasoline vapor condensed from the charged gas as the result of the compression was thereby increased. The low temperature of the gas and gasoline vapors also obviated any material cracking or chemical breaking down of the various hydrocarbons contained. It is also believed that the glycerine was to a certain extent instrumental in removing by absorption some of the impurities contained in the gasoline vapors as received in the compression cylinder.

The experiments were not carried far enough to determine the ultimate possibilities of the glycerine injection process as a means of removing water, sulphur, sulphur compounds, and other impurities from the gasoline. The apparatus used was assembled from material readily available on the market, so that the results do not represent the economic value of this distillation process.

A complete description of the several modifications of the fundamental process described in the above note is contained in patent specification No. 193624, filed September 28, 1917, and entitled "Process of cleaning and refining distillates of petroleum."