



*Ministry of Higher Education and
Scientific Research
AL Mustaqbal university college
Chemical Engineering
Department*



Petroleum Properties Laboratory

2nd. Stage.

***Exp. No. 4
Carbon Residue Test***

***Prepared by
a. Ban Ali Hassan***

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Purpose of this test:

the purpose of this test to determine the carbon residue of sample crude oil.

Introduction and theory :

The Conradson carbon residue test was designed to give a method for comparing the tendencies of various motor oils to deposit carbon in an internal combustion engine. Investigators offer data to confirm the view that the Conradson carbon residue of an oil is an approximate indication of the tendency to deposit carbon in an automobile engine, all other controlling factors maintained constant.¹¹ While these deposits are constantly referred to as "carbon" deposits, they contain very little, if any, chemically uncombined carbon. Gruse reports that these deposits contain a portion of unchanged oil, an intermediate coke-like portion, and mineral matter which appears as ash.

Some of the more important factors in determining the rate of formation of carbonaceous deposits in gasoline powered engines are: Engine design and operating conditions, running conditions, oil consumption, dust in the air, air-fuel ratio used, characteristics of the fuel, and characteristics of the lubricating oil. Since a complete discussion of all these factors is beyond the scope of this study, this discussion will be limited to the effect of the characteristics of the lubricating oil on the formation of engine deposits. A comprehensive study of carbon deposits, conducted under the supervision of W. A. Gruse at the Mellon Institute of Industrial Research, Pittsburgh, Pennsylvania, is available.

In considering the influence of motor oils on the formation of engine deposits, it is necessary to assume that the other controlling factors are to be maintained constant..

The two possible mechanisms for the phenomenon of the deposition of carbon recognized by Gruse are: (1) The cracking of the oil to coke, and (2)

the oxidation of the oil to materials which eventually produce coke. However, he is of the opinion that little oxidation occurs normally.

In the combustion chamber the oil is sprayed up rather violently; some of it stays in the gas space, is burned, oxidized or coked, and the products pass out with the exhaust. The fate of these products is of no importance unless they stick to the exhaust valve or stem. The oil which hits the metal surfaces is more important. If it is volatile at the metal temperature (exposed to periodic flames), it will distil away nearly completely before much can happen to it. If it is completely non-volatile under these conditions there is a possibility that it will cause trouble. The oxygen content of the chamber rises periodically to a little less than 19 per cent, but it is always mixed with oxidizable gasoline vapor, usually in excess, and during the greater part of the time, the oxygen content of the system is very low. Furthermore, the oil is protected by a layer of its own rising vapor. In other words, little or no oxidation in the combustion chamber need be expected. But the oil is on a hot surface and it is being broiled by a periodic flame, thus effecting what is essentially a coking distillation. Under these conditions, the amount of deposit would seem to depend on: (1) the amount of residue not volatile at the prevailing temperature; (2) the amount of coke formed from this residue; and (3) the degree of adherence of this coke.

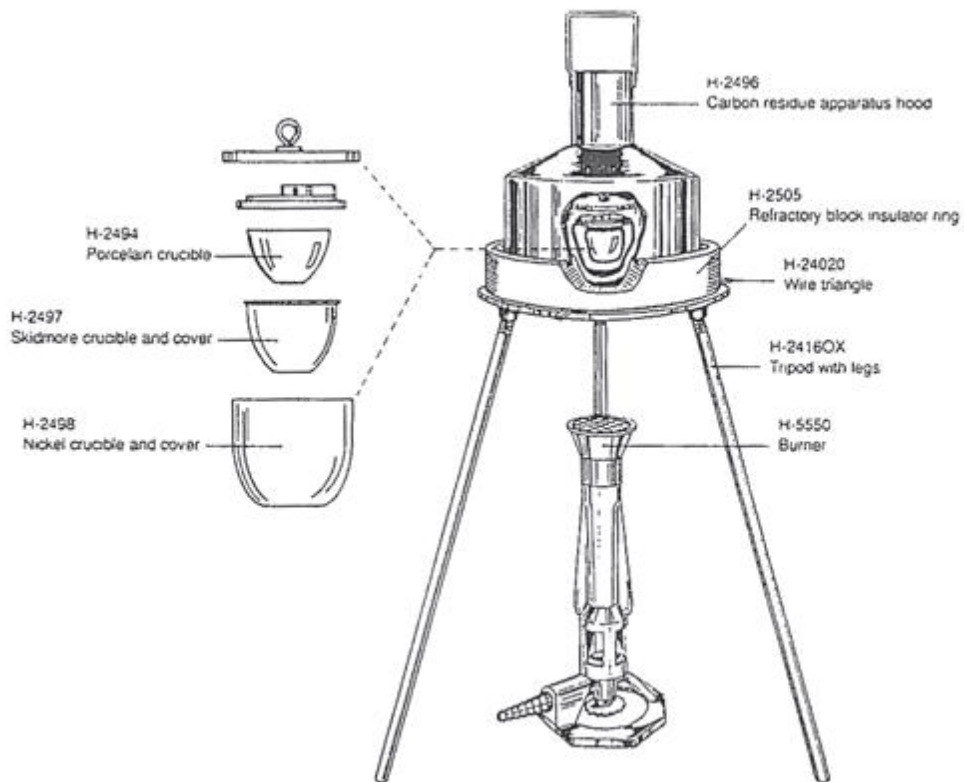
The amount of residue left on the walls seems entirely a matter of boiling point. The nature of this residue and the products from it are of considerable significance. If it contains an appreciable content of resins which yield coke, or if it forms much coke itself in cracking, and if, furthermore, the coke formed is adherent, the conditions for a troublesome deposit are present.

Significance and Use

1.The carbon residue value of burner fuel serves as a rough approximation of the tendency of the fuel to form deposits in vaporizing pot-type and sleeve-type burners. Similarly, provided alkyl nitrates are absent (or if present, provided the test is performed on the base fuel without additive) the carbon residue of diesel fuel correlates approximately with combustion chamber deposits.

2.The carbon residue value of motor oil, while at one time regarded as indicative of the amount of carbonaceous deposits a motor oil would form in the combustion chamber of an engine, is now considered to be of doubtful significance due to the presence of additives in many oils. For example, an ash-forming detergent additive may increase the carbon residue value of an oil yet will generally reduce its tendency to form deposits.

3.The carbon residue value of gas oil is useful as a guide in the manufacture of gas from gas oil, while carbon residue values of crude oil residuums, cylinder and bright stocks, are useful in the manufacture of lubricants.



Conradson Carbon Residue Apparatus

Procedure:

- 1- Weigh the porcelain crucible.
- 2- Fill the porcelain crucible with 20g of crude oil .
- 3- Set-up the apparatus by placing the wire triangle on top of the tripod and then the refractory block insulator ring on top of the wire triangle.
- 4- Place the porcelain crucible inside the skidmore crucible and then place the skidmore crucible inside the nickel crucible. Cover the skidmore crucible and then cover the nickel crucible.
- 5- Place the nickel crucible inside the insulator ring.
- 6- Place the carbon residue apparatus hood on top of the insulator ring.
- 7- Light up the h-5550 burner and place it under the tripod.
- 8-Start the timer and wait for the hood to produce smoke and flame.
- 9- Once the hood stops producing smoke and flame, record the time.
- 10- Wait for the crucible to cool down and then check for residue.



Sample calculation:

$$\text{C.R \%} = \frac{W_2}{W_3} * 100\%$$

W_2 = weight of the crucible and carbon residue - weight of crucible

W_3 = weight of the crucible and oil - weight of crucible

Discussion:

1. What is pyrolysis of petroleum materials?
2. What are the two types of carbon residue produced by pyrolysis?
3. What is incomplete combustion? How does it occur
4. What other samples can be used in this experiment? and what is the percentage of carbon in it compared to crude oil?