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## Note

# THERMOGRAVIMETRIC DETERMINATION OF THE FLUID CONSTITUENTS IN RESERVOIR ROCKS

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When a new crude oil reservoir is discovered, it is obviously important to determine how much oil and/or gas it contains, for these factors decide the justification for undertaking the expense of the development and the production and design of the operation [1].

Fluid content can serve as a valuable guide for predicting the productive potentialities of the formation being cored, and also gives us a picture of the distribution of fluid in reservoir rocks, and the well locations to be drilled [2].

The most general type of oil reservoir contains three fluids: gas, oil and water. Free gas is not always present, but there is always some dissolved in the oil phase [3].

Determination of the amount of fluid content and specific fluid saturations of cores is an important factor in the interpretation of core analysis data [4]. Specialized analytical techniques have been developed for the study and determination of core fluid, amongst these elaborate methods are the Retort method at atmospheric pressure, distillation and solvent extraction, all of which provide acceptable data [4–6].

Thermal analysis and pyrolysis-gas chromatographic techniques have been used extensively recently in crude oil and source rock identification and characterization [7–9].

The present investigation involves the application of a simple and quick thermogravimetric method for the approximate quantitative determination of the fluid constituents of some cores obtained from a local reservoir rock which provided useful information and acceptable data.

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## EXPERIMENTAL

### *Apparatus*

Thermogravimetric (TG) and differential thermogravimetric (DTG) measurements were carried out in a Heraeus TA 500 thermal analyser.

TG and DTG curves were recorded simultaneously by placing a sample weighing 10–15 mg in a platinum crucible and heating at a rate of 20°C $min^{-1}$ under an atmosphere of nitrogen or oxygen gas flowing at 100 $cm^3$ $min^{-1}$.

### *Materials*

Several core samples were obtained at different depths from the same reservoir. The cores were crushed to mesh size 40–60, followed by thorough homogenization. The homogeneity of the crushed cores was checked by the reproducibility of the thermogravimetric curves which were obtained from triplicate determinations on each core sample.

## RESULTS AND DISCUSSION

Typical TG and DTG traces performed between room temperature and 800°C under nitrogen and oxygen gas for different core samples are displayed in Figs. 1 and 2, respectively.

It is clear from Fig. 1 that the weight changes occurring in the temperature range 100–700°C under the inert atmosphere of nitrogen gas are

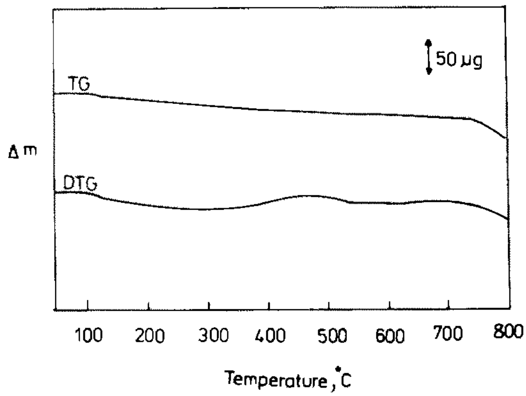


Fig. 1. Typical TG and DTG traces for the core samples performed between room temperature and 800°C in nitrogen gas.

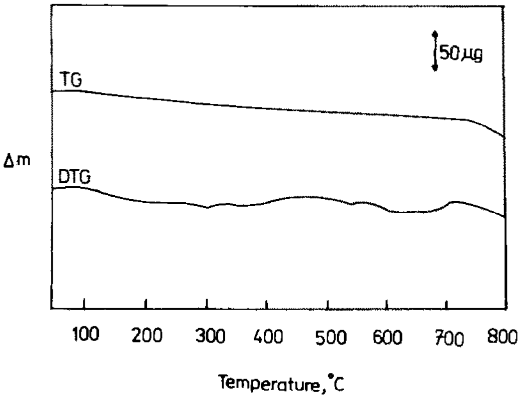


Fig. 2. Typical TG and DTG traces for the core samples performed between room temperature and 800 °C in oxygen gas.

attributed to the volatilization of water, gases dissolved in the oil phase, the light, medium and heavy oil constituents of the cores. These transitions were followed by another major weight loss commencing at about 725 °C which is related to the loss of carbon dioxide resulting from the decomposition of the mineral constituents of the cores which are composed mainly of dolomite ($MgCO_3 \cdot CaCO_3$) in addition to calcite and gypsum. A similar behaviour was again observed when the determinations were repeated under oxygen gas. However, due to the presence of the oxidizing conditions, the weight loss transitions recorded in the same temperature region (100–700 °C) were of a rather complex nature corresponding to degradative volatilization.

The weight loss values (obtained from TG curves) recorded under nitrogen gas were slightly lower than those recorded under oxygen gas as shown in Table 1. The slight decrease in these values was expected and attributed to the fact that small amounts of heavy organic compounds present in the cores are not completely volatilized in the temperature range 100–700 °C

TABLE 1

The percentage weight lost between 100 and 700 °C recorded from the TG curves of the studied core samples

| Sample No. | % weight lost in $N_2$ | % weight lost in $O_2$ |
|---|---|---|
| 1 | 9.45 | 9.6 |
| 2 | 10.5 | 11.0 |
| 3 | 11.55 | 11.9 |
| 4 | 10.3 | 11.0 |
| 5 | 9.66 | 9.85 |
| 6 | 12.5 | 13.05 |
| 7 | 10.2 | 10.5 |
| 8 | 15.65 | 16.1 |

under inert atmosphere, whereas under oxidizing atmosphere, their complete removal is enhanced by their oxidative breakdown to lighter products prior to their volatilization.

The results achieved when using the thermogravimetric technique in determining the fluid constituents in reservoir rocks correlated well with those obtained from the standard methods of evaluation [10].

The method employed proved to be useful in obtaining approximate data on the fluid constituents of reservoir rocks. Factors weighing heavily in favour of using the thermogravimetric technique are shorter time, smaller sample size, simplicity of the technique and multiple dimensions of the results obtainable, i.e. the method could also be used for characterization and identification of mineral cores from different reservoir sources.

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