Geochemical Interpretation of Albanian Crude Oils Based On the Engler Distillation Data

Irakli Prifti[a], Augent Xhaferaj[a] and Ervin Minga[b]
[a]Polytechnic University of Tirana, Albania
[b]ELBU 2009 (inspection of pressure vessels companie), Albania

---

Abstract

Albania is reach in oil and gas reserves. The accumulation of hydrocarbon is related with two natural reservoirs: 75% are related with sandstone reservoirs and 25% with carbonate reservoirs. Almost all physical and chemical indicators of crude oils, including the Engler distillation, are analyzed. Based on these data the classification and correlation of different oils are carried out. The inclusion of the data obtained by Engler distillation has detailed the groupings and correlations. The indicators of correlation are correlated with oil density or the API. In order to facilitate the interpretation, the crude oils are divided into two groups: the crude oils related with carbonate reservoirs and the crude oils related with sandstones reservoirs. In this paper we have used two terms: oil traps and oilfields. In one oilfield there are different oil traps. The data of Engler distillation have been interpreted reaching important conclusions about the geochemical characteristics of Albanian oils.
The indicators of the Engler distillation are: the boiling point, the fraction of the boiling point to 200°C, the fraction from 250°C to 300°C. The oils of the two groups react differently versus distillation, thus the condensates of the Delvina oilfield are different from those of Cakran-Mollaj oilfield. The changes are related with different conditions of generation, migration, accumulation and preservation of the hydrocarbons.
The industrial distillation is represented by four oil refineries, which belong to the old technology. Two of these refineries were closed leaving a polluted environment; such is the case of Kuçova refinery.
The compilation of this study is realized with the aim to support the investments in the field of oil refining.

KEYWORDS: Crude oil, Engler distillation, API, boiling point, distillation fraction.

MATERIAL AND METHODS

The Engler distillation procedures are carried out according to the Albanian state standard, which is conform to the European ISO standard.
The distillation is an ancient practice used by Albanian people. It has been used for two purposes:

- For the distillation of fermented fruits with the purpose to obtain alcoholic drinks, such as the traditional Albanian “raki”.
- The distillation of crude oils taken from the surface manifestations; the respective fractions were used for the illumination.

In Albania the distillation process is carried on in three directions:

1. Laboratory distillation of the crude (this is the purpose of this paper) as well as of the natural waters in order to obtain distilled water.

2. The traditional distillation to obtain alcoholic drinks. This distillation is carried on in an industrialized form too.
3. Industrial distillation of oils is represented by petroleum refineries.

The distillation of crude oil in Albania has been carried out by two Laboratories: the Laboratory of the Chemichs & Proceeding in Kuçova town and Geochemical Laboratory of the Oil and Gas Geological Institute in Fier. The distillation methodology is based on the Albanian state standard which follows the European ISO Standard.

The laboratory equipment is simple, following the standard which includes three principal proceedings: the test heating process, that of the condensation and that of the accumulation of the distillates. The distillation has been gone on in atmospheric conditions.

1.Holder of still pot; 2. A source of heat; 3. Still pot; 4. Thermometer/Boiling point temperature; 5. Heat control; 6. Condenser; 7. Cooling water in; 8. Cooling water out; 9. Still receiver; 10. Distillate/receiving flask.

These requirements and other reasons make the preparation of petroleum before processing very necessary (Vastly Simanzhenkov, Raphael Idem.2003). Petroleum preparation includes:

- drying (removal of water or dewatering),
- desalting of petroleum,
- complete or partial removal of dissolved gas.
- Density measurement.

Generally, a quantity of 100ml is taken from the crude oil samples (including the specter from heavy oils to the condensates). The distilled fraction is estimated in ml, but in the same time they are weighed (at 20°C) noting the data in gram.
After the distillation we obtained the following indicators:

1. Start of boiling (boiling point), °C
2. Fractions (ml), start of boiling to 100°C (212°F);
3. Fractions (ml); 100°C to 150°C (302°F);
4. Fractions (ml); 150°C to 200°C (392°F);
5. Fractions (ml); 200°C to 250°C (482°F);
6. Fractions (ml); 250°C to 300°C (572°F).

The industrial distillation began before the Second World War. For this a distillery with for boiler was built; it was designated to produce fuel while the mazout was accumulated into holes excavated into the earth. This petroleum refinery plant is returned to the museum object.

Photo 2. Refinery plant built before the Second World War, now is a museum object.

After the Second World War in Kuçova was built the section of the distilleries and soon, by the beginning of the 1945, started Nr 1 distillery (near the Laboratory) which produced fuel. Between 1945-1946 began the reconstruction of the Distillery Nr 2, bigger than the first one but very damaged by occupation armies; this distillery started at the beginning of 1946. In order to meet the needs of the country for fuel, was decided to construct a new distillery, Nr 3, on the western hill of Kuçova; it was conceived to function by self flowing. Actually, the complex of refineries in Kuçova is destructed (Nensi Mehmeti & **Irakli Prifti**. 2012).

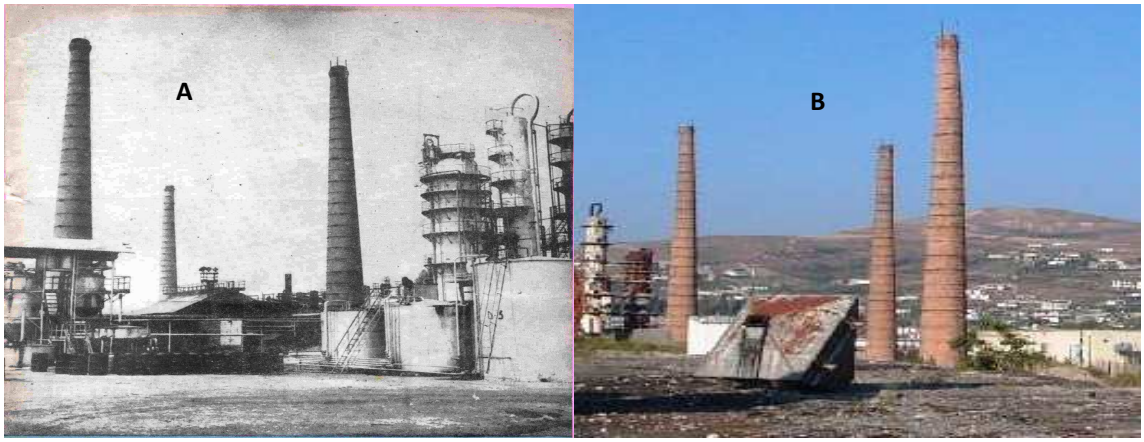


Photo 3. Kuçovë petroleum refinery: (A) 1980 year and (B) today.

Later on, the refineries in Cerrik (now out of service), in Fier (on working conditions) and in Ballsh (on working conditions) have been constructed.

Engler distillation was carried out by the Laboratory of Oil and Gas Geological Institute. Engler distillation has been carried out almost in all types of crude oils. The results are noted in the master register of the Laboratory. The determined parameters are correlated with the oil density converted in API.

Figure1. Infrastructures of the petroleum industry in Albania (oilfields, gasfields, pipelines and petroleum refineries)

DISCUSSION OF THE RESULTS

Here are the parameters obtained by Engler distillation: start of boiling (°C), as well as the distilled fractions at each 50°C, from 100°C up to 300°C.
In order to facilitate the interpretation of the data, we have calculated the following indicators: the beginning of the boiling point (°C); the quantity of the fractions distillated up to 200°C together with the fractions distillated between 250°C and 300°C. The indicators have been correlated with the density of the oils (D), converted in API using the formula:

API =141.5/D-131.5

Also, taking in considerations the lithology of the reservoirs as well as the great number of the analyzed samples, we have divided (PRIFTI I. 2011) the crude oils into two groups: the grude oils of the carbonate reservoirs and the grude oils of sandstone reservoirs.

The grude oils in the carbonate reservoirs

Because of the great number of the data related with the Engler distillation, their presentation in this paper was impossible.
We have presented only the mean values and in parentheses we give the number of samples which has served as bases for the calculation of mean values.

Engler distillation results (averages) of oil in carbonate reservoirs Table 1

Oilfields	API	Boilling point(°C)	Distillated fractions (ml)				
			Up to100 °C	100-150 °C	150-200 °C	200-250 °C	250-300 °C
Amonica	25,64 (16)	59,84 (16)	3,78 (16)	12,24 (16)	19,725 (16)	28,718 (16)	38,125 (16)
Ballsh-Hekal	14 (15)	83,93 (15)	1,75 (15)	5,253 (15)	11,166 (15)	17,426 (15)	26,029 (14)
Cakran-Mollaj	28,54 (106)	77,6 (106)	2,74 (106)	12,033 (106)	22,78 (106)	28,24 (106)	40,29 (98)
Kreshpan oil trap	24,2 (21)	81,71 (21)	3,3 (21)	10,715 (10)	20,6 (21)	30,171 (21)	39,46 (19)
Delvina condensate	46,428 (6)	103,83 (6)	1,5 (6)	23,23 (6)	47,416 (6)	67,416 (6)	54,916 (6)
Gorisht	16,235 (18)	59,61 (18)	1,6 (18)	7,144 (18)	12,933 (18)	18,3(18)	26,30 (18)
Karbunar ap	20,81 (7)	60,0(7)	2,78 (7)	8,21 (7)	15,214 (7)	22,5 (7)	32,557 (7)
Visok	9,86 (5)	79,2 (5)	0,7 (5)	2,92 (5)	7,12 (5)	11,7 (5)	20,7 (5)
Gernec	28,6 (18)	74,6 (18)	2,84 (18)	9,427 (18)	18,983 (18)	30,638 (18)	39,791 (18)

In our opinion, the condensates are related with the change of hydrocarbon phase state. So, in the Engler profile we have excluded the condensates of Delvina oilfield.
The Engler distillation profile helped us to identify three crude oil groupings:

I. Oil with high content (>38ml) of fractions distillated up to 250°C-300°C. In this group are included the oils of Cakran-Mollaj and Amonicë oilfields as well as the oils from Gërnec and Kreshpan oil traps.

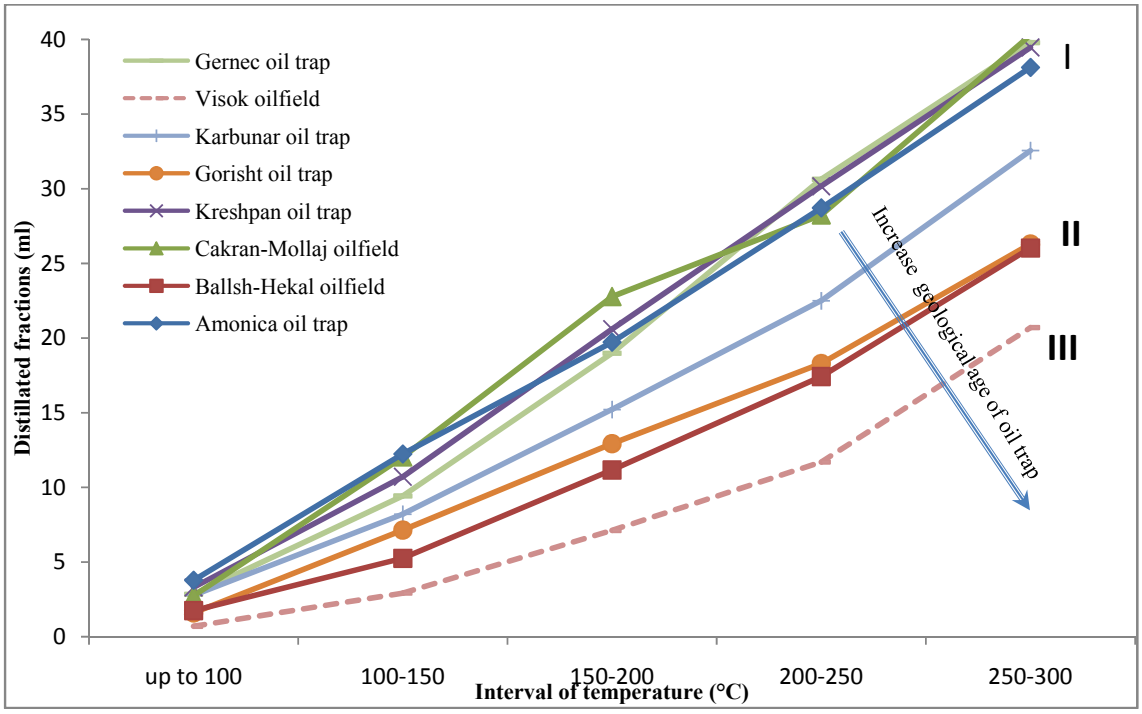


Figure 2. Profile of Engler distillation of crude oils from limestone reservoirs.

II. Oils with intermediary content (26ml) of the fractions distillated till 250°C-300°C. In this group are included the oils of Ballsh-Hekal and Gorrisht oilfields.
III. Oils with low content (20.7ml) of the fractions distillated till 250°C-300°C (in which predominate the residues of over 300°C). These oils are characteristic for the Visoka oilfield.

Different trends of the Engler distillation profiles could be conditioned by two factors:

- Oil trap time formation. The oil traps having the more extensive profile (third group) have been formed earlier.
- The degree of biodegradation of the oils. The oils of the third group are the most biodegradated, (I.Prifti**,** K. Muska. 2013) like those of Visoka.

From the comparison between the boiling point and API observes the trend that with the fall of API raises the beginning of boiling point. The condensates of Delvina oilfield are an exception, because their boiling point is higher than that of other condensates. This means that the condensates of Delvina speak about a generation history has been that different from the other oils (PRIFTI I. & MUSKA K. 2003).

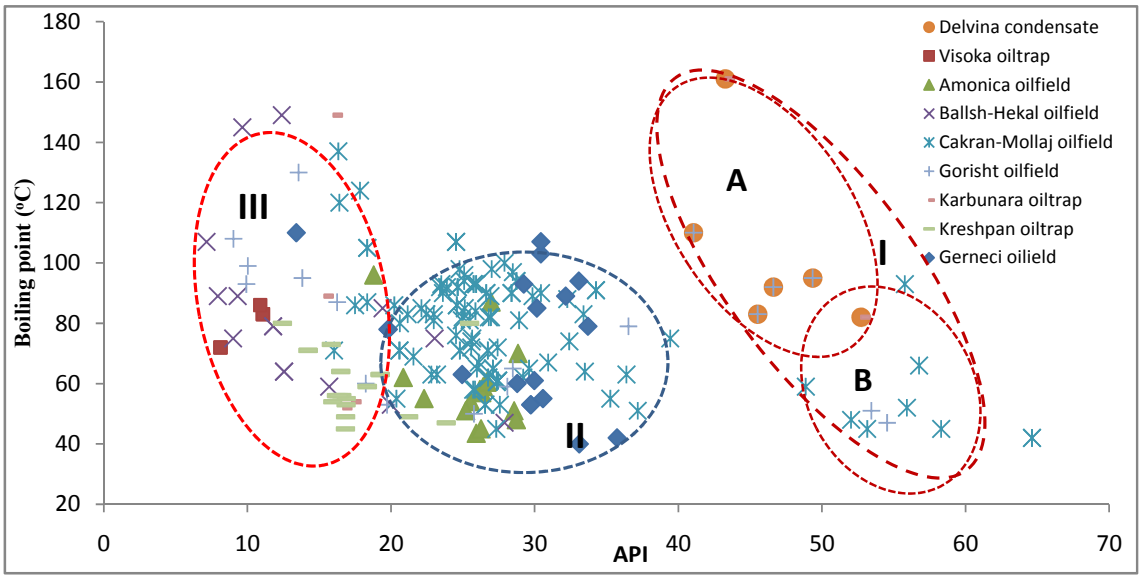


Figure 3. Three groups of Albanian crude oils based on Engler distilation (boilling points)
and API

Considering the two above mentioned parameters the oils are classified into three groups (Figure 3):

I. The condensates that may be divided in two groups:
   a. The condensates of Delvina oilfield (API>41, boiling point>82°C). May be the result of the high content of cycloalkane hydrocarbons.
   b. Condesates of the Cakran-Mollaj oilfields (API>48, boiling point 42-93°C) in this group are included also small quantities of very light oils up to condensates (only two samples), extracted from the sandstones of the flysch formation above the massive trap of Gorisht oilfield.
II. The larger group of oils in Albania, the intermediate to light oils (API 20-40, boiling point 40-107°C)
III. Heavy oils, mostly biodegradated, which have been observed near the contact oil-water of the oil traps (API<30, boiling point 45-149°C). This group is nearly the same as that of distillation profiles.

The fractions up to 300°C are divided in two groups: the fractions up to 200°C and the fractions between 250°C -300°C. The correlation of these groups manifest the trend according to which in the oils, passing from condensates to heavier ones, the content in fractions up to 300°C decreases; in consequence the content of residues above 300°C increases (Fig. 4). Even by this correlation, some samples of Delvina condensates as well as four samples from Cakran-Mollaj and Kreshpan oilfields are an exception, because have the higher content of the fractions up to 200°C and a low content of the fractions 250°-300°C.
The oils of carbonate reservoirs manifest a prevalence of the fractions up to 300°C (Fig. 4).

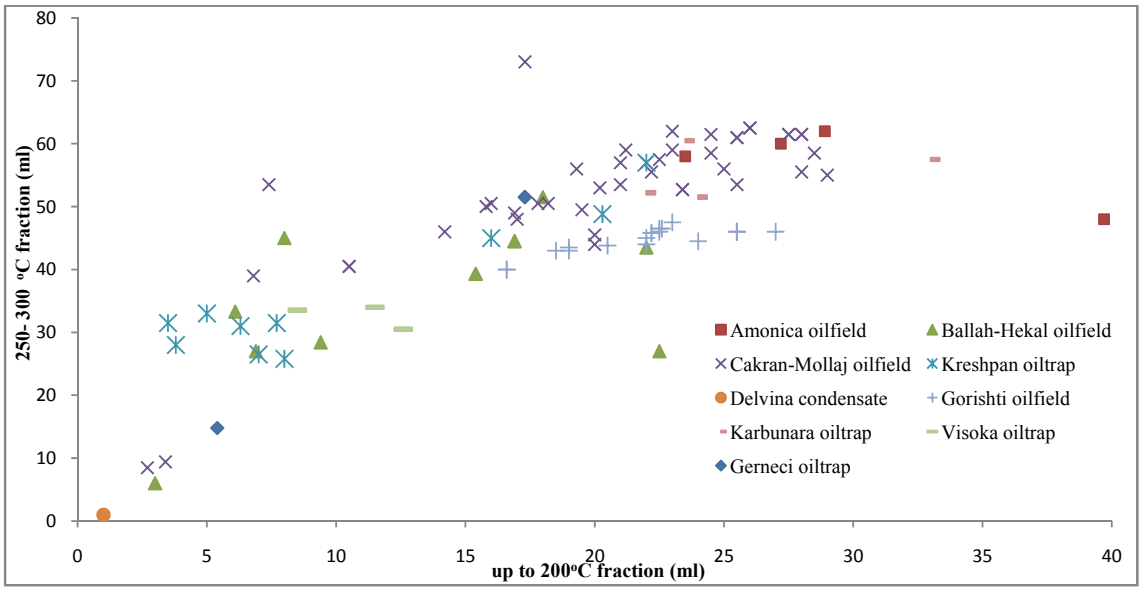


Figure 4 Correlation of Engler distillation fractions of Albanian crude oils from limestone reservoirs

Conclusively, the results of Engler distillation isolate the Delvina condensates from the condensates of the other oilfields (Prifti & Bitri.1999).

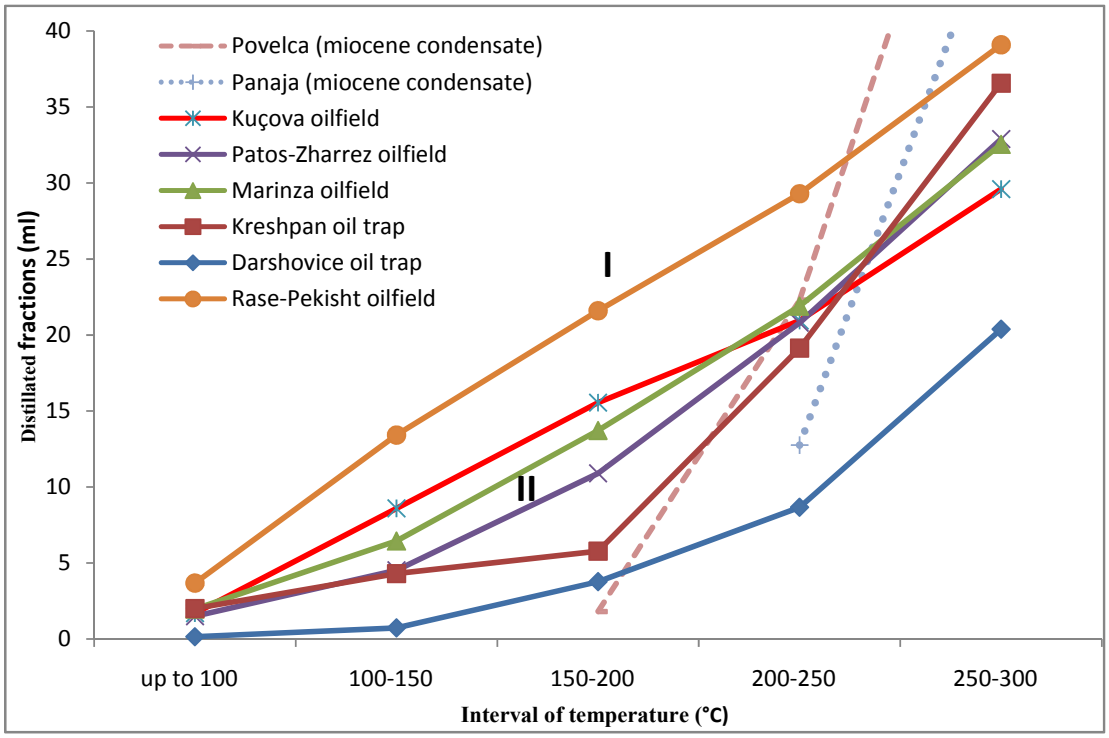
The oils of the sandstone reservoirs

The geologic reserves of the oil related with the sandstone reservoirs constitute 75% of all the oils in Albania (PRIFTI 2011). It is impossible to present the results of Engler distillation, therefore, in this case too, we present only the mean values for each oilfields; in parentheses the number of analyzed samples is given.

Engler distillation results (averages) of oil in sandstone reservoirs Table 2

Oilfields	API	Boilling point(°C)	Distillated fractions (ml)				
			Up to100 °C	100-150 °C	150-200 °C	200-250 °C	250-300 °C
Darshovice	20,17 (9)	130,77 (9)	0,15 (2)	0,729 (7)	3,77 (9)	8,66 (9)	20,38 (9)
Kreshpan	17,53 (7)	131,71 (7)	2 (1)	4,3 (3)	5,78 (7)	19,14 (7)	36,57 (9)
Marinza	18,55 (49)	91,27 (49)	1,96 (31)	6,45 (47)	13,72 (49)	21,9 (49)	32,55(48)
Patos-Zharrez	16,26 (5)	72,8 (5)	1,5 (5)	4,52 (5)	10,9 (5)	20,8 (5)	32,9 (5)
Kuçova	17 (10)	71,8 (10)	1,7 (10)	8,5 9 (10)	15,55 (10)	20,95 (10)	29,6 (10)
Rase-Pekisht	24,87 (5)	58 (5)	3,68 (5)	13,42 (5)	21,6 (5)	29,3 (5)	39,1 (5)

The Engler distillation profile of the sandstone reservoirs oils is simpler in comparison with that of carbonate section.
In the sandstones of flysch formation (Lower Oligocene), as is the case of Drashovica and Kreshpan, represent small reserves. Their distillation profile is different from that



of Miocene section (Figure 5).

Figure 5. Profile of Engler distillation of grude oils from sandstone reservoirs

Thus, the oils from Miocene section, according to the distillation profile, are classified into two groups. Otherwise, the oils generated by the Miocene sediments, named "Condensates", are not maturated oils.

I. The oil of Rrasë-Pekisht oilfield is characterized by higher content of the distillated fractions (PRIFTI et al. 2014).
II. The oils of the other oilfields as Patos-Marinëz, Kuçovë, which manifest similar trends of the distillation curves.

These differentiations are related with different times of their formation, with different distances of secondary hydrocarbon migration as well as with different degrees of their biodegradation. The correlation between the beginning of the boiling point (°C) and API makes it possible to separate two groups represented by two parallel lines (Figure 6).
In the first line are included the oils of Marinza, Bubullima formations as well as those of Drashovica (Figure 6). The beginning of the boiling point is higher than that of the oils of the second line.
The second line is represented by the oils of Driza and Marinza formations as well as the oils of the Kuçovë-Arrëz and Rrasë-Pekisht oilfields.
The highest boiling point is related to the oils of Drashovica oilfield and the oil of "Driza" formation; the lowest boiling point is related to the oils of "Marinza" and "Bubullima" formations and to those of Kuçovë-Arrëz and Rasë-Pekisht oilfields.

The content of fractions up to 300°C (Figure 7) decreases passing from very light oils to those of heavy oils. The oils of the "Marinza", "Bubullima" formation as well as those of the Rrasë-Pekisht have the highest content in fractions up to 300°C. The oils of Drashovica, in

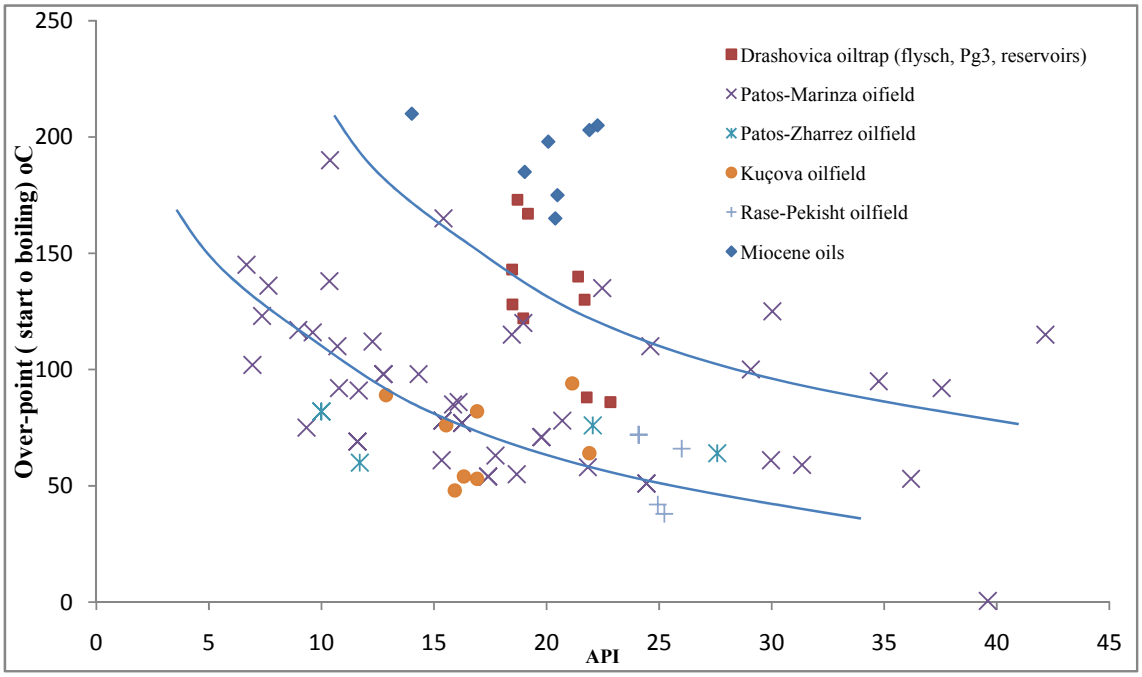


Figure 6. Correlation of crude oils from sandstone reservoirs based on Engler distilation (boilling points) and API

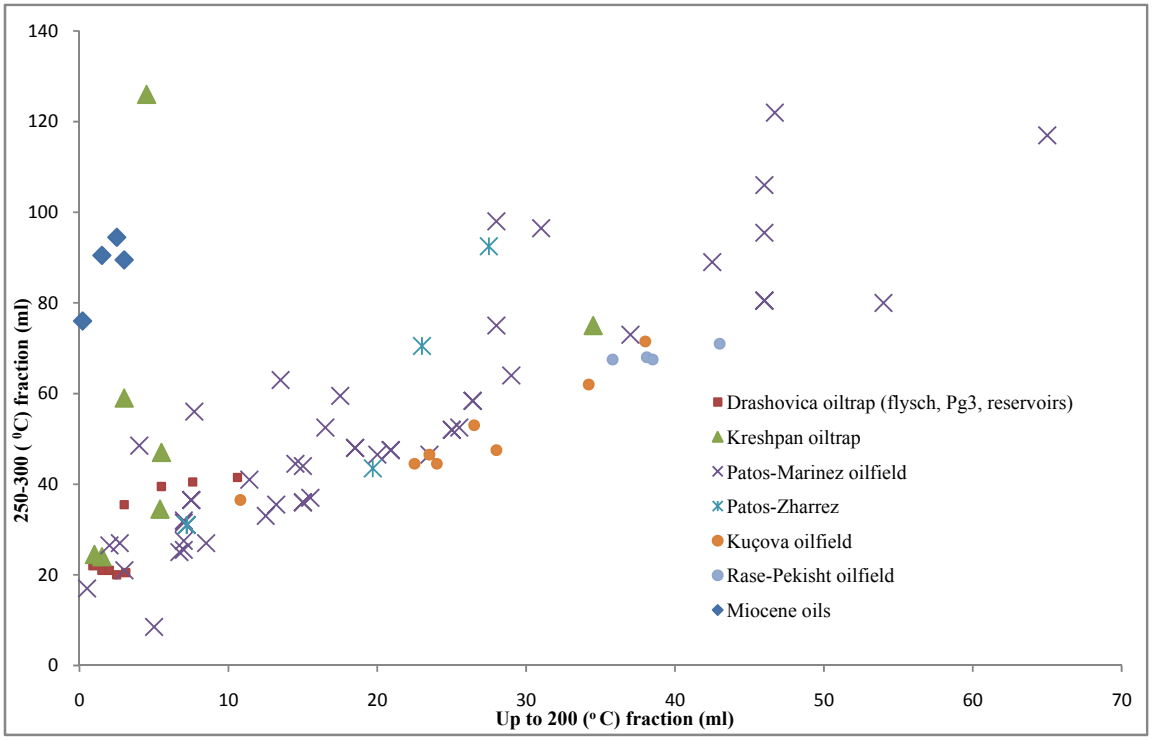


Figure 7. Correlation of Engler distillation fractions of Albanian crude oils from sandstone reservoirs

spite of being light oils, do not follow this law; they have the lowest content of fractions up to 300□C.

In the Geochemical Laboratory of Oil and Gas Geological Institute, (Fier, Albania) have been carried out many analysis according to Engler distillation. From the correlation between the "boiling point" and API one can observe that the crude oils in Albania are included nearly in one and the same group having API=10-40 and the boiling point=38-100□C.

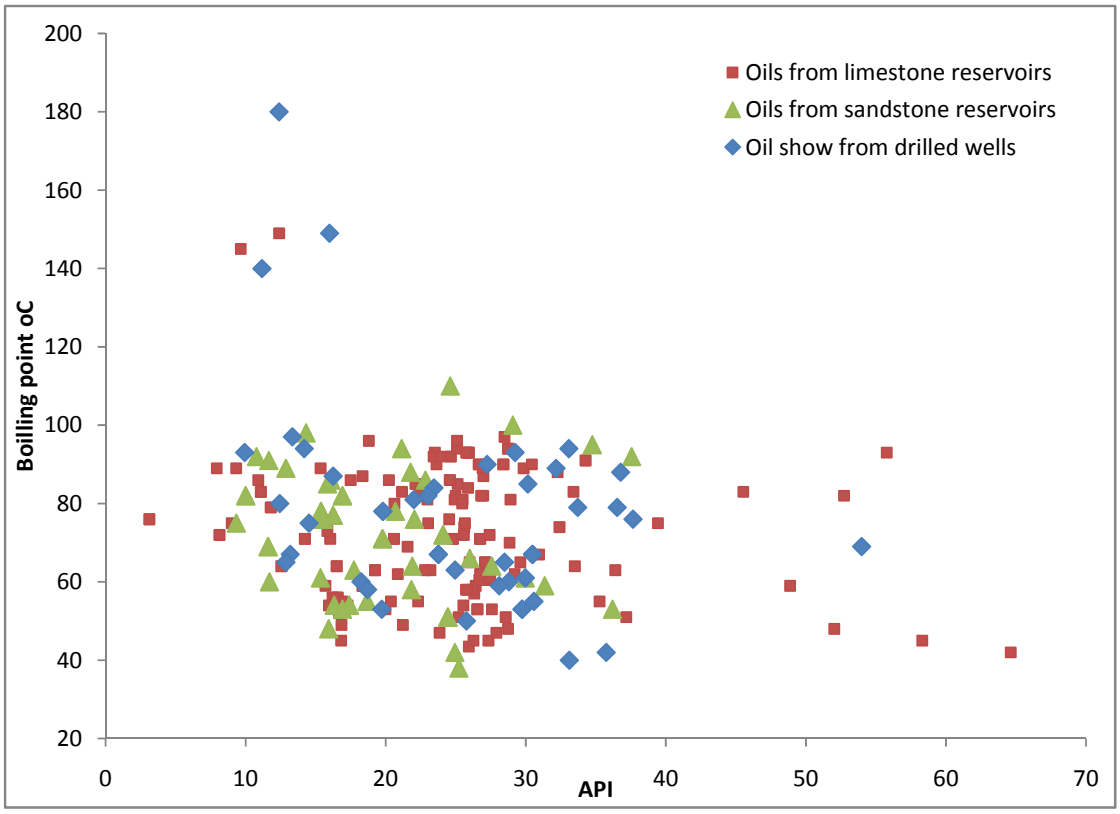


Figure 8. Correlation of Albanian crude oils based on Engler distilation (boilling points) and API

CONCLUSIONS

The application of Engler distillation has helped for the classification of the Albanian crude oils.

The crude oils related to carbonate reservoirs are grouped into three groups where predominates the second group. Based only on the boiling point, the Delvina condensates manifest the highest values of this indicator. According to Engler distillation, the 300□C fractions decrease passing from the condensates towards the heavy oils. The Delvina condensates and condensates shows observed in the oilfield

of natural gas do not follow this law. This is related to the different origin compared with other oilfields.
Based on the Engler distillation data, the oils of Patos-Marinëz are very different. This is related to the existence of different oil traps formed as a result of different migration phases of hydrocarbons with different biodegradation degree.
Based on the distillation of the oil traces taken from the exploration wells, we conclude they belong to the second group of oils. This is very interesting as far as the oil exploration is concerned.

ACKNOWLEDGEMENTS

The authors wish to thank the colleagues of the Geochemical Laboratory of the Oil and Gas Geological Institute for the application of the Engler distillation of Albanian crude oils.

REFERENCE

I.Prifti,A.Bitri.1999. Geochemical model of oilfields (scientific report in albanien), The archive of the National Agency of Natural Resources, Fier, Albania.

I.Prifti**,** K. Muska, 2013. Hydrocarbon occurrences and petroleum geochemistry of Albanian oils (pp. 228-235) . *Ital. J. Geosci.* (Boll. Soc. Geol. It.), Vol. 132, No. 2.

Nensi Mehmeti, **Prof. Asc. Irakli Prifti**. 2012. Methods used in surface rehabilitation in the ex-petroleum refinery in Kuçova (pp.225-233). "Scientific Bulletin" of Albanian Geological Survey Tirana, Albania.

PRIFTI I. & MUSKA K. (2003) - *Classification of Albanian oils.* In:
Scientific meeting "Albanian geology in time" (From Franc Nopça) (pp. 98-102). Tirana, November 2003,.

PRIFTI I. 2011. Oil Accumulations in Albanides (pp.95-100). Gjeoalb, Mitrovicë, Kosovë. pages,

PRIFTI Irakli, MEHMETI Nensi, DAUTI Suela. 2014. Petroleum system of east part of Ionian zone in Albania (pp.49-65). Online International Interdisciplinary Research Journal, Kolhapur, Maharashtra India.

Standarti shteteror i analizave të naftës.1980. National Library of Albania

Vastly Simanzhenkov, Raphael Idem.2003. Crude Oil Chemistry