Tracer Tests vs RST

Studies in Romanian reservoirs

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The mature oil reservoirs are interesting because of the continuously increasing need for oil and also due to the significant investments implied in discovering new reservoirs. This interest is closely related to accurately knowing the hydrocarbon saturation and its distribution inside the reservoir. There is a series of methods, investigations and tests which allows measuring the residual oil saturation in the reservoir. The geophysical investigations in cased wells and the tracer tests are only two of these methods, frequently used in the case of water injection processes.Likewise, single well chemical tracer test plays an important role to evaluate the efficiency of oil recovery process by determining the amount of oil displaced due to injection of IOR/EOR agent. Thepartition coefficient of chemical tracers, a ratio of chemical tracer concentration in oil to concentration in brine, is a critical parameter for designing a single well chemical tracer test. Brine salinity, oil composition, temperature and sometimes, laboratory procedure for measuring the partition coefficient can directly influence this critical parameter. Results of laboratory test performed for measuring the partition coefficient of the ethyl acetate, under reservoir conditions are discussed in this paper. This paper presents an analysis of the measurements' results of three SWCTT (Single Well Chemical Tracer Test) tests and three RST (Reservoir Saturation Tool) investigations performed in the same wells, on different structures in Romania, aiming to obtain information about the saturation state of the area around the well bore, as well as a comparative analysis of the results obtained by using these two methods.

Keywords: oil saturation, mature oil reservoirs, investigation techniques, SWCTT, RST

For a reservoir engineer managing the production of an oil reservoir, the ideal situation would be to have an accurate map of the saturations in that reservoir. But the more mature the reservoir is, the bigger the distance to the ideal situation. This is why any effort made in order to obtain information related to the fluids saturation in the zone neighboring the well, or in the drainage zone of the well, or inside the entire reservoir is always welcomed. There is a number of methods to investigate the saturation state in oil reservoirs, with their advantages, limitations and uncertainty degrees [1-8]. In most of the cases the specialists may talk about the methods completing each other in determining saturations.

The tracer tests and the geophysical investigations specific to saturation determination are largely used in different applications. Present work refers to two methods of determining saturations around the well, namely SWCTT and RST, in the context of identifying the potential IOR/ EOR methods' application. The analysis starts from the fact that the tracer test applied in one well determines the average saturation of immobile oil from the invaded zone, while the RST method, by measuring the sigma and the C/O ratio values for the formation, generates a profile of the water saturation for the investigated interval, both on the level of perforations and for the non-perforated zones. Another assumption considered here is that the solution of chemical tracers penetrates preferentially the zones of maximum permeability, so the obtained oil saturation only refers to those zones, more precisely it is an average for those zones. The production data and the ones related to the reservoir pressure allow the evaluation of the gas saturation around the well and also, the determination of the oil saturation from the RST recordings, in order to compare it to the one determined by the tracer tests, but only on the intervals affected by them.

This paper presents the analysis of the SWCTT and RST measurement results performed in three oil wells in Romania, based on the assumptions presented above. The first thing to notice is the good correlation between the saturation values provided by the two methods. The most important result of this experiment is the significant increase of the certainty degree related to the residual oil saturation, defined as the minimum value of the saturation resulted after flooding with water or other solutions.

This new approach is useful and important for a precise design of the IOR and EOR processes, meaning the accurate evaluation of the saturation variation limits for oil, respectively the efficiency of such processes.

Tracer tests for oil saturation evaluation & RST, capabilities and limitations

The *classical* methods for evaluating the oil saturation are the capture of the neutrons impulses PNC (Pulsed Neutron Capture) and the determination of the carbon/ oxygen ratio (C/O).

The first PNC equipment dates back to the 60's. Since then, this technology was continuously improved, from the oldest PNC tool containing a single detector and capable to produce a single neutron explosion, developed by Lane, to the state-of-the art tools presently used in cased wells.

The PNC method also called TDT (Thermal Decay Time) or NLL (neutron lifetime log) measures the time of thermal disintegration of the neutrons and is mainly used in reservoirs with high porosity and water salinity values. The method provides good quality saturation measurements when water salinity is high, constant and known. In case water salinity is low (< 35,000 ppm), the device cannot accurately determine the fluid nature (water or oil), because the two fluids have rather similar capture sections, Σ (sigma).

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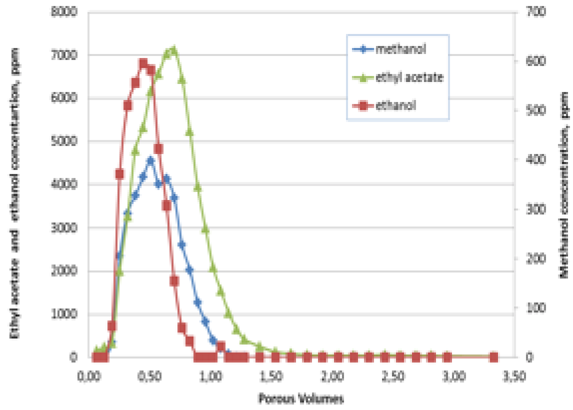


Fig. 1 The breakthrough times for the tracers of differentK$_d$, for a porous space with 24.2 % S$_{or}$

The C/O ratio is determined by neutron impulses coming from a neutron source of 14 MeV, using a gamma ray detector, similar to the ones used in the TDT method, but able to support a higher speed of the neutrons (20 kHz), with different detection times and different energy domains. The gamma radiations coming from the non-elastic interactions of the neutrons with carbon, oxygen, calcium and silicon are transposed into C/O respectively Ca/Si ratios used to determine the oil saturation and the lithology, irrespectively of the salinity of the formation water and the shale content (Smith and Schultz, 1974). Because the C/O (or Ca/Si) ration does not depend on the chloride content of the reservoir water, this type of investigations can be used where the TDT method cannot be applied.

These *classical* methods are limited by the high values of water salinity and by the fact that they can only be used if there is no tubing in the well, which means that the well has to be killed, with all the related negative consequences.

In order to eliminate the above-mentioned limitations, the two methods have been integrated in a single device, called RST (Reservoir Saturation Tool), which can be run in through the tubing, thus allowing well investigation under normal operating conditions [1,8]. Another advantage consists in the fact that the following can be measured in only one run: (sigma), porosity, C/O ratio, the shale volume, the formation lithology, respectively the water saturation, S$_w$, the total hydrocarbon saturation - S$_{hc}$ representing difference (S$_{hc}$ = 1- S$_w$). Depending on the moment of performing the RST investigation, the water saturation can be:

-initial water saturation, if the investigation is done at the beginning of exploitation,

-the water saturation at the moment of performing the investigation (the irreducible water plus the water coming from other sources), if the investigation is done at a certain moment during production (this is the case of the three RST investigations presented in this paper).

In addition, this instrument can determine the water/oil ratio in the tubing or in the zones of oil or water accumulations in the horizontal wells.

On the other hand, it has to be mentioned that knowing quantitatively the mineral composition of the formation is a key parameter for saturation evaluation based on the determination of the C/O ratio. Inaccurate lithological information will lead to inaccurate saturation estimation.

The tracer tests aiming to estimate the oil saturation were applied for the first time in East Texas reservoir in 1968 [9] and the patent rights have been awarded to Deans in 1971. From this point, many petroleum companies have used the SWCTT method [10-15] mostly for measuring the residual oil saturation after water flooding. In case the test is performed when the well produces 100% oil, the irreducible water saturation can also be determined.

A tracer test performed in a single well in the field is preceded by laboratory works for the determination of the partition coefficient, K$_d$, of the selected tracer. Reservoir temperature selects the esters suited to the SWCTT. Hydrolysis reaction of formate esters is approx. 50 times faster than the acetate esters, being used at reservoir temperatures of 21 to 57°C. The slower reacting acetate esters are generally used for temperatures of 54 to 120°C.

As an example, figure 1 presents the partition curves of the tracers used to determine the partition coefficient of the ethyl acetate (K$_d$=2.8) for one of the three tests performed in the field, under the conditions of well SW-3 drilled on reservoir Z3.

The laboratory tests were conducted on natural cores, with fluids from the reservoir and under reservoir pressure and temperature conditions, using the FRT Chandler (Formation Response Tester) equipment.

The determination method consisted in injecting an ethyl acetate solution plug (the main tracer) and methanol (used for the materials balance), through a porous space brought to residual oil saturation. After injecting the tracers in the water phase, the phase that flows through the porous space, a reaction break followed, lasting approx. 5 days, for the ester hydrolyses and the generation of the secondary tracer, the ethanol. The breakthrough times were measured for each tracer (t$_p$, t$_w$ – the time of the ethyl acetate, respectively of the ethanol) used to calculate the partition coefficient according to equation 1:

$$K_d = \frac{(t_p - t_w)}{t_w}\frac{(1 - S_{or})}{S_{or}} \qquad (1)$$

Tracers detection was done by using the gas chromatography (GC-FID), the detection limits being 0.5 - 1 ppm (parts per million).

For most of the tracers soluble both in water and in oil, the partition coefficient depends on oil and reservoir water compositions, on tracer concentration and temperature [11, 13, 16, 17]. The results of the laboratory tests performed to determine the K$_d$ of the ethyl acetate, under different conditions, are presented in detail in the paper [17]. K$_d$ was measured for 5 oil types, from a heavy asphalt-resinous oil to a light oil, all coming from different reservoirs of Romania. The influence of oil type could be noticed regarding both its density and resin, asphaltene and paraffin content.

The tracer test in a single well applied in the field comprises 3 phases: injection, reaction and production. Thus, the tracer (ester) is injected in the reservoir through a production well to a certain distance, depending on the available tracer quantity. The well is then shut in, so asto allow the ester to react with the formation water, being this way partially hydrolyzed. The result is the generation of a new tracer in the reservoir. The new tracer, together with the un-hydrolyzed ester form a pair of tracers situated at a certain distance in the reservoir. When the well is put back in production, both tracers will be analyzed in the produced water. By measuring their concentration and knowing the partition coefficient for the concrete conditions (fluids composition, temperature), the oil saturation is calculated for the zone where the traces was injected [12,16].

The second series of tracer tests aimed to determine the fluid saturations state has been developed by Cooke in 1971 and is known as the TWTT tests. The method consists in injecting two tracers with different solubility values in water and oil, through an injection well, and in collecting

Table 1
RST GEOPHYSICAL INVESTIGATIONS VS TRACER TESTS

	Advantages	Disadvantages
RST investigations	Performed in cased wells Do not depend on water salinity Good accuracy Saturations profile on well depth	Formation minerals influence significantly the results obtained using C/O Require the use of calibration curves Small investigation radius (25 cm)
SWCTT	The investigated pore volume is rather large and can be controlled Large investigation radius (up to 7m) Good accuracy	The investigated zone has to be free of fractures in order to avoid losing the tracer in the layer. The result is an average saturation on the entire investigated interval. The simultaneous opening of several productive layers limits results accuracy.
TWTT	The investigated pore volume is large, The investigation radius is the distance between the well	Time consuming

water samples from the production wells situated in the influence zone of the injector. In the case of these tests, the investigated reservoir interval is much bigger, depending on the injector-producer distance. This is the only method of saturation determination that is independent of porosity. It has a good accuracy in many cases and provides information on reservoir's heterogeneity; it can be applied both in new and old wells, in cased or open holes.

In the case of the tracer tests performed in two wells, the landmark method is used in designing the test and calculating the saturation. This method was proposed by Tang [11] based on the idea that the response curves of the two tracers should be similar because the injected tracers have the same flow path in the reservoir and different breakthrough times. Saturation can be determined using the breakthrough curves of the tracers if a time mark is selected on each curve.

Table 1 presents comparatively the advantages and disadvantages of the two investigation methods.

Case studies

This paper presents the SWCTT and RST measurement results for three oil wells in Romania: SW-1 on reservoir Z1, SW-2 on reservoir Z2 and SW-3 on reservoir Z3. For all the three wells, the first investigation run was the RST, followed by SWCTT.

For a better understanding and interpretation of the results, table 2 presents some characteristics of the reservoirs on which the tests have been applied, and table 3 shows some of the significant characteristics of the fluids produced by each well.

The results of the three SWCT tests

The composition of the tracer solution prepared in the field, as well as the injection parameters are presented in table 4.

During the first 3 days after reopening the wells, water samples have been taken every 30 min (48 samples a day), and during the next 2 days, every 1 hour (24 samples a day).

The samples were analyzed immediately after sampling, during the daytime, to avoid further advancement of the hydrolysis reaction of the ethyl acetate, which could have resulted in inaccurate results. Also, the volume of produced water was accurately measured at the moment of sampling.

The breakthrough time and tracer concentrations were determined by gas chromatography (GC-FID). The results are presented as graphs in figures 2-4.

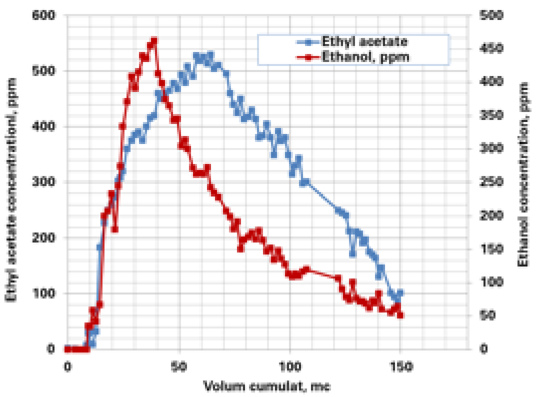


Fig.2 Tracers breakthrough in well SW-1

Table 2
DATA ABOUT THE RESERVOIRS AND PRODUCTION WELLS

Reservoir	Z1 – Triassic - Dogger	Z2 - Meotian	Z3 - Sarmatian
Lithology	Sandstone and siliceous sand	predominantly marly - sandy facies	sandstone, siliceous sand
Temperature	87°C	60-63°C	65°C
Effective porosity	18 %	29%	29%
Permeability	32 mD	520 mD	1.595 mD
Connate water	30%	30%	24.3%
Production well	**SW-1**	**SW-2**	**SW-3**
Cement level	2.009 m	1.262 m	1.098 m
Perforations	2.002-1.993 m	1,251.5 – 1.248.5 m	1.093-1.088 m
Well productivity	20 m^3/day x 95 %=1.2 tons/day, Qg=4,000 Stcm/day	43 m^3/day x 97.5% = 1 ton/day, Qg=100 Stcm/day	35 m^3/day x 95% = 1.5 tons/day

Characteristics	Well SW-1	Well SW-2	Well SW-3
Oil			
Oil density at 20°C, kg/m3	817.5	923	898.1
Kinematic viscosity at 60°C	2.29	14.47	8.34
Paraffin content,%	1.84	< 1	< 1
Resin content,%	7.53	12.62	11.15
Asphaltene content,%	0.26	1.28	0.59
Reservoir water			
Water type	$CaCl_2$	$CaCl_2$	$NaHCO_3$
Water density at 20°C, g/cm3	1.0278	1.0419	1.0104
Salinity, mg/l	37,259	56,523	13,504

Table 3
PRODUCED FLUIDS CHARACTERISTICS

	Well SW-1	Well SW-2	Well SW-3
Tracers solution	17 m^3 sol. 3.1% ethylacetate + 1% methanol	30 m^3 sol. 2.4% ethylacetate + 0.6% methanol	24.5 m^3 sol. 3.1% ethylacetate + 1% methanol
Push solution	17 m^3 sol. 1% methanol	30 m^3 sol. 0.6% methanol	26.5 m^3 sol. 1% methanol
Formation water	20 m^3	30 m^3	18 m^3
Injection rate	9.4 m^3/hour	21 m^3/hour	12 m^3/hour
Shut in period	6.5 days	6 days	4 days

Table 4
PARAMETERS OF THE SWCT TESTS

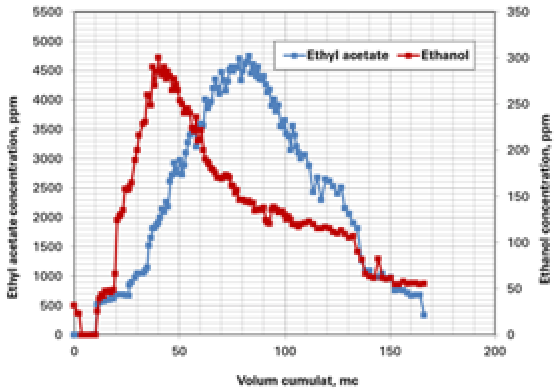


Fig.3 Tracers breakthrough in well SW-2

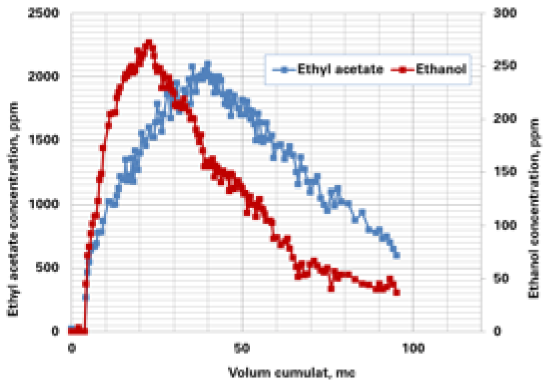


Fig.4 Tracers breakthrough in well SW-3

Residual oil saturation determination in the SWCT tests

Considering the water volume left in the well bore after having shut in the well, d, as well as the water volume produced by that well after reopening it until getting the maximum ester and methanol concentrations, V_{ester} and $V_{ethanol,}$ the equation giving the residual oil saturation is:

$$S_{or} = \frac{\left(\frac{V_{ester}-\delta}{V_{etanol}-\delta} - 1\right)}{\left(\frac{V_{ester}-\delta}{V_{etanol}-\delta} - 1 + K_d\right)} \qquad (2)$$

The partition constant for the ethyl acetate was determined in the laboratory under the specific conditions of each reservoir (temperature and reservoir fluids) and δ was estimated for each well.

Considering the moments of tracers maximum concentration breakthrough, respectively an average value of the maximum concentration (the arithmetic average between the water cumulatives obtained for the half-maximum concentration for each tracer), the oil saturation around the three wells was calculated, (table 5).

"Landmarks"	Produced water, m^3		K_d	δ, m^3	S_{or}, %
	Ethanol,	Ethyl acetate			
Well SW-1					
Maximum concentration	38.5	64	6	20	18.6
Average value of the maximum concentration	42.8	71			17.1
Average value of S_{or}					17.9
Well SW-2					
Maximum concentration	40	81	3.9	6	23.6
Average value of the maximum concentration	45.5	84			19.9
Average value of S_{or}					21.8
Well SW-3					
Maximum concentration	23	40	2.8	5	25.2
Average value of the maximum concentration	21.5	38.5			22
Average value of S_{or}					23.6

Table 5
HE CALCULATED VALUES OF THE RESIDUAL OIL SATURATION AROUND THE PRODUCTION WELLS

Well	Well SW-1	Well SW-2	Well SW-3
Invasion radius, m	2.7	4.5	3.5
Produced methanol from the injected quantity, %	72.5	97	76

Table 6
THE METHANOL IN THE PRODUCED WATER AND SOLUTION'S INVASION RADIUS

Table 7
THE PETROPHYSICAL RESULTS INTERPRETATION FOR WELLS SW-1, SW-2 AND SW-3

Flag name	Top	Bottom	Av_shale volume, %	Av_Porosity, %	Av_Water saturation, %	Av_Sigma, %
RST Sigma - well SW-1						
Aquifer with hydrocarbon traces	1.9922	1.999	14.5	19.9	65.3	21.562
RST Sigma/RST CO - well SW-2						
Possible hydrocarbons	1.248.5	1.258	17.8	13.1	62.2	22.605
RST CO - well SW-3						
Possible hydrocarbons	1.088	1.093.5	16.4	11.7	62	na

Av_is the average value for the respective interval

The determination of the methanol quantity in the water produced after the reaction break showed that it has been recovered in different quantities depending on the well, table 6. The fact that the percentage of methanol produced by the two wells was 72.5%, respectively 76% of the injected quantity means that part of the methanol was not produced, but lost in the reservoir.

The RST investigation results for the three wells

The results presented below come from the technical reports of the service company having performed the three RST tests.

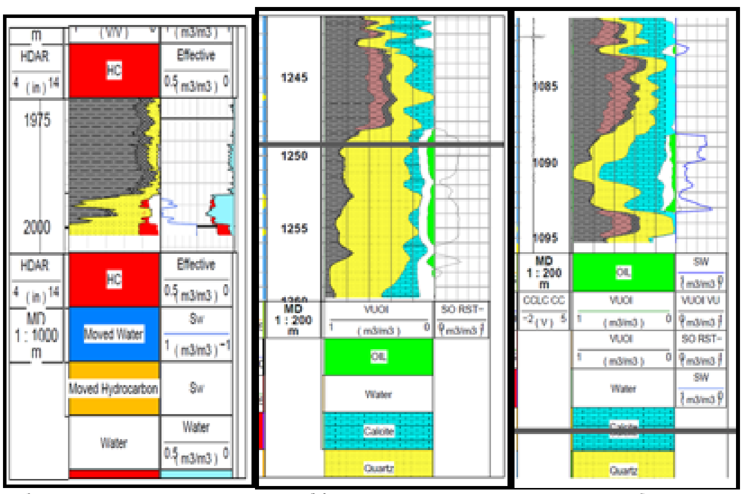
According to the RST reports, the data recorded on the investigated intervals showed good quality, for all the three wells. The RST investigations allowed the determination of water saturation, respectively the hydrocarbon saturations as the difference 1- Sw, the porosity and the shale volume. These results are presented in table 7.

Results discussions

The comparative results of the SWCT tests and RST investigations performed for the three wells are presented in table 8. After comparing the results of the two methods, it is obvious that they are different. The fact that the tracer tests provide always smaller values than the geophysical investigations is also mentioned by other specialty works [18,19].

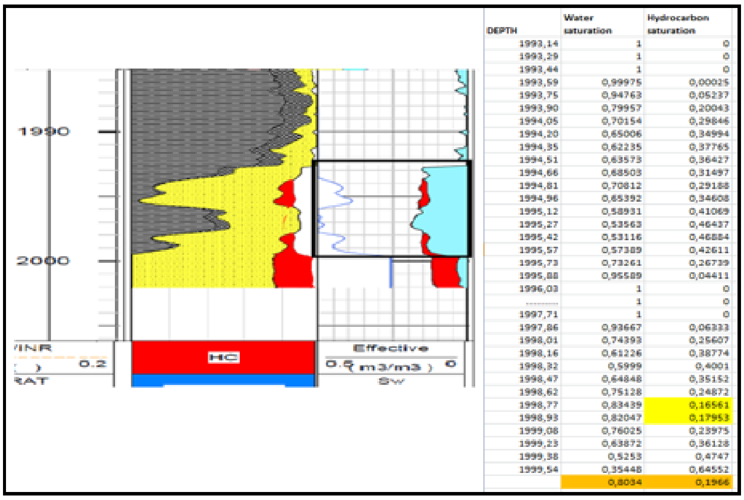
The difference is given, first, by the fact that the oil saturation resulted from the RST investigations includes both the residual saturation (immobile oil) and the saturation of mobile oil. SWCTT measures the residual oil saturation and represents the minimum saturation value resulted after water flooding, on the micro scale, meaning for those pores subjected to the displacement process. This value depends, besides the balance between the viscosity, capillary and gravity forces, on the volume of displacing agent having flooded the respective porous space. The different parts of the reservoir, even when there are no facies variations, are drained differently and, as a consequence, the residual saturation will be different. In other words, SWCTT measures the residual oil saturation after the water injection process or any other displacing phase. This is the reason for which such tests are done in wells producing high water cuts, in order to be sure that the zone around the well is at the residual saturation, or close to this value.

Secondly, the higher value of the RST investigation is also due to the fact that this type of investigation does not make the difference between the hydrocarbons types, oil respectively gas, the value comprising both phases. This might explain the rather high value of 34.7% hydrocarbon saturation obtained for well SW-1. In the moment of testing,



a) b) c)

Fig. 5 Diagrams of RST investigations for a) well SW-1, b) well SW-2 and c) well SW-3



DEPTH	Water saturation	Hydrocarbon saturation
1993,14	1	0
1993,29	1	0
1993,44	1	0
1993,59	0,99975	0,00025
1993,75	0,94763	0,05237
1993,90	0,79957	0,20043
1994,05	0,70154	0,29846
1994,20	0,65006	0,34994
1994,35	0,62235	0,37765
1994,51	0,63573	0,36427
1994,66	0,68503	0,31497
1994,81	0,70812	0,29188
1994,96	0,65392	0,34608
1995,12	0,58931	0,41069
1995,27	0,53563	0,46437
1995,42	0,53116	0,46884
1995,57	0,57389	0,42611
1995,73	0,73261	0,26739
1995,88	0,95589	0,04411
1996,03	1	0
....	1	0
1997,71	1	0
1997,86	0,93667	0,06333
1998,01	0,74393	0,25607
1998,16	0,61226	0,38774
1998,32	0,5999	0,4001
1998,47	0,64848	0,35152
1998,62	0,75128	0,24872
1998,77	0,83439	0,16561
1998,93	0,82047	0,17953
1999,08	0,76025	0,23975
1999,23	0,63872	0,36128
1999,38	0,5253	0,4747
1999,54	0,35448	0,64552
	0,8034	0,1966

Fig. 6 Diagram for the RST investigation for well SW-1 and the values obtained on small intervals

Table 8
SWCTT VS. RST COMPARATIVE RESULTS FOR THE THREE INVESTIGATED WELLS

	Well SW-1	Well SW-2	Well SW-3
Residual oil saturation - SWCTT, %	17.9	21.8	23.6
Hydrocarbons saturation – RST investigation, %	34.7	37.8	38

Table 9
THE PETROPHYSICAL INTERPRETATION RESULTS CONSIDERING THE VALUES OBTAINED ON SMALLER INTERVALS

Flag name	Top	Bottom	Av_Water saturation, %	Av_Hydrocarbon saturation, %	Observations
RST Sigma - well SW-1					
Aquifer with hydrocarbon traces	1,992.2	1,999	65.3	34.7	Values from report (cutoff >0.85 Sw)
	1,992.2	1,999	80.34	19.66	All the values from the perforated interval were considered in calculations
RST Sigma/RST CO - well SW-2					
Possible hydrocarbons	1,248.5	1,258	62.2	37.8	Values from report (with cutoff >0.85 Sw)
	1,248.5	1,251.5	71	29	All the values from the perforated interval were considered in calculations
RST CO - well SW-3					
Possible hydrocarbons	1,088	1,093.5	62	38	Values from report (with cutoff >0.85 Sw)
	1,088	1,093.5	66.5	33.5	All the values from the perforated interval were considered in calculations
	1,090	1,092.8	78.1	21.9	Average value on the interval where the obtained values were close to the SWCTT ones

the well was at the residual oil saturation due to the massive water loses during its preparation which made the well produce 100% water for a long time.

Another aspect to consider in comparing the two methods is the investigated interval. The invasion radiuses are different for the two methods. The petrophysical investigations have measured the hydrocarbon saturation on a 25 m radius, while SWCTT measures the residual oil saturation on considerably higher distances from the well, depending on the injected tracer volume. In the case of the three wells, the penetration radius was between 2.7 and 5.3 m.

If we refer to the perforated interval, the RST investigation measures an average value on its entire length, while SWCTT measures the residual oil saturation only on water's penetration path, more precisely on the path swept by water which represents, from case to case, a part, bigger or smaller, of the perforated interval.

Starting from this last aspect, the water, respectively hydrocarbon saturation values obtained from the RST investigation were analyzed, this time on smaller intervals, i.e. 15 cm, figures 6-8. Moreover, an average value of the hydrocarbon saturation was calculated considering all the values, for the entire perforated interval, because this represents the interval through which the tracer solution could have invaded the formation, without eliminating the ones exceeding 85% water saturation. The values are presented in table 9.

This reinterpretation of the RST investigations results in the reduction of the differences from the SWCTT method

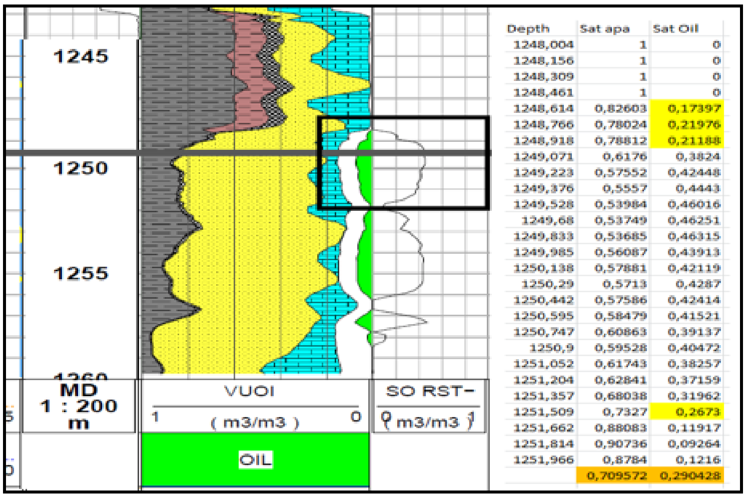


Fig. 7 Diagram for the RST investigation for well SW-2 and the values obtained on small intervals

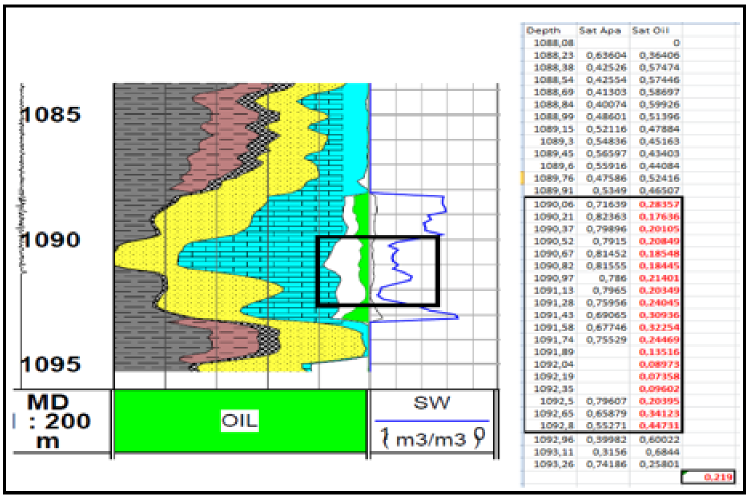


Fig. 8 Diagram for the RST investigation for well SW-3 and the values obtained on small intervals

for wells SW-2 and SW-3, practically obtaining the same value as in the case of well SW-1. A further detailed analysis of the RST investigation values is presented in figures 6-8; it can be noticed that values similar to the SWCTT method were obtained in the lower part of the perforated interval, marked in yellow in figure 6. This can be explained by the fact that fluids flow in and out of the productive layer through that zone of the perforated interval and not through the entire interval. This statement could have been further supported if a permeability profile had existed for the investigated wells, based on which a correlation between the high permeability zones and the high water saturation zones could have been made.

In the case of well SW-2, the similar values of the two methods, marked in yellow in figure 7, were obtained for the upper part of the perforated interval, fact that might suggest that the fluids flow in and out of the productive layer through that zone of the perforated interval.

Related to the third well, SW-3, one entire interval could be identified, 1,090-1,092 m (marked in red in fig. 8), with comparable saturation values obtained from both methods: 21.9% from RST and 23.6% from SWCTT.

The fact that SWCTT determines the residual oil saturation in the zone swept by a displacing agent and RST measures the oil saturation in the non-flooded zones as well, raises the problem of the recovery methods able to produce the hydrocarbon quantity corresponding to the difference between the two methods.

Conclusions

Each method evaluating the saturations in oil reservoirs has its limitations, so the simultaneous use of more methods diminishes the uncertainties related to their results. Present work analyzed the results of two methods that complete each other successfully: SWCTT and RST;

The selection of the tracers used in the three investigated wells was done in ICPT Câmpina laboratory on natural cores, aiming at determining the partition coefficients of the ethyl acetate soluble both in water and in oil, by reproducing the reservoir conditions (pressure, temperature, rock and fluids);

Thepartition coefficient of chemical tracers is a critical parameter for designing a single well chemical tracer test and has to be measured for each candidate well. Factors such as brine salinity, oil composition and temperature influence this parameter.Reservoir temperature selects the esters suited to the SWCTT. Hydrolysis reaction of formate esters is approx. 50 times faster than the acetate esters, being used at reservoir temperatures of 21 to 57°C. The slower reacting acetate esters are generally used for temperatures of 54 to 120°C.

The saturation values for the three analyzed wells, as average per perforated interval, obtained from the two methods are very different. The paper has set a valuing method for the obtained saturation pairs, aiming to provide trustful values needed for the evaluation of the potential of using certain methods of enhancing oil recovery on the reservoirs in question;

The comparative analysis of the oil saturations obtained from the two methods required the selection of the rock packages from the perforated intervals through which the tracer solution could invade the productive layer. These are, in fact, the intervals of interest, because they show which is the value of the residual oil saturation after a water flooding process. The presence of a permeability profile in the investigated wells can better identify the zones of the productive formation where the tracer solution penetrates preferentially;

The high values of the oil saturation in the non-flooded areas determined from RST measurements and the differences from the residual saturation represent a good calculation base for the quantity of recoverable oil from those reservoirs.

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