Investigation of the upper Khamiformationsin MahshahrNo.1 well and Hendijan No.6 well with use of well logging

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Abstract: Khami group with thickness more than 1500 meter, in Dezful Embayment separated from Bangestan group by Kazhdomi shale formations. Dezful Embayment is an structuralreality in the southwest of Zagros mountains range, that it contain almost of Irans oil fields. The upper Khami group make up carbonate formations Such as: Fahliyan, Gadvan and Dariyanwith Aptian- Neocomian age.The Hendijan Field is located in the north of Persian gulf and near beach. Mahshahr anticline is located in the north border of Persian gulf in the northern Dezful.Hendijan anticline is located in the east and Tango anticline in the north of Dezful zone. Informations of logs help to understand of useful parts, thickness and depth of reservoir, presence of water, oil and Gas in the formation and prediction of hydrocarbon reserves. The first, Corrections must execute on the digital datas that is published by National Iranian Oil Company, before they load in Excel software. Excel software is an applied software by user in order to calculations and finally, for estimations of parameter, that used in this study.In this study usedinformation of petrology, formation temperature and characteristics of drilling fluids, such as: the resistance of formation water and mud filtrate. Shale volume is calculated after determinationof gamma index by use of CGR log.Porosity logs such as: Neutron, Density and Sonic used for calculation of porosity by one or two logs. For calculation of water saturation, important equation of Archie for carbonate rocks, and for determination of Lithology, combination of Neutron and Density logs are used. Investigation of changes in porosity, shale volume and water saturation ofDariyan formation in two reservoir of Hendijan and Mahshahrshows, Dariyan formation in Hendijan well have better quality than Dariyan formation inMahshahr well because of less shale and water saturation. With comparison of these parameters, we can conclude that the Khalij member of Gadvan formation in Hendijan reservoir have better reservoir quality than Mahshahr reservoir due to high porosity and less shale and water saturation. Regarding to lowlow porosity ofFahliyan formation in both of reservoir and high shale volume and water saturation, there is not quality differences between Hendijan and Mahshahrreservoires.

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1. Introduction

Because there is giant oil and gas basins, Zagros is considered as one of the most important petroleum basins in the world. The absent of igneous activities, existence of excellent source rockswith rich organic matter, porous reservoir rocks with variable permeability and appropriate cap rocks provide ideal conditions for accumulation and production hydrocarbons.It is caused Zagros zoneconsidered as one of the biggest oil and gas province in the world [2]. Because Khami group is very deep in Dezful embayment, drilling and access to it,s reservoirs has several difficulties. Like drilling wide jet wells in Gachsaran formation, pass through extremely fractured Asmari and Bangestan formations specially in regions that have gaseous lime stone.Because of these problems, many drillingisn't done in Khami group of Dezful Embayment.Hence our information about each of petroleum reservoirs isn't more of several wells data[9].

Khami group with thickness over than 1500 meter separated from Bangestan reservoirs by Kazhdomi shale formation in Dezful Embayment[8]. Carbonates in Jurassic and early Cretaceous are known as Khami group in Iran. First nomination is done by Strong and Falcon that is includemassiveand thin layer limestones in high rocks of khami mountain in the northeast of Gachsaran oil field in the southwest of Iran.

Khami group is divided to five formations, contain of: Surmeh, Hith, Fahliyan, Gadvan and Dariyan. SurmehandHithbelong to late Jurassic and Fahliyan, Gadvan and Dariyanbelong to early cretaceous[21]. Yet, more of observation on Khami group, are include stratigraphy, sedimentology, sedimentary environments and microfacies studies are done by various researchers inside and outside of Iran, but, in relation tointerpretation of logging charts and quality evaluation of reservoir aren't done any

studies in these formations specially two told reservoirs.

2. Material andmethods

1-2.Studying area

Dezful Embayment is a structural reality in the southeast of Zagros thrust that it include majority of Iran oil and gas fields.Generally, Dezful Embayment belong to part of Zagros that, Asmari is without outcrop there. DezfulEmbyment is located between three important structural zones, it restricted in the north to flexure zone of Baba Rood with east – westtrend, and in the northeast limit to JebheKohestan flexure with northwest – southeast trend, and in the east – southeast limit to a complex flexure zone and southern fault with north – south strike [8].

Hendijanfield is located in the northern part of Persian gulf and near beach. This field is located in the north of Bahregansar field, in the east of Mahshahr field and the southwest of Tango and Rage Sefidfields, too, it has northern – southern trend. Distance of6-Hendijan well untilHendijan city is about 16/5 kilometers [4]. Mahshahr anticline is located in the northern border of Persian gulf in the region of northern Dezful.Hendijan anticline is located in the east and Tango anticline is located in the north – northwest of Mahshar[10]. Mahshahr anticline strick is north-northwest to south-southeast.

2.2. Studying of formations in the region

Dariyan formation: It's name get from Dariyan village situated in the south of type section. This formation had been call Orbitoline limestone, Albian – Aptian limestone and it has consider as Khamigroup, too. Type section of Dariyancarbonate formation has been measure in Gadvan mountain, exactly in the north of Dariyan village [8]. Dariyan formation exist in many areas expect south and southeast of lorestanprovince. In this area, Dariyancarbonate formation has been changed to Garoo shale facies. In the upper part of Dariyan formation in often region of Fars province, has been recorded unconformities [7]. This unconformity disappeared to middle Fars and Dezfulembayement side.This formation change to garu formation in the southwest of Lorestan. In coastal Fars and Khuzestan province, there are observation that show unconformity in the upper layers of this formation (top of Dariyan formation)[1].

Gadvan formation: The type section of this formation has been chose in the eastern of Gadvan mountain that is located in 39 kilometer east – northeast of shiraz.The lower part of this formation with Fahliyan formation is concordant and traditional [8]. Gadvan formation is located in depth of 4512-4391 meters of Mahshahr well, and contain alternation of gray – brown argillaceous – Silty limestone and dark gray shale [13]. Gadvan formation is located in depth of 3423-3545 meters of Hendijan well and it has been made of soft gray marlsand sometimes calcareous, and gray to light gray claystones[4].

Fahliyan formation: The type section of this formation located in southern sideof Dal mountain, near Fahliyan village and in 20 kilometers east – southeast of Gachsaran city in Fars region. Fahliyan formationinclude 365 meter of brown to gray massive limestone[8]. This formation is located in depth of 2012 – 4512 metersMahshahr well and it's thickness is about 500 meters[13]. Chiefly, it contain clay limestone, compact, hard andcream limestone and sometimesStylolite limestone. Generally, Fahliyan formation is considered a calcareous unit between Hith and Gadvan formations. This formation has most distribution in Fars province, but it observe in the north east of DezfulEmbyment and in Lorestanprovince, too. Fahliyan formation laterally change to shale and clay limestones of Garuformation in the central region of Lorestan and Dezful Embayment.These changes are gradual andinterfingering[8].Fahliyan formation separate fromSurmeh formation by HithAnhydrite in the border of Fars province [1].

3. Researchmethod

Carbonate reservoirs have highheterogenesis, common type of these rocksproduct 25-30 percent of oil in place by ordinary recovery methods [18]. one of methods of the reservoir evaluation is use of petrophysical features and well logging. logging charts provide essential information for quantity evaluation of Hydrocarbon, rock type and fluid characterisations inside them, too. Running logs in the well, have information that determine reservoir features, indirectly. Remarkably, information get from logs help to recognition of the reservoirs pay zones. Thickness and depth of them,determine of oil, water and gas in the formation and estimate of hydrocarbon reserves. Because petrophysical features of formation aren't directly measurable, thus, they must be concluded by other parameters of reservoir rocks such as: electrical resistance, density, sound transmit time, Radioactive and amount of Hydrogen[20]. Development of reservoir facies in sedimentary rocks result of sedimentation in continental shelf untilcontinental slope and sedimentation of Fahliyan formation in this position and change to the deep impermeablefacies toward Lorestan provide conditions for make of oil reservoirs. Therefore study of stratigraphy, sedimentology and petrophysicalevaluation of

thesereservoires is very important for recognition of region with the best reservoir quality in the Embayment of the northern Dezful. Some of this aimes has been done in this research.

Goal of this research is survey of logging charts in the 1. Mahshahr well and the 6.Hendijan well for determination of reservoir features of the formation such as: porosity, permeability, shale volume and etc.

3.1. Calculation methods of parameters and data analysis

3.1.1. resistance of formation water (R_w)

Accurate knowing of formation water resistance for determination of correct amount of saturation degree of a reservoir is necessary.There are several way for correct calculation of formation water resistance[3]:

A) calculationof(R_w) by special chart (schlumberger Gen-9)that in this chart, formation temperature is located against formation salinity and (R_w) is calculated.
B) We can determine (R_{wa}) in the clean zones and saturated of water, then consider the least quantities as (R_w).

$$FR_w / R_t = FR_{mf} / R_{xo} \Rightarrow R_{xo} / R_t = R_{mf} / R_w \quad (1)$$

$$R_w = (R_t R_{mf}) / R_{xo} \quad (2)$$

3.1.2. Calculation of formation real resistance (R_t)

Formation real resistance is related to uninvaded zone. Resistance logswith high survey depth measure this resistance. With having measured resistances in various depths of the formation contain: (R_{xo})=(resistance of flushed zone), (R_{lls})=(total resistance and of invaded and transition zone) and (R_{llD})=(total of invaded, transition and flushed zone resistance), we can get (R_t) by several ways[3]:

A)by having (R_{llD}) and (R_{lls}), we can calculate the real resistivity of the formation by the down experimental formula:

Relation (3), while it is:

$$R_{mf} < R_w \; R_t = 1.7RLLD - 0.7RLLS$$

Relation (4), while it is:

$$R_{mf} > R_w \; R_t = 2.4RLLD - 1.4RLLS$$

B)other way, is use of Tornado chart, with having (R_{llD}) and (R_{lls}) and (R_{Msfl}).

3.1.3. Calculation of porosity

Porosity is the percent of void volume ratio to total volume ($\phi = v_p / v_t$) andit may create two forms:

1. The primary or contemporary with sedimentation and
2. The secondary or after sedimentation.

The porosity is without dimension and express with percent. In order to calculation of porosity is used porosity logs like: Notron, Density, Sonic and usually the porosity is calculated by one or two log[15].

For years, The sonic log has been a ordinary tool for the porosity calculation because it hadthe less sensitivity to the changes of well walls and mud cake. But compound of Neutron and Density logs is considered as source for calculation of the porositylatterly [14]. Neutron and Density logs is used for calculation of the total porosity and sonic log for primary porosity that we can get secondary porosity of difference between those [3].

4.1.3. Shale volume

The existence of shale in Hydrocarbon reservoirs, has much effect on estimation of reserve and production ability. Shalesdo not haveconstant mineralogy but clay mineral, quartz, feldspar, carbonates, amorphous silica, pyroclastic and organic matter are major constituents. Calculation of the shale volumefrom logging data for exactestimate of porosity and saturation is necessity[3]. If influence of the shale volumedon't survey in the formation, visible influence will have on the results of water saturation, permeability and porosity of the reservoir[17], because clay minerals for having microporosityeffects onpetrophysic features (permeability, porosity, saturation). Existence of clays in reservoirs cause to decrease of electrical resistance of the rock and create unreal results in the saturation and porosity calculation. Thus, estimating of shale volume and its impacts is very essential[3].

There are several ways for calculate of shale volume [3]:

A)The ways base on logs that it's response to shale volume, primarily and were known as shale indicators.

B) The ways base on logs that shale percentage isn't first effective parameter but influences on log response in various ways.

5.1.3. Calculation of water saturation (S_w)

Generally, water saturation is the water volume in the pores in contrast with total volume of water that determine with percent and it'ssymbol is (S_w) [5]. Actually, the content of the fluid saturation in porouseenvironment is include water saturation (S_w), oil saturation (S_o) and gas saturation and the total of those in the rock equals one.

Generally, all of ways of water saturation calculation base on Archie method and labratory measurements in the years 1941-1942 established, and water saturation depend on the porosity, electrical resistance, formation resistance factor, shale volume, shales resistance and ionic balance capacity of the clay minerals in the all ways. but,sometimeswater saturation relatedtovelosity. Because, the fluid content influence seismic waves speed, extremely[16].

The Archie equation is used among told important relations for saturation water calculation. This relation is used for sandstone and carbonates that has been expressed below:

Relation (5)

$$S_w = \sqrt{\frac{FR_w}{R_t}}$$

In this relation (S_w) equals water saturation (n) is saturation coefficient and (n) equals two (n=2). (R_w) is formation water resistance and (F) is formation resistance factor and (F) obtain of below relation:

Relation (6)

$$F = \frac{a}{Q^m}$$

In this relation (a) is tortusitycoefficient and (Q) is porosity and (m) is cementation coefficient and it consider aspores figure factor recently.

Usually, (a) equals one (a=1) and (m) equals two (m=2) in carbonates, and (a) equals 0.81 (a=0.8) and (m) equals two (m=2) in consolidated sandstones and (a) equals 0.61 (a=0.61) and m equals 2.15 (m=2.15) in not consolidated sandstone, is considered[3].

6.1.3.Calculation of water total volume:

Water total volume is waters saturation (S_w),multiply porosity(Q)[5].

$$BVW = S_W \times \varphi$$

If the calculation contents (BVW) are fixed in various depths, it shows a homogenous layer and it will stand in the position of irreducible water saturation.So, present waters in univadedzone aren't able to movement because capillary force by rock particles prevent of flow. Thus Hydrocarbon production do without water in zones that are located in irreducible water saturation[19]. A formation, doesn't stand in position of irreducible water saturation, shows different content of (BVW).

The content of water that a formation can retain by capillary power, depend on particles size. With decrease of particle size,capillary power and (BVW) increase in rocks. Thus, we can use from amount of (BVW) for recognition of various porosities, as aindicator in carbonate rocks [12].

Table 1: Relation between bulk volume water and porosity types[5].

bulk volume water (BVW)	Carbonates
0/005 - 0/015	Vug
0/015 - 0/025	Vug and Intercrystallin (Intergranular)
0/025 - 0/04	Intercrystallin (Intergranular)
BVW>0/05	Chalk

Table2: Relation between bulk volume water and decrease particle size [5].

bulk volume water (BVW)	Particle size (milimeter)
0/02 - 0/025	5- 1 Coarse
0/025 - 0/035	0/25 - 0/5 medium
0/035 - 0/05	0/125 - 0/25 Fine
0/05 - 0/07	0/0625 - 0/125 Very fine
0/07 - 0/09	<0/0625 Silt

7.1.3. Determination of lithology by use of logs:

One of the important usage of logs isdetermine of lithology.Lithology features, that influence on logs, are mineralogy, texture, structure, shale bulk, fluids content[3].For determine of lithology, the best spot is place, that have the least shale bulk and porosity and is saturated of water.It cause Hydrocarbon affect on logs response get minimum [11].

We can use of two or three logs for determine of lithology.

8.1.3. Velocity – Deviation log

Velocity – Deviation log generatefrom combination of sonic with Neutron or density logs. This log is mapped as velocity- Deviation log by conversion porosity chart datas to artificial velocity.

There are two ways for calculation of velocity – deviation log:
1) VDL calculation by usage of Sonic and Notron log.
2) VDL calculation by usage of Sonic and density log.
Generally, we can record type of porosity by deviations this log to left (negative extent) or right (positive extent).

4. Discussion and cinclusion

Comparison ofDariyan formation in two field of Mahshahr 1 and Hendijan6:

By study of changes amplitude[6] in Dariyan formation in two reservoirs, we can consider 10% porosity as weak porosity in Dariyan formation.Other aspect is shale bulk that respectively, shale content is 12% and 23% is Hendijan and Mahshahr in Dariyan formation, thus the content of shale bulk in Dariyan formation of Hendijan is lesser than Dariyan formation of Mahshahr. Content of saturation is 59% and 72% in two reservoir of Hendijan and Mahshahr, respectively, that it shows less water saturation content of Dariyan formation in Hendijan reservoir.Thuse with compare this of 3 parameters, can considerDariyan formation in Hendijan well have more quality than Dariyan formation in Mahshahr well.

Comparison ofGadvan formation (Khalij member) in Mahshahr 1 and Hendijan 6 reservoir:

By study of changes amplitude [6] in Gadvan formations in Mahshahr andHendijan reservoirs that they respectively have 12% and 26% porosity, based on reservoir quality, porosity in Mahshahr well is medium and Hendijan well is good. Respectively, the content of shale in Hendijan and Mahshahr reservoirs is 3% and 13% that it is a low shale average. Water saturation is 60% and 40% in Mahshahr and Hendijan reservoirs, respectively. Thus with compare of 3 parameteres, can conclude that Khalij member of Gadvan formation in Hendijan reservoir has more quality than Mahshahr reservoirs.

Comparison ofFahliyan formation in Mahshahr 1 and Hendijan 6 reservoirs:

By study of changes amplitude[6] in Fahliyan formation in Mahshahr and Hendijan reservoirs, that they respectively, have 7% and 6% porosity and it consider a weak porosity. respectively, shale average is 11% and 18% in Mahshahr and Hendijan reservoirs. Thus shale average is low in both reservoirs.Thus with comparison of these parameters conclude quality is equal at two reservoirs.

EValuation of logs of Dariyan, Gadvan and Fahliyan formation provide many information about porosity and shale volume.

By done studies on formations in Mahshahr and Hendijan reservoirs, each of formations separated to zones:
1. Respectively, Dariyan, Gadvan and Fahliyan formation have been separated to 9,10,15 zones in Hendijan reservoir.
2. Respectively, Dariyan, Gadvan and Fahliyan formation have been separated to 12,7,13 zones in Mahshahr reservoir.

- Analysis of well logging data shows porosity is weak in Dariyan and Fahliyan formation and shale content is low.
- Becausesonic chart just measure background porosity and Neutron and density charts calculate total porosity of rock, sonic chart hasn't been considered in calculations.
- Khalij member of Gadvan formation in Hendijan reservoir with porosity content equals 26% and saturation equals 41% and shale volume equals 3% has more reservoir quality than the Khalij member of Gadvan formation in Mahshahr reservoirs with porosity average equals 12% and water saturation equals 60% and shale volume equals 13%.

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References

1. Khosro Tehrani, Kh, (1360), Facies sedimentary in tin section, Tehran university publication, page 195.
2. Darvishzadeh, A, (1370), Geology of Iran, Neda publication.
3. Rezaee, Mohammad, R and Chehrazi, Ali, (1385). Well logging interpretation and deduction elements, page 699. Tehran university publication.
4. Shah Hoseini, Kourosh, (1386). Oil engineering complementary report of Hendijan well.
5. Seyrafian, Ali, (1372). Basic well log analysis for Geologists, page 212. Esfahan university publication.

6. Tabatabaei, Javad, (1384). Petroleum engineering, page 324 – negaresheolum publication.
7. Ghalavand, Hormoz, Lithostratigraphy and Biostratigraphy in the formation Dariyan and Kazhdomi, Shahid Beheshti university, page 290.
8. Motiee, Homayoon, (1372). Geology of Iran, Zagros stratigraphy, Geological survey of Iran.
9. Motiee,Homayoon, (1374). Zagros oil geology, Geological survey of Iran.
10. Maleki, Asadolah and Niktabie, Mohammad, R(1381). The exploratory well complementary report of Mahshahr.
11. -Asquith, G.B. and case, C.R., (1983), CNT-A dolomite response, Trans. spwla 24th Annual logging symposium, papers.
12. -Asquith, G. And D. krypowski, (2004), basic well log analysis: AAPG methods in Explorations series, no.16.244p.
13. Bahrami, H., (2001). Biostratigraphy and Micropaleontological studies on the cutting samples of Mahshahr No.1.
14-Dewan, J,T., (1983), Essentials of modern open – Hole log interpretation, penn well publishing company, Tulsa.
15. Kharkwal. G et al., (2012), Taxonomic Diversity of Understorey Vegetation in Kumaun Himalayan orests, life science journal. 9(2)
16. Hearts, J,R., Nelson, P,H., Andpaillet, F,L., (2000), well logging for physical properties, John wiley & sons, ltd, chilchester.
17. Kamel, M.H., Mabrrouk, W.M., 2002, Anequation for estimation water saturation in clean formation untilizing resistivity and sonic log:theory and application, Journal of petroleum science and engineering, V.36,pp.159-168.
18. Lucia, F.J. (1999): carbonate reservoir characterization, springer –rerlog Berlin, Heindberg, Germany, 226p.
19. -Lashin, A., Linder (Freiberg), (2002), H., Abu Ashor, N., sharf E1 Dien, M., Zahra, h., Hydrocarbon potentialities and sourse rock recognition in the area north of octobr field – Gulf of suez –Gulf of suez – Egept. 2,3 p.
20.-Morris, R.L., and Biggs, w.p., (1967), using log – derived values of water saturation and porosity: spwla, 8th annual logging symposium transactions, paper 0.
21-Schlumberger, (1989), Schlumberger log interpretation charts, Houston, texas.
22- Setudehnia,A, (1972), Lexiquesteratigraphy International ASIE v. Fascicule 96.2 Iran du sud quest.

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