BIT DULLNESS EVALUATION FOR THREE DRILLED WELLS IN ZUBAIR FIELD BY USING DIMENSIONLESS PARAMETERS

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Abstract

The present paper deals with using a useful method to monitor the wear of the teeth of milled tooth bits during drilling. This approach is done by using two dimensionless parameters T_D (dimensionless torque) and R_D (dimensionless rate of penetration) . By plotting T_D vs. R_D , The constants a_1 and a_2 could be determined and both used to calculate the two other dimensionless parameters E_D (bit efficiency) and F_D (bit dullness) as a bit dullness evaluation indicators , which could be used rather than other traditional techniques. This approach applied on three wells , Zubair #166 , Zubair #162 and Zubair #174 in Zubair field Southern Iraq .The obtained results could be useful to detect bit wear and according to that, the decision of pulling and using new bits could be determined easily and therefore drilling operations will be actively done with lowest costs and efforts.

Keywords: Bit wear , Bit dullness , tooth wear , bit efficiency , bit flatness .

استخدام المعاملات عديمة الوحدات لتقييم استهلاك الحافرة لثلاثة ابار محفورة في حقل الزبير

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الخلاصة:

البحث المقّدم يتعامل مع استعمال طريقة مفيدة لمراقبة استهلاك أسنان الحافرات أثناء الحفر . هذه الطريقة تتم بواسطة استخدام حّدين عديمي الوحدات هما T_D (العزم المدور) و R_D (معدل الاختراق) و بواسطة رسمهما مع بعض ، يتم تحديد قيم الثابتين a_1 و a_2 و اللذان كلاهما يستخدمان لحساب الحدّين عديمي الوحدات الآخرين و هما E_D (كفاءة الحافرة) و F_D (مدى استهلاك الحافرة) كمؤشرين لتقييم استهلاكية الحافرة أكثر من الطرق التقليدية الأخرى. هذه الطريقة طُبقّت لثلاث آبار : زبير رقم ١٦٦ و زبير رقم ١٦٢ و زبير رقم ١٧٤ في حقل الزبير جنوبي العراق. النتائج المُستحصلة يمكن أن تكون مفيدة لاكتشاف استهلاكية الحافرة و وفقاً لذلك فأن قرار سحب و استعمال حافرات جديدة يمكن تحديدهُ بسهولة و بذلك فأن عمليات الحفر يمكن أن تتم بفعالية و بأقل تكاليف و جهد.

Nomenclature :

a_1: Empirically constant represent the intercept of the cross plot of T_D vs. square root of R_D .
a_2: Empirically constant represent the slope of the cross plot of T_D vs. square root of R_D.
d : Bit diameter (in.).
E_D : Bit drilling efficiency (dimensionless).
F_D : Dimensionless tooth flat (dimensionless).
M : Measured torque (lb.in).
N : Speed rotation of the bit (rpm).
R : Rate of penetration (ft/hr).
R_D : Dimensionless rate of penetration .
T_D : Dimensionless torque.
W : Weight on bit (1000 lb.)
W_D : Dimensionless weight on bit.

Introduction :

A new method is proposed to estimate the degree of tooth wear of drill bit by comparing its actual drilling performance , measured in real time , with the theoretical performance calculated from the properties of the bit by a knowledge of the operating conditions and the strength of the rock being penetrated. To do this, it will be necessary to make measurements of the properties of the rock as , or shortly after , it has been penetrated. Instruments are currently available to make these measurements, but sufficient data to test the method were not available , so an alternative simulation techniques have been used to demonstrate the method in principle **(Cooper 2002).** Another method is provided for determining the state of wear of multicone drill bit. Vibrations generated by the working drill bit are detected and converted into a time oscillatory signal from which a frequency spectrum is derived. The periodicity of the frequency spectrum is extracted . The rate of rotation of at least one cone is determined from the periodicity and the state of wear of drill bit is derived from the rate of cone rotation (**Jardine and Stuart 1990**). One key factor in minimizing drilling costs is understanding rock-bit behavior, particularly the bit-tooth wear at the bottom . It had been described a method that gives information about bit –tooth wear during drilling. The basic concept requires the torque equation which is a function of weight of bit. The equation is determined from measurement while drilling (MWD) data. In today's harsh economic environment field applications of the method should lead to more-accurate decisions about when to pull out bits and thus should reduce drilling costs(**Fay 1993**).A method for measuring the wear of milled tooth bits during oil well drilling uses surface and subsurface wellsite sensors to determine averaged values of penetration rate , rotation speed and MWD (measurements while drilling) values of torque and weight on bit to obtain a real time measurement of tooth wear , drilling efficiency and the in situ shear strength of the rock being used **(Warren 1984)** and (**Burgess and Lesso 1985**).
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Theoretical background:

A driller always wishes to know the state of wear of his drill bit , but without having to remove it from the hole. Observing a decrease in the rate of penetration of the bit is , however , not sufficient evidence unless the strength of the rock being penetrated is also known. In general ,a driller noting a decrease in the rate of penetration of the bit but he is unable to say whether it is because the bit teeth are worn, the bit is choked by an accumulation of sticky cuttings(bit balling) or whether the bit is still in good condition and simply penetrating a more resistant. There are many efforts to distinguish between these conditions .

Milled tooth drilling bit

One of the practical efforts made by **(Burgess and Lesso 1985)** and **(Fay 1993)**. After measuring the weight on bit (W) , the torque required to rotate the bit (T) , the speed of rotation of the bit (N) and rate of penetration (R)(all these data calculated by MWD (measurement while drilling)).
The dimensionless torque T_D calculated from equation (1).

$$T_D = M \ / W \ . d \qquad (1)$$

Where , M: is the measured torque (lb.in) or (lb.ft) , W: is the weight on bit (tons) or (kgms) or (lbs)and d is the bit diameter (in.). Using appropriate dimensions to produce a dimensionless rate of penetration R_D from the following equation :

$$R_D = R / N .d \qquad (2)$$

where, R: is the rate of penetration (ft/hr) or (m/hr) , N: is the rate of rotation of the drill bit (rph) and d: is the diameter of the bit (in.) . Using appropriate dimensions to produce a dimensionless R_D . The values of a_1 and a_2 for a sharp drill bit determined empirically by plotting T_D vs. Square root of R_D from data collected for a sharp drill bit , with a_1 being the intercept of the T_D axis and a_2 being the slope of the time through the plotted points and determining bit efficiency from the equation following

$$E_D = (T_D - a_2 .\sqrt{R_D}) / a_1 \qquad (3)$$

Where , E_D: bit drilling efficiency (dimensionless). And according to E_D , pulling the bit when the bit efficiency drops to a preselected value. Calculating the dimensionless tooth flat or bit flatness F_D by computing the dimensionless weight on bit W_D from the following equation :

$$W_D = R_D / (4 . a_1 . E_D) \qquad (4)$$

Where, W_D :dimensionless weight on bit (dimensionless unit) and computing F_D from the following equation :

$$F_D = W_D \,.\, (1 - E_D) \qquad (5)$$

Where , F_D : dimensionless tooth flat . (dimensionless)

Results and discussion:

The presented research concentrated on three wells in Zubair field: Zubair #174 , l Zubair #162 and l Zubair #166. All tables and graphs used shown in the end of the research. All data required to compute the dimensionless parameters needs to be modify to homogeneous units in order to be ready to use in calculations. Bit record data while drilling was given in **Tables 1 , 4** and 7 for wells Zubair #174 , #162 and #166 respectively. Data needed for dimensionless parameters calculations are rate of penetration (R) , measured torque (M) , weight on bit (W) , Rotary speed (N) and bit diameter (d). Modified data using conversion factors were tabulated in **Tables 2 , 5 and 8** through columns(3-7).Dimensionless torque (T_D) had been computed by using equation (1) , while dimensionless rate of penetration (R_D) calculated from equation (2). Both T_D and R_D were tabulated in **Tables 2 , 5 and 8** through columns 8,9. The values of a_1 and a_2 were calculated by cross plotting T_D versus square root of R_D , while square root values of R_D were tabulated in **Tables 2 , 5** and 8 in column 10. **Figure(1)** represent the above plot for well Zubair #174 with intercept a_1= 29.508 and slope a_2= 0.1151 according to Excel fitness program. The same plot was done for well Zubair #162 as shown in **Figure (5)** with a_1= 41.253 and a_2= 0.0266 as well as for well Zubair #166 ,where a_1= 45.369 and a_2= 0.0247 which is shown in **Figure (9)**. Bit efficiency (E_D) was calculated by using equation (3), then calculating dimensionless weight on bit (W_D) from equation (4) and finally computing bit flatness F_D by using equation (5). Results of E_D , W_D and F_D were tabulated in **Tables 3 , 6 and 9** for wells Zubair #174 , #162 and #166 respectively. Generally we expect that a_1 has a greater value for soft formation bits than for hard formation bits , because of the longer teeth and the gouging action , while a_2 is generally greater for hard formation bits than for soft formation bits , because hard formation bits drill by a rolling action that crushes and grinds the rock. According to the theory of **Burgess and Lesso** E_D is a positive value less than 1. E_D is equal to 1 for a sharp new bit. As wear occurs , E_D decreases towards zero. E_D also decreases when the rock formation becomes harder. E_D value could be increased by increasing the weight on bit.

Zubair well#174:

The computed data of bit efficiency (E_D) and bit flatness F_D displayed in **Figures (2),(3)**and**(4)** for well Zubair #174 , where an important drop of E_D from (0.710744) at depth 1759m to (0.660564) at depth 1777m was recognized .Corresponding to bit record data from **Table (1)** at depth 1759m , it was noticed that bit bearing dullness reaches 7 out of 8 , which means that bearing of the bit is nearly dulled and due to that the bit must be pulled and replaced by a new one. Meanwhile at depth 1777m tooth dullness equals to 1 out of 8 and bearing wear is 2 out of 8 (**Table 1**) which means using a new bit . The same thing is also shown at depth 3084m , where E_D drops from (1.135093) to (0.926803) at depth 3093m . From **Table (1)** at depth 3084m tooth dullness is equals to 5 out of 8 and bearing dullness is 3 out of 8 and due to that a decision made to pull the dulled bit at depth 3084m , where at depth 3093m tooth bearing is equals to 1 and bearing dullness is equals to zero which means using a new bit at that depth. When the values of E_D proceeds 1 this can be interpreted as places in which stabilizers between the (MWD) tools and the bit are rubbing the formation. When these stabilizers lose a significant amount of torque the result is high E_D values and low F_D values . The interpretation of F_D is so similar to E_D , where bit flatness (F_D) for a new bit is close to zero and when F_D increases significantly above zero this means that the bit is nearly worn and needs to be replaced. From **Table (3)** and **Figure (4)** for well Zubair #174 , the value of F_D equals to (0.004526) at depth 1759m and significant increase to (0.10494) at depth 1777m , which means bit is nearly worn at depth

1759m and replaced by a new one at depth 1777m. Also at depth 3084m F_D equals to (-0.00224) and increases significantly to (0.000597) at depth 3093m.

Zubair well#162:

Values of E_D and F_D plotted versus depth for well Zubair #162 was shown in **Figure(6) , (7)** and **(8).** From **Table (6)** it had been recognized that at depth 660m E_D equals to (0.870655) which drops to (0.870645) at depth 947m . Beside that at the same depth above i.e.660m F_D equals to (0.001951) and increases significantly to (0.003404) at depth 947m . All that mean using a new bit at depth 947m bit .Table (4) emphasized the replacing of a new bit by the data tabulated under dullness condition columns. Also at depth 2074m, E_D = (1.792553) and drops to (1.075509) at depth 2440m , while , F_D = (-0.00724) at depth 2074m and then increased to (-0.00192) at depth 2440m and that mean using a new bit between depth (2074m-2440m). This procedure is illustrated well in **Table (4)** where, bit tooth dullness = 4 out of 8 beside bit bearing wear = 4 out of 8 , which means as shown before that the bit had been replaced at depth 2440m where both bit bearing dullness and tooth dullness equals to 2 out of 8 , which means using a new bit.

Zubair well#166:

Again E_D and F_D sketched versus depth for well Zubair #166 in **Figures (10) , (11)** and **(12)** .Also by getting the benefit of **Table (7)** , it was noticed that at depth 1407m E_D equals to (0.961305) and significantly drops to (0.678565) at depth 1887m. Also F_D at depth 1407m equals to (0.001057) and then increases to (0.0079) at depth 1887m. And hence this means that it is necessary to use a new bit between the above mentioned depths. Now between depths 2070m and 2281m the values of E_D equals to (1.466934) and (1.179081) respectively , which illustrates significant drop in E_D value , while at the same depths above , F_D equals to (-0.0048) and (-0.00406) respectively, and that means increasing in F_D value. Both E_D and F_D values gave an indication that at depth 2070m the bit is worn and need to be replaced .This is also illustrated clearly in **Table (7)** , where under dullness condition at depth 2070m the tooth dullness equals to 6 out of 8 and bearing dullness equals to 6 out of 8 which means that the bit is completely worn and must be changed , while at depth 2281m tooth and bearing dullness is much lower than before which means that the bit is replaced by a new one.

Conclusions :

1- Detecting bit wear (bit efficiency E_D) and (bit flatness F_D) would be a significant advantage to obtain information regarding tooth wear and cone or tooth failure. With such information, drill bit could be used to the full extent of its useful life and so to maximize the drilling operation and decreasing drilling costs.

2- Using this approach is so useful to lead to more accurate decisions about when to pull out bits and using new ones depending upon the value of E_D and F_D rather than using old techniques, and thus should reduce drilling costs.

3- The sketches of E_D and F_D versus depth give a reliable indication of tooth wear and could become possible to accurately predict bit wear in real time from measurements while drilling.

References:

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Table (1) Bit record of well Zubair#174

COUNTRY : IRAQ	FIELD :-ZUBAIR	STATE: BASRAH	SECTION:	TOWNSHIP:	RANGE :	LOCATION: H0 4J - 28 9
CONTRACTOR : I.D.C.O		RIG: OILWELL E-2000 No 9	OPERATOR : SOC	TOOLPUSHER : ABDALRAHMAN		

NO	SIZE	MAKE	TYPE	JET	SERIAL	DEPTH OUT (M)	M	HRS	Rop M/HR	Meas. Torque lb.in	WT . 1000 TON	N RPM	PUMP PRES. PSI	L/M	SPM		MUD			DULL COND.			
															1	2	WT GM /CC	V SEC.	WL CC	T	B	G	OTHER
1.	26	Smith	DSJC	3*20	MJ9816	511	511	84.5	6.0473	21721.84	15-18	95	1000	3500	60	60	1.04	55	20	4	4	1	-
2.	171/2	SMF.	TS2	WITH OUT	4628	755	244	58	4.2069	6235.934	5-10	60	800	2442	55	55	1.06	48	-	2	4	1	-
3.	171/2	SEC.	S84F	3*18	489884	1318	563	154	3.6558	18707.8	18	75	2100	2500	75	75	1.06 - 1.12	50	8	3	3	1	-
4.	171/2	SEC.	S84F	3*18	489407	1585	267	89.5	2.9832	17668.48	17	75	2250	2475	75	75	1.12 - 1.13	47	8	2	6	2	-
5.	171/2	SEC	S84F	3*18	489415	1759	174	71	2.4507	13580.48	10-18	70	1980	2000	60	60	1.11 - 1.13	47	8	2	7	1	-
6.	171/2	Hug.	R1	3*18	850 KK	1777	18	4	4.5	17460.61	18	70	1980	2000	60	60	1.15 - 1.16	50	8	1	2	-	-
7.	121/4	Hug.	JD4	3*14	BM793	2040	263	47	5.5957	19954.99	18	80	2100	1730	60	55	1.16	48	6	5	5	1	-
8.	121/4	SEC.	M44NG	3*14	512080	2207	167	99	1.6869	21202.17	18	85	2500	1900	60	55	1.16	48	6	4	7	2	-
9.	121/4	SEC.	S86F	3*14	523081	2521	314	120	2.6167	21202.17	18	85	2700	1980	60	60	1.16	48	6	1	4	2	-
10	121/4	SEC.	S86F	3*13	511418	3084	97	60.5	1.6033	21202.17	18	85	2400	1810	55	55	1.17	48	5.8	5	3	1	
11	121/4	SEC.	S86F	WITH OUT	508991	3093	9	9	1	12471.87	15	60	1100	1500	45	45	1.17	48	5.8	1	-	-	
12	8 ½	Smith	F3	2*12+ 1*13	MJ8362	3226	133	61	2.1803	13511.19	15	65	2100	1350	40	60	1.18	47	4	5	6	1	
13	8 ½	Smith	F3	2*12+ 1*13	MJ8366	3345	119	56.5	2.1803	13511.19	15	65	2250	1375	45	55	1.19	47	4	5	6	1	

Table (2) Converted data required to equations calculations for well Zubair#174.

Depth (m)	Bit diameter (in.)	Weight on bit (1000lb)	Rate of penetration (ft/hr)	Measured Torque (lb.in)	Measured Torque (lb.ft)	Rate of penetration (in./min.)	Dimensional Rate of penetration (R_D)	Dimensional Torque (T_D)	Square root dimensional Rate of penetration (R_D)
511	26	36.37628	19.84035	21721.84	1810.153	3.968069	1.607E-03	23	0.040081
755	17.5	16.53467	13.80215	6235.934	519.6611	2.760431	2.629E-03	21 5/9	0.051274
1318	17.5	39.68321	11.99424	18707.8	1558.983	2.398848	1.828E-03	27	0.042752
1585	17.5	37.47859	9.787534	17668.48	1472.373	1.957507	1.491E-03	27	0.038619
1759	17.5	30.86472	8.040368	13580.48	1131.706	1.608074	1.313E-03	25 1/7	0.036231
1777	17.5	39.68321	14.76378	17460.61	1455.051	2.952756	2.410E-03	25 1/7	0.049096
2040	12.25	39.68321	18.35874	19954.99	1662.916	3.671749	3.747E-03	41	0.06121
2207	12.25	39.68321	5.534346	21202.17	1766.848	1.106869	1.063E-03	43 3/5	0.032604
2521	12.25	39.68321	8.584865	21202.17	1766.848	1.716973	1.649E-03	43 3/5	0.040607
3084	12.25	39.68321	5.26019	21202.17	1766.848	1.052038	1.010E-03	43 3/5	0.031786
3093	12.25	33.06935	3.28084	12471.87	1039.322	0.656168	8.927E-04	30 4/5	0.029879
3226	8 1/2	33.06935	7.153307	13511.19	1125.932	1.430661	2.589E-03	48	0.050886
3345	8 1/2	33.06935	6.910088	13511.19	1125.932	1.382018	2.501E-03	48	0.050014

Table (3) Calculated dimensionless Bit efficiency (E_D) and dimensionless bit flat (F_D) for well Zubair#174

Depth (m)	Bit efficiency (E_D)	Dimensional Weight on bit (W_D)	Dimensional bit flat (F_D)
511	0.62199	0.021883	0.008272
755	0.530345	0.041998	0.019725
1318	0.746173	0.020752	0.005267
1585	0.762292	0.016576	0.00394
1759	0.710744	0.015648	0.004526
1777	0.660564	0.030916	0.010494
2040	1.152375	0.027546	-0.0042
2207	1.350903	0.006667	-0.00234
2521	1.319685	0.010586	-0.00338
3084	1.354093	0.006322	-0.00224
3093	0.926803	0.008161	0.000597
3226	1.430466	0.015337	-0.0066
3345	1.43387	0.01478	-0.00641

Table (4) Bit record of well Zubair#162

COUNTRY : IRAQ	FIELD :ZUBAIR	STATE:BASRAH	SECTION:	RANGE :	LOCATION:S-19
CONTRACTOR : ID.CO		RIG NO.:QW 23	OPERATOR : SOC		
SPUD	UNDER SURF :	UNDER INTER:	SET SAND.ST	REACHEL	PUMP POWER
DRILL PIPE 5	TOOL JOINT	SIZE :63/8 TYPE:E O.D:5	DRILL COLLARS		

NO	SIZE	MAKE	TYPE	JET 32 NO. IN	SERIAL	DEPTH OUT	M	HOURS	ROP M/HR	MEAS. TORQUE Lb.in	WT. 1000 kg	N RPM	PUMP PRESS	L/M	SPM		MUD			DULL COND.			
															1	2	WT		WL	T	B	G	OTHER
14.	26	SMF	TS25	3*20	138K62	38	38	6	6.33	13857.63	10	100	40	2200	60	60	1.05	6		2	2		
15.	17 ½		R1	3*20	003LK	660	622	107.5	5.78	13857.63	10	100	40	2200	60	60	1.05	113.5	-	2	2		
16.	12 1/4		X3A	-	010CK	947	287	77.5	4.94	17460.61	18	70	25	1950	60	50	1.06	171.5	-	2	4		
17.	12 1/4	TSK	3MSS	3*14	20918	1440	493	20	6.36	18707.8	18	75	90	=	110		1.13	249	8	4	3		
18.	12 1/4	SEC	M44NG	=	506704	1530	90	87	4.5	18707.8	18	75	90	=	110		1.14	269	8	2	3		
19.	12 1/4		X3A	=	778AK	1721	191	83	2.19	22449.36	18	90	90	=	110		1.12	356	-	3	4		
20.	12 1/4		JD4	=	DR150	1925	204	42.5	2.45	22449.36	18	90	100	2000	110		1.13	439	8	3	4		
21.	8 ½	SEC	J4	3*13	CD801	2074	147	42.5	3.5	20786.45	15	100	130	1500	90		1.15	481.5	10	4	4		
22.	=		S84F	2*12 1*11	515243	2440	366	104	3.5	12471.87	15	60	130	1560	92		1.15	585.5	6	2	2		
23.	5 7/8		J33	-	BX940	USE	TO	CHECK	F.C	13857.63	7"	CSG						FOR					

Table (5) Converted data required to equations calculations for well Zubair#162.

Depth (m)	Bit diameter (in.)	Weight on bit (1000lb)	Rate of penetration (ft/hr)	Measured Torque (lb.in)	Measured Torque (lb.ft)	Rate of penetration (in./min.)	Dimensional Rate of penetration (R_D)	Dimensional Torque (T_D)	Square root dimensional Rate of penetration (R_D)
38	26	22.04623	20.76772	13857.63	1154.803	4.153543	0.001598	24.17582	0.039969
660	17 ½	22.04623	18.96326	13857.63	1154.803	3.792651	0.002167	35.91837	0.046554
947	12 1/4	39.68321	16.20735	17460.61	1455.051	3.24147	0.00378	35.91837	0.061483
1440	12 1/4	39.68321	20.86614	18707.8	1558.983	4.173228	0.004542	38.48397	0.067397
1530	12 1/4	39.68321	14.76378	18707.8	1558.983	2.952756	0.003214	38.48397	0.056691
1721	12 1/4	39.68321	7.18504	22449.36	1870.78	1.437008	0.001303	46.18076	0.036103
1925	12 1/4	39.68321	8.038058	22449.36	1870.78	1.607612	0.001458	46.18076	0.038186
2074	8 ½	33.06935	11.48294	20786.45	1732.204	2.296588	0.002702	73.94958	0.051979
2440	8 ½	33.06935	11.48294	12471.87	1039.322	2.296588	0.004503	44.36975	0.067105

Table (6) Calculated dimensionless Bit efficiency (E_D) and dimensionless bit flat (F_D) for well Zubair#162

Depth (m)	Bit efficiency (E_D)	Dimensional Weight on bit (W_D)	Dimensional bit flat (F_D)
38	0.586012	0.016520502	0.006839
660	0.870655	0.015084928	0.001951
947	0.870645	0.026311831	0.003404
1440	0.932833	0.029509051	0.001982
1530	0.93284	0.020878891	0.001402
1721	1.119429	0.007056162	-0.00084
1925	1.119427	0.007893889	-0.00094
2074	1.792553	0.009134328	-0.00724
2440	1.075509	0.025373679	-0.00192

Table (7) Bit record of well Zubair#166

COUNTRY : IRAQ	FIELD : NORTH-ZUBAIR	STATE: BASRAH	SECTION:	TOWNSHIP:	RANGE :	LOCAT ION: K-29
CONTRACTOR : I.D.C.O		RIG : EM -25	OPERATOR : SOC	TOOLPUSHER : ABDAL RAHMAN		
SPUD	UNDER SURF :	UNDER INTER:	SET SAND.ST	REACHEL TD	PUMP NO.1 LINER : 6 ½''	PUMP NO.2 LINER : 6 ½''	PUMP POWER
DRILL PIPE	TOOL JOINT	SIZE : 5 / 3 ½ — TYPE : 4 ½ IF / 3 ½ IF — O.D 6 3/8'' / 4 ¾''	DRILL COLLARS	NUMBER: 20, 20, 24, 24 — O.D.: 8'', 8'', 6 ¾'', 4¾'' — I.D.: 3'', 3'', 213/16'', 2 ¼'' — LENGTH: 177.16, 177.16, 221.58, 224.95		

NO	SIZE	MAKE	TYPE	JET	SERIAL	DEPTH OUT	M	HRS	ROP M/HR	MEA. TORQUE Lb.in	WT. 1000 TON	N RP M	PUMP PRES. KG/CM²	L/M	SPM 1	SPM 2	MUD WT	MUD V	MUD WL	DULL COND. T	B	G	OTHER
24.	17 ½''	HUS	R1	3*20	842KK	706	670	43.5	15.4	13857.63	10	100	60	2400	80	80	1.06	53	16	4	4	-	-
25.	12 ¼''	TSK	3MSS	-	22170TK	919	213	46.5	4.58	6790.239	7	70	85	1950	60	70	1.08	45	10	4	4	-	-
26.	12 ¼''	HUS	XIG	1*16+ 2*15	198FF	1407	488	64.5	7.56	17668.48	15	85	90	2135	70	70	1.13	51	7	6	6	-	-
27.	12 ¼''	SEC	S86F	3*15	506308	1887	480	141.5	3.39	9561.765	10-12	60	60	1296	85	-	1.13	47	5	6	4	-	-
28.	121/4	TSK	3MSS	3*14	21046TK	1920	33	11.45	2.88	13095.46	12-15	70	90	1350	45	45	1.14	47	5	4	4	-	-
29.	8 ½''	HUS	J 4	3*14	AM511	2070	150	47	3.19	18707.8	15	90	95	1520	50	50	1.17	48	4	6	6	-	-
30.	8 ½''	HUS	J 4	3*14	AM563	2220	150	38	3.94	18707.8	15	90	100	1525	50	50	1.18	47	3	2	4	-	-
31.	57/8''	SEC	M88F	1*11+ 1*14+ 1*16	546259	2281	61	28	2.17	4157.289	6	50	90	640	42	-	1.17	47	4	3	5	-	-
32.	57/8''	SEC	M88F	2*16 1*20	673780	2332	51	18.5	2.75	4157.289	6	50	100	762	50	-	1.17	48	3	2	2	-	-

Table (8) Converted data required to equations calculations for well Zubair#166.

Depth (m)	Bit diameter (in.)	Weight on bit (1000lb)	Rate of penetration (ft/hr)	Measured Torque (lb.in)	Measured Torque (lb.ft)	Rate of penetration (in./min.)	Dimensional Rate of penetration (R_D)	Dimensional Torque (T_D)	Square root dimensional Rate of penetration (R_D)
706	17 ½"	22.04623	50.52494	13857.63	1154.803	10.10499	0.005774	35.91837	0.075989
919	12 ¼"	15.43236	15.02625	6790.239	565.8532	3.005249	0.003505	35.91837	0.0592
1407	12 ¼"	33.06935	24.80315	17668.48	1472.373	4.96063	0.004764	43.61516	0.069023
1887	12 ¼"	25.35316	11.12205	9561.765	796.8137	2.22441	0.003026	30.78717	0.055013
1920	121/4	29.76241	9.448819	13095.46	1091.288	1.889764	0.002204	35.91837	0.046945
2070	8 ½"	33.06935	10.46588	18707.8	1558.983	2.093176	0.002736	66.55462	0.052308
2220	8 ½"	33.06935	12.92651	18707.8	1558.983	2.585302	0.003379	66.55462	0.058133
2281	57/8"	13.22774	7.119423	4157.289	346.4408	1.423885	0.004847	53.49544	0.069622
2332	57/8"	13.22774	9.02231	4157.289	346.4408	1.804462	0.006143	53.49544	0.078376

Table (9) Calculated dimensionless Bit efficiency (E_D) and dimensionless bit flat (F_D) well Zubair#166

Depth (m)	Bit efficiency (E_D)	Dimensional Weight on bit (W_D)	Dimensional bit flat (F_D)
706	0.791653	0.040192	0.008374
919	0.791662	0.024394	0.005082
1407	0.961305	0.027309	0.001057
1887	0.678565	0.024576	0.0079
1920	0.791668	0.015339	0.003196
2070	1.466934	0.010278	-0.0048
2220	1.466931	0.012695	-0.00593
2281	1.179081	0.022653	-0.00406
2332	1.179076	0.028708	-0.00514

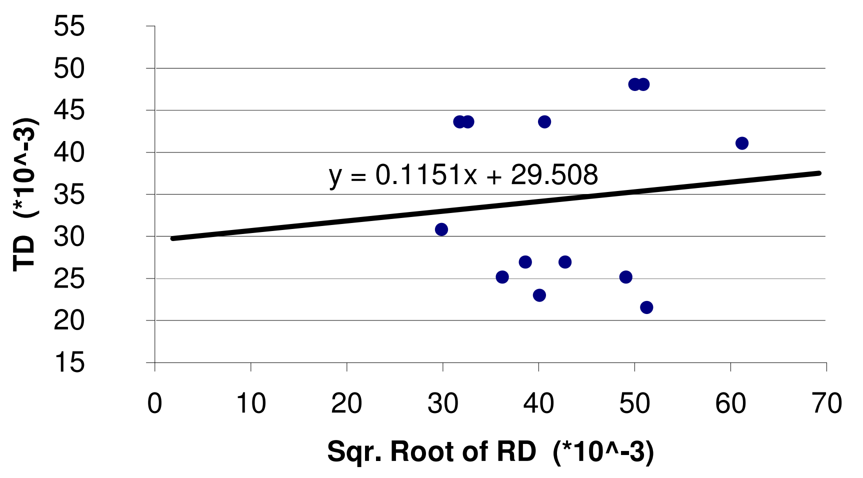

Fig.(1) Cross plot of TD Vs. Sqr. Root of (RD) for well Zubair

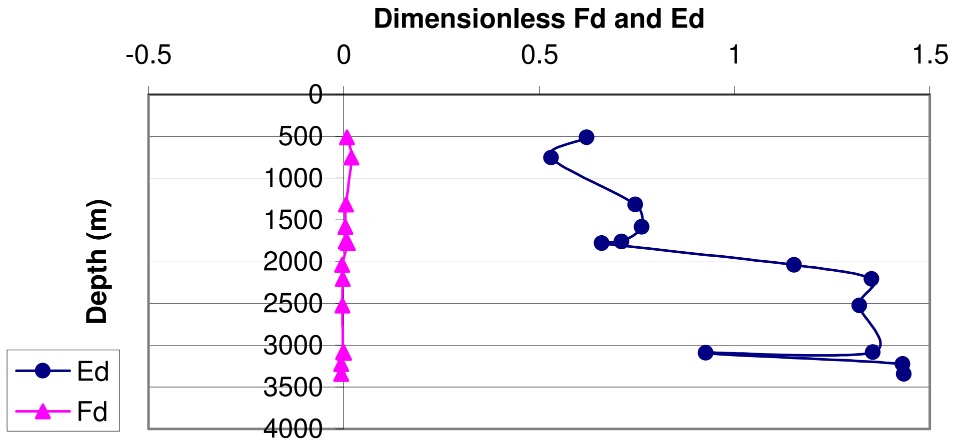

Fig.(2) Cross plot of bit efficiency and bit fltness vs. depth for well Zubair #174

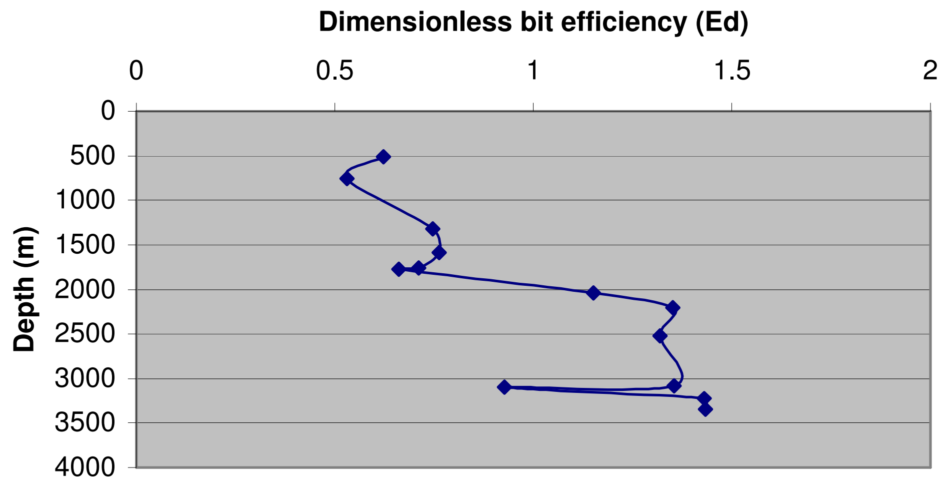

Fig.(3) Cross plot of bit efficiency vs. depth for well Zubair #174

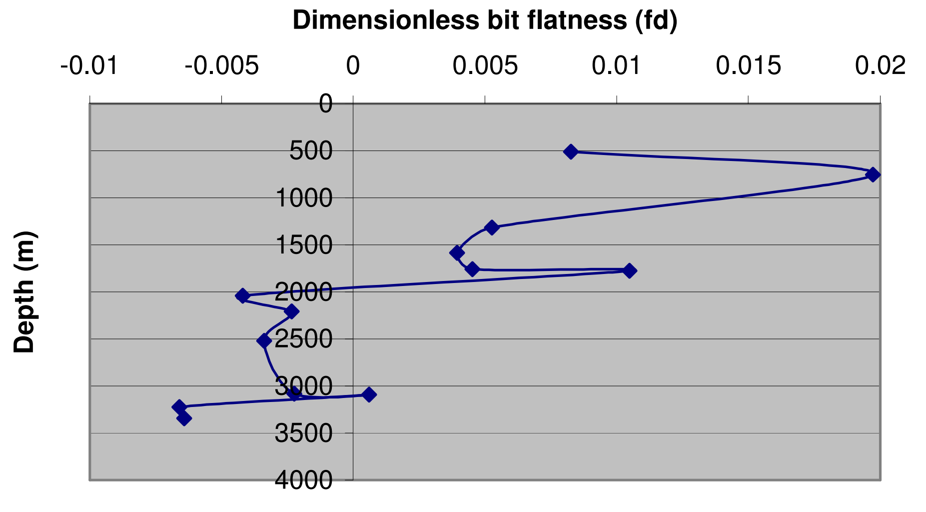

Fig.(4) Cross plot of bit flatness vs. depth for well Zubair #174

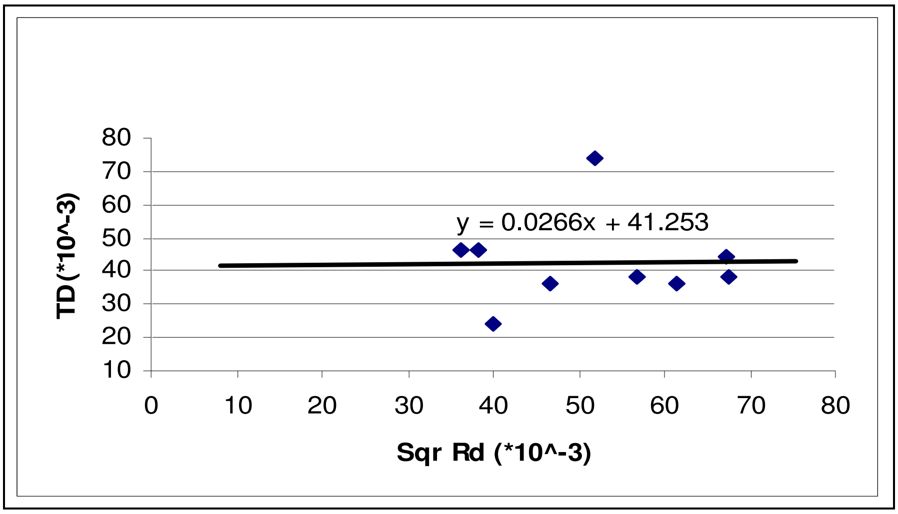

Fig.(5) Cross plot of Td vs. Sqr. Root of (Rd) for well Zubir#162

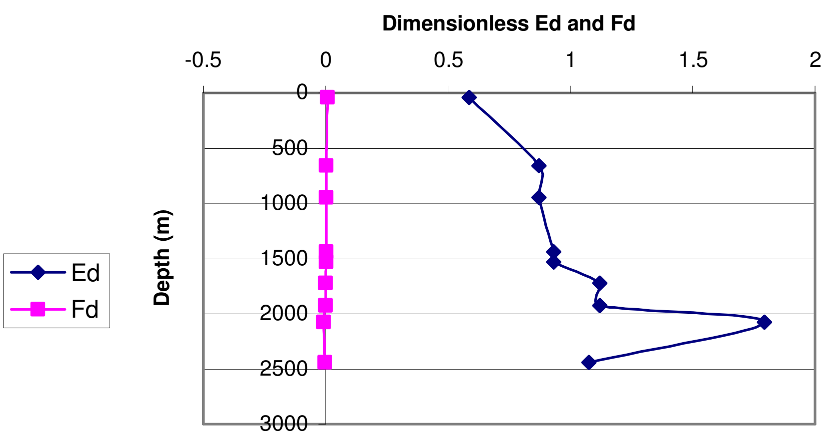

Fig.(6)Cross plot of bit efficicency and bit flatness vs. depth for well Zubair #162

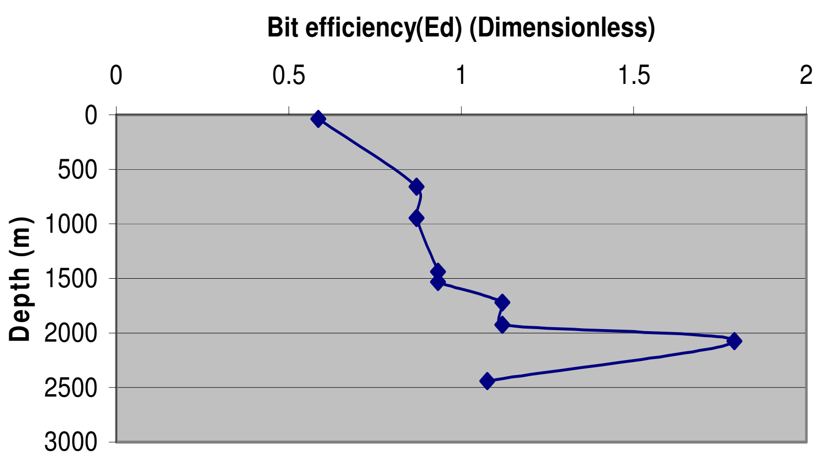

Fig.(7)Cross plot of bit efficiency vs. depth for well Zubair #162

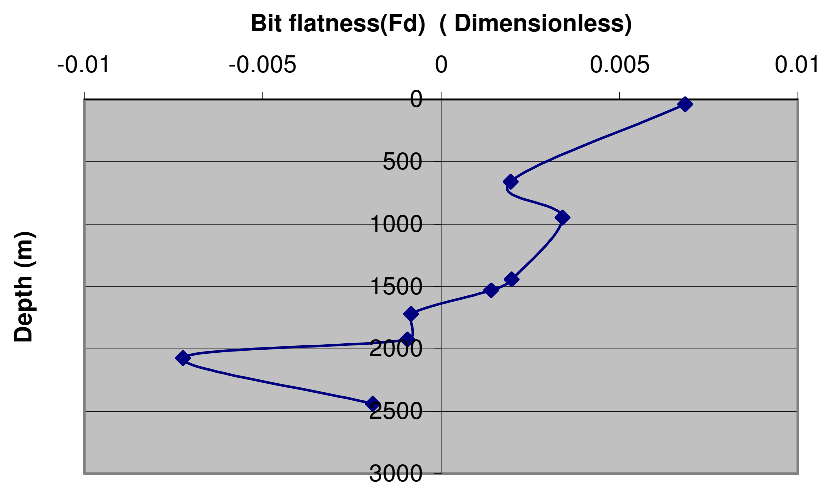

Fig.(8)Cross plot of bit flatness vs. depth for well Zubair #162

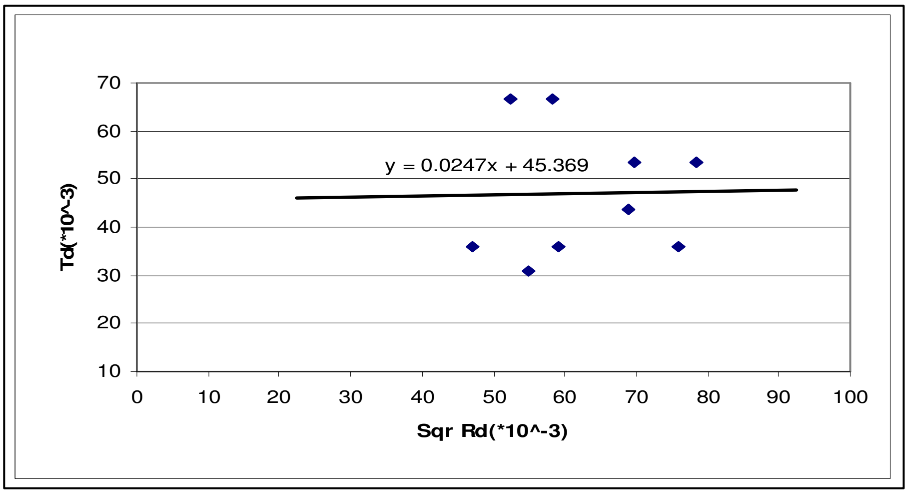

Fig.(9) Cross plot of Td vs. Sqr root of (Rd) for well Zubair#166

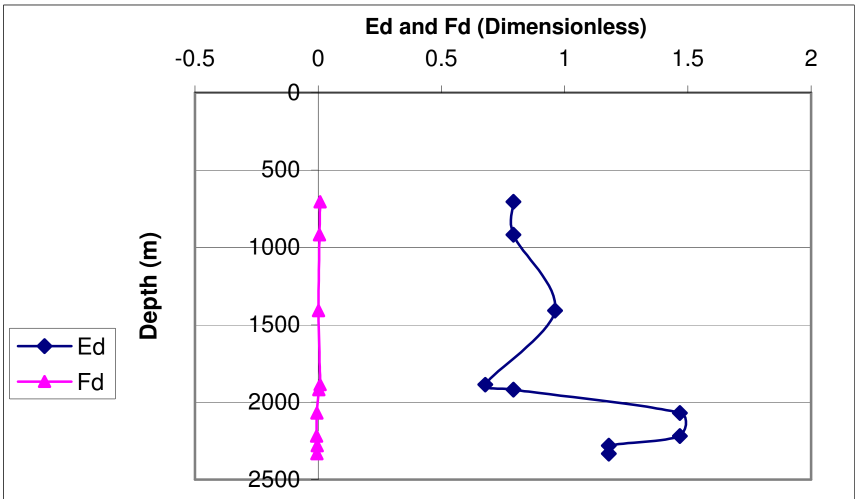

Fig.(10) Cross plot of bit efficiencyand bit flatness vs. depth for well Zubair#166

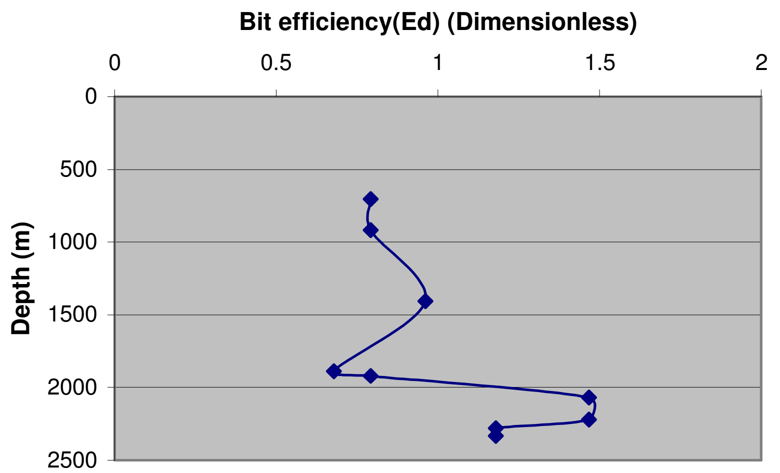

Fig.(11) Cross plot of bit efficiency vs. depth
for well Zubair#166

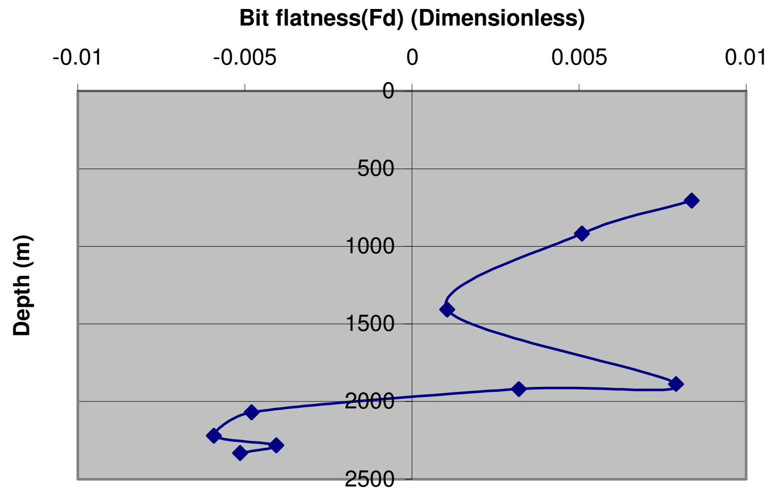

Fig.(12) Cross plot of bit flatness vs. depth
for well Zubair#166

EFFECT OF ECCENTRICITY ON THE PRESSURE AND VELOCITY GRADIENTS ALONG A STREAMLINE PAST A CYLINDERICAL BODY

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Abstract

In chemical technology and power engineering, equipment containing heat exchanging pipes and various cylindrical links immersed into moving fluid was often used. The estimation of the hydrodynamic action on these elements is based on the solution of the plane problem on the flow past a cylinder. In the hydrodynamics of inviscid flow past a body of nonzero thickness, it was assumed that there are regions near the body in which the flow accelerates from the front stagnation point to the midsection and decelerates behind the midsection. According to the Bernoulli theorem, a pressure counter-gradient arises in the deceleration region, which acts both in the outer flow and in the boundary layer. For the inviscid flow, the fluid particles store sufficiently much kinetic energy in the acceleration region to overcome this barrier, but in the frictional flow, the fluid particles that remain in the boundary layer cannot reach the region of higher pressure. They are pushed away from the wall, and an opposite flow arises downstream. This phenomenon is known as the boundary layer separation. A CFD models were simulated for the viscous flow past bodies changed from a circular cylinder to flat plate. FLUENT 6.3.26 package was used for solving the model preprocessed in GAMBIT 2.3.16 for flow past a body. Fluent solvers were based on the finite volume method and general conservation (transport) equation for momentum was discretized into algebraic equations. The pressure and velocity gradients for viscous flow past bodies changed from a circular cylinder to flat plate was predicted and plotted and the effect of eccentricity on the pressure and velocity gradients was studied.

Key words: viscous flow, aspect ratio, boundary layer separation, wake, bluff body

تأثير معامل المركزية على تدرج السرعة والضغط على طول خطوط الجريان حول جسم اسطواني

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