Cairo University

DETERMINATION OF CASING WEAR FACTOR FOR PROPOSED NEW WELLS USING SIMULATION BACK MODELING

By

Hany Kamal Hassan Abo El-Enein

A Thesis Submitted to
The Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
Master of Science in
Petroleum Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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Under the Supervision of

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Title of Thesis:

Determination of Casing Wear Factor for Proposed New Wells Using Simulation Back Modeling

Key Words:

Wear factor; Actual wear; Simulated wear; Maximum wear factor.

Summary:

In this thesis, two wells used to introduce method to determine casing wear factor, by using simulator software and real field parameters. Simulated wear graph compared to actual wear graph to find proper wear factor, which represent worst wear scenario. Thesis focuses on worst wear scenario, because it represents the maximum wear factor, which recommended in the prediction of casing wear in similar wells at design phase.

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I greatly appreciate the massive effort by my professors & supervisors to guide me through the various phases of this study, Specially Prof. Dr. Abdel-Alim Hashem El-Sayed for his patience and continuous support all the times.

Eng. Hany Kamal

DEDICATION

To all those who helped and motivated me to finish this work, I couldn't have done it without you.

Eng. Hany Kamal

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NOMENCLATURES

$(DLS)_{i,j,a}$: Apparent dogleg severity between stations i and j, Degree /100ft
$(DLS)_{i,j,r}$: Real dogleg severity between stations i and j, Degree/100ft
BR : Build Rate.
C_{wr} : Rotating wear coefficient cu.in /lb.ft
C_{wt} : Tripping wear coefficient, cu.in /lb.ft
C_{ww} : Wireline wear coefficient, cu.in /lb.ft
D_h : Depth of wear point, ft
DL : Dogleg.
DLS : Dogleg severity, degree /ft
D_t : Total depth of well at time of interest, ft
d_{tj} : Tool joint diameter, in
E : Specific energy, lb_f.ft / cubic inch
EW : East West axis.
F : Contact force, lb
F_A : Axial force, Ib_f
F_f : Frictional force, Ib_f
Fpm : Flow rate, feet per minute
F_{tj} : Normal force on the tool joint per foot, lb/ft
F_w : Gravitational force ,Ib_f
F_y : Forces in y-direction ,Ib_f
h : Casing wear groove depth, in
HD : Horizontal Displacement.
IRAV : Casing Internal radius average
K : The ratio between $L_{i,j}$ and L_{act}
L_{act} : Actual dogleg interval length, ft
L_{dp} : Drill pipe joint length, ft
$L_{i,j}$: Measured depth from station i to station j, ft
L_{tj} : Tool joint length, ft
MW : Mud weight
N : Rotary speed, rpm
NF_{dp} : Normal force on the drill pipe per foot, lb/ft
NRDPPs : Non rotating drill pipe protectors.
NS : North South axis.
N_t : Number of round trips per day (assumed to equal 1 for conventional bits and 0.25 for diamond bits)
N_w : Number of wireline runs.
P : Radius of wear groove circle, in
ppg : Pound per gallon
R : Casing inner radius, in

r : Tool joint outer radius, in

ROP : Rate of penetration, ft/hr

RPM : revolution per minute

S : Offset distance, in

Sd : Sliding distance, that drill-string or wireline travel across wear point, ft

t : Contact time, hr

T : Drill-string tension load, lb

T_a : Average tension in the drill string or wireline at the wear point, lb

THAV : Casing thickness average.in

TR : Turn rate.

TVD : True vertical depth.

T_w : Maximum wireline tension at the surface, lb

V_r : Wear volume caused by rotating , cu.in/ft

VS : Vertical section.

V_t : Wear volume caused by tripping , cu.in/ft

V_w : Wear volume caused by wireline running , cu.in/ft

W : Casing wear groove width, in

WD_s : Buoyed weight of drill-string below wear point, lb

WF : Casing wear factor for drill string rotation , E-10Psi-1

W_f : Frictional work, Ibf.in/ft

WOB : Weight on bit, lb

$\Delta\Phi_{i,j}$: Difference in direction from station i to station j, degree

ε : Fraction of drill pipe per joint that contacts wear point (usually taken as 0.1)

θ : Deviation angle from vertical, degree

μ : Friction coefficient ,[dimensionless]

ABSTRACT

As shallow and easily accessible oil and gas reservoirs are becoming depleted, so oil and gas industry turned its interest towards deeper and complex reservoirs. Traditional drilling methods have been less convenient for deep drilling challenges. More complex well paths and tough drilling conditions have pushed drilling technology off limits. Deep wells needs longer drill strings and large number of rotating hours, which have been found to wear out casing pipes that supports the walls of the well at dangerous rates. The use of top drive systems and the ability to back ream while rotating is now common practice, which exaggerate the problem.

Casing wear can become a critical problem threatening well safety and permanence. It can cause the abandonment of a well before reaching total depth or, in certain cases; it can lead to blowouts, lost production, and other hazardous and expensive problems.

For many years, the measure taken to deal with wear problem was the application for wear resistant materials on the drill pipes tool joints. These wear resistant materials are commonly referred to as hard-banding materials. The hard-banding materials successfully protected the drill pipes from wear but, they have been found causing rapid sever wear to the casing inner surface which increased the problem. Operators start recognizing the operational threat to the integrity of their wells and the associated economic and environmental impact, so they have start-studying casing wear issues. Pre determined laboratory wear factors have shown to correlate poorly with actual wear seen in the wells after it has been drilled.

Therefore, our study will focus on how to find a method to determine a proper wear factor from real wells that already have been drilled, by simulating casing wear based on drilling data from field and thereby back calculate the wear factor by adjusting the software wear prediction graph to fit with actual wear graph. Comparing the simulated software wear graph with actual wear graph, will produce two wear factors the average wear factor and the maximum wear factor. Study will focuses on maximum wear factor, which recommended for use in the casing design phase.

Our results shows that L80-13cr casing has much less wear resistance than P-110 casing, and wear factors are dependent upon individual wells and its wear peaks. Casing wear peaks may be unpredictable at the planning phase, which make casing wear accurate prediction very difficult process.