

National Exams December 2014

98-Pet-A4, Oil and Gas Well Drilling Completion

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM.
Any non-communicating calculator is permitted.
3. FOUR (4) questions constitute a complete exam paper.
The first four questions as they appear in the answer book will be marked.
4. Each question is of equal value.

1.

a-) By using the data given below, decide how many drilling lines you must have. Ignore buoyancy effect.

TVD ft	L _{DC} ft	L _{DP} ft	Hoisting Speed ft/min	W _{DC} lb/ft	W _{DP} lb/ft	Input Power to Fast Line, HP
1080 0	120 0	9,600	40	107	16.6	400

b-) Which one of the following three rigs would you choose for this well?

Rig Type	Maximum Equivalent Derrick Load, lbm
A	300,000
B	800,000
C	1,500,000

c-) What size of drilling lines should you use?

Assume only Extra Improved Plow Steel type of drilling lines are available.

Nominal Breaking Strengths of Galvanised Wire

Nominal Diameter	Approximate Mass	Extra improved plow steel
<u>in</u>	<u>lbm/ft</u>	<u>lbf</u>
1/2	0.46	26,600
9/16	0.59	33,600
5/8	0.72	41,200
3/4	1.04	58,800
7/8	1.42	79,600
1	1.85	103,400
1 1/8	2.34	130,000
1 1/4	2.89	159,800
1 3/8	3.5	192,000
1 1/2	4.16	228,000
1 5/8	4.88	264,000
1 3/4	5.67	306,000
1 7/8	6.5	348,000
2	7.39	396,000

TVD : True vertical Depth, ft

L_{DC} : Length of drill collars, ft

L_{DP} : Length of drill pipe, ft

w_{DC} : Unit weight of drill collar in the air, lbm/ft

w_{DP} : Unit weight of drill pipe in the air, lbm/ft

2-) Given the following data:

Drilling Fluid Density : 12 ppg

Well Depth: 10,000 ft.

Drill Bit Nozzle Sizes: 13-13-13

Pump Horsepower: 1800

Pump Volumetric Efficiency: 80%

Maximum Pump Pressure: 4,500 psi

Minimum Flow Rate: 350 gpm

Parasitic pressure losses of 2,173 psi and 1,388 psi are anticipated while circulating mud at flow rates 500 gpm and 390 gpm respectively.

a-) Determine the parasitic pressure losses when the bit hydraulic horsepower is maximum.

b-) Determine the optimum flow rate when the bit hydraulic horsepower is maximum.

c-) Determine the pressure drop across bit nozzles when the bit hydraulic horsepower is maximum.

d-) Determine the optimum sizes of three nozzles to be used for the next bit run using the maximum bit hydraulic horsepower criteria.

3-)

Your company wants to complete a well at 15,000 ft. using a 6 5/8 in. production casing. Relevant drill hole data are given below:

Open Hole Diameter : 8 1/2 in.
 Mud Weight @ 15,000 ft. : 16 ppg
 Formation Pore Pressure Gradient @ 15,000 ft. : 15.5 ppg
 Formation Fracture Pressure Gradient @ 15,000 ft.: 17.6 ppg
 Formation Temperature @ 15,000 ft : 180 °F
 Normal Formation Pressure Gradient: 0.465 psi/ft.

a-) Please prepare a casing program for this well. Your design should provide **Grade** , **Weight**, and **length** of the each casing section selected. Consider anticipated **collapse burst** and **tensile load** for your design. Assume that the gas is going to be produced.

Casing Design Factors

 Burst 1.1
 Collapse 1.0
 Tensile 1.6

Available Casings	Burst Rating, psi	Collapse Rating, psi	Body Strength, lbf	Joint Strength Buttress, lbf
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N-80, 24 lb/ft	7,440	5,760	555,000	615,000
N-80, 32 lb/ft	10,040	10,320	734,000	814,000
P-110, 32 lb/ft	13,800	13,220	1,009,000	1,040,000

4-)

Drill Hole Data :

Depth: 12,200 ft

Casing : 10 3/4 in. x 10 in. set at 4000 ft.

Mud Weight : 12 ppg.

Open Hole Diameter : 8 1/2 in.

Mud Circulation Rate : 400 gal/min

Parasitic Pressure Losses at 400 gpm. : 3000 psi.

Reduced Speed Pump Circulating Rate : 200 gpm.

Parasitic Pressure Losses at 200 gpm. : 750 psi.

Total Volume of Mud in Tanks : 1000 bbl.

Surface Temperature: 60 °F

Temperature @ casing shoe : 120 °F

Temperature @ 12,200 ft : 160 °F

Drill String Data :

Length of Drill Pipe : 11,600 ft.

Length of Drill Collars : 600 ft.

Capacity of Drillpipe: 0.014 bbl/ft

Capacity of Drill Collar: 0.0087 bbl/ft

Capacity of Drill collar-Openhole annulus: 0.035 bbl/ft

Capacity of Drillpipe-Openhole annulus: 0.0775 bbl/ft

Capacity of Drillpipe casing annulus: 0.1215 bbl/ft

Initial Kick Data :

Pit Gain : 15 Bbl. Methane Kick (assume kick moves as a slug)

Shut-in Casing Pressure : 400 psi.

Shut-in Drill Pipe Pressure : 200 psi

Safety Margin : 0.2 ppg for kill mud weight

100 psi for initial circulating pressure

It was decided to circulate the kick out of the well using **Drillers method**.
When the top of the kick zone reaches to the casing shoe, determine the following parameters;

a-) Length of kick zone, ft.

b-) Equivalent mud density at the casing shoe, ppg.

c-) Casing pressure at the surface

d-) Mud volume pumped, bbl

e-) Determine the drill pipe pressure schedule (drill pipe pressure vs. time) as the kill mud is being pumped down the well.

5-)

The average bit life of the bits in use is 30 hrs. After 15 hrs of drilling, the bit was pulled out at 12,000 ft. depth and well logging was run.

Then, the drilling is to be resumed and your decision is needed whether to run this half used bit or a new one.

Make your decision based on the minimum cost criteria and the fact that used bit costs you nothing.

The other relevant data are given as follows:

Rig operational cost: \$ 1500/hr

Bit Cost: \$ 10000

Trip Time: $0.0012 \cdot D_{out}$

Connection Time: 2 min/single

Length of 1 single : 30 ft

Based on the field data, the following relationship is known for drilling time vs. distance drilled.

$$D_{out} = \frac{\ln(0.025t_d + e^{0.00008D_{in}})}{0.00008}$$

Where:

D_{in} = Depth at the start of the drill bit run, ft

D_{out} = Depth at the end of the drill bit run, ft

t_d = Drilling time, hrs.