Question 1 data

Current well depth: 10,000ft
Hole size: 10.5 inches
Drill pipe specifications: 4.5", 16.6#/ft, 4" ID
Drill collar specifications: 8" x 3.5", for 500ft
Surface casing set at 4000 ft: 13.375", 68#/ft
Fracture gradient @ 4000 ft: 0.7 psi/ft
Surface temperature, T_{surf}: 70 degF
Temperature gradient, T_{grad}: 1.2 degF/100ft
Temperature at depth D = [T_{surf} +T_{grad}*(D/100)] in degF
SIDPP=300 psi
SICP = 650 psi
Pit level increase=45 bbls
Mud weight = 10 ppg

Question 2 data

Well System

Hole size (inches)	Casing size (inches)	Casing top (ft)	Casing shoe (ft)	Top of lead cement (ft)	Top of tail cement (ft)	Bottomhole static temperature (degF)	Hole excess (%)
36	30(ID=28")	0	1000	0	500	40	50
26	20 (133#/ft)	0	5000	0	4500	90	30
17.5	13.375 (68#/ft)	0	9000	3500	8500	170	20

Shoe track for 13.375" casing string=270ft

Slurry design

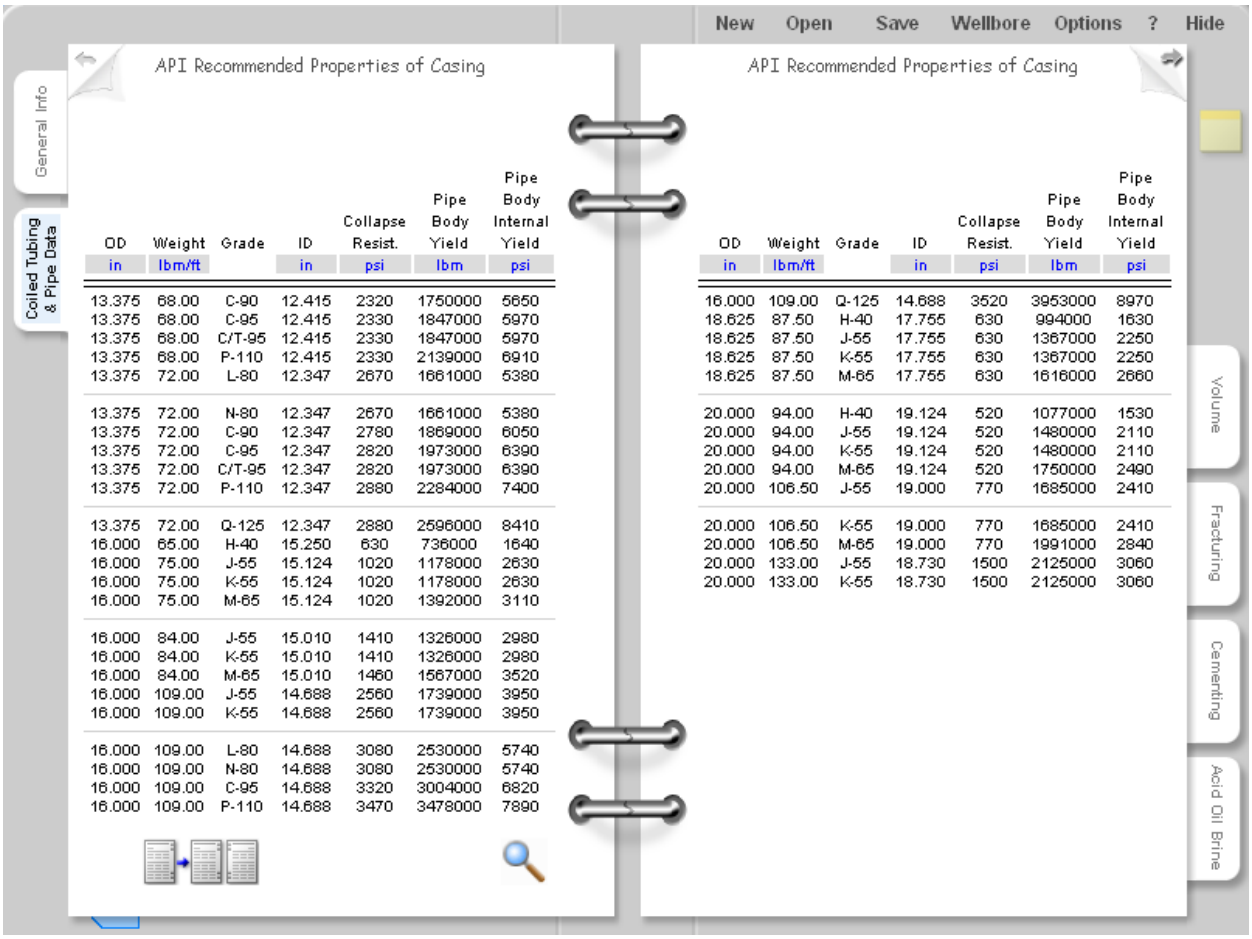
Lead slurry (12.8 ppg)	Tail slurry (16 ppg)
Yield: 2.005 ft^3/sack Water required: 11 gallons/sack Bentonite: 5% by weight of water Foam preventer: 0.02 gallons per sack Fluid loss additive: 0.4 gallons per sack Dispersant: 0.4 gallons per sack Retarder: 0.15 gallons per sack	Yield: 1.52 ft^3/sack Water required: 6 gallons per sack Foam preventer: 0.02 gallons per sack Fluid loss additive: 0.14 gallons per sack Dispersant: 0.18 gallons per sack Retarder: 0.007 gallons per sack Strength retrogression additive: 35% by weight of cement

Mud properties

Mud weight; 10.2 ppg
Yield point: 6 lbf/100 sq. ft

Water property

Water density: 8.33 pounds per gallon

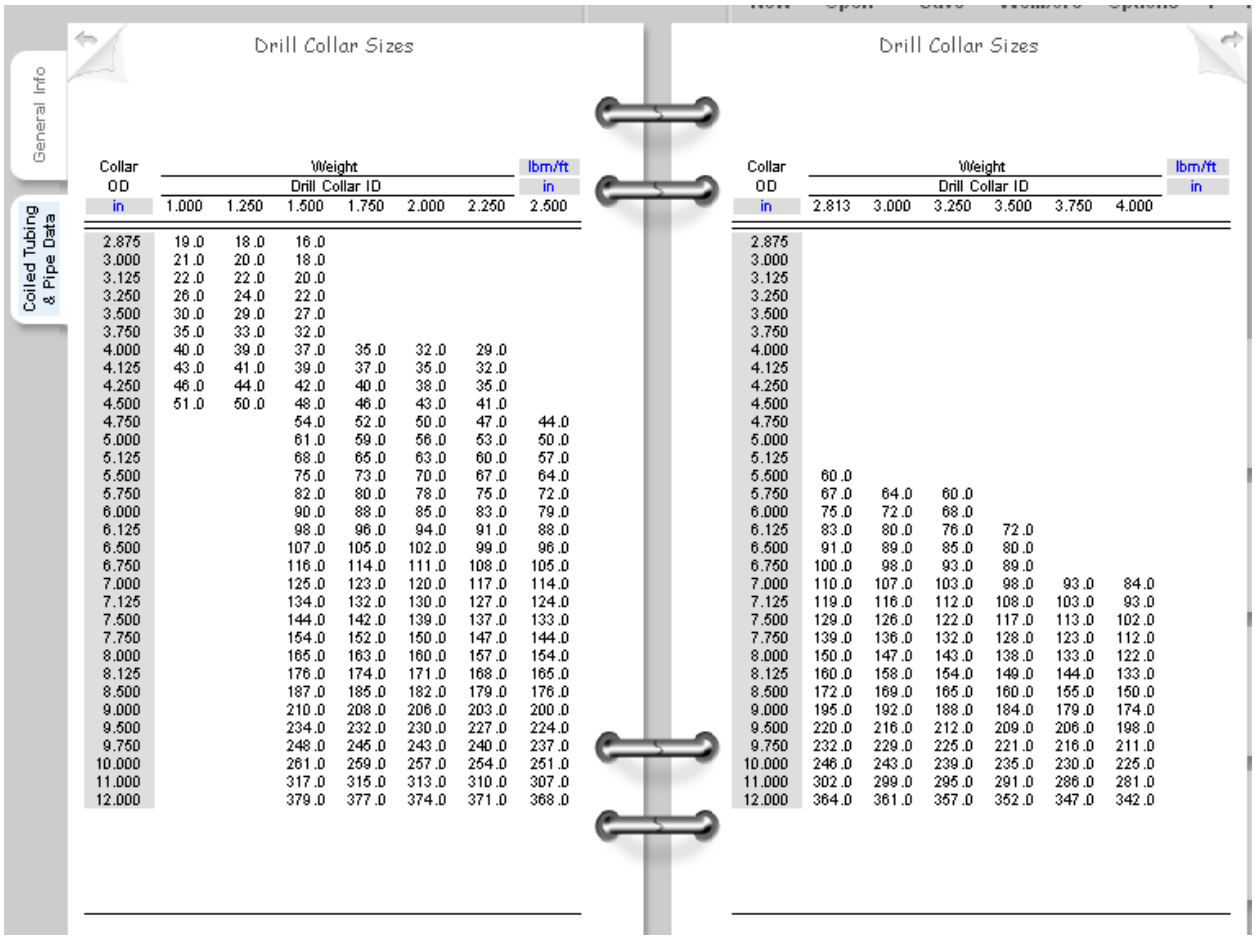


API Recommended Properties of Casing

OD	Weight	Grade	ID	Collapse Resist.	Pipe Body Yield	Pipe Body Internal Yield
in	lbm/ft		in	psi	lbm	psi
13.375	68.00	C-90	12.415	2320	1750000	5650
13.375	68.00	C-95	12.415	2330	1847000	5970
13.375	68.00	C/T-95	12.415	2330	1847000	5970
13.375	68.00	P-110	12.415	2330	2139000	6910
13.375	72.00	L-80	12.347	2670	1661000	5380
13.375	72.00	N-80	12.347	2670	1661000	5380
13.375	72.00	C-90	12.347	2780	1869000	6050
13.375	72.00	C-95	12.347	2820	1973000	6390
13.375	72.00	C/T-95	12.347	2820	1973000	6390
13.375	72.00	P-110	12.347	2880	2284000	7400
13.375	72.00	Q-125	12.347	2880	2596000	8410
16.000	65.00	H-40	15.250	630	736000	1640
16.000	75.00	J-55	15.124	1020	1178000	2630
16.000	75.00	K-55	15.124	1020	1178000	2630
16.000	75.00	M-65	15.124	1020	1392000	3110
16.000	84.00	J-55	15.010	1410	1326000	2980
16.000	84.00	K-55	15.010	1410	1326000	2980
16.000	84.00	M-65	15.010	1460	1567000	3520
16.000	109.00	J-55	14.688	2560	1739000	3950
16.000	109.00	K-55	14.688	2560	1739000	3950
16.000	109.00	L-80	14.688	3080	2530000	5740
16.000	109.00	N-80	14.688	3080	2530000	5740
16.000	109.00	C-95	14.688	3320	3004000	6820
16.000	109.00	P-110	14.688	3470	3478000	7890

API Recommended Properties of Casing

OD	Weight	Grade	ID	Collapse Resist.	Pipe Body Yield	Pipe Body Internal Yield
in	lbm/ft		in	psi	lbm	psi
16.000	109.00	Q-125	14.688	3520	3953000	8970
18.625	87.50	H-40	17.755	630	994000	1630
18.625	87.50	J-55	17.755	630	1367000	2250
18.625	87.50	K-55	17.755	630	1367000	2250
18.625	87.50	M-65	17.755	630	1616000	2660
20.000	94.00	H-40	19.124	520	1077000	1530
20.000	94.00	J-55	19.124	520	1480000	2110
20.000	94.00	K-55	19.124	520	1480000	2110
20.000	94.00	M-65	19.124	520	1750000	2490
20.000	106.50	J-55	19.000	770	1685000	2410
20.000	106.50	K-55	19.000	770	1685000	2410
20.000	106.50	M-65	19.000	770	1991000	2840
20.000	133.00	J-55	18.730	1500	2125000	3060
20.000	133.00	K-55	18.730	1500	2125000	3060



Drill Collar Sizes

Collar OD	Weight Drill Collar ID						lbm/ft
in	1.000	1.250	1.500	1.750	2.000	2.250	2.500
2.875	19.0	18.0	16.0				
3.000	21.0	20.0	18.0				
3.125	22.0	22.0	20.0				
3.250	26.0	24.0	22.0				
3.500	30.0	29.0	27.0				
3.750	35.0	33.0	32.0				
4.000	40.0	39.0	37.0	35.0	32.0	29.0	
4.125	43.0	41.0	39.0	37.0	35.0	32.0	
4.250	46.0	44.0	42.0	40.0	38.0	35.0	
4.500	51.0	50.0	48.0	46.0	43.0	41.0	
4.750			54.0	52.0	50.0	47.0	44.0
5.000			61.0	59.0	56.0	53.0	50.0
5.125			68.0	65.0	63.0	60.0	57.0
5.500			75.0	73.0	70.0	67.0	64.0
5.750			82.0	80.0	78.0	75.0	72.0
6.000			90.0	88.0	85.0	83.0	79.0
6.125			98.0	96.0	94.0	91.0	88.0
6.500			107.0	105.0	102.0	99.0	96.0
6.750			116.0	114.0	111.0	108.0	105.0
7.000			125.0	123.0	120.0	117.0	114.0
7.125			134.0	132.0	130.0	127.0	124.0
7.500			144.0	142.0	139.0	137.0	133.0
7.750			154.0	152.0	150.0	147.0	144.0
8.000			165.0	163.0	160.0	157.0	154.0
8.125			176.0	174.0	171.0	168.0	165.0
8.500			187.0	185.0	182.0	179.0	176.0
9.000			210.0	208.0	206.0	203.0	200.0
9.500			234.0	232.0	230.0	227.0	224.0
9.750			248.0	246.0	243.0	240.0	237.0
10.000			261.0	259.0	257.0	254.0	251.0
11.000			317.0	315.0	313.0	310.0	307.0
12.000			379.0	377.0	374.0	371.0	368.0

Drill Collar Sizes

Collar OD	Weight Drill Collar ID						lbm/ft
in	2.813	3.000	3.250	3.500	3.750	4.000	in
2.875							
3.000							
3.125							
3.250							
3.500							
3.750							
4.000							
4.125							
4.250							
4.500							
4.750							
5.000							
5.125							
5.500	60.0						
5.750	67.0	64.0	60.0				
6.000	75.0	72.0	68.0				
6.125	83.0	80.0	76.0	72.0			
6.500	91.0	89.0	85.0	80.0			
6.750	100.0	98.0	93.0	89.0			
7.000	110.0	107.0	103.0	98.0	93.0	84.0	
7.125	119.0	116.0	112.0	108.0	103.0	93.0	
7.500	129.0	126.0	122.0	117.0	113.0	102.0	
7.750	139.0	136.0	132.0	128.0	123.0	112.0	
8.000	150.0	147.0	143.0	138.0	133.0	122.0	
8.125	160.0	158.0	154.0	149.0	144.0	133.0	
8.500	172.0	169.0	165.0	160.0	155.0	150.0	
9.000	195.0	192.0	188.0	184.0	179.0	174.0	
9.500	220.0	216.0	212.0	209.0	206.0	198.0	
9.750	232.0	229.0	225.0	221.0	216.0	211.0	
10.000	246.0	243.0	239.0	235.0	230.0	225.0	
11.000	302.0	299.0	295.0	291.0	286.0	281.0	
12.000	364.0	361.0	357.0	352.0	347.0	342.0	

List of formula

$$pressure(psi) = 0.052 * density(ppg) * height(ft)$$

$$tubular\ capacity\ \left(\frac{bbl}{ft}\right) = \frac{ID^2}{1029.4}, \text{ ID is in inches}$$

$$annular\ capacity\ \left(\frac{bbl}{ft}\right) = \frac{OD^2 - ID^2}{1029.4}, \text{ OD, ID is in inches}$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Unit conversion

42 gal = 1 bbl=5.6146 ft^3

1 cp = 0.01 dynes-second/cm^2.

1 eq. cp = 0.01 dynes-second^n/cm^2.

1 dynes/cm^2=0.209 lbf/100 sq.ft

1 sack of cement = 94 lbs

1 metric tonne (MT) =~2,200 lbs

PETE 426—DRILLING ENGINEERING, Spring 2014
Class Instructor: Dr. Dare Awoleke

Final Exam, Tuesday, 6th May, 2014

Duration: 6:00—9:00pm

Instructions

- Write your name at the back of your exam booklet.
- Closed book, closed notes.
- Write your answers in this booklet. You might want to use a pencil just in case of erasures.
- You need writing material and a simple calculator.
- The use of phones and all other types of electronic gadgets is not allowed.
- If in doubt about the use of any device, ask.

Q1: 50 points

Q2: 50 points

Total: 100 points

Question 1 questions

a) Draw a schematic using the well data for Question 1. Label the casing (OD, ID, weight, seat), open hole, drill pipe (OD, ID, weight), drill collars (OD, ID, weight), the SIDPP and the SICP (**5 points**).

b) What is the kill mud weight? (**2.5 points**)

c) Calculate the annular capacities in bbls/ft between:

i. The drill collar and the open hole (**1 point**)

ii. The drill pipe and the open hole(**1 point**)

iii. The drill pipe and 13.375" casing(**1 point**)

d) What is the height of the kick at bottomhole? (**3.5 points**)

e) What is the hydrostatic pressure due to the kick at 10,000ft? Which type of fluid is the kick? (**3.5 points**)

f) What is the hydrostatic pressure due to the kick when the top of the kick is at 4,000ft? (**2.5 points**)

g) What is the height of the kick (in terms of pressure) when the top of the kick is at 4000ft? (**5 points**)

h) What is the pressure at the casing seat when the top of the kick is at the casing seat (4000ft)? Use the Wait and weight method.(**15 points**). **Note:** If you use the Driller's method to solve this problem, you will automatically lose 50% of the points associated with this question.

i) What is the annular pressure at the surface at this time? (**5 points**)

j) What is the pressure gradient at the shoe? Compare this value to the fracture gradient at the shoe and make your comments. (**5 points**)

Question 2 questions

a) Draw the schematic for the well-system desribed in the dataset for Question 2 showing the top of cement behind each casing size. Also label each casing size and seat. (**5 points**)

All the questions below pertain primarily to the 17.5" hole section(13.375" casing cementing).

b) What is the volume of the
   i. tail cement slurry in barrels (**2.5 points**)

   ii. lead cement slurries in barrels? (**2.5 points**)

c) How much is the mud displacement is barrels? (**5 points**)

d) At the end of displacement, what pressure should the cementer see on the pump on surface just after the pumps are shut down in psi? (**5 points**)

e) We cam mix and pump the cement slurry at 7 barrels per minute. The mud displacement is pumped at 10 barrels per minute. What is the minimum pump time for (use 50% safety factor):
   i. Lead slurry (**5 points**)

   ii. Tail slurry (**5 points**)

f) Calculate the following quantities:
   i. The amount of cement needed for the job in lbs and metric tonnes (**5 points**)

   ii. The amount of water needed for the job. (**5 points**)

iii. The amount of bentonite needed for the job. (**2.5 points**)

iv. The amount of strength retrogression additive needed for the job (**2.5 points**)

g) At the end of the job, the actual pump pressure seen by the cementer is 400psi. Determine the top of the lead slurry assuming the top of the tail slurry is still at 8500ft. What is the significance of this result? Is this a bad or good cement job? (**5 points**)