IWCF Workbook
Well Intervention
Level 3/4

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COMPLETION OPERATIONS – PRINCIPLES & PROCEDURES

EXERCISE COMPLETION OPERATIONS 1

Given Well Data:

Well Depth (MD) = 12,650 ft (MD) and 11,353 ft (TVD)
Current Formation Pressure = 5,903 psi

Answer question # 1 and 2

1. What is the minimum fluid density required to kill the well given estimated Formation Pressure above?

   Answer:_____ppg

2. The pressure gradient of production fluid (fluid/gas) inside the tubing is 0.13 psi/ft. What is the expected [surface] Tubing Head Pressure?

   Answer:_____psi

3. A gas well has a total depth of 15,000 ft MD or 13,200 ft TVD

Packer is set at:	11,500 ft MD or 9,800 ft TVD
Shut-in wellhead pressure:	2,700 psi
Gas pressure gradient:	0.15 psi/ft
The Annulus is full of:	9.0 ppg brine

   What is the differential pressure between tubing and annulus at the underside of the Tubing Hanger?

   Answer:_____psi

4. The following information had been collected from a gas well prior running the production casing and installing wellhead equipment: -

Well Depth:	13,200 ft MD and 6,500 ft TVD
Form. Press. Gradient:	0.5720 psi/ft
Gas Gradient:	0.0707 psi/ft

   a) Calculate Formation Pressure: Answer:_____psi
   b) Calculate Max. Surface Pressure: Answer:_____psi
   c) What should be Rated Working Press of Xmas Tree? Answer:_____psi

5. Refer to Well Data on Question-4: -
The 7" Casing has now been run to the bottom of the well after which 3-1/2" OD completion string is run and landed in the Tubing Head Spool. Before we perforate the production zone, drilling mud in the well must be displaced with brine such that we will BALANCE the formation pressure. Calculate Brine Density required for this operation?

Answer_____ppg

6. In a production oil well, a Sliding Sleeve [SSD] has to be opened.
Well data is as follows:

End-of-Tubing:	9,175 ft MD and 8,100 ft TVD
Packer depth:	8,500 ft MD and 7,250 ft TVD
SSD depth:	8,100 ft MD and 6,825 ft TVD
Density Compl. Fluid:	9.2 ppg
Density of Oil:	6.8 ppg
SITHP:	750 psi

a) Calculate the differential pressure across the SSD

Answer_____psi

b) Referring to the previous question, which side of the SSD has a higher pressure?

Answer: _____

7. A well is to be killed with 10.0 ppg brine. The well depth is 12,000 ft MD and 11,000 ft TVD. The formation pressure is 5,620 psi.
Calculate the overbalance in this well after heavy brine has been pumped?

Answer:_____psi

8. Well data is as follows:

Well depth:	6,150 ft TVD and 12,500 ft MD
Pore Press. Gradient:	0.572 psi/ft
Gas Gradient:	0.0707 psi/ft

Calculate the Maximum Surface Pressure prior installation of production casing and wellhead equipment.

Answer:_____psi (approx.)

9. Well Data is as follows: -

Tubing Depth:	9,500 ft MD and 8,700 ft TVD
Tubing Capacity:	0.0025 bbl/ft
Annular Capacity:	0.0052 bbl/ft
Pump Rate:	0.75 bbl/minute

For a forward circulation (i.e. pump down the tubing and up into annulus), calculate time required (in minutes) to pump bottoms up and to pump a full circulation?

[NOTE: Packer is unseated, i.e. we can circulate past the Packer]

a) Calculate the time required to pump bottoms up?

Answer:_____minutes

b) Calculate the time required for a full circulation?

Answer:_____minutes

10. The Well Data is as follows: -

Well Depth:	12,200 ft MD and 6,120 ft TVD
Tubing shoe depth:	11,000 ft. MD and 5,980 ft TVD
Formation Pore Press. Gradient:	0.572 psi/ft
Gas Gradient:	0.0707 psi/ft
Casing Capacity:	0.04049 bbl/ft
Tubing Capacity:	0.00829 bbl/ft
Tubing closed-end displacement:	0.01190 bbl/ft
Pump displacement:	0.0899 bbl/stroke

Calculate how many strokes are required to displace the tubing string volume?

Answer:_____strokes

11. What is the meaning of Formation FRACTURE Pressure?

_____

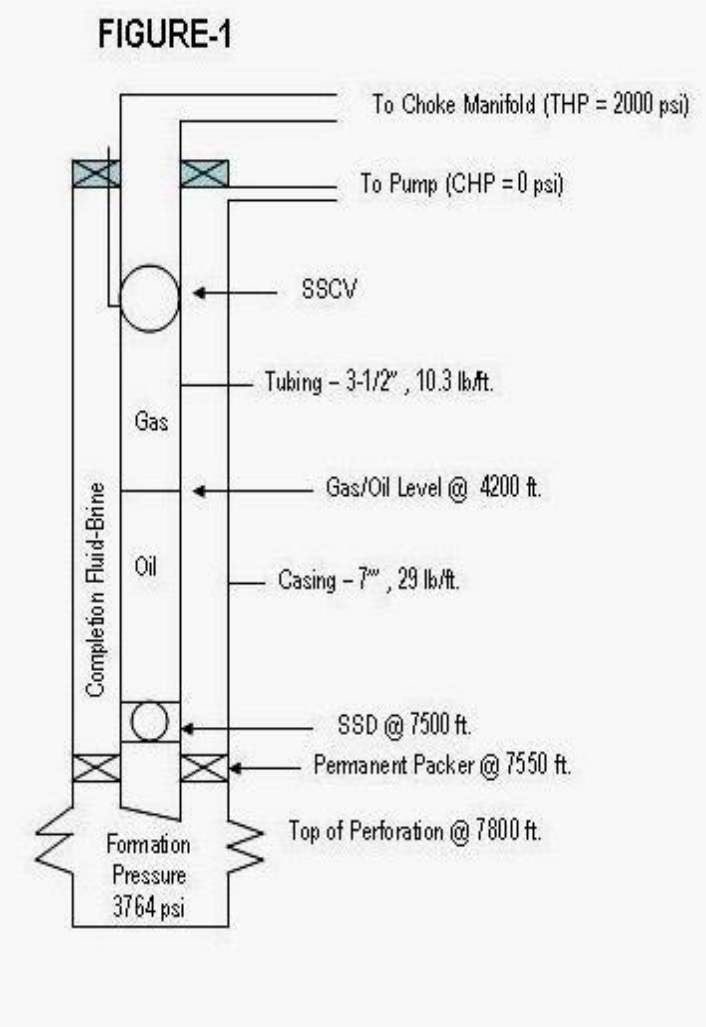
12. What is the meaning of Formation BREAKDOWN Pressure?

_____

13. If the well program does not include a signed approval from a designated and authorized person, what action to take prior to commencing a job?

_____

Figure 1 below shows the configuration of a well which is shut in and will be killed by REVERSE CIRCULATION method. See next page for further details.



Tubing Capacity: 0.0083 bbl/ft
CasingCapacity: 0.0371 bbl/ft
Annulus Capacity: 0.0252 bbl/ft

Gradients:
Brine (in Annulus): 0.45 psi/ft
Oil (in Tbg & Csg): 0.35 psi/ft

Gas (in Tbg): 0.12 psi/ft
Kill fluid: 0.52 psi/ft

Gas/Oil contact: 4200 ft
SSD: 7500 ft
Packer: 7550 ft
Top Perforation: 7800 ft

Formation Press.: 3764 psi

Shut in THP: 2000 psi
Shut in CHP: 0 psi

- The Tubing has a constant ID/OD and contains gas and oil.
- The Casing below the Packer is filled with oil.
- The Annulus is filled up with completion brine.

The kill fluid is to be pumped through annulus via the Sliding Sleeve until formation fluid, gas and brine completion fluid are displaced out entirely.

During this killing operation, an overbalance of 200 psi above the formation pressure at top of the tubing side is to be maintained.

Use information given above to calculate and answer the question 14 - 19.

NOTE: Round off your values to a whole number, i.e. no decimals

14. Calculate tubing volume used for this operation _____bbls

15. Calculate annular volume used for this operation _____bbls

16. Calculate downhole pressure in a static condition at the Sliding Sleeve [SSD] of the following periods during reverse circulation well killing.

    a) Expected pressure to be maintained constant at SSD during entire kill operation (include overbalance):_____psi

    b) When tubing is full of completion brine (include overbalance):_____psi

    c) When reverse circulation was completed [without overbalance):_____psi

17. After pumping 63 bbls, the tubing head pressure is maintained constant at 200 psi until 189 bbls have been pumped. What is the reason for maintaining a constant pressure at 200 psi over this interval?

    Answer: _____

18. While pumping between 63 bbls until 189 bbls, if tubing head pressure is held constant at 150 psi instead of 200 psi, will the well become under-balanced?

    Answer:_____(Yes or No)

19. How many barrels of kill fluid must be pumped to fill the annulus to the point where gas has just been displaced out of the tubing string?

    Answer:_____bbls

20. During a well intervention operation, an emergency situation arises and it becomes necessary to kill the well. Which killing method is the most appropriate to be used if the formation interval is exposed [perforated] and the maximum surface working pressure is high enough to handle the pressures for this method?

    Answer: _____

21. If the recommended method in your answer to question 20 is not possible, what is the second best method that should be used?

    Answer: _____

22. Given data: -

Tubing depth:	9,500 ft MD and 8,750 ft TVD
Tubing capacity:	0.0025 bbl/ft
Annular capacity:	0.0052 bbl/ft
Pump rate:	0.75 bbls/min

    Calculate the time required to pump full circulation.

    Answer:_____minutes

23. What are the possible consequences when attempting to open a closed valve while there is pressure on one side only? (TWO ANSWERS)

    a) It can cause the valve itself to become damaged
    b) It will reduce the risk of damage to the valve
    c) It will reduce chance of pressure locking the valve
    d) It can cause less hydraulic shock to the system
    e) It can cause equipment downstream of the valve to become damaged

4. Which of the following are commonly used as barriers, when we are able to monitor and maintain the fluid level? (THREE ANSWERS)

   a) Brine
   b) Nitrogen
   c) Diesel
   d) Condensate
   e) Drilling mud
   f) Inhibited Sea Water

5. Which barrier terminology (Primary, Secondary or Tertiary) is used to classify Water, IF this water is pumped into the well, stabilizes the well pressure and there is no flow to surface?

   Answer _____

6. The well has just been shut in on a gas kick. What is the expected behavior of this gas influx at the bottom of the well? [FOUR ANSWERS]

   a) Gas will migrate upwards as a result of its lower density compared with other fluids in the well
   b) The surface shut-in pressure will decrease with time after the well is shut in
   c) The surface shut-in pressure will increase with time after the well is shut in
   d) The bottom hole pressure will increase with time after the well is shut in
   e) The bottom hole pressure will decrease with time after the well is shut in
   f) The gas influx bubble pressure will remain the same

7. When planning a kill on a standard 'single completion' well, which killing method is always preferred?

   Answer _____

8. Which of the following measures or actions can prevent or remove hydrates? (THREE ANSWERS)

   a) Rapid bleed-off of gas to a vent or flare system
   b) Use of water/glycol mixture during pressure testing
   c) Pressure testing up to the maximum working pressure of the equipment
   d) Raising the temperature of the affected equipment
   e) Injecting methanol into the affected equipment

9. Can a fluid barrier be a Secondary Barrier?

   a) YES
   b) NO

10. Which of the following statements describe an effective kick-off or toolbox meeting?

    a) Get everyone involved to attend the meeting and explain exactly what is going to happen during the operation
    b) Get everyone involved to attend the meeting and go through plans, ask for feedback and comments, modify the plan if necessary and make sure that everyone understands it properly
    c) Get everyone involved to attend the meeting and read out the plan sent out by the onshore organization. Explain that the plan must be followed to the letter

11. If a problem occurs during an intervention operation, who should shut in the well and be responsible for safe working practices? (TWO ANSWERS)

    a) The Operator Representative (or Well Foreman)
    b) The Well Intervention planner
    c) The person who is designated to operate a control panel
    d) The Production Manager
    e) The leader of the Well Intervention team
    f) The operator of on-site Well Intervention equipment

12. Can hydrate ONLY be formed with free water in the well?

    a) YES
    b) NO

13. Hydrates may cause damage to Well Intervention Equipment if they are released as a result of high differential pressure!

    a) TRUE
    b) FALSE

14. Which of the following mechanical devices can be installed by Well Intervention methods and is accepted to function as a barrier? (TWO ANSWERS)

    a) Hi-vis pill
    b) Casing Cement Retainer
    c) Pump Open plug
    d) Orifice valve
    e) Expandable Plug

15. A rod pumping well will be re-completed. Does the well need to have the same minimum number of well control barriers in place when compared with a well that has natural flow?

    a) NO
    b) YES

WORKBOOK COMPLETION OPERATIONS – ANSWER KEYS

EXERCISE COMPLETION OPERATIONS-1	
1.	10.0 ppg
2.	4427 psi
3.	2700 psi
4a.	3718 psi
4b.	3259 psi
4c.	5000 psi
5.	11.0 ppg
6a.	102 psi
6b.	Annulus
7.	100 psi
8.	3083 psi
9a.	66 minutes
9b.	97.5 minutes
10.	1015 strokes
11.	Formation FRACTURE pressure is the pressure that initiates the first fractures to which formation is exposed [such as formation across perfs].
12.	Formation BREAKDOWN pressure is the pressure that breaks down the formation and is higher than the fracture pressure. When we break down the formation, the fractures we initiated now rapidly extend radially. It has the risk of reducing the maximum allowable surface pressure on the well to be lower than the pressure applied when initiating first fractures.
13.	Suspend the operation [and usually means that we have to await further advice from the office-based Well Intervention Supervisor].
14.	63 bbls
15.	189 bbls
16a.	3859 psi [use formation pressure + 200 psi overbalance]
16b.	3859 psi [answer 'must' be the same as 16a]
16c	3900 psi [kill brine creates overbalance of 241 psi]
17.	Tubing is now filled [and remains to be filled] with completion brine, so that the hydrostatic pressure over that interval pumped remains unchanged
18.	No
19.	35 bbls
20.	Bullheading
21.	Lubricate & Bleed
22.	98 minutes
23.	a, e

EXERCISE COMPLETION OPERATIONS-2	
1.	5309 strokes
2.1	11.0 ppg
2.2	5000 psi
3.	100 psi
4.	a, e, f
5.	Primary
6.	a, c, d, f
7.	Reverse Circulation
8.	b, d, e
9.	No
10.	b
11.	c, f
12.	Yes
13.	a
14.	c, e
15.	Yes

EXERCISE COMPLETION OPERATIONS-3	
1.	b, d
2.	c
3.	c, d, e
4.	a, e
5.	a, e
6.	d
7.	a, e
8.	c, e
9.	a, b, e
10.	b
11.	b
12.	b
13.	a, c
14.	b, e
15.	b, d, e