Al-Ayen University

Petroleum Engineering College

Drilling Engineering 2

Fourth year

(((WELL PROBLEMS-2))))

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Lecture (3)

WELL PROBLEMS

I. Well kicks.
II. Stuck pipe
III. Lost circulation.
IV. Restriction in the drilling string.
V. Washout of the drilling string.

I.Well Kicks

It is the entering of the formation fluid to the wellbore.

- this occur when the formation pressure exceeds the hydrostatic pressure.
- A blowout is uncontrolled kick.
- Overbalance.
- Underbalance.
- Factors controlling the kicks sevirity:-
    1. permeability.
    2. underbalance

Reasons for Kicks

1. Insufficient Mud Weight.
2. Swabbing.
3. Gas cut mud.
4. Failure to keep the hole full.
5. Lost circulation.

1.Insufficient Mud Weight.

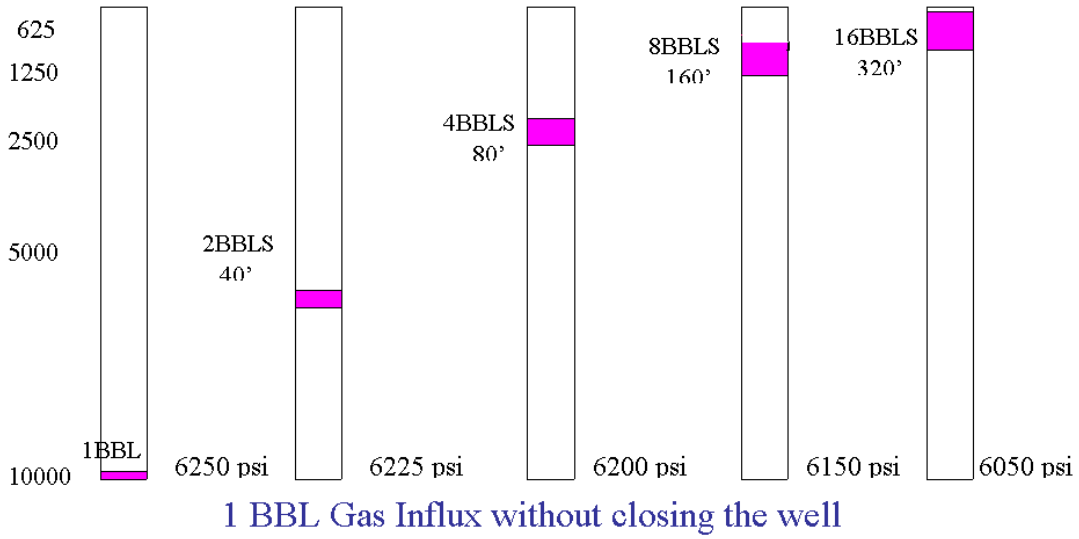
The formation pressure is higher than the hydrostatic pressure.

2.Swabbing

A negative hydrostatic pressure causing reducing bottom hole pressure

- The speed of the drill pipe pulling.
- Mud flow properties; yp, gel.
- Hole geometry.
- Balled up string.

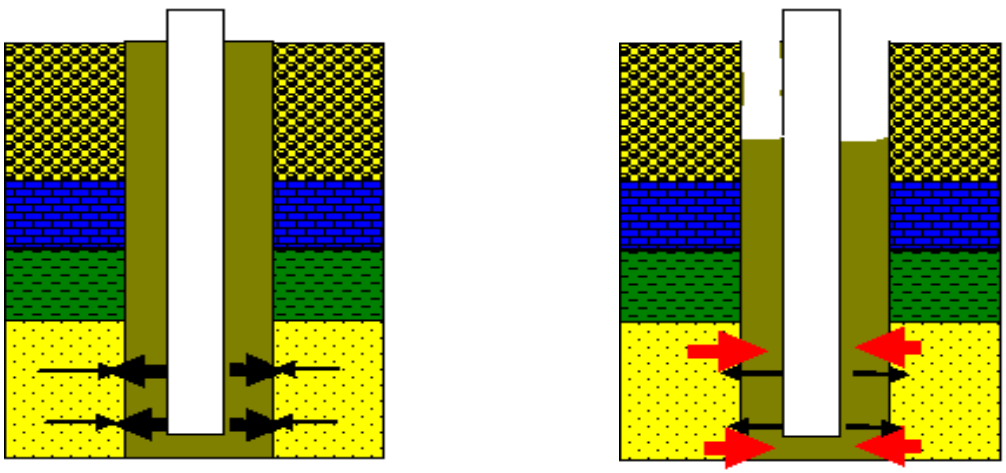
3.Gas cut mud



1 BBL Gas Influx without closing the well

4.Failure to keep the hole full. 5.Lost circulation

5.Lost circulation



Indications of Kicks

- Changes in mud gas.
- Drilling breaks.
- Improper hole fillups in trips.
- Pump pressure decrease and pump strokes increase
- Flow out rate increase.
- Pit Volume Increase.
- String weight change.
- Well flowing with pumps off.

WELL CONTROL

Early kick recognition & prompt execution of correct shut-in procedures is the key to successful kick control.

Objectives

1. Kell safely.
2. Minimize borehole stresses.

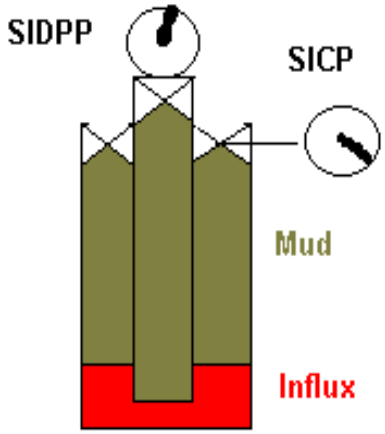
A. Shut-in Procedures

- Hard Shut-in:

the adjustable choke is closed before taking a kick.

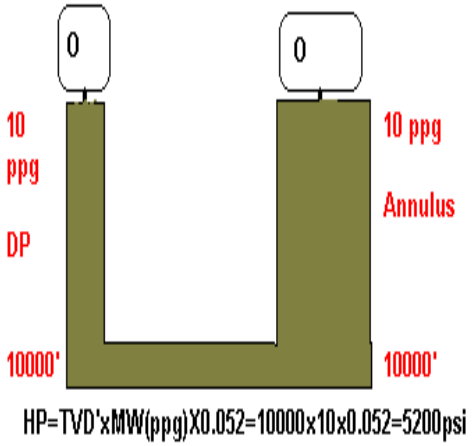
- Soft Shut-in:

the adjustable choke is opened before taking a kick.



In order to kill a well the bottom hole pressure must be maintained constant at a level greater than or equal to the formation pressure.

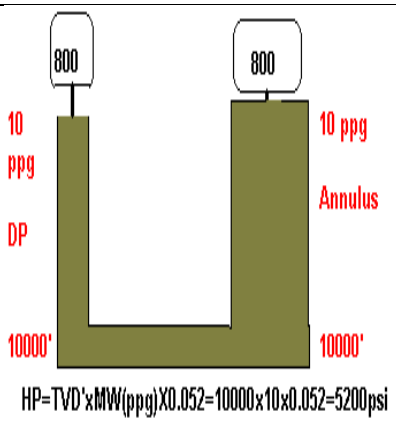
B. U – tube Theory



1- No influx, no Imposed pressure.

2- BHP = HP + IP + PL

BHP=5200+0+0=5200psi

	**2. No Influx, with imposed pressure** FP=HP+IP+PL =5200+800+0=6000psi

The pump rate at which the system pressure loss is recorded for purpose of well control is called:

- ✓ Reduced circulating pressure,
- ✓ Kill rate,
- ✓ Reduced pump rate,
- ✓ Slow pump pressure,
- ✓ Slow pump rate.

Shut-in Pressure

The shut-in drill pipe pressure is the amount by which the formation pressures exceeds the hydrostatic head of the mud in drill pipe

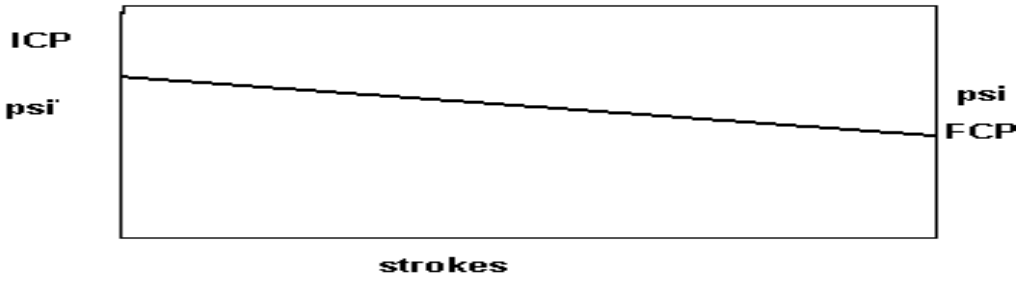
C. Killing Procedures

1. Wait and Weight Method.
2. Driller's Method.
3. Concurrent Method.

1.Wait and Weight Method.

The well is shut-in, the surface mud is weighted and the kill weight mud is pumped in one cycle.

- Initial circulating pressure=SIDPP+SPR
- Final circ. Pressure= SPRx (KWM/OMW)



2. The Driller Method.

1.The influx is pumped out first,

2.The well is shut-in until the mud is weighted,

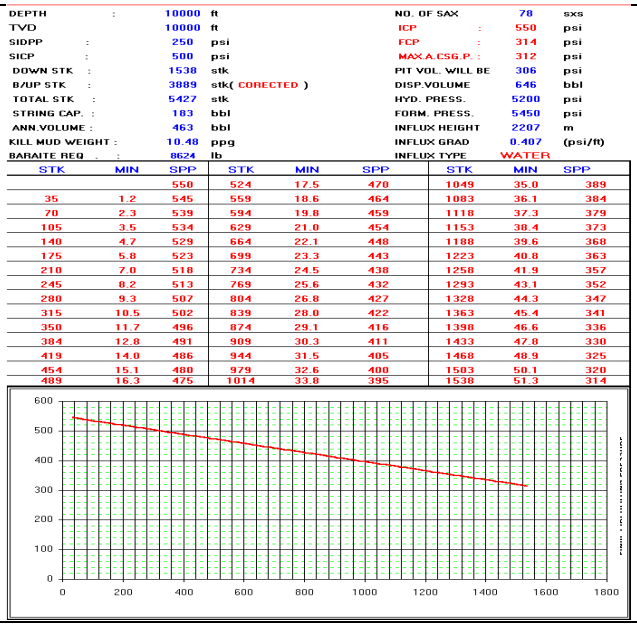
3.The kill weight mud is then pumped.

3. The Concurrent Method.

1. Pumping is begun immediately and the mud weight is raised while circulating the kick out.
2. It needs several cycles of circulation.

Kill Sheet

The kill sheet includes:
all the necessary data for killing the well including
the drop down pressure against pumped strokes.



DEPTH	:	10000	ft	NO. OF SAX		78	sxs	
TVD		10000	ft	ICP	:	550	psi	
SIDPP	:	250	psi	FCP	:	314	psi	
SICP	:	500	psi	MAX.A.CSG.P.	:	312	psi	
DOWN STK	:	1538	stk	PIT VOL. WILL BE		306	psi	
B/UP STK	:	3889	stk(CORECTED)	DISP.VOLUME		646	bbl	
TOTAL STK	:	5427	stk	HYD. PRESS.		5200	psi	
STRING CAP.	:	183	bbl	FORM. PRESS.		5450	psi	
ANN.VOLUME	:	463	bbl	INFLUX HEIGHT		2207	m	
KILL MUD WEIGHT	:	10.48	ppg	INFLUX GRAD		0.407	(psi/ft)	
BARAITE REQ.	:	8624	lb	INFLUX TYPE		WATER		

STK	MIN	SPP	STK	MIN	SPP	STK	MIN	SPP
		550	524	17.5	470	1049	35.0	389
35	1.2	545	559	18.6	464	1083	36.1	384
70	2.3	539	594	19.8	459	1118	37.3	379
105	3.5	534	629	21.0	454	1153	38.4	373
140	4.7	529	664	22.1	448	1188	39.6	368
175	5.8	523	699	23.3	443	1223	40.8	363
210	7.0	518	734	24.5	438	1258	41.9	357
245	8.2	513	769	25.6	432	1293	43.1	352
280	9.3	507	804	26.8	427	1328	44.3	347
315	10.5	502	839	28.0	422	1363	45.4	341
350	11.7	496	874	29.1	416	1398	46.6	336
384	12.8	491	909	30.3	411	1433	47.8	330
419	14.0	486	944	31.5	405	1468	48.9	325
454	15.1	480	979	32.6	400	1503	50.1	320
489	16.3	475	1014	33.8	395	1538	51.3	314

Kick Tolerance

((Is the maximum allowable pressure or its equivalent ppg that the weakest point in a wellbore can withstand))

- The weakest point is the casing shoe.
- No influx in the wellbore.
- **Kick toleance= [Shoe depth * (FR – MW)]/Depth.**

II. Stuck pipe

Drilling string cannot be raised, lowered or rotate.

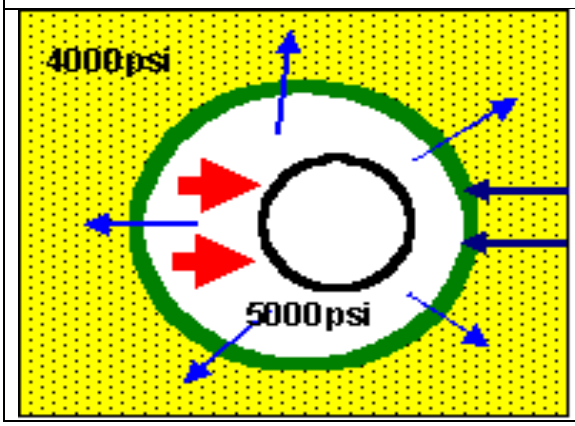
Mechanisms of stuck pipe

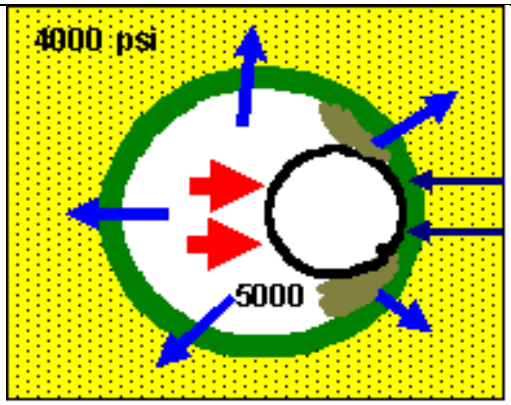
A. Differential Stuck.

B. Wellbore Geometry.

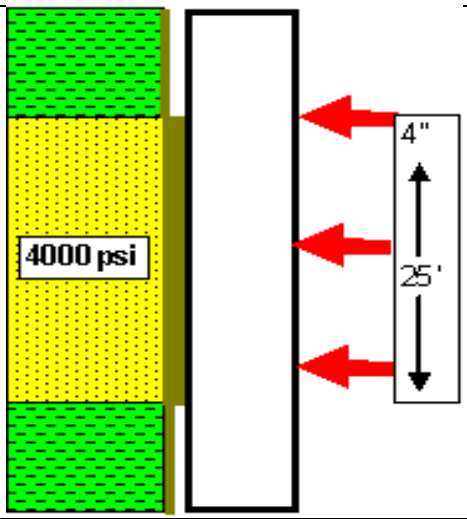
C. Hole packing off.

A. Differential Stuck
Sticking of pipe against a permeable formation as the result of the pressure of the mud in the hole exceeding the bore fluid pressure.





Differential sticking



- Stuck breadth = 4”
- Stuck length = 25’
- Fm pressure = 4000 psi
- H pressure = 5000 psi
- D. F=4*25*12*(5000-4000)
- **1,200,000**lbs

Differential sticking

- **Cause:**
  - Drill string contacts a permeable zone.
  - Developing of static filter cake.
  - High differential force.

- **Warning:**
    - Prognosed low pressure sands
    - Long / unstabilized BHA.
    - Increasing overpull, slack off weight or torque to start string movement.
- **First action:**
    - Apply torque and jar down with maximum trip load.
    - Spot a pipe releasing pill if the string does not jar free.

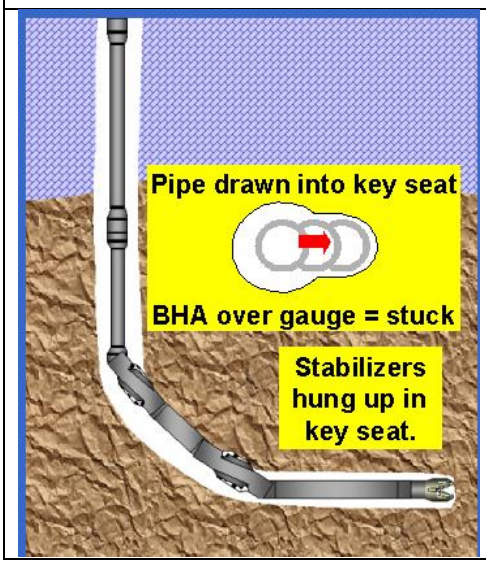
Preventing Action

1. Maintain minimum required mud weight.
2. Keep string moving when BHA is opposite suspected zones.
3. Minimize seepage loss in low pressure zones.
4. Minimize unstabilized BHA & use spiral DC.
5. Control drill suspected zones

B. Wellbore Geometry

Hole diameter and / or angle relative to BHA geometry and / or stiffness will not allow passage of the drill string

1. Key seat
2. Microdoglegs
3. Ledges
4. Stiff assembly
5. Mobile formation
6. Under gauge hole

Key Seat	
	Causes: 1. Abrupt change in angle or direction in soft formations. 2. High string tension and pipe rotation wears a slot into the formation. 3. While POOH the drill collars jam into the slot.

Warning, indications, first action

Warning:

1. High angle doge leg in upper hole section.
2. Long drilling hours with no wiper trips through the dogleged section
3. Cyclic over pull at tool joint intervals on trips.

Indications:

1. Occurs only while POOH.
2. Sudden over pull as BHA reaches dogleg depth.
3. Unrestricted circulation.
4. Free string movement below key seat depth.

First action:

Applay torque and jar down.

Attempt to rotate with low over pull to work through dogleg.

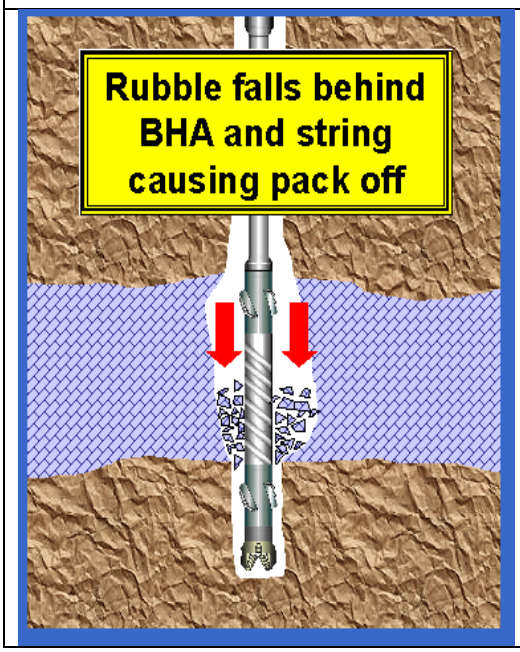
Preventive Action

- Minimize dog leg severity to 3deg/100’ or less.
- Limit over pull through suspected intervals.
- Run string reamer or key seat wiper if suspected.

C. Packing Off & Bridging

Formation cuttings cavings or medium to large pieces of hard formation, cement or junk settle around the drill string and pack off/bridging the annulus.

1. Settled cuttings
2. Shale instability +
3. Unconsolidated formations
4. Fractured formations
5. Cement related.
6. Junk.

Settled Cutting Straight Hole	
	Causes: • Low annular velocity and/or poor mud properties. • When circulation is stopped, the cuttings fall back down the hole and pack off the drill string.

Warning:

1. High ROP, low pump rate, little to no circulation time at connections.
2. Torque, drag and pump pressure increase.
3. Over pull off slips, pump surge to break circulation
4. Fill on bottom.

Indications:

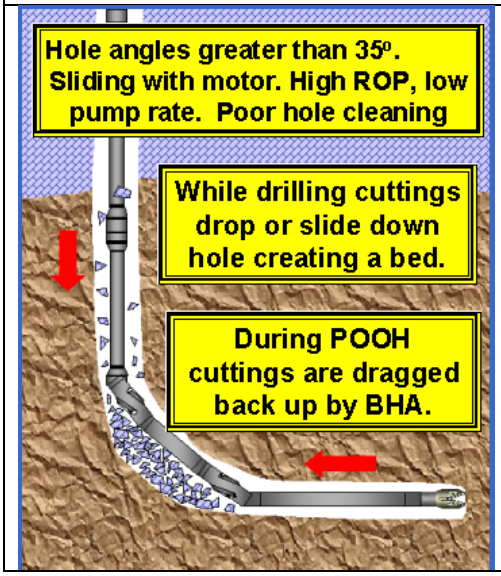
1. Likely to occure on connections.
2. Possible during trips.
3. Circulation restricted or impossible.

First action:

- Applay low pump pressure (200-400psi).
- Apply torque and jar down.
- Circulate clean to avoid recurrence.

Preventive Action:

- Control ROP, maximize annular velocity.
- Maintain sufficient gel strength and YP.
- Circulate 5- 10 min before connections.
- Circulation clean before POOH.

Settled Cutting Deviated Hole	
	**Causes:** • Drill cuttings settle on the low side forming a cutting bed. • The cutting bed builds and slide down hole. • While POOH the cuttings is dragged upward by the BHA

Warning:

1. Hole angle > 35deg..
2. Drilling with a down hole motor.
3. High ROP, low GPM, increase torque, increase pump pressure.

Indications:

1. Likely to occure while POOH, possible while drilling.
2. Increase overpull on trips.
3. Circulating pressure restricted or impossible

First action:

- Apply low pump pressure (100-400psi).
- Jar down & Apply torque with caution .
- Circulate clean to avoid recurrence.

Preventive Action:

- Record trend indicators for inadequate hole cleaning.
- Control ROP, maintain mud properties, maximize annular velocity, maximize string rotation.
- Circulation clean before POOH.
- Use low vis/high vis density sweps.