Drilling Fluids-Related Problems

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Lost circulation

- One of the major problems in drilling operation
- **Definition: Partial or complete loss of drilling fluid during drilling, tripping, or running casing.**
- Occurred in almost every formation and at virtually all depths
- Occurs when hydrostatic pressure of mud exceeds the breaking strength of the formation

Causes of Lost Circulation

1. Formations that are inherently fractured, cavernous, or have high permeability
2. Rapid running of pipe i.e., generating surge pressures (tripping in)
3. Raising mud weight too quickly
4. Improper balanced column of mud ($P_{hyd} > P_f$)
5. Increasing pump pressure too quickly
6. High gel strength
7. Sloughing shales (closed annular space)

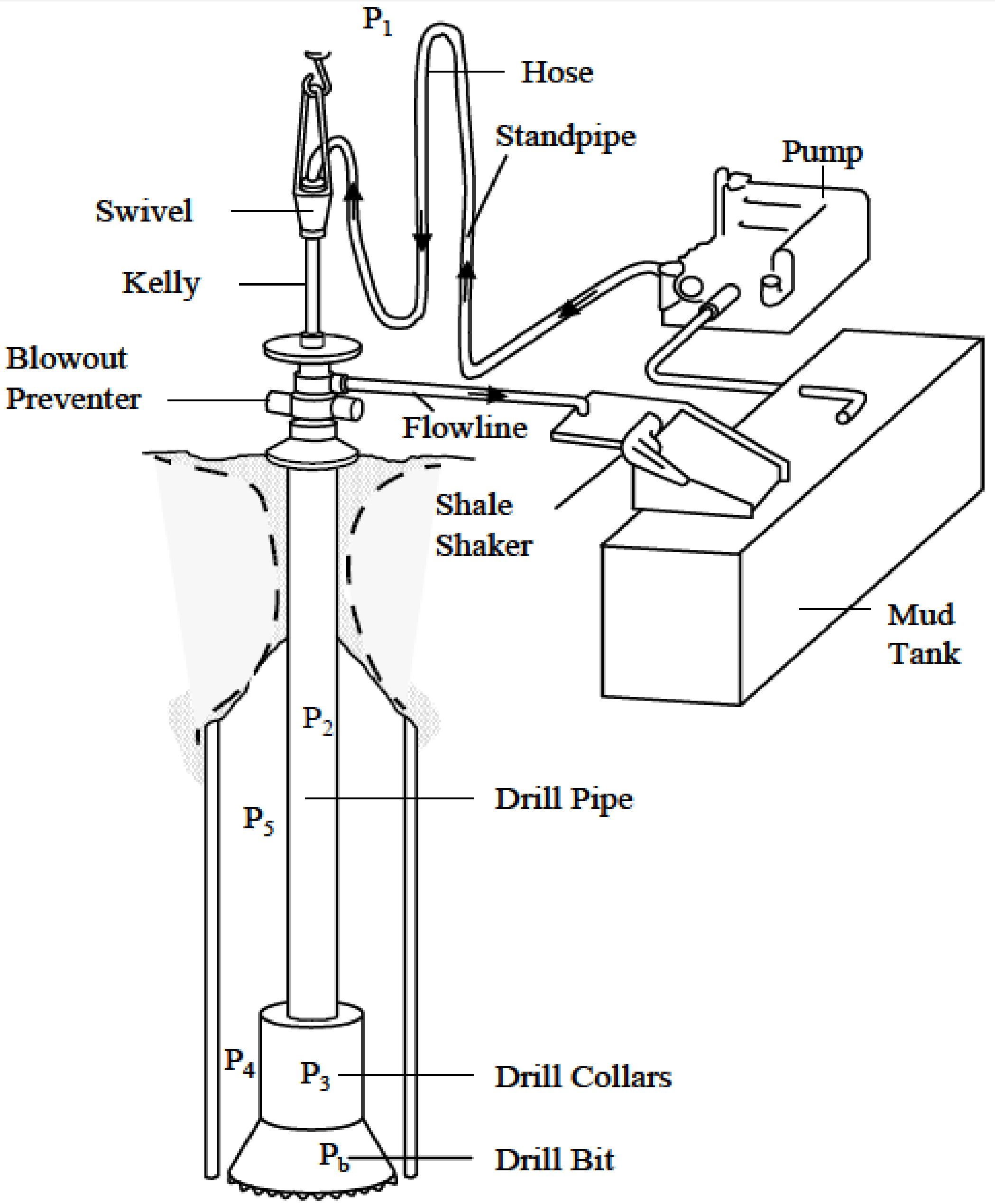
Remedial actions

1. Maintaining proper mud weight
2. Minimizing annular-friction pressure losses during drilling and tripping in
3. Adequate hole cleaning
4. Avoiding restrictions in the annular space
5. Setting casing to protect upper weaker formations within a transition zone
6. Updating formation pore pressure and fracture gradients for better accuracy with log and drilling data

Practical Rig Hydraulics

Improperly designed hydraulics systems can cause

- slow drill rate
- fail to clean the hole of cuttings
- cause kicks


P1
Hose
Standpipe
Pump
Swivel
Kelly
Blowout Preventer
Flowline
Shale Shaker
Mud Tank
P2
Drill Pipe
P5
P4
P3
Drill Collars
Pb
Drill Bit

Hydraulics System Purposes

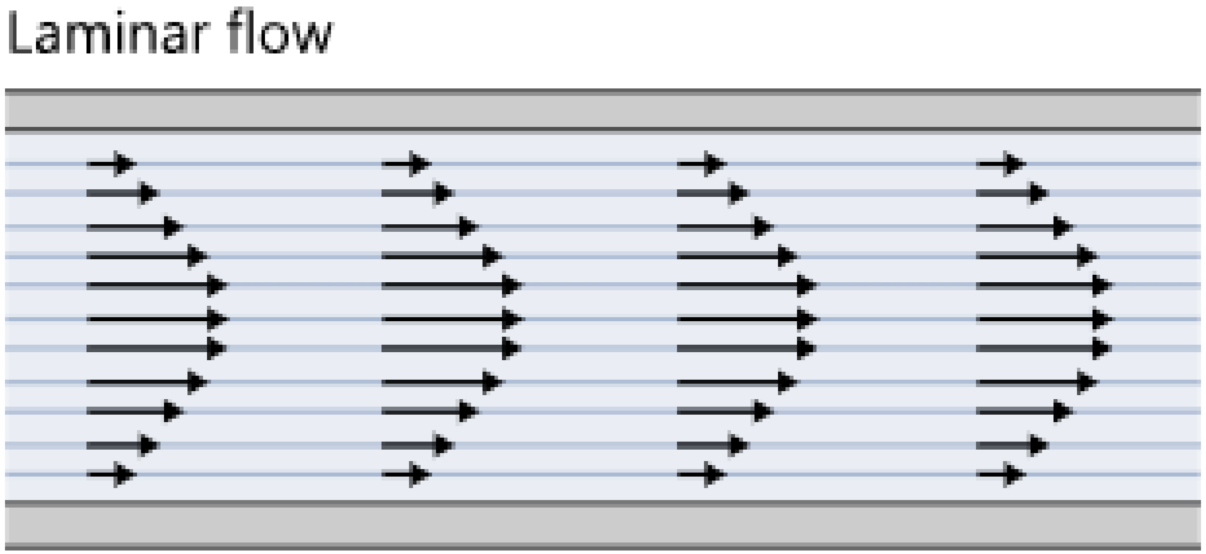
1) Control subsurface pressures
2) Cutting transport and remove cuttings from below the bit
3) Provide a buoyant effect to the drill string and casing
4) clean the bit
5) Minimize wellbore pressure reductions from swabbing when pulling pipe from the well
6) Maintain control of the well during kicks

Flow Regimes

1. Laminar
2. Turbulent
3. Transitional

Laminar flow

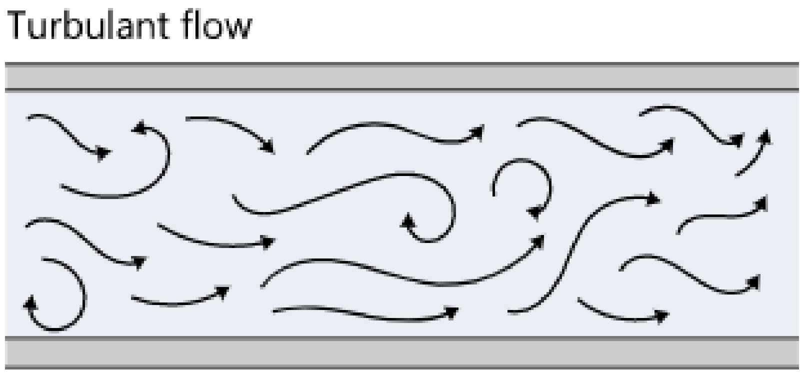
In laminar flow, fluid layers flow parallel to each other in an orderly fashion. This flow occurs at low to moderate shear rates when friction between the fluid and the channel walls is at its lowest. This is a typical flow in the annulus of most wells.



Turbulent flow

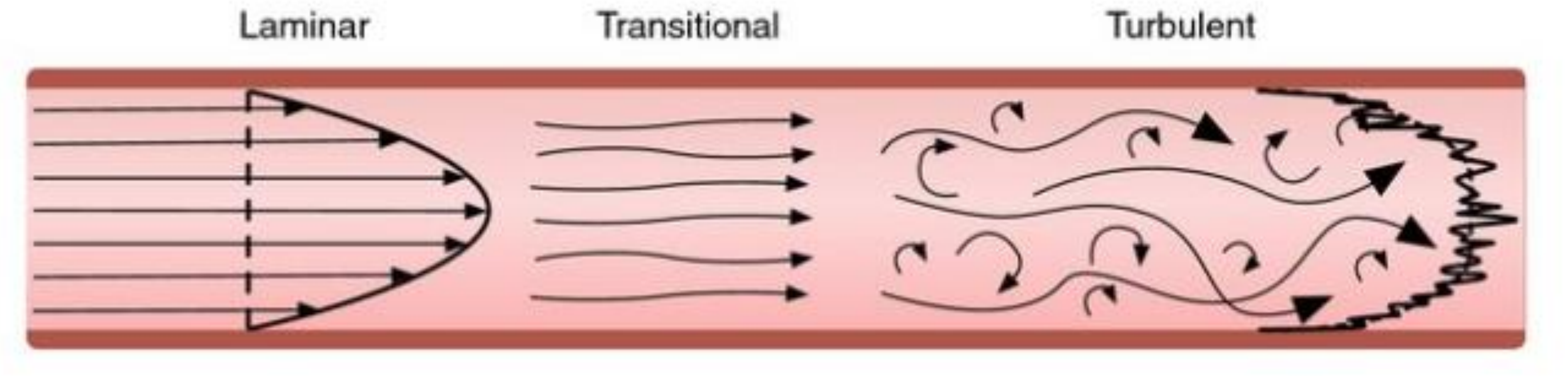
This flow occurs at high shear a rate where the fluid particle move in a disorderly and chaotic manner and particles are pushed forward by current eddies. Friction between the fluid and the channel walls is highest for this type of flow. This is a typical flow inside the drill pipe and drill collars.

Unlike laminar flow, mud parameters (viscosity and yield point) are not significant in calculating frictional pressure losses for muds in turbulent flow.



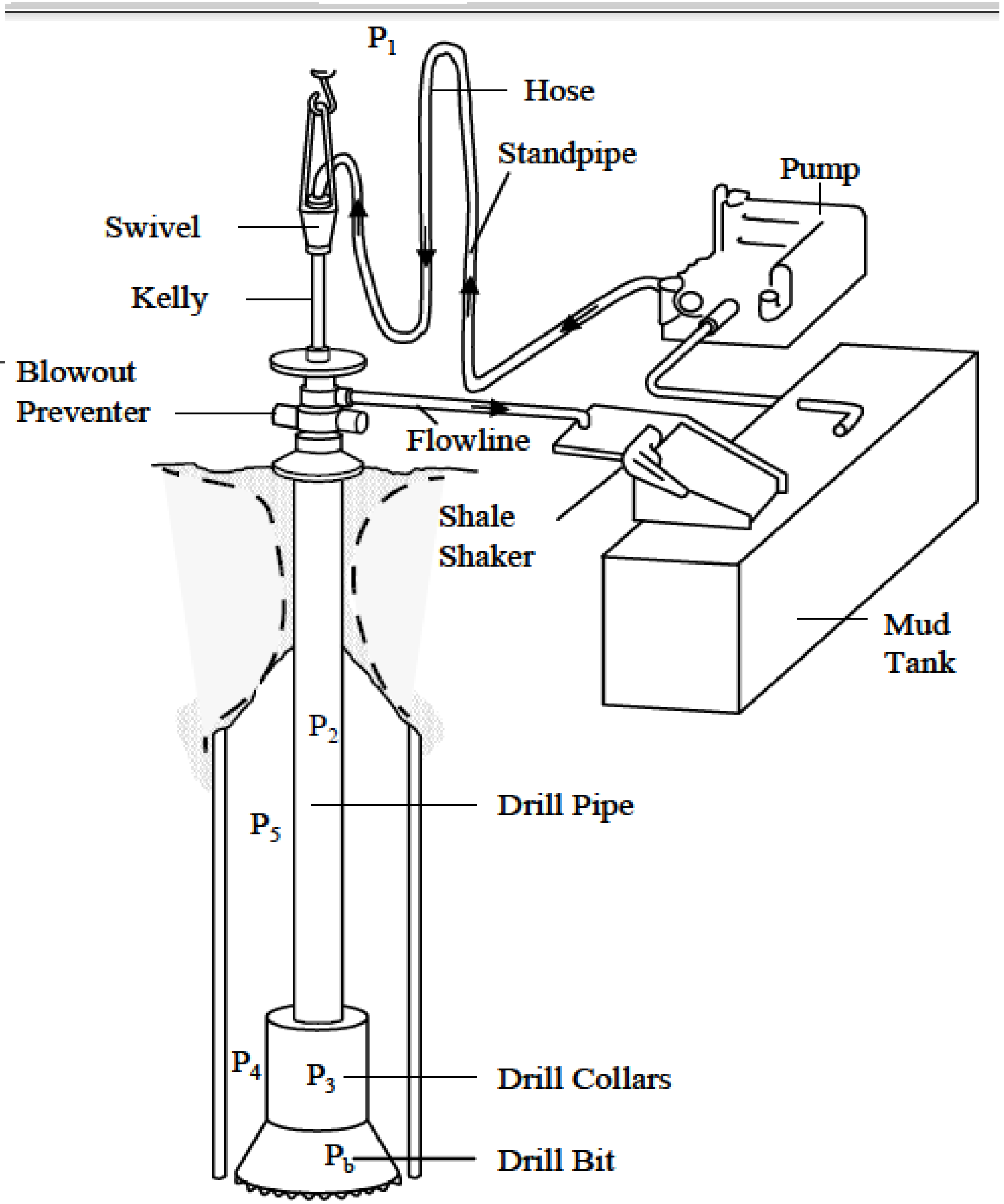
Transitional flow

- occurs when the fluid flow changes from laminar to turbulent or vice versa.



Pressure Loss

1. Surface connections
2. Pipes including drill pipe, heavy drill pipe and drill collars
3. Annular areas around drill pipes, drill collars
4. Drill bit



Surface Connection Losses (P1)

Pressure losses in surface connections (P_1) are those taking place in standpipe, rotary hose, swivel and kelly.

The following general equation may be used to evaluate pressure losses in surface connections:

$$\Delta P_s \text{ (psi) or } P_1 = E * \rho^{0.8} * Q^{1.8} * PV^{0.2}$$

ρ = Mud weight (lbm/gal) ppg

Q = Volume rate (gpm)

E = A constant depending on type of surface equipment used

PV = Plastic viscosity (cp)

Table (3): Types of surface equipment

Case	Standpipe	Hose	Swivel	Kelly	Eq. Length 3.826 in ID
1	40 ft long 3 in ID	45 ft long 2 in ID	20 ft long 2 in ID	40 ft long 2.25 in ID	2600ft
2	40 ft long 3.5 in ID	55 ft long 2.5 in ID	25 ft long 2.5 in ID	40 ft long 3.25 in ID	946ft
3	45 ft long 4 in ID	55 ft long 3 in ID	25 ft long 2.5 in ID	40 ft long 3.25 in ID	610ft
4	45 ft long 4 in ID	55 ft long 3 in ID	30 ft long 3 in ID	40 ft long 4 in ID	424ft

Table (4): Values of constant E

Surface equipment type	Value of E	
	Imperial units	**Metric units**
1	$2.5*10^{-4}$	$8.8*10^{-6}$
2	$9.6*10^{-5}$	$3.3*10^{-6}$
3	$5.3*10^{-5}$	$1.8*10^{-6}$
4	$4.2*10^{-5}$	$1.4*10^{-6}$