

Section 1. Filled-in kill sheet exercises - Gauge problem exercises

Gauge problem exercises are created from a pre-completed kill sheet containing all relevant volume and pressure calculations.

Each question is based on strokes, pump rate, drillpipe and casing gauge readings at a specific point in time during well kill operation. Any one or a combination of these readings could indicate the action required. Options are shown in the multiple-choice answers.

The casing and/or drillpipe pressures will only be relevant to the action if:

 The casing and/or drillpipe pressures given in the question are below the expected pressures.

or

 The casing and/or drillpipe pressures given in the question are 70 psi or more above the expected pressures.

Section 2. Calculation formula

Abbreviation	Term		
0.052	constant factor		
bbl	barrels (us)		
bbl/ft	barrels (us) per foot		
bbl/min	barrels (us) per minute		
bbl/stroke	barrels (us) per stroke		
BHP	bottomhole pressure		
ВОР	blowout preventer		
ft	feet		
ft/hr	feet per hour		
ft/min	feet per minute		
lb/bbl	pounds per barrel		
LOT	leak-off test		
MAASP	maximum allowable annular surface pressure		
ppg	pounds per gallon		
psi	pounds per square inch (pressure)		
psi/ft	pounds per square inch per foot		
psi/hr	pounds per square inch per hour		
SICP	shut-in casing pressure		
SIDPP	shut-in drillpipe pressure		
SPM	strokes per minute		
TVD	true vertical depth		



1. Hydrostatic pressure (psi)

2. Pressure gradient (psi/ft)

3. Fluid density (ppg)

or

$$\frac{\text{hydrostatic pressure (psi)}}{\text{TVD (ft)} \times 0.052}$$

4. Formation pressure (psi)

hydrostatic pressure in drillstring (psi) + SIDPP (psi)

5. Pump output (bbl/min)

pump displacement (bbl/stroke) × pump rate (SPM)

6. Equivalent circulating density (ppg)

fluid density (ppg) + (annular pressure loss (psi)
$$\div$$
 TVD (ft) \div 0.052) or fluid density (ppg) + $\left(\frac{\text{annular pressure loss (psi)}}{\text{TVD (ft)}}\right)$

7. Fluid density (ppg) with trip margin (psi) included

fluid density (ppg) + (trip margin (psi) ÷ TVD (ft) ÷ 0.052) or fluid density (ppg) +
$$\left(\frac{\text{trip margin (psi)}}{\text{TVD (ft)} \times 0.052}\right)$$

8. New pump pressure (psi) with new pump rate (SPM) (approximate)

current pump pressure (psi)
$$\times \left(\frac{\text{new pump rate (SPM)}}{\text{current pump rate (SPM)}}\right)^2$$



9. New pump pressure (psi) with new fluid density (ppg) (approximate)

current pump pressure (psi)
$$\times \left(\frac{\text{new fluid density (ppg)}}{\text{current fluid density (ppg)}}\right)$$

10. Maximum allowable fluid density (ppg)

LOT fluid density (ppg) + (surface LOT pressure (psi)
$$\div$$
 casing shoe TVD (ft) \div 0.052) or LOT fluid density (ppg) + $\left(\frac{\text{surface LOT pressure (psi)}}{\text{casing shoe TVD (ft)}}\right)$

11. MAASP (psi)

(maximum allowable fluid density (ppg) - current fluid density (ppg)) × 0.052 × casing shoe TVD (ft)

12. Kill fluid density (ppg)

current fluid density (ppg) + (SIDPP (psi)
$$\div$$
 TVD (ft) \div 0.052) or current fluid density (ppg) + $\left(\frac{\text{SIDPP (psi)}}{\text{TVD (ft)} \times 0.052}\right)$

13. Initial circulating pressure (psi)

circulating pressure at kill rate (psi) + SIDPP (psi)

14. Final circulating pressure (psi)

$$\left(\frac{\text{kill fluid density (ppg)}}{\text{current fluid density (ppg)}}\right) \times \text{circulating pressure at kill rate (psi)}$$

15. Gas migration rate (ft/hr)

rate of increase in surface pressure (psi/hr) ÷ fluid density (ppg) ÷ 0.052

or

rate of increase in surface pressure (psi/hr)

fluid density (ppg) × 0.052



16. Gas laws

$$P_1 \times V_1 = P_2 \times V_2$$

$$P_1 = \frac{P_2 \times V_2}{V_1}$$
 $V_1 = \frac{P_2 \times V_2}{P_1}$

$$V_1 = \frac{P_2 \times V_2}{P_1}$$

$$P_2 = \frac{P_1 \times V_1}{V_2}$$

$$P_2 = \frac{P_1 \times V_1}{V_2}$$
 $V_2 = \frac{P_1 \times V_1}{P_2}$

17. Pressure drop per foot tripping dry pipe (psi/ft)

fluid density (ppg) \times 0.052 \times metal displacement (bbl/ft) riser or casing capacity (bbl/ft) - metal displacement (bblft)

18. Pressure drop per foot tripping wet pipe (psi/ft)

fluid density (ppg) \times 0.052 \times closed end displacement (bbl/ft) riser or casing capacity (bbl/ft) - closed end displacement (bbl/ft)

19. Level drop pulling remaining collars out of well dry (ft)

length of collars (ft) × metal displacement (bbl/ft) riser or casing capacity (bbl/ft)

20. Level drop pulling remaining collars out of well wet (ft)

length of collars (ft) × closed end displacement (bbl/ft) riser or casing capacity (bbl/ft)

21. Length of tubulars to pull dry before overbalance is lost (ft)

overbalance (psi) × (riser or casing capacity (bbl/ft) - metal displacement (bbl/ft)) fluid gradient (psi/ft) × metal displacement (bbl/ft)

or

overbalance (psi) × (riser or casing capacity (bbl/ft) - metal displacement (bbl/ft)) fluid density (ppg) × 0.052 × metal displacement (bbl/ft)

22. Length of tubulars to pull wet before overbalance is lost (ft)

overbalance (psi) × (riser or casing capacity (bbl/ft) - closed end displacement (bbl/ft)) fluid gradient (psi/ft) × closed end displacement (bbl/ft)

or

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May 2024	EX-0035	Version 3.0	Page 4 of 5



overbalance (psi) × (riser or casing capacity (bbl/ft) - closed end displacement (bbl/ft))

fluid density (ppg) × 0.052 × closed end displacement (bbl/ft)

23. Volume to bleed due to gas migration in a vertical well (bbl)

working pressure to bleed (psi)
$$\times \left(\frac{\text{annular capacity (bbl/ft)}}{\text{pressure gradient (psi/ft)}}\right)$$
 or working pressure to bleed (psi) $\times \left(\frac{\text{annular capacity (bbl/ft)}}{\text{fluid density (ppg)}} \times 0.052\right)$

24. Slug volume (bbl) for a given length of dry pipe

25. Pit gain due to slug U-tubing (bbl)

slug volume (bbl)
$$\times \left(\frac{\text{slug density (ppg)}}{\text{current fluid density (ppg)}} - 1 \right)$$

26. Riser margin (ppg)

$$\frac{\left(\left(\text{air gap (ft)} + \text{water depth (ft)}\right) \times \text{fluid density (ppg)}\right) - \left(\text{water depth (ft)} \times \text{water density (ppg)}\right)}{\text{TVD (ft)} - \text{air gap (ft)} - \text{water depth (ft)}}$$

27. Hydrostatic pressure loss if casing float fails (psi)

May 2024 EX-0035 Version 3.0 Page 5 of 5