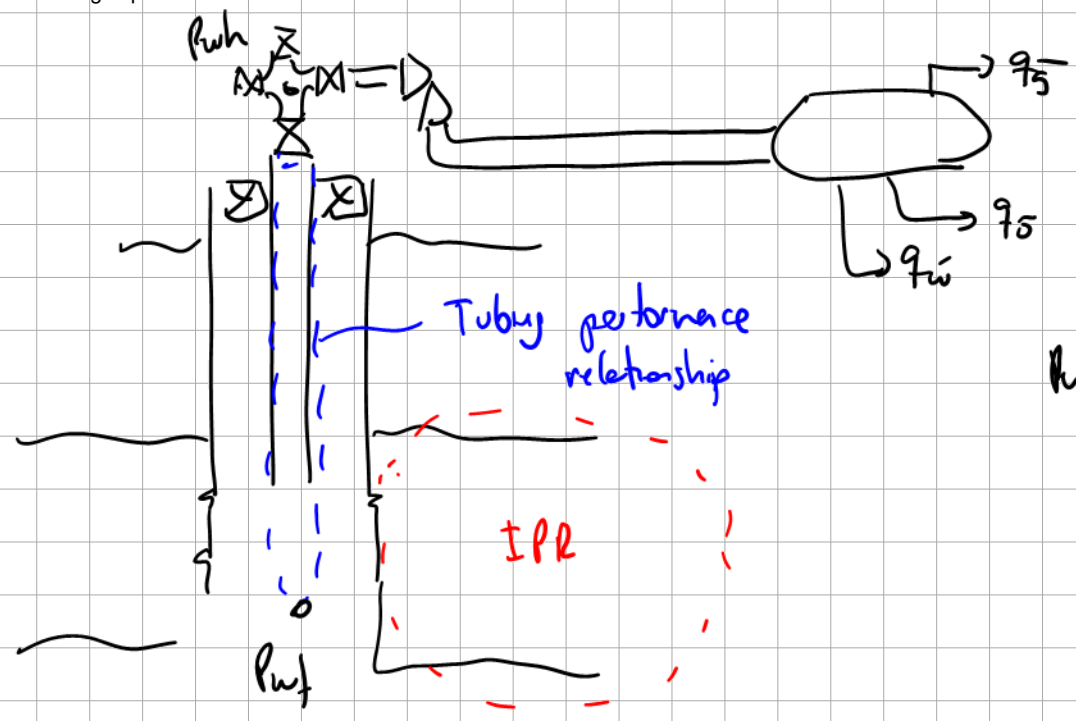
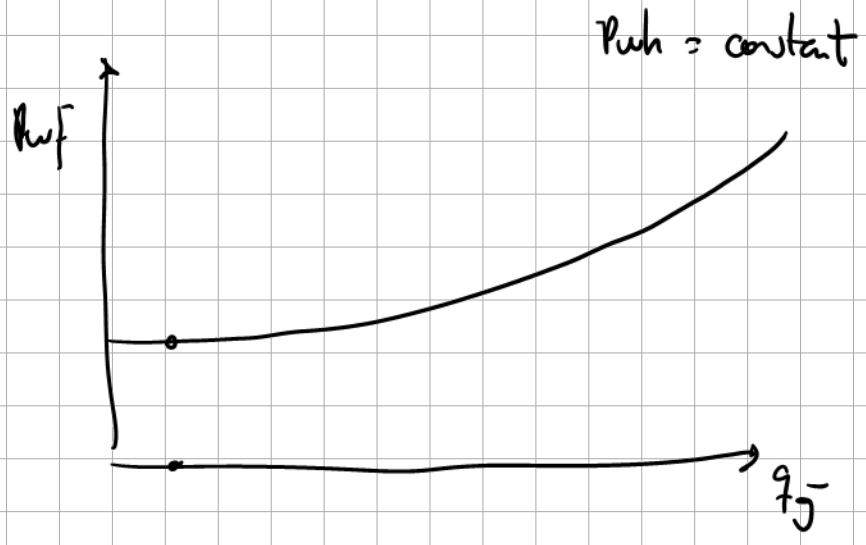
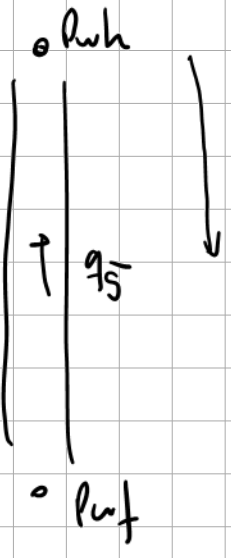
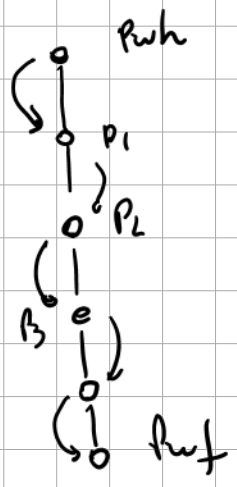
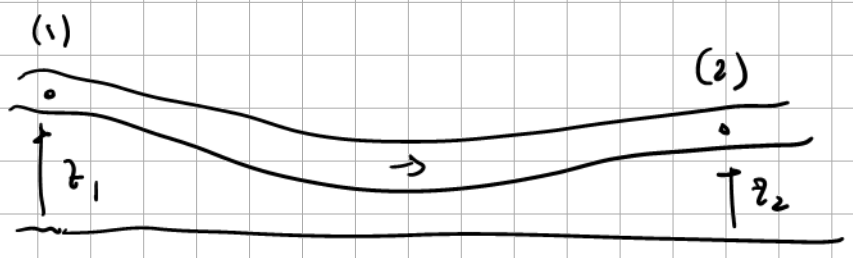






Caller current to calculate Pwf (pressure integration)





Lead → $h_1 = h_2$ (no energy losses) $\quad h = z + \frac{p}{\rho g} + \frac{v^2}{2g}$ incompressible !!

$h_1 = h_2 + \Delta h_{losses}$ $\quad \Delta h_{losses} = \Delta h_{accessories} + \Delta h_{friction}$

$\Delta h_{accessories} \to 0$ values restrictions

$\Delta h_{friction} = f \frac{L}{\phi} \frac{v^2}{2g}$

f ← Moody friction factor

$h_1 = z_1 + \frac{p_1}{\rho g} + \frac{v_1^2}{2g} = z_2 + \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + f \frac{L}{\phi} \frac{v^2}{2g}$

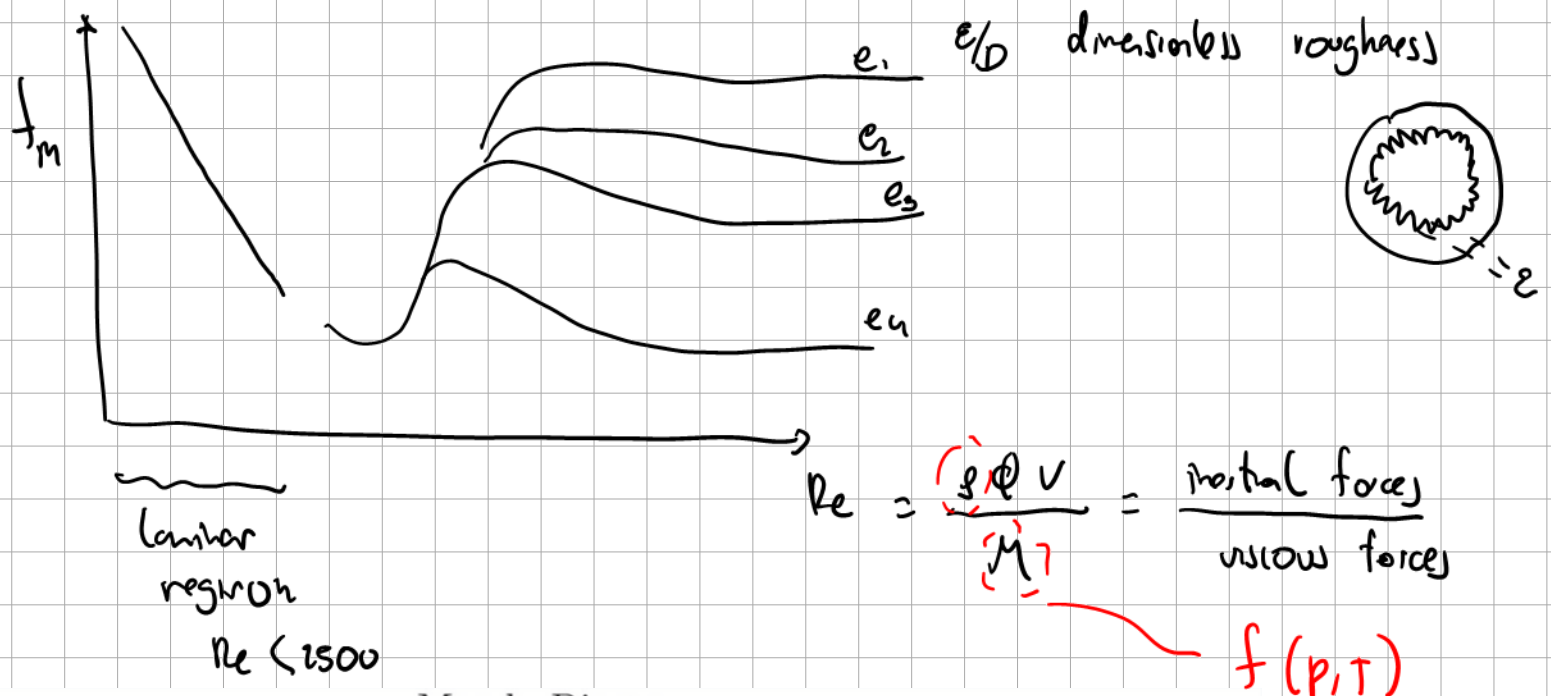
its incompressible, so $v_1 = v_2 = v$

ϕ = constant

$\Delta p = (p_1 - p_2) = \rho \cdot g \cdot \left((z_2 - z_1) + f \frac{L}{\phi} \frac{\rho g}{2g} v^2 \right)$

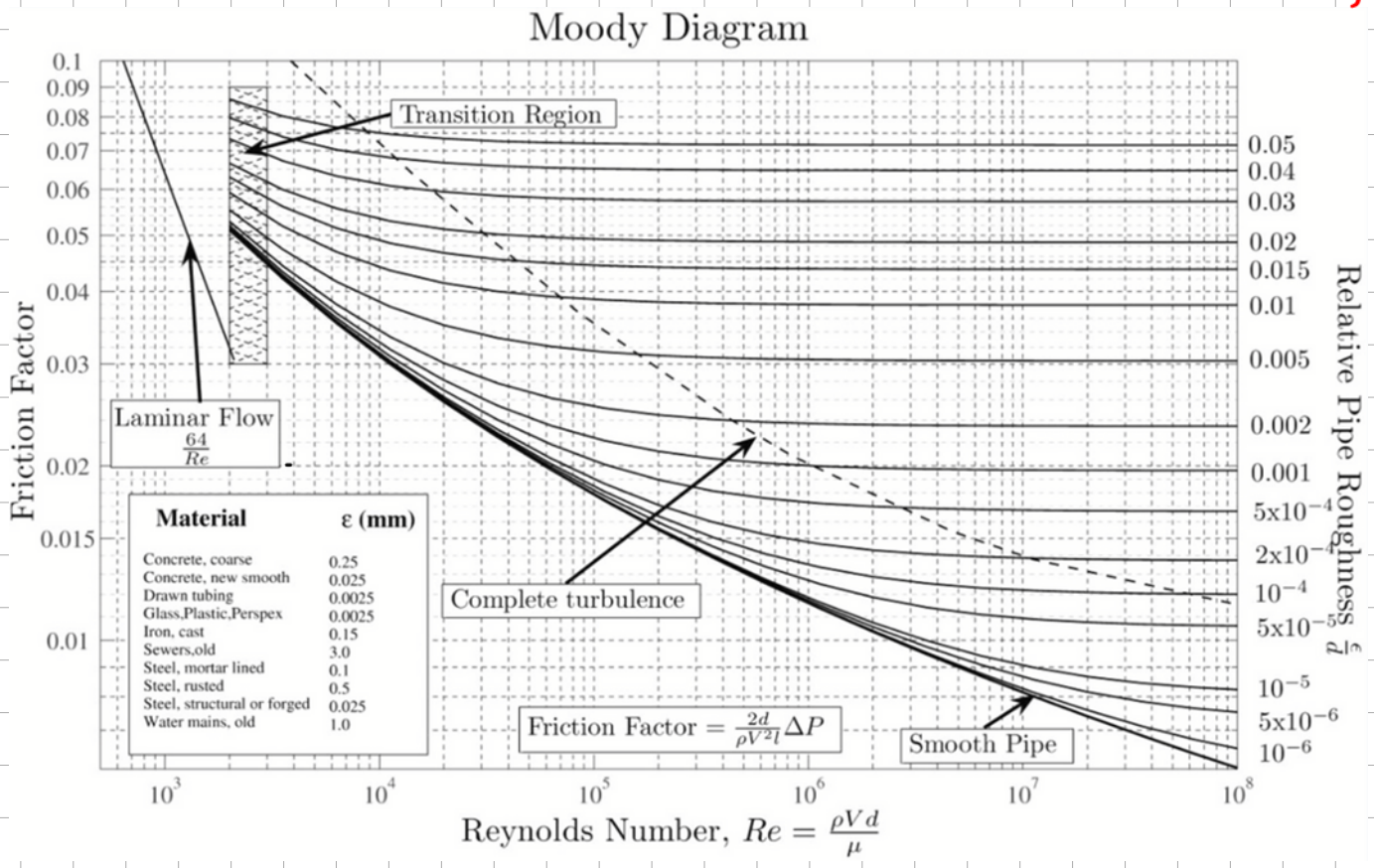
$(p_1 - p_2) = \underbrace{\Delta z \cdot \rho g}_{\text{hydrostatic}} + \underbrace{f \frac{L}{\phi} \rho \frac{v^2}{2}}_{\text{friction}}$

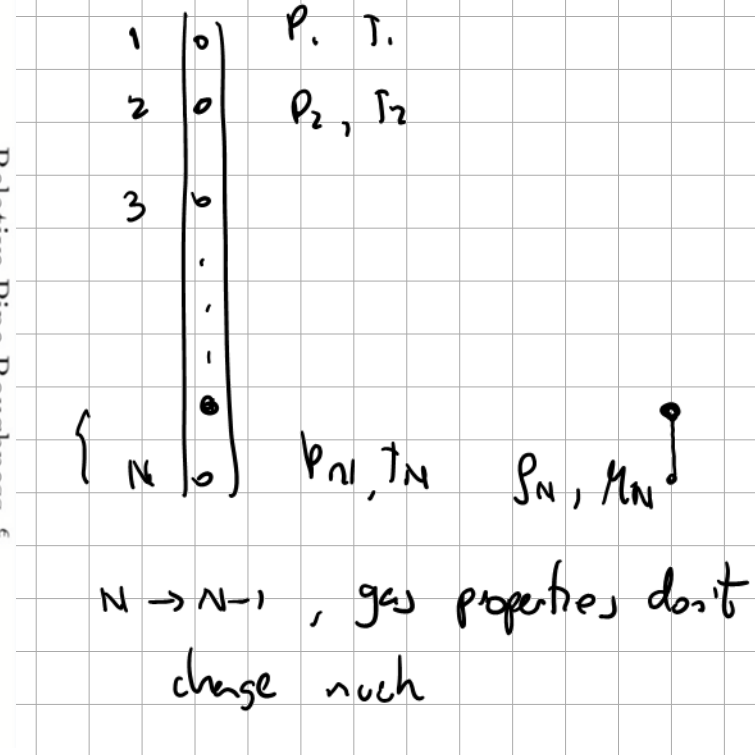
for gas $\rho = f(p, T)$



$$Re = \frac{\rho v}{\mu} = \frac{\text{inertial forces}}{\text{viscous forces}}$$

$\rho = f(p,T)$





$N \to N-1$, gas properties don't change much

valid if ΔL is small

ΔT
Δp is small

$$v_g = \frac{q_g}{A} = \frac{q_{\bar{s}} B_g(p,T)}{A}$$

$$B_g = \frac{q_g}{q_{\bar{s}}}$$

$$q_{\bar{s}} \cdot \rho_{\bar{s}} = q_s \cdot \rho_s$$

$$B_g = \frac{q_g}{q_{\bar{s}}} = \frac{\rho_{\bar{s}}}{\rho_g} = \frac{zT\left(\frac{p_{sc}}{p}\right)}{T_{sc}}$$

$$\rho_{\bar{s}} = \frac{p_{sc}}{R z_{sc} T_{sc}}$$

$m^3/d \quad \frac{1d}{24h} \quad \frac{1h}{3600s}$

$$\rho_s = \frac{p}{zRT}$$

qg [Sm3/d]	2.85E+06
Gas gravity	0.7
Tubing ID [m]	0.157
Tubing cross section area [m2]	0.019
Tubing roughness [m]	1.50E-06

TVD [m]	p [bara]	T [C]	Z [-]	deng [kg/m3]	Bg [m3/Sm3]	viscg [cp]	qg [m3/d]	vg [m/s]	p-calc [bara]
0	40	87	0.948	28.6	3.00E-02	1.36E-02	8.54E+04	51.03	
284	46	89	0.942	32.9	2.60E-02	1.38E-02	7.41E+04	44.28	
567	51	90	0.938	36.8	2.32E-02	1.39E-02	6.63E+04	39.61	
851	56	92	0.934	40.4	2.12E-02	1.41E-02	6.04E+04	36.14	
1135	61	94	0.930	43.6	1.96E-02	1.43E-02	5.59E+04	33.43	
1418	66	96	0.928	46.7	1.83E-02	1.45E-02	5.23E+04	31.25	
1702	70	98	0.926	49.5	1.73E-02	1.46E-02	4.92E+04	29.44	
1986	74	99	0.924	52.2	1.64E-02	1.48E-02	4.67E+04	27.92	
2269	78	101	0.922	54.8	1.56E-02	1.49E-02	4.45E+04	26.61	
2553	81	103	0.921	57.3	1.49E-02	1.51E-02	4.26E+04	25.47	
2837	85	105	0.920	59.6	1.44E-02	1.52E-02	4.09E+04	24.46	

2837 - 2553

$p_{N-1} = p_{wf} - \rho \cdot g \, \Delta z - f \frac{L}{D} \rho \frac{v^2}{2}$

using conditions at p_{wf} !

```
Function Pout(qtl, ID, den, visc, Length, teta, pin, roughness)
    'Function that give pressure available at the oulet of a pipe with a flow qt and inlet pressure pressure pin
    'Calculation made for liquid single phase flow
    'Takes in data in SI
    'qt flow [m^3/d]
    'ID inner diameter of pipe [m]
    'den density of fluid, [kg/m^3]
    'visc viscosity of fluid, [Pa s]
    'Length, pipe length, [m]
    'teta inclination angle of pipe with respect to horizontal [°]
    'pin, discharge pressure required, [bara]
    'roughness of pipe [m]

    'Gravitational acceleration g, [m/s(2]
    g = 9.81
    'Pi number
    Pi = 4 * Atn(1)
    qt = qtl / (3600# * 24#)  '[m^3/s]

    'Calculating area and velocity
    Area = Pi * (ID ^ 2) / 4
    v = qt / Area

    Presscalcl = pin - (Length * Sin(teta * Pi / 180) * den * g / 100000#) - (ffactor(den, visc, ID, roughness, v) * Length * (v ^ 2) * den / (ID * 200000#))
    Pout = Presscalcl

End Function
```

change for m3/d to m3/s

dividing by 1E5 to take from Pa to bara

TVD [m]	p [bara]	T [C]	Z [-]	deng [kg/m3]	Bg [m3/Sm3]	viscg [cp]	qg [m3/d]	vg [m/s]	p-calc [bara]
0	40	87	0.948	28.6	3.00E-02	1.36E-02	8.54E+04	51.03	35.55
284	46	89	0.942	32.9	2.60E-02	1.38E-02	7.41E+04	44.28	41.50
567	51	90	0.938	36.8	2.32E-02	1.39E-02	6.63E+04	39.61	47.03
851	56	92	0.934	40.4	2.12E-02	1.41E-02	6.04E+04	36.14	52.27
1135	61	94	0.930	43.6	1.96E-02	1.43E-02	5.59E+04	33.43	57.29
1418	66	96	0.928	46.7	1.83E-02	1.45E-02	5.23E+04	31.25	62.15
1702	70	98	0.926	49.5	1.73E-02	1.46E-02	4.92E+04	29.44	66.88
1986	74	99	0.924	52.2	1.64E-02	1.48E-02	4.67E+04	27.92	71.52
2269	78	101	0.922	54.8	1.56E-02	1.49E-02	4.45E+04	26.61	76.08
2553	81	103	0.921	57.3	1.49E-02	1.51E-02	4.26E+04	25.47	80.59
2837	85	105	0.920	59.6	1.44E-02	1.52E-02	4.09E+04	24.46	85.04

surprisingly close !