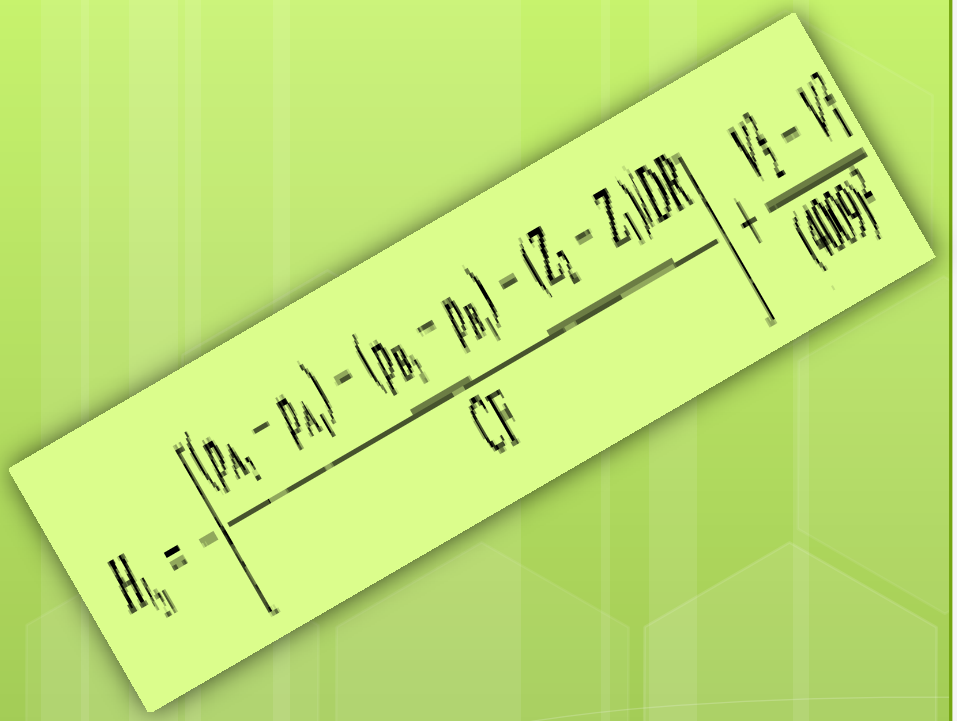

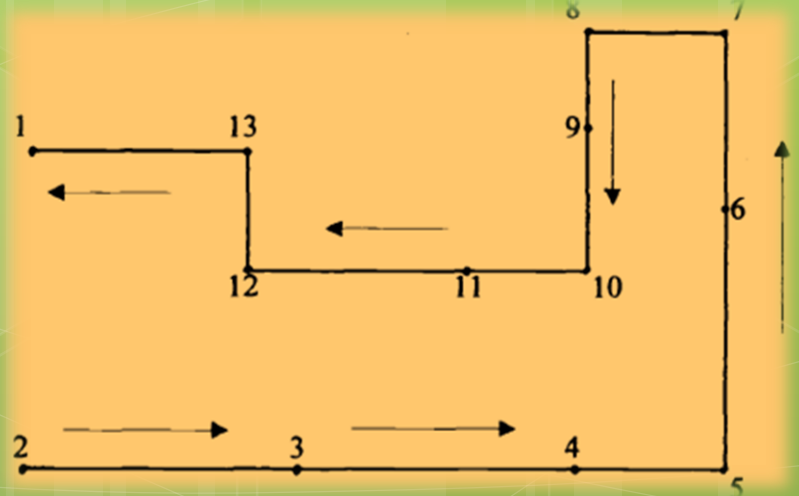

ENVIRONMENTAL & SAFETY OF MINES SUBJECT

Ventilation Measurements and Surveys

College of Petroleum & Mining Eng.

Mining Engineering Dept.

4th Class

Lecture No.3 – Chapter 6-Part-III

Mr. Omer Haitham Kanam

Overview-PART-III

- Example 6.5

- Example 6.6

Pressure Survey

- **Example 6.5 :**
- Data from an underground pressure survey shown in Table 6.3 were obtained by the leapfrogging method. Determine the head loss between adjacent stations.

TABLE 6.3 Altimeter Survey Data Obtained Using Leapfrogging Method (Example 6.5).

	Elevation, ft		Altimeter Reading, ft		Wet-Bulb t_w, °F		Dry-Bulb t_d, °F		Station Area, ft²		Average Air Velocity, fpm	
Stations	A	B	A	B	A	B	A	B	A	B	A	B
0–7	750	760	800	1073	40	60	45	60	100.0	120.0	1000	833
0–1	750	745	804	834	40	45	45	50	100.0	95.3	1000	1050
1–2	745	748	838	857	45	52	50	55	95.3	94.0	1050	850
2–3	748	750	860	878	52	60	55	60	94.0	95.0	850	632
3–4	750	752	878	948	60	60	60	60	95.0	80.0	632	500
4–5	752	750	945	979	60	60	60	60	80.0	85.0	500	706
5–6	750	755	975	1016	60	60	60	60	85.0	87.0	706	920
6–7	755	760	1015	1090	60	60	60	60	87.0	95.0	920	1055
7–0	760	750	1090	803	60	38	60	40	95.0	100.0	1055	1000

Conversion factors: 1 ft = 0.3048 m, °C = [t(°F) − 32]/1.8, 1 ft² = 0.0929 m², 1 fpm = 0.00508 m/s.

Pressure Survey

- **Solution Example 6.5 :**
- Data from an underground pressure survey shown in Table 6.3 were obtained by the leapfrogging method. Determine the head loss between adjacent stations.
- ***Solution:***
- Example calculations shown are for stations 7 and 0 only. Chart values for DR and CF are first obtained as follows.
- 1. *Determine DR.* Use psychometric tables (Appendix Table A.2), or Table 6.1 or a psychometric chart (Fig. 2.2) to find relative humidity.

Pressure Survey

- **Solution Example 6.5 :**

For $t_{d_1} = 60°F$ and $t_{w_1} = 60°F$, read $\phi_1 = 100\%$

For $t_{d_2} = 40°F$ and $t_{w_2} = 38°F$, read $\phi_2 = 92\%$

$$\text{Final average } \phi = \frac{\phi_1 + \phi_2}{2} = 96\%$$

$$\text{and average } t_d = \frac{t_{d_1} + t_{d_2}}{2} = 50°F$$

From Fig. 6.15, DR = 1.00

2. *Determine CF* (Fig. 6.16):

$$\text{Find average altimeter reading} = \frac{1090 + 803}{2} = 946 \text{ ft}$$

Pressure Survey

- **Solution Example 6.5 :**

Moving horizontally from the altimeter scale until it intersects the appropriate line (ft air column per in. water), CF the air column equivalent to a pressure of 1 in. (25.4 mm) water is found to be 69 ft (25.15 m).

Substituting survey data and the above values in Eq. 6.12:

$$H_{l_m} = -\left[\frac{(1090 - 803) - (760 - 750)/1.0}{69}\right] + \frac{(1055)^2 - (1000)^2}{(4009)^2}$$

$$= 4.00 \text{ in. water } (-998 \text{ Pa})$$

The computed head losses between adjacent stations are tabulated in Table 6.4.

Pressure Survey

- **Solution Example 6.5 :**

TABLE 6.4 Results of Altimeter Survey (Example 6.5)

Stations	Altimeter Difference, ft	Elevation Difference, ft	Head Loss Due to Airflow, in. water	Average Air Quantity, cfm
0–7	−273	−10	+4.00	—
0–1	−30	+5	+0.50	100,000
1–2	−19	−3	+0.25	80,000
2–3	−18	−2	+0.25	60,000
3–4	−70	−2	+1.00	40,000
4–5	−34	+2	+0.50	60,000
5–6	−41	−5	+0.50	80,000
6–7	−75	−5	+1.00	100,000
7–0	+287	+10	−4.00	—

Source: Mancha (1946). (By permission from AIME, New York, copyright 1996).
Conversion factors: 1 ft = 0.3048 m, 1 in. water = 249.089 Pa, 1 cfm = 0.000472 m^3/s.

Pressure Survey

- **Example 6.6 :**

Data for this example are taken from McElroy and Kingery (1957). A fixed-base altimeter survey was run from station 1, the surface fan house, following the airflow through the mine, and closed back to station 1, as shown in Fig. 6.17. The altimeter scale was offset 1000 ft. The base altimeter was read every 10 min, and the base altimeter reading at the time of the roving altimeter reading at a station was interpolated.

Separate but simultaneous altimeter readings were made by another crew at stations 12 and 13, respectively, the bottom and top of the return shaft, and at stations 2 and 3, respectively, the top and bottom of the slope. The survey data are summarized in Table 6.5.

Calculate the static and total head losses between the survey stations and the total head at each station. Comment on the fan and closure error. Calculate the head losses in the slope and shaft from the simultaneous altimeter readings.

Pressure Survey

- **Example 6.6 :**

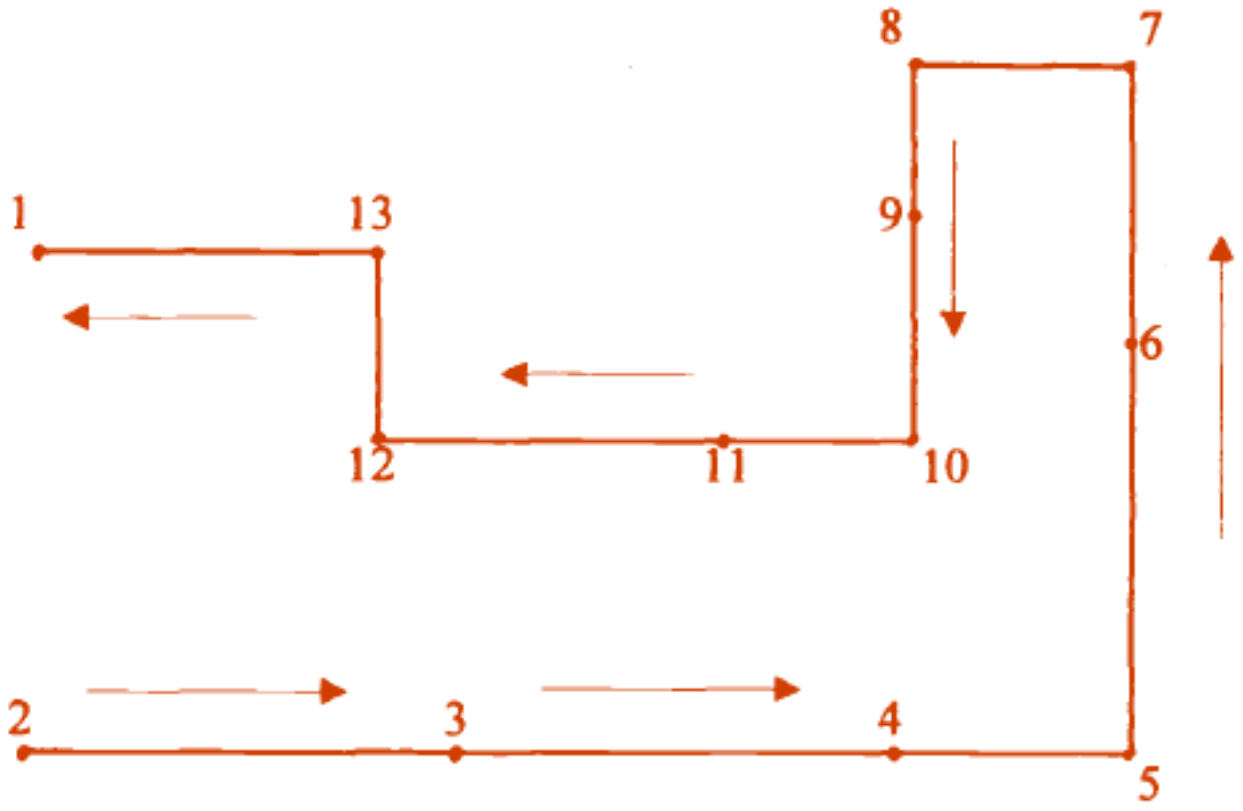

FIGURE 6.17 Fixed-base altimeter survey (Example 6.6).

- **Example 6.6 :**

TABLE 6.5 Altimeter Ventilation Pressure Survey Data (Example 6.6)[a]

Sta.	Location	I/R	Elevation, ft	Time	RAR, ft	Temperature		Velocity,[b] fpm	BAR, ft
						Wet-bulb, °F	Dry-bulb, °F		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	Surface at fan house	Base	482	8:22	1391	49	53	—	1391
2	Rock slope portal	I	496	8:35	1387	50	53	—	1373
3	Rock slope bottom	I	120	8:59	1010	57	64	475	1355
4	Main N by sta. 1925	I	104	9:10	998	57	65	450	1355
5	Main N by sta. 2700	I	57	9:18	952	60	65	390	1350
6	Junction MN and ME	I	−28	9:45	859	62	65	360	1325
7	ME, opposite 2N	I	−27	10:15	848	62	64	230	1311
8	ME opposite 3N	I	−17	10:30	847	63	65	130	1291
9	ME return at 3N	R	−16	10:50	889	70	72	475	1291
10	ME return at MN	R	−24	11:37	894	69	70	350	1276
11	MN at old coal slope	R	114	1:30	1230	70	70	220	1274
12	Bottom, upcast shaft	R	317	1:53	1410	70	70	880	1264
13	Top upcast shaft—fan inlet	R	482	2:45	1610	68	68	1590	1241
1	Surface at fan house	Base	482	2:53	1238	43	50	—	1239
2	Top of rock slope portal	I	496	8:50	909	31	37	—	Simultaneous readings
3	Bottom of slope portal	I	120	8:50	539	47	54	475	
12	Bottom of shaft	R	317	9:25	1041	69	69	880	Simultaneous readings
13	Top of shaft	R	482	9:25	1264	69	69	1590	

Source: McElroy and Kingery (1957).

[a] *Abbreviations:* RAR, BAR—roving, base altimeter readings; MN, ME—main north, main east.

[b] Velocity negligible, taken as zero in calculations.

Conversion factors: 1 ft = 0.3048 m, $°C = \frac{t(°F) - 32}{1.8}$, 1 ft² = 0.0929 m², 1 fpm = 0.00508 m/s.

Pressure Survey

- **Solution Example 6.6 :**

Step 1. Determine the relative humidity and velocity heads at stations 4 and 5, table 6.1 pages 184-185

Station 4 Relative humidity from Table 6.1 ($t_d = 65°F$, $t_w = 57°F$)

$\phi = 61\%$

$$\text{Velocity head } H_{v_4} = \frac{450^2}{4009^2} = 0.013 \text{ in. water}$$

$$\text{Total head } H_{t_4} = -0.165 \text{ in. water (assume given)}$$

Station 5 Relative humidity from Table 6.1 ($t_d = 65°F$, $t_w = 60°F$)

$\phi = 75\%$

$$\text{Velocity head } H_{v_5} = \frac{390^2}{4009^2} = 0.010 \text{ in. water}$$

Pressure Survey

- **Solution Example 6.6 :**

Step 2. Calculations for conditions between stations 4 and 5: use fig. 6.15 and 6.16

Elevation difference, $Z_5 - Z_4 = 57 - 104 = -47$ ft
Density ratio DR for the air column between 5 and 4:

$$\text{Average relative humidity } \phi = \frac{61 + 75}{2} = 68\%$$

$$\text{Average dry-bulb temperature } t_d = \frac{65 + 65}{2} = 65°\text{F}$$

From Fig. 6.15, DR = 1.034
Altimeter difference, $p_{A_5} - p_{A_4} = 952 - 998 = -46$ ft
Base correction, $-(p_{B_5} - p_{B_4}) = 5$ ft

$$\text{Elevation correction, } -\frac{(Z_5 - Z_4)}{\text{DR}} = \frac{47}{1.034} = 45 \text{ ft}$$

Corrected head difference in ft. of air $= (-46 + 5 + 45) = 4$ ft

$$\text{Average altimeter reading} = \frac{p_{A_5} + p_{A_4}}{2} = \frac{952 + 998}{2} = 975 \text{ ft}$$

The conversion factor CF for the average altimeter is read from the 1000-ft offset scale from Fig. 6.16:

CF = 66.8 ft per in. water

Pressure Survey

- **Solution Example 6.6 :**

Difference in static head $H_s = -\left(\frac{4}{66.8}\right) = -0.060$ in. water

Difference in velocity heads $= H_{v_5} - H_{v_4} = 0.010 - 0.013 = -0.003$ in. water

Difference in total head $H_t = -0.060 + (-0.003) = -0.063$

Total head at 5 H_{t_5} = total head at 4 H_{t_4} + the difference in total head between 5 and 4 $= -0.165 + (-0.063) = -0.228$ in. water.

- The negative difference in total head ($H_{I5} - H_{I4}$) indicates that the airflow is from 4 to 5.
- Note that total pressure differences from station 1 back to station 1 must add up to zero.

- **Solution Example 6.6 :**

TABLE 6.6 Altimeter Ventilation Pressure Survey Calculation (Example 6.6)

Station	ϕ	H_v, in. water	Diff. elev.	DR	Alt. diff.	Base corr.	Elev. corr.	Head ft. of air	Avg. alt. rdg.	Feet of air per in. water	ΔH_s	ΔH_v	ΔH_t	H_t
											in. water.			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1	75	0												0
			14	1.008	−4	+18	−14	0	1389	67.7	0	0	0	
2	81	0												0
			−376	1.022	−377	+18	368	9	1199	67.4	−0.133	0.014	−0.119	
3	65	0.014												−0.119
			−16	1.034	−12	0	15	3	1004	66.8	−0.045	−0.001	−0.046	
4	61	0.013												−0.165
			−47	1.034	−46	+5	45	4	975	66.8	−0.060	−0.003	−0.063	
5	75	0.010												−0.228
			−85	1.035	−93	+25	82	14	906	66.8	−0.210	0	−0.210	
6	85	0.010												−0.438
			1	1.038	−11	+14	−1	2	854	66.4	−0.030	−0.01	−0.04	
7	90	0.0												−0.478
			10	1.038	−1	+20	−10	9	848	66.4	−0.136	0.0	−0.136	
8	90	0.0												−0.614
			1	1.048	42	0	−1	41	868	66.4	−0.618	0.014	−0.604	
9	91	0.014												−1.218
			−8	1.054	5	+15	8	28	892	66.5	−0.421	−0.004	−0.425	
10	95	0.010												−1.643
			138	1.048	309	+2	−132	179	1049	67.0	−2.672	−0.01	−2.682	
11	100	0.0												−4.325
			203	1.049	207	+10	−193	24	1307	67.7	−0.355	0.048	−0.307	
12	100	0.048												−4.632
			165	1.046	200	+23	−158	65	1510	68.2	−0.953	0.110	−0.843	
13	100	0.158												−5.475
			0	1.022	−372	+2	0	−370	1424	67.9	+5.45	−0.158	5.292	
1	55	0												0.183

Source: McElroy and Kingery (1957).
Conversion factors: 1 ft = 0.3048 m. 1 in. water = 249.089 Pa.

Pressure Survey

- **Solution Example 6.6 :**

- In the example problem, the sum is +0.183 in. water in a total head of 5.475 in. water. This is called the closure error and is the result of errors in measurements and the presence of any natural ventilation.
- The calculations for the head losses in the slope (and the shaft) are similar to those in Example 6.5 and are left for the reader to verify.
- The head loss in the slope is 0.122 in. water, and in the shaft is 0.856 in. water.

END OF PART-III