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Environmental & Safety Mines

College of Petroleum & Mining Eng.

Mining Engineering Dept.

4th Class

Lecture No. 2 – Chapter 5

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Shock Loss, Page-160

Shock losses occur in mine ventilation in addition to friction losses and are caused by changes in the direction of airflow or the shape or size of the duct. Obstructions cause shock loss by reducing the duct area. Although generally constituting only 10–30% of the total head loss in mine ventilation systems, shock losses should always be considered in exact calculations, in major airways, or in short lengths of duct with many bends or area changes.

Shock losses do not lend themselves to precise calculation because of the great range of variability in occurrence and because of a lack of understanding about their actual nature. Basically, for a given source of shock, the head loss varies as the square of the velocity or directly as the velocity head. Calculation of individual shock losses can be carried out in several ways.

Calculation of Shock Loss Directly, Pages 160-161

$$H_x = XH_v \qquad (5.23)$$

X: shock loss factor (constant @ constant conditions), it depends on fittings/duct/pipe shape

Calculation of Shock Loss by Equivalent Length Method, Page 161-162

- Using The equation below,

$$L_e = \frac{5.2\, w R_h X}{K(1098)^2} \approx \frac{3235\, R_h X}{10^{10}\, K} \text{ ft} \qquad (5.24)$$

- Le: equivalent Length
- W: specific weight of air (=0.0750 lb/ft^3 @ standard cond.)
- Rh: hydraulic radius
- X: shock loss factor
- K: friction factor

Note:

This method is a time consuming because we need to Know (K, Rh, &Le) in order to get Shock loss

Equivalent Length from Table 5.3, Page 162

TABLE 5.3 Equivalent Lengths for Various Sources of Shock Loss

Source	ft	(m)	Source	ft	(m)
Bend, acute, round	3	(1)	Contraction, gradual	1	(1)
Bend, acute, sharp	150	(45)	Contraction, abrupt	10	(3)
Bend, right, round	1	(1)	Expansion, gradual	1	(1)
Bend, right, sharp	70	(20)	Expansion, abrupt	20	(6)
Bend, obtuse, round	1	(1)	Splitting, straight branch	30	(10)
Bend, obtuse, sharp	15	(5)	Splitting, deflected branch (90°)	200	(60)
Doorway	70	(20)	Junction, straight branch	60	(20)
Overcast	65	(20)	Junction, deflected branch (90°)	30	(10)
Inlet	20	(6)	Mine car or skip (20% of airway area)	100	(30)
Discharge	65	(20)	Mine car or skip (40% of airway area)	500	(150)

- **Note:**
- This table based on $K=100*10^{-10}$, $w=0.075$ IB/ft^3 & $Rh=2ft$
- Fitting type must be known

Combined Head Loss, Page 163

- The below equation is for Head loss at the duct
- Calculate the H_{mine} by summate H_l for all sections

$$H_l = H_f + H_x = \frac{KO(L + L_e)Q^2}{5.2A^3} \qquad (5.25)$$

- All parameters in this equation were discussed before.

Air Power, Page 165

- It's the power required to overcome the energy losses in an airstream

$$P_a = \frac{5.2HQ}{33,000} = \frac{HQ}{6346} \text{ hp} \qquad (5.26)$$

Compressibility Effect, Page 166

- Air is compressed at low pressure
- If you neglect a compressibility effect then, there is an error percentage while selecting the fan or blower & that error is calculated by

$$\%\ Error = 1 - \frac{H_s}{H_s + H_f}$$

- That error is affected to quantity of air supplied to the duct or tunnel, & that's mean the fan should be at greater size than it is.

1. IF the fan located @ discharge then

$$Q_{new} = Q_{old} - Q_{error\%}$$

2. IF the fan located @ Inlet then

$$Q_{new} = Q_{old} + Q_{error\%}$$

Compressibility Effect, Page 167

- It's advice to consider compressibility effect @ :

1. High pressure >20 in.water by applying below formula

$$p_1^2 - p_2^2 = \frac{K_c Q^2 L}{D^5} \qquad (5.27)$$

- P: absolute pressure @ points 1&2
- K_c: compression friction factor

2. Long ventilation pipe in mines and tunnel
3. Deep shaft where difference in elevation exceed 1400 ft

Example 5.7, Page 163-164

- Required:
- $H_{combined}$, Hmine, and H_{loss} for all sections shown in the figure below

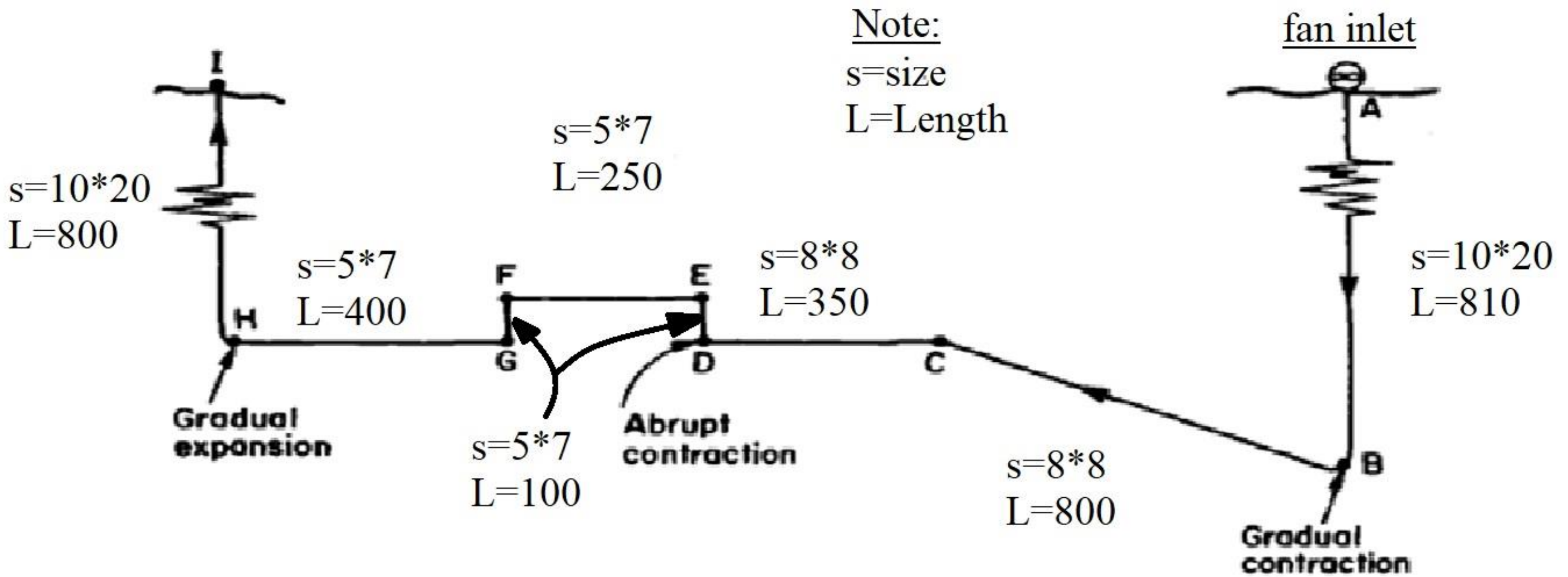

FIGURE 5.12 Mine ventilation system in Example 5.7.

Example 5.7, Page-164

- Given Info.

$$K = 125 \times 10^{-10} \text{ lb}\cdot\text{min}^2/\text{ft}(0.0232 \text{ kg/m}^3)$$

$$Q = 20{,}000 \text{ cfm } (9.44 \text{ m}^3/\text{s})$$

$$w = 0.0750 \text{ lb/ft}^3(1.201 \text{ kg/m}^3)$$

- In addition to, all information given in the figure

Example 5.7, Page-164

- Solution

1. Divide the duct into numbers of sections (AB, BC…etc)
2. Select all airways having the same dimension, because they get similar calculations
3. You have to figure out the type of fitting from the figure
4. Calculate Le, for all fittings in the given duct, using Table 5.3 (you have to add each Le for the fitting to the length of it's airway once, before or after)
5. Apply eq. 5.25 to compute head loss
6. To find Hv, from eq. 5.14, but Velcity from V=Q/A
7. Apply the above procedure to all sections step by step and finally summate the Hs
8. Summate Hv
9. See, the next slide for full solution

Example 5.7, Page-164

Airway	Size, ft	L, ft	L_e, ft[a]	$L + L_e$, ft	A, ft^2	O, ft	H_L, in. water (Pa)
AB	10 × 20	810	(None)	—	—	—	—[b]
BC	8 × 8	800	(b) (c) 3 + 1 = 4				
CD	8 × 8	350	(b) 15	1169	64	32	0.1372 (34.1)
DE	5 × 7	100	(b) (c) 70 + 10 = 80				
EF	5 × 7	250	(b) 70				
FG	5 × 7	100	(b) 70				
GH	5 × 7	400	(b) 70	1140	35	24	0.6136 (152.7)
HI	10 × 20	800	(b) (c) (d) 1 + 1 + 65 = 67	1677	200	60	0.0121 (3.0)

mine $H_s = \sum H_L$ = 0.7629 in. water (189.8 Pa)

mine H_v = 0.0006 (0.1)

mine H_t = 0.7635 (190.0)

END OF LECTURE