

Problem Set #3

Solutions

$$\begin{aligned}
 1. \quad M_s &= M_d(1-B_{ws}) + 18B_{ws} & P_s &= P_{Bar} + p_s/13.6 \\
 &= 30.1(1-0.112) + 18(0.112) & &= 29.92 + -1.1/13.6 \\
 &= 26.73 + 2.02 & &= 29.84 \\
 &= 28.75 & & \\
 & & P_m &= P_{Bar} + \Delta H/13.6 \\
 & & &= 29.92 + 1.0/13.6 \\
 & & &= 29.99
 \end{aligned}$$

} How to determine P_m if not provided

$$\begin{aligned}
 D_n &= \sqrt{\frac{0.0385 Q_m P_m}{T_m C_p (1 - B_{ws})}} \sqrt{\frac{T_s M_s}{P_s \Delta P_{avg}}} \\
 D_n &= \sqrt{\frac{(0.0385)(0.75)(29.99)}{(460 + 80)(0.79)(1 - 0.112)}} \sqrt{\frac{(460 + 310)(28.75)}{(29.84)(1.5)}} \\
 D_n &= \sqrt{\frac{(0.8052)}{(540)(0.79)(0.888)}} \sqrt{494.58} \\
 D_n &= \sqrt{(0.002126)(22.24)} \\
 D_n &= \sqrt{(0.04728)} \\
 D_n &= 0.217
 \end{aligned}$$

2. Choose 0.261" nozzle

$$\Delta H = K \Delta P$$

$$K = 846.72 D_n^4 \Delta H @ C_p^2 (1 - B_{ws})^2 \frac{M_d T_m P_s}{M_s T_s P_m}$$

$$K = 846.72 (0.261)^4 (1.24)(0.79)^2 (1 - 0.112)^2 \left(\frac{(30.1)(540)(29.84)}{(28.75)(770)(29.99)} \right)$$

$$\begin{aligned}
 K &= 846.72 (0.004646)(1.24)(.6241)(0.7885)(1.047)(0.7018)(0.995) \\
 K &= 1.75
 \end{aligned}$$

3. $\Delta H = K \Delta P$

$$= (1.75)(1.2)$$

$$= 2.1 \text{ in H}_2\text{O}$$

Problem Set #3

Solutions

4. a) $\Delta H = K\Delta P$

$$= (1.75)(0.86)$$

$$= 1.5 \text{ in H}_2\text{O}$$

b) $\Delta H = K\Delta P$

$$= (1.75)(1.0)$$

$$= 1.75 \text{ in H}_2\text{O}$$

5. $D_e = \frac{2(LW)}{(L+W)}$ $D_e = \frac{2(25)(40)}{(25+40)} = 30.8''$

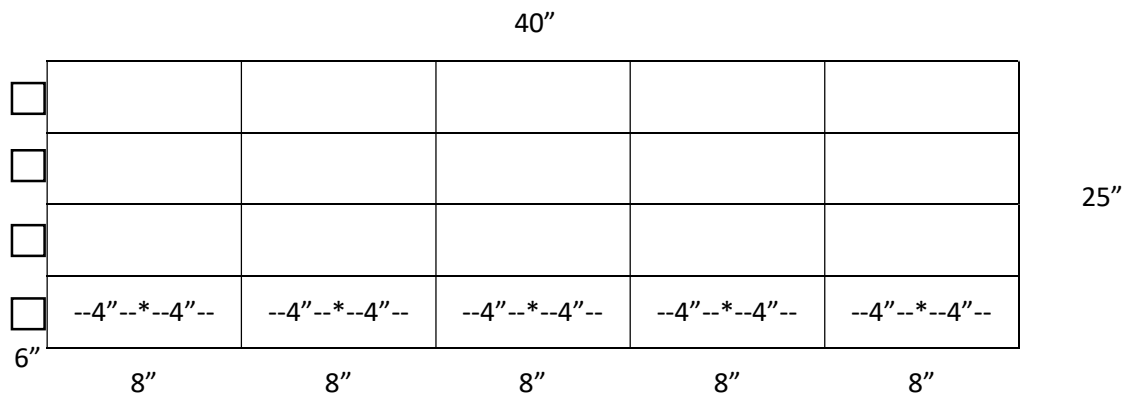
Choose downstream @ 5.5 duct diameters

$$5.5 \times 30.8 = 169.4''$$

$$231'' - 169.4'' = 61.6''$$

$$61.6/30.8 = 2 \text{ duct diameters upstream from stack exit}$$

From USEPA Method 1, Fig 1.1 => 20 sampling points are required.



Mark from the probe tip:

Point No.

1

2

3

4

5

10''

18''

26''

34''

42''

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6. Use F_o factor:

Method 3B

8/3/2017

$$F_o = \frac{20.9 - \%O_2}{\%CO_2} = \frac{20.9 F_d}{100 F_c} = \frac{20.9 * 9780}{100 * 1800}$$

$$F_o = \frac{20.9 - 8}{9.1} = 1.14$$

$$F_o = 1.4 \neq 1.14$$

Table 3B-1— F_o Factors for Selected Fuels

Fuel type	F_o range
Coal:	
Anthracite and lignite	1.016–1.130
Bituminous	1.083–1.230

The experimental value of 1.4 is 22% higher than that give by F_o factor. The test F_o factor should be within the range of 1.083 – 1.230 for bituminous coal. (40 CFR Appendix A Method 3B)

7. $M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + CO)$

$$= 0.44(14.2) + 0.32(7.2) + 0.28(78.6 + 0)$$

$$= 6.25 + 2.30 + 22.0$$

$$= 30.55$$

$$M_s = M_d(1 - B_{ws}) + 18(B_{ws})$$

$$= 30.55(1 - 0.07) + 18(0.07)$$

$$= 28.41 + 1.26$$

$$= 29.67$$

8. $V_s = \frac{V_m}{(1 - B_{ws})} \frac{T_s}{T_m}$ assume no pressure difference

$$V_s = \frac{32}{(1 - 0.12)} \frac{(460 + 198)}{(460 + 68)} \quad \text{assume meter temperature is } 68^\circ\text{F}$$

$$V_s = \frac{32}{(0.88)} \frac{(658)}{(532)}$$

$$V_s = 45.3 \text{ ft}^3$$