Fabric filters Problems

6.1 From the following test data, estimate the values of K_s and K_e for the filter drag model.

Limestone Dust Loading $1.00\ \text{g/m}^3$
Fabric Area $1.00\ \text{m}^2$
Air Flow Rate $0.80\ \text{m}^3/\text{min}$

Time, min	5	10	15	20	25	30
Filter ΔP, Pa	330	490	550	600	640	700

Give your answers in units of (Pa-min-m)/g and $(\text{Pa} - \text{min})/\text{m}$, respectively.

Solution

$\Delta P = \text{SV}$

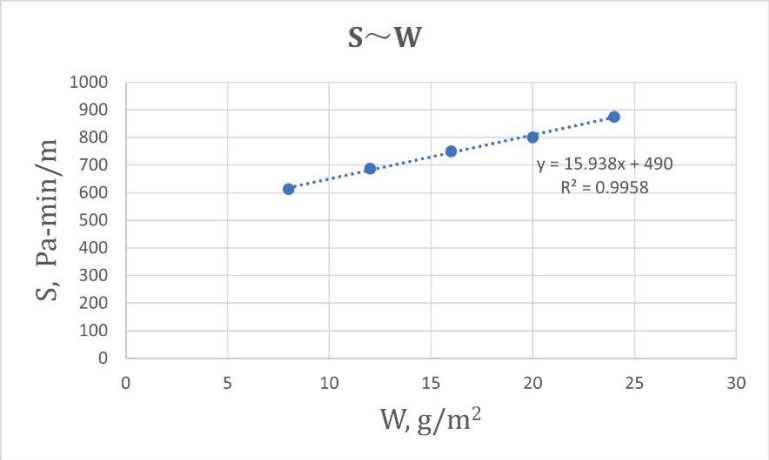
$S = K_\text{e} + K_\text{s} W$

$W = cVt$

where $c = 1.00 g/m^3$ $V = \frac{Q}{A} = \frac{0.8}{1.00} = 0.8\, m/min$

Use the test data to generate a plot of $\frac{\Delta P}{V}$versus W.

The data to be plotted are.



From a linear least-squares fit of the last five data points, the values of the constants K_e and K_s are $490\ \text{Pa} - \text{min/m}$ and $15.938\ \text{Pa} - \text{min} - \text{m/g}$, respectively.

6.2 For $K_e = 0.577$ in. $\text{H}_2\text{O} - \text{min/ft}$ and $K_s = 0.00986$ in. $\text{H}_2\text{O} - \text{min} - \text{ft/}$ gr, design a reverse-air baghouse to filter $20{,}000\text{cfm}$ of air with 2.5gr/ft^3 of flour. Assume a cleaning time of 3.0 minutes and a filtration time of 60 minutes. In your design, specify the number of compartments, the filtering velocity, the cloth area per compartment, and the total number of bags required if each bag is 10 ft long and 1 ft in diameter. Also, specify the maximum pressure drop that will be experienced during the run.

Solution

For flour, the filtering velocity V=2.50ft/min(Table 6.1)

the area of fabric needed is $A = \frac{20000\text{cfm}}{2.5\text{ft/min}} = 8000\text{ft}^2$

the number of compartments N=3(Lecture PPT Table 6.4, Textbook Table 6.3)

To meet the design filtering velocity when filtering with one compartment off-line, there must be 4000ft^2 of fabric in each compartment, for $12{,}000\text{ft}^2$ total.(总共 3 个室，当一个室离线清灰时，其它两个工作室的过滤面积仍有8000ft^2)

The fabric area of one bag is $\pi \times 1 \times 10 = 31.42\text{ft}^2$

总的布袋条数=$\frac{12000\text{ft}^2}{31.42\text{ft}^2} = 382$

每个室的布袋条数=$\frac{382}{3} = 127.3$

向上取整为 128

the total area of the bag openings is $31.42\text{ft}^2 \times 382 = 12002\ \text{ft}^2$

With all three compartments in service, $V_N = 20000/12002 = 1.666$ ft/min. With only two compartments on-line, $V_{N-1} = 20{,}000/(31.42 \times 128 \times 2) = 2.486\text{ft/min}$. From Eq. (6.12) for a cleaning time of 3 minutes, a filtration time of 60 minutes , we obtain t_r as

$$t_r = \frac{(t_f + t_c)}{N} - t_c = \frac{60+3}{3} - 3 = 18\ min$$

计算表明：每个室清灰时间t_c是 3min，过滤时间t_f=60min，一个室一旦完成清灰立即又投入除尘工作，除尘 18 分钟后（t_r），下一个室开始清灰，依次进行。因此，一个室在过滤时间段内，有$(N-1)t_c$的时间（也就是除开自己因清灰不能除尘工作外，其余$N-1$室的清灰时间段内，还是在工作）处于过滤风速为 V_{N-1}的阶段，有Nt_r的时间（也就是N个室全部处于过滤状态）处于过滤风速为 V_N的阶段，一个室阻力达到最大时间，就是该室过滤时间满后的时间。

在整个过滤时间段内，室内布袋上黏附的粉尘量为：

$W_j = \text{c} \times V_{N-1} \times (N-1)t_c + \text{c} \times V_N \times Nt_r$

$= 2.5 \times 2.486 \times (3-1) \times 3 + 2.5 \times 1.666 \times 3 \times 18$

$= 261.93\ \text{gr/ft}^2$

The maximum allowable filter drag $S_j = 0.577 + 0.00986 \times 261.93 = 3.16$

平均过滤风速为：

$V_j = f_N V_{N-1}$（Using $f_N = 0.87$ from Textbook Table 6.4）

$V_j = 0.87 \times 2.486 = 2.16\text{ft/min}$

$\Delta P_m = S_j \times V_j = 3.16 \times 2.16 = 6.83\ \text{in.H}_2\text{O}$

最终：

the number of compartments=3

the filtering velocity= V=2.50ft/min

the cloth area per compartment=128 x31.42=4022ft²

the total number of bags=128x3=384

the maximum pressure drop$\Delta P_m = 6.83\ \text{in.H}_2\text{O}$

6.3 A pulse-jet baghouse is to be designed to filter the air of Problem 6.2. Calculate the number of bags required if each bag is 8 ft long and 6 in. in diameter.

solution

For flour, the filtering velocity V=13.0ft/min(Lecture PPT Table 6.2, Textbook Table 6.5)

the area of fabric needed is $A = \frac{20000\text{cfm}}{13.0\text{ft/min}} = 1538.5\text{ft}^2$

The fabric area of one bag is $\pi \times \frac{6}{12} \times 8 = 12.568\text{ft}^2$

the number of bags required is $N = \frac{1538.5\text{ft}^2}{12.568\text{ft}^2} = 122.4$

取整

the number of bags required is $N = 123$