WTS Cost Example 2

Consider a prototype system with the following characteristics:

1. coagulant dosage of 60 mg/L
2. flowrate 800 mL/min
3. run time of 55 minutes
4. 2 inches of anthracite and 6 inches of filter sand
5. replace filter material once every five years
6. 3 prototype sedimentation tanks

Compute the total yearly cost of this system

Coagulant and Flocculation Cost

$$wt_c\left[\frac{kg}{gal}\right] = coagulant\ dosage\left(\frac{mg}{liter}\right)\left(\frac{3.785\ liters}{gallon}\right)\left(\frac{kg}{10^6\ mg}\right) = (60\ mg/L)\left(\frac{3.785\ L}{gal}\right)\left(\frac{Kg}{10^6\ mg}\right) = 2.2710 \times 10^{-4}$$

$$NCF = \left[\frac{required\ daily\ volume(gpd)}{5\times10^6(gpd)}\right]\times SF = \frac{20MGD}{5MGD}(1.2) = 4.8 = 5\ UNITS$$

$$Cost_{CF} = \underline{5}\,NCF\left(\frac{\$25{,}000}{year}\right) + \left(\underline{2.271\times10^{-4}}\ wt_c\ \frac{kg}{gal}\right)[\underline{20{,}000{,}000}\ \text{required daily volume(gpd)}]\left(\frac{365\ days}{year}\right)\left(\frac{\$1}{kg}\right)$$

$$= \$125{,}000 + \$1{,}657{,}830 = \$1{,}782{,}830$$

Sedimentation Cost

$$t_P = \frac{n_t\,(1.56 \text{ gallons})}{\left(\text{flowrate}\,\frac{\text{ml}}{\text{minute}}\right)\left(\frac{\text{liter}}{1{,}000\text{ml}}\right)\left(\frac{\text{gallon}}{3.785 \text{ liter}}\right)} = \frac{3(1.56\text{gal})}{\left(800\text{mL/min}\right)\left(\text{L}/1{,}000\text{mL}\right)\left(\text{gal}/3{,}785\text{L}\right)} = 22.14\text{ min}$$

$$Q_{ST} = \frac{75{,}000 \text{ gallons}}{t_P} = \frac{75{,}000\text{ gal}}{22.14\text{ min}} = 3{,}387\text{gpm}$$

$$Q_{SE} = \frac{Q_{ST} \times \text{filter run time}}{60 \text{ minutes}} = 3{,}387\text{gpm}\left(\frac{55\text{min}}{60\text{min}}\right) = 3{,}105\text{gpm}$$

$$NS = \left[\frac{\text{required daily volume (gpd)}}{Q_{SE}\text{(gpm)}}\right]\left[\frac{\text{day}}{1{,}440\text{min}}\right] \times SF = \frac{20{,}000{,}000\text{ gal}}{3{,}105\text{gpm}}\left[\frac{1\text{ day}}{1{,}440\text{min}}\right] 1.2 = 5.37 = 6\text{ TANKS}$$

$$\text{Cost}_S = NS\left(\frac{\$35{,}000}{\text{tank}}\right) = 6\text{ TANKS}\left(\frac{\$35{,}000}{\text{TANK}}\right) = \$210{,}000$$

Filter Cost

$$Q_F = \left(\text{flowrate}\frac{\text{ml}}{\text{minute}}\right)\left(\frac{\text{liter}}{1{,}000\text{ml}}\right)\left(\frac{\text{gallon}}{3.785\,\text{liter}}\right)\left(\frac{1}{0.0668\ \text{ft}^2}\right) = 800\,\text{mL/min}\left(\frac{1\,\text{gal}}{3785\,\text{mL}}\right)\left(\frac{1}{0.0668\,\text{ft}^2}\right)$$

$$= 3{,}164\ \text{gpm/ft}^2$$

$$Q_{FT} = Q_F\left(\text{gpm}/\text{ft}^2\right) \times 1{,}000\left(\text{ft}^2\right) = 3{,}164\,\text{gpm}$$

$$Q_{FE} = \frac{Q_{FT}(\text{gpm}) \times \text{filter run time}}{60\ \text{minutes}} = 3{,}164\,\text{gpm}\left(\frac{55\,\text{min}}{60\,\text{min}}\right) = 2{,}900\,\text{gpm}$$

$$NF = \left[\frac{\text{required daily volume (gpd)}}{Q_{FE}(\text{gpm})}\right]\left[\frac{\text{day}}{1{,}440\,\text{min}}\right] \times SF = \frac{20{,}000{,}000\,\text{gal/day}}{2{,}900\,\text{g/min}}\left[\frac{1\,\text{day}}{1{,}440\,\text{min}}\right] 1.2 = 5.75 = 6$$

$$\text{Cost}_F = NF\left(\frac{\$45{,}000}{\text{filter}}\right) = 6\ \text{FILTERS}\left(\frac{\$45{,}000}{\text{FILTER}}\right) = \$270{,}000$$

Filter Media Cost

$$\text{Cost}_{FM_A} = \left(\frac{\$9.50}{\text{ft}^3}\right)\left(\frac{\text{thickness (in)}}{12\ \text{inches}}\,\text{ft}\right)(1{,}000\ \text{ft}^2)\left(\frac{NF}{\#\,\text{of years}}\right) = \$1{,}900$$

(2 in; NF = 6; # of years = 5)

$$\text{Cost}_{FM_S} = \left(\frac{\$5.90}{\text{ft}^3}\right)\left(\frac{\text{thickness (in)}}{12\ \text{inches}}\,\text{ft}\right)(1{,}000\ \text{ft}^2)\left(\frac{NF}{\#\,\text{of years}}\right) = \$3{,}540$$

(6 in; NF = 6; # of years = 5)

$\$1{,}900 + \$3{,}540 = \$5{,}440$

Total Cost

$Cost_{CF}$ = $1,782,830

$Cost_{S}$ = $210,000

$Cost_{F}$ = $270,000

$Cost_{FMa}$ = } $5,440

$Cost_{FMs}$ = }

Total Cost = $2,268,270