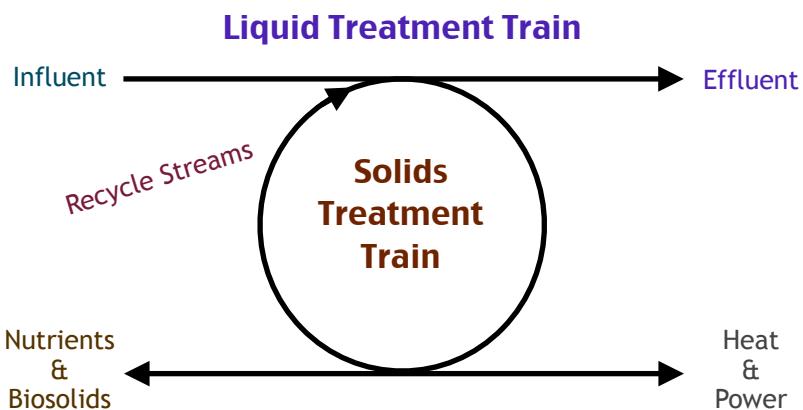




Problem of the Day 2014.Oct.24

Discussion

From this graphic, let's consider the Biosolids output from a wastewater treatment plant (WWTP).



Generic WWTP graphic showing interaction between liquid and solids treatment trains, potential for resource recovery in the effluent, heat and power, and nutrients and biosolids outputs, and the potential impacts of recycle streams.

Depending on where your plant is, disposing of biosolids is getting more and more difficult. The disposal of biosolids, again depending on where your plant is, also is **very expensive**, and this is important for the people that pay for the construction, operation and maintenance of our WWTPs: the ratepayers. While many operators believe their job is merely to "make permit," our jobs are much more complicated than that and getting more so. The "mission statement" WWTT uses to guide our efforts while on the job goes something like this:

The mission of wastewater treatment plant operators is to remove pollutants from the incoming water, while complying with all permit requirements—water, land and air—and convert them to safe disposable biosolids as sustainably and cost effectively as possible.

In other words, the cost of doing wastewater treatment matters.

Today's problem looks at a cost comparison having to do with biosolids disposal.

Problem

Problem of the Day: On average, the Green Meadow Resource Recovery Facility generates 95,000 pounds per day of total solids after anaerobic digestion. The O&M staff is considering two different dewatering technologies, a belt filter press and a centrifuge. The staff operated side-by-side demonstration units for a period of three months. The belt filter press produced a cake that averaged 22.6% TS, whereas the centrifuge produced a cake with 24.8% TS. The bulk density of cake off the belt filter press averaged 67.6 lb/ft³. Because the solids content was greater, the density of the cake from the centrifuge was a little higher, 68.3 lb/ft³. The hauling cost averages \$2.30 per cubic foot of cake. The land-disposal fee is \$220 per wet ton. Based on the results from the demonstration testing, what would the annual cost difference be between the two units for hauling and disposal?

Solution

There is a lot going on in this problem. Obviously, there are the two different dewatering units being considered. In addition, the hauling cost is based on ft^3 of cake, whereas the disposal fee is based on ton of cake (note: “wet ton” is “code” for cake because cake is always “wet”).

Here is what we know from the problem statement, labeled the way WWTT recommends:

- Hauling cost = \$2.30/ ft^3 cake
- Disposal cost = \$220/ton cake
- Cake TS, belt filter press = 22.6% = 22.6 lb TS/100 lb cake
- Cake TS, centrifuge = 24.8% = 24.8 lb TS/100 lb cake
- Cake density, belt filter press = 67.6 lb cake/ ft^3 cake
- Cake density, centrifuge = 68.3 lb cake/ ft^3 cake

Without doing a step-by-step narrative of how the railroad tracks are populated, the solution will be broken down into 7 steps: (1) cost of hauling, belt filter press cake, (2) disposal cost, belt filter press cake (3) total cost, belt filter press cake, (4) cost of hauling, centrifuge cake, (5) disposal cost, centrifuge cake, (6) total cost, centrifuge cake, and (7) cost difference. Although there isn’t a lot of difference between the two cakes and it’s hard to say what the impacts are on costs, you will be surprised!

Cost of Hauling, Belt Filter Press Cake. To calculate the annual hauling cost for the belt filter press cake, $\$/\text{yr}$, the railroad track is started with the hauling cost, followed by the necessary unit cancelations.

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\$	=	\$2.30	ft^3 -cake	100 lb-cake	95,000 lb-TS	365 d
yr		ft^3 -cake	67.6 lb-cake	22.6 lb-TS	d	yr

All units have canceled except those needed in the answer, $\$/\text{yr}$, so the math is done and the arithmetic gives the answer.

$$2.30 \times 100 \times 95,000 \times 365 \div 67.6 \div 22.6 = \$5,220,224/\text{yr}.$$

Cost of Disposal, Belt Filter Press Cake. To calculate the annual disposal cost for the belt filter press cake, $\$/\text{yr}$, the railroad track is started with the disposal cost, followed by the necessary unit cancelations.

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\$	=	\$220	ton	100 lb cake	95,000 lb-TS	365 d
yr		ton cake	2,000 lb	22.6 lb-TS	d	yr

All units have canceled except those needed in the answer, \$/yr, so the math is done and the arithmetic gives the answer.

$$220 \times 100 \times 95,000 \times 365 \div 2,000 \div 22.6 = \$16,877,212/\text{yr}.$$

Total Hauling and Disposal Costs, Belt Filter Press Cake. The annual hauling and disposal costs for the belt filter press cake is the sum of the two costs just calculated.

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\$	=	$\$(5,220,224 + 16,877,212)$		=	\$22,097,436/yr
yr			yr		

Cost of Hauling, Centrifuge Cake. To calculate the annual hauling cost for the centrifuge cake, \$/yr, the railroad track is started with the hauling cost, followed by the necessary unit cancelations.

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\$	=	\$2.30	ft ³ -cake	100 lb-cake	95,000 lb-TS	365 d
yr		ft ³ -cake	68.3 lb-cake	24.8 lb-TS	d	yr

All units have canceled except those needed in the answer, \$/yr, so the math is done and the arithmetic gives the answer.

$$2.30 \times 100 \times 95,000 \times 365 \div 68.3 \div 24.8 = \$4,708,384/\text{yr}.$$

Cost of Disposal, Centrifuge Cake. To calculate the annual disposal cost for the centrifuge cake, \$/yr, the railroad track is started with the disposal cost, followed by the necessary unit cancelations.

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\$	\$220	ton	100 lb cake	95,000 lb TS	365 d
yr	ton cake	2,000 lb	24.8 lb TS	d	yr

All units have canceled except those needed in the answer, \$/yr, so the math is done and the arithmetic gives the answer.

$$220 \times 100 \times 95,000 \times 365 \div 2,000 \div 24.8 = \$15,380,040/\text{yr}.$$

Total Hauling and Disposal Costs, Centrifuge Cake. The annual hauling and disposal costs for the centrifuge cake is the sum of the two costs just calculated.

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\$	$(\$4,708,384 + 15,380,040)$	=	\$20,088,424/yr
yr	yr		

Total Hauling and Disposal Costs, Difference. Because of the slight increased solids content, the hauling and disposal costs associated with the centrifuge cake are less, by a lot!

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\$	$(\$22,097,436 - 20,088,424)$	=	\$2,009.012/yr
yr	yr		