

## Homework #9

### ***Solid Waste Problems***

#### **1. Waste container sizing based on population:**

The student population of a high school is 881. The school has 30 standard classrooms. Assuming a 5-day school week with solid waste pickups on Wednesday and Friday before school starts in the morning, determine the size of storage containers required. Assume waste generation rate = 0.11 kg/capita/day and 3.6 kg/room, density of waste = 120 kg/m<sup>3</sup>, standard containers are 1.5, 2.3, 3.0, and 4.6 m<sup>3</sup>

#### **2. More MSW volume calculations:**

The Pleasant Valley landfill serves a population of 253,000. Each week 325 trucks bring a total of 2180 tons of MSW. The volume of the landfill is 11,240,000 m<sup>3</sup>. At the present time 63% of the landfill is used. The ratio of cover to compacted fill is 1.9. Determine the projected life remaining for the landfill. Assume the density of the compacted waste to be 490 kg/m<sup>3</sup>.

#### **3. Landfill areas & volumes:**

A sanitary landfill is being designed to handle solid waste generated by the town of Bernie, VT, at a rate of 50 Mg/day. It is expected that the waste will be delivered by compactor truck on a 5 days/wk basis. The density as spread is 122 kg/m<sup>3</sup>. It will be spread in 0.50 meter layers and compacted to 0.25 meters. Assuming three such lifts per day and a daily cover of 0.15 meters, determine the following: (a) annual volume of landfill consumed in cubic meters, and (b) daily horizontal area covered by the solid waste. Ignore the soil volume between the stacks.

#### **4. Energy from Waste:**

A developer plans to build a completely self-contained city. The city will have a population of 555,000. The homes in the city are to be heated with methane gas generated at the landfill. The landfill will have a gas collection system. Through education and conservation, MSW generation will be reduced to a rate of 0.45 kg/capita/day. It is anticipated that gas can be produced at an annual rate of 25 L of gas per Kg of MSW delivered to the landfill and the gas will contain 58% methane. Gas recovery is 25% of that which is generated. The heat content of the methane gas is approximately 18,000 kJ/m<sup>3</sup> (a value lower than the theoretical value because of dilution of the methane with air during recovery). The homes are estimated to use an average of 40 x 10<sup>6</sup> kJ of heat energy per year. Peak usage during the winter is 1.5 times the average usage. Is this proposal feasible from the standpoint of generating sufficient heat for domestic use? What are the alternative sources of "waste" materials that could be used as a resource to generate heat?

**5. Waste Classification:**

Using the data in the attached tables, calculate: (A) the specific weight of a typical composite US residential MSW; (B) the specific weight of the Davis, CA residential MSW (You can assume that the specific weight of misc. organics is 220 pounds per cubic yard), and (C) the moisture content of a typical composite US residential MSW.

*Assigned: 4 December 19*

*Due: 11 December 19*

Composition of residential MSW excluding recycled materials and food wastes discharged with wastewater (values are in percent by weight)

<b>Component</b>	<b>Typical U.S.</b>	<b>Davis, CA</b>
<b><i>Organic</i></b>		
Food wastes	9	6
Paper	34	33.1
Cardboard	6	7.9
Plastics	7	10.7
Textiles	2	2.4
Rubber	0.5	2.5
Leather	0.5	0.1
Yard Wastes	18.5	17.7
Wood	2	5
Misc. Organics		0.4
<b><i>Inorganic</i></b>		
Glass	8	5.8
Tin cans	6	3.9
Aluminum	0.5	0.4
Other metal	3	3.6
Dirt, ash, etc.	3	0.5
<b>TOTAL</b>	<b>100.0</b>	<b>100.0</b>

### **Typical Properties of Residential, uncompacted MSW**

Type of Waste	Specific Weight (lb/yd <sup>3</sup> )	Moisture Content (% by wt.)
Food wastes (mixed)	490	70
Paper	150	6
Cardboard	85	5
Plastics	110	2
Textiles	110	10
Rubber	220	2
Leather	270	10
Yard wastes	170	60
Wood	400	20
Glass	330	2
Tin cans	150	3
Aluminum	270	2
Other metals	540	3
Dirt, ashes, etc.	810	8
Ashes	1255	6
Rubbish	220	15