

## Critical Thinking Questions – Thermal Conversion

### **I. Thermal Conversion Basics**

1. Define thermal conversion.
2. List reasons for using thermal conversion processes to manage MSW.
3. When and where was the first WTE facility constructed in the US?
4. How many waste to energy facilities are currently being operated in the US?
5. How many waste to energy facilities are located in our state? How do you feel about this number?
6. Describe the different types of technologies used for waste combustion.
7. Is waste incinerated in Europe? If so, which country in the European Union has the largest number of incinerators?

### **II. Waste to Energy Processes**

1. Draw a detailed diagram that illustrates the important components of a waste to energy facility.
2. Using the diagram constructed in question 1, list and describe the steps in a typical waste to energy process.
3. What are the main outputs from a waste to energy process?
4. What do you believe is the most advantageous attribute of waste to energy processes? Why?
5. What do you believe is the most disadvantageous attribute of waste to energy processes? Why?

### **III. Emissions from Waste to Energy Facilities**

1. How do emissions from waste combustion compare to those expected from electricity generation from fossil fuel sources?
2. What kinds of air pollution control devices are often used to control these emissions?
3. Develop a flow chart describing how you would treat flue gas from waste combustion.

### **IV. Overview of Thermal Conversion Processes and Techniques**

1. Food waste diversion from landfills is becoming more and more prevalent. Would you recommend thermal conversion technologies be used to manage this waste? Why or why not?
2. Which thermal conversion technique is most interesting to you? What do you find interesting about this particular technique?
3. Would you recommend your community use any of these thermal conversion techniques? Why or why not?

4. Define the following terms:

Term	Definition
Waste combustion	
Hydrothermal carbonization	
Pyrolysis	
Gasification	
Ultimate analysis	
Van Krevelen Diagram	
HHV	
LHV	

5. How does the amount of air introduced affect flue gas temperature?
6. How does the amount of energy in a waste affect flue gas temperature?
7. How does the amount of moisture in waste affect flue gas temperature?

*After developing your spreadsheet, answer the following questions:*

8. A waste stream with the composition listed below is being combusted.

Waste Component	Composition of waste (% by weight)
Food Waste	6
Paper	38
Cardboard	8
Plastics	6
Textiles	3
Rubber	1
Leather	0.8
Yard Wastes	15
Wood	4
Glass	6.7
Tin Cans	8
Aluminum	2
Dirt, ash, etc.	1.5

Assuming stoichiometric amounts of air are added, determine the following:

- (a) What is the temperature of the flue gas?
- (b) What is the mass of carbon (g) emitted in the flue gas per g of waste material combusted?
- (c) What is the temperature of the flue gas if 25% excess air is added?
- (d) How does adding excess air influence carbon emitted in the flue gas?

9. A waste stream to be combusted has the chemical composition shown below. It is also known that this waste stream has an energy content of 11,500 J/g.
- (a) How much carbon will be emitted in the flue gas stream during combustion at stoichiometric air levels?
- (b) How many moles of air are required for the stoichiometric combustion of this waste?

Element	Mass (g)
Carbon	34.0
Hydrogen	5.0
Oxygen	27.0
Nitrogen	0.31
Sulfur	0.10
Water	18.0
Ash	15.59