

CARLSON, JEFFREY L.*, PETE W. JENSEN, Minn-Dak Farmers Cooperative, 7525 Red River Road, Wahpeton, ND 58075-9698 **Environmental mass balance at Minn-Dak Farmers Cooperative.**

Introduction

In a market-driven economy, profit is the difference between the income and the costs. The products must meet the needs of the customers so a lot of attention is given to the products.

The beet sugar refining process is a series of separation processes. The beets are separated from the dirt and trash in the washhouse. The pulp is separated from the juice in diffusion. Water is separated from the pulp in pressing and drying. The nonsugars are separated from the juice in purification. The water is separated from the juice in evaporation. The sugar is separated from the juice in crystallization. The mother liquor is separated from the crystals in centrifugation. The water is separated from the sugar crystals in granulation.

The separation processes are not spontaneous and require the input of energy. Most of the energy is supplied by chemical reactions between oxygen in the air and a fossil or biologically derived fuel. The free energy driving these reactions comes from the greater release of enthalpy of the carbon dioxide formation, then the capture of energy necessary for the carbon-carbon, carbon-hydrogen and oxygen-oxygen bond breaking. In addition, there is a great increase in entropy when a mixture of gasses is created from pure solids, liquids or gasses.

The great amount of material separated from the sugar and byproducts as well as material created or used in the process is waste. The total amount of wastes has a significant impact on the environmental costs to beet processing facilities.

There are many options for dealing with the waste materials, each with associated costs and problems. This paper discusses the generic options of dealing with various waste streams as well as choosing an overall waste-management strategy.

Mass Balance

Sugarbeet processing facilities take in raw materials, then produce sugar, byproducts, and waste products. Figure 1 shows the major inputs Minn-Dak Farmers Cooperative used in its 2003-2004 sugarbeet processing campaign. Sugarbeets have the greatest mass of all inputs. They include the dirt, weeds and rocks. The air is a close second with the factory using about 80% on beets. The air is used in combustion as source of oxygen as well as heat and combustion waste transport. The coal, limestone, coke and process chemicals make up about 5%

The mass of all the outputs equals the mass of all inputs. Sugar and byproducts are sold and waste products are released to the environment or to landfills. Figure 2 shows the major outputs from Minn-Dak Farmers Cooperative in its 2003-2004 sugarbeet processing campaign. The gas discharges include the combustion wastes of carbon dioxide, sulfur dioxide, nitric oxide, as well as the excess air (nitrogen and oxygen) used for heat and material transport. Sugarbeets, being 75% water, are the primary reason for the high water discharges. The solid waste is primarily dirt and trash brought in with the sugarbeets and precipitated calcium carbonate from juice purification. The sugar, pulp pellets and molasses made up only 11% of the outputs during the 2003-2004 campaign.

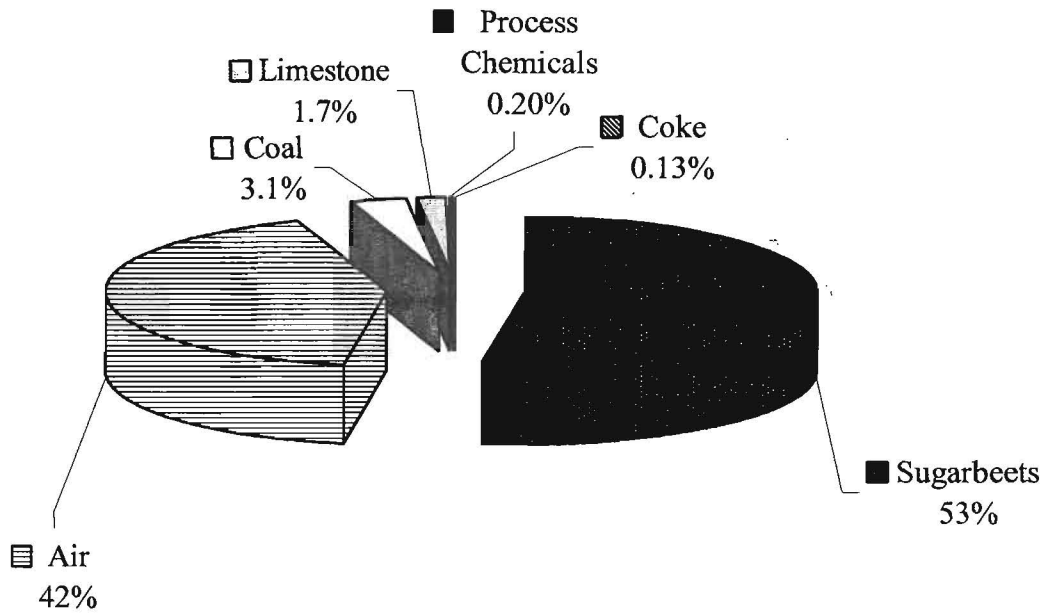


Figure 1. Major inputs Minn-Dak Farmers Cooperative used in its 2003-2004 sugarbeet processing campaign as a percent on total mass of inputs.

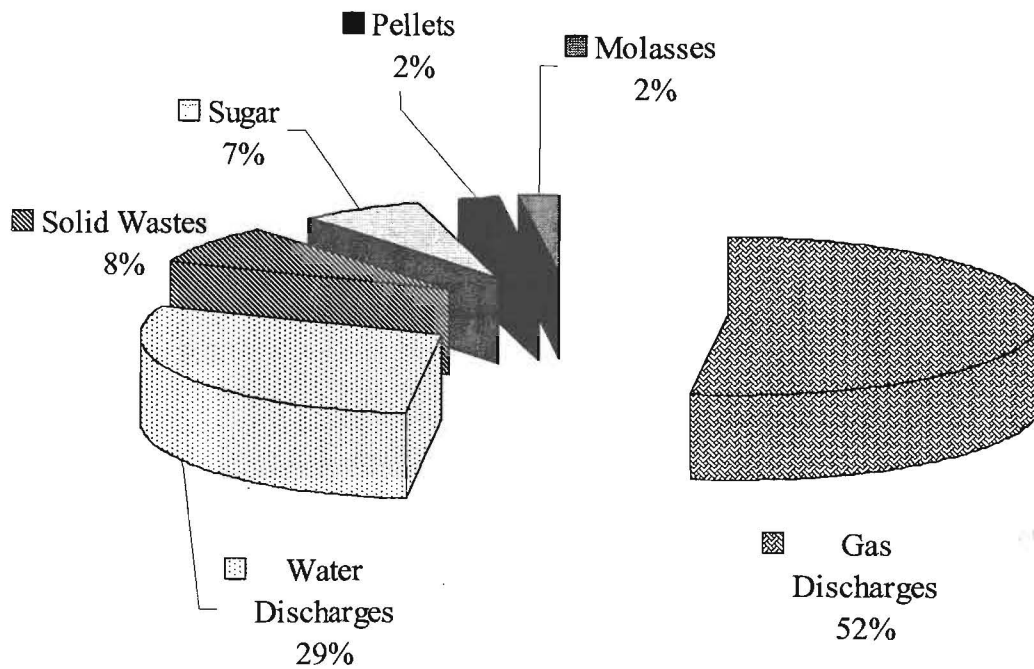


Figure 2. Major outputs from Minn-Dak Farmers Cooperative in its 2003-2004 sugarbeet processing campaign as a percent on total mass of outputs.

Strategies for Wastes

For sugarbeet processors waste materials are costly because 1) so many tons of wastes are generated relative to products and 2) wastes are regulated and have high associated compliance costs. There are four ways of dealing with waste materials

- Prevention
- Reuse or recycling
- Release
- Storage

Prevention goes hand-in-hand with increasing efficiency and lowering costs. Increasing energy efficiency reduces the combustion associated wastes and costs. Lowering wastewater generation reduces the cost of wastewater treatment. Both of these reduce the potential for out-of-compliance discharges. Sometimes facility operators can accomplish prevention through tighter controls and changes in process parameters. Usually, however, significant prevention takes large capital investments like the installation of a steam-powered pulp dryer, or replacing fluming with dry beet handling.

Reuse or recycling materials can significantly reduce the disposal requirements for wastes. Sugarbeet facilities have to treat wastes for release while treatment for reuse may be no more expensive. Removing solids from beet wash water and keeping microbiological growth in it low allow for a high rate of recycle back into the washhouse. Recalcining precipitated calcium carbonate from purification reduces the amount of waste. Other wastes such as fly ash have beneficial uses such as soil stabilization or cement manufacture.

Releasing wastes into the environment is most often done with combustion gas wastes and excess water. For both cases, the federal and state governments have created a regulatory bureaucracy for governing the discharges. The environment has limited capacity to accept pollutants without detrimental consequences.

Releases come from point sources (smoke stacks or water discharge pipes) and nonpoint sources (storm water runoff and fugitive dust). Discharges of either type can carry pollutants and thus all are regulated.

To protect the environment and people, the regulatory authorities have set both concentration and total emission limits for releases in a given period. Most gas and water discharges require treatment prior to release to lower the pollutants to acceptable levels. Treatment systems often generate their own wastes. Pollutants taken from gas streams, like particles or sulfur, will end up as solid waste or dissolved in water. Wastewater treatment systems produce sludge. These wastes need treatment and disposal

The costs associated with discharging include moving the material and the compliance costs (permitting, treatment, discharge monitoring, reporting and record keeping, training and fines).

Prior to treatment and/or release, wastewater is stored in ponds; dirt is stored in mud ponds and mud-solids storage areas, ash is stored in silos and bunkers; and waste lime is stored in ponds or staging areas. Some solid wastes or hazardous wastes that cannot be released or it is uneconomical to release must be stored in permanent facilities.

Because the contents of storage facilities can pollute, governments regulate all aspects of storage areas including construction, waste types, operations and maintenance, environmental contamination, odors, storm water runoff, fugitive dust, and security.

Even though waste storage facilities are designed to protect the environment, there are often breaches in liners and walls that allow environmental contamination. When this happens,

the original waste generators are held legally responsible for repairs and cleanup costs. For this reason, it is advisable to minimize the use of storage facilities.

The costs for not obeying environmental rules can be high for both companies and individuals. Noncompliance can bring civil and criminal court action. Penalties can include fines, jail time, and disqualification for participation in government programs. Penalties escalate for repeat offenders.

There is no single ideal strategy for minimizing environmental costs as they are dependent on many site- and company-specific determinants, including the existing equipment, location-specific environmental rules, and available capital for improvements. When developing a strategy for dealing with waste costs the following need to be considered.

- Balance Costs and Benefits
- Fit into larger corporate strategy
- Consider outside stakeholders
- Consider short- and long-term consequences

There are many choices in how to handle wastes at sugarbeet processing facilities. The high cost of handling waste material and the competitive nature of the industry make it important for managers to understand why they have the costs and what can be done to lower them.