Supply Chain Model for a New Processing Infrastructure and Approaches in Bio-Waste Treatment

V. Nevrlý*, R. Šomplák², M. Pavlas², F. Janošták³

1Institute of Process Engineering, Faculty of Mechanical Engineering, Brno University of Technology, Czech Republic
2Sustainable Process Integration Laboratory – SPIL, NETME Centre, Faculty of Mechanical Engineering, Brno University of Technology, Czech Republic
3Faculty of Mechanical Engineering, Brno University of Technology, Czech Republic

Abstract

Waste management systems are constantly enhanced according to the current needs and legislation changes. This paper presents an approach for determination of suitable localities and appropriate treatment facilities for processing of bio-waste generated by municipal sector. This bio-waste is divided into two different kinds (yard waste and household bio-waste) because the structure and composition of the waste vary a lot. Based on this, it is necessary to process a particular type of waste in the treatment facility that makes it possible from a technical perspective. Each type requires a different way of pre-processing, e.g. the household waste has to go through a stabilization process before it is composted. These important facts and legislation changes create a necessity to have a sufficient treatment facility infrastructure. Currently, there are already some processing facilities for bio-waste. They have fixed capacities and processing cost for given type of waste. The capacity of the potential treatment facilities is unknown and the processing cost depends on it. This dependence is described by a nonlinear concave function. The suggestions for the construction of new treatment facilities and assigning producers to the specific facility is based on network flow model with the utilization of piecewise linear function for linearization of nonlinear cost functions. The model also introduces a new type of constraint that connects the capacity of the facility with both types of the waste by special mixing permission relation. This model has been tested through a case study involving particular territory area (Czech Republic). The change in legislation contributes to the significant increase of biodegradable waste production. The current trend indicates an exponential increase, but in the future, it will be limited by some maximal value. In this area, there was created a transportation network based on a real infrastructure and potential localities for the construction of processing facilities were identified. Further, cost parameters for transportation and processing of individual types of waste were analysed and defined.
Based on these input data, probability functions were created. They provide important insight into the total cost, its variability, and frequency. Essential information is the separation of the total cost into transportation and treatment cost. The main results of these simulations are suggestions about facility location for the specific type of bio-waste. It has been found, that it is applicable to any territory, type of waste and treatment facility.