Designing a biosolids management plan involves many considerations

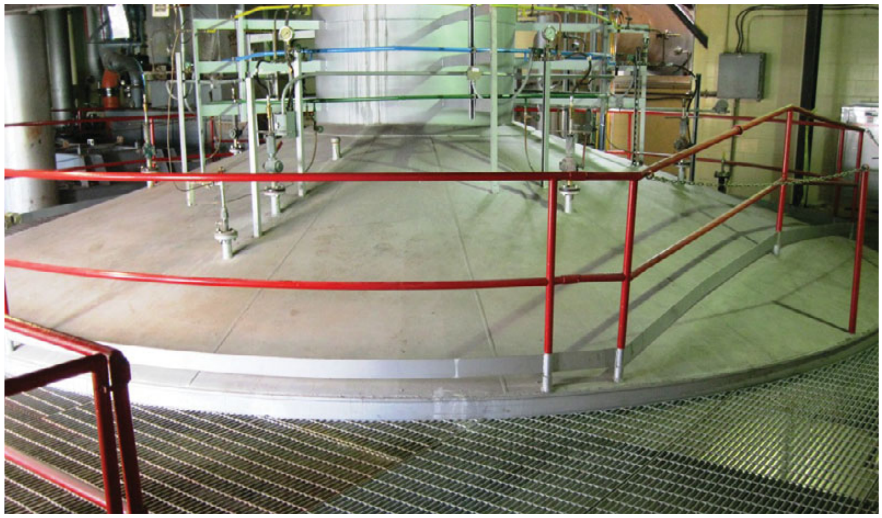
By Tom Woodcock

Wastewater treatment plant owners and operators have a significant decision to make when selecting a biosolids management plan. A thorough evaluation of treatment options should be made, taking into account local soil conditions, regulatory requirements, and capital and operational costs.

The processes practised in Canada for over 60 years are land application, incineration, and land-filling. Each of these methods has known environmental concerns.

In recent years, the Ontario government has passed and amended legislation that regulates biosolids management practices. These regulations include O.Reg. 267 of the *Nutrient Management Act*, and O.Reg. 347 of the *Environmental Protection Act*, which stipulate:

- The locations and soil conditions necessary for land application;
- How many months of the year land application is permitted due to weather constraints;
- Maximum allowable pathogenic content in biosolids;
- Maximum allowable metal concentrations in soils post-biosolids application; and
- Treatment process and storage requirements at wastewater treatment plants.



Top of the fluidized bed incinerator at Greenway Pollution Control Centre in London, Ontario.

O.Reg. 267 specifies that biosolids can only be applied to agricultural lands when there is less than 5 cm of snow on the ground. The result is that biosolids must be stored at wastewater treatment plants, or a centralized biosolids facility during the restricted application period. In Ontario, this is typically from October to March.

Furthermore, this regulation defines permissible locations for biosolids application sites, specifically the proximity of an application site to underground aquifers and bodies of water, whether streams, rivers or lakes. The maximum allowable pathogenic content in the biosolids is stipulated, requiring stabilization treatment to reduce colony-forming units (CFUs) present in the biosolids. CFUs are a measure of the viable bacterial cells in a sample.

O.Reg. 419 of the *Environmental Protection Act* regulates the maximum allowable concentration of combustion gases and particulate matter generated by incineration of any material. The incineration of biosolids generated from treatment processes at wastewater facilities falls under O.Reg.419 as biosolids are considered a solid waste.

Reductions in the maximum allowable concentrations are to be staged, and are currently regulated under Schedule II, which is set to expire on Jan. 31, 2020. After that date, Schedule III will take effect and multiple hearth incinerators may not be able to achieve the maximum allowable concentrations stipulated.

In addition, there are Canada-Wide Standards developed by the Canadian Council of Ministers of the Environment for dioxins, furans and mercury air emissions.

These regulations determine the treatment process required at wastewater treatment plants once a biosolids management plan has been finalized.

Land application

The requirement for treatment plants to store stabilized sludge during the non-application period increases a plant's footprint due to the need for large storage tanks and digesters.

Stabilization of wastewater biosolids is required prior to land application to reduce pathogen levels. This can be achieved by conventional digestion, whether it be aerobic or anaerobic, or, alternatively, by chemical or biochemical reactions. There are several processes available on the market, such as Lystek, N-Viro and Bioset. Adding lime to biosolids creates a Class A product that is rich in nutrients and can correct the pH of acidic soils. This is especially beneficial to farmers in areas with acidic soils.

Digestion can be divided into two subcategories of treatment, aerobic and anaerobic, and each have unique process requirements and characteristics.

Aerobic treatment requires oxygen to be present in the process environment to promote the breakdown of biomass by micro-organisms. In anaerobic digestion, gaseous oxygen is detrimental to the process, and micro-organisms are able to digest biomass in the absence of oxygen. The end products of aerobic digestion are mainly carbon dioxide and water, whereas the end products of anaerobic digestion are water, methane, carbon dioxide and trace amounts of hydrogen sulphide.

Aerobic digestion is a delicately balanced process, that requires the control of dissolved oxygen levels, temperature, biosolids feed rate, and pH to create an environment that promotes the digestion of biomass by bacteria. Dissolved oxygen levels in the process environment can be monitored, and used to control the aeration of the aerobic digestion tank to achieve an efficient process. On the other hand, anaerobic digestion requires the control of temperature, pH, biosolids feed rate, and mixing.

The pH of both digestion processes must be controlled to prevent the biomass from becoming acidic, which reduces the efficiency of digestion reactions. In an anaerobic digester, pH and alkalinity are monitored and the biosolids feed rate must be carefully controlled and regulated to achieve an efficient process. In an aerobic digester, pH, dissolved oxygen and alkalinity are monitored. pH can be controlled by either modulating the air

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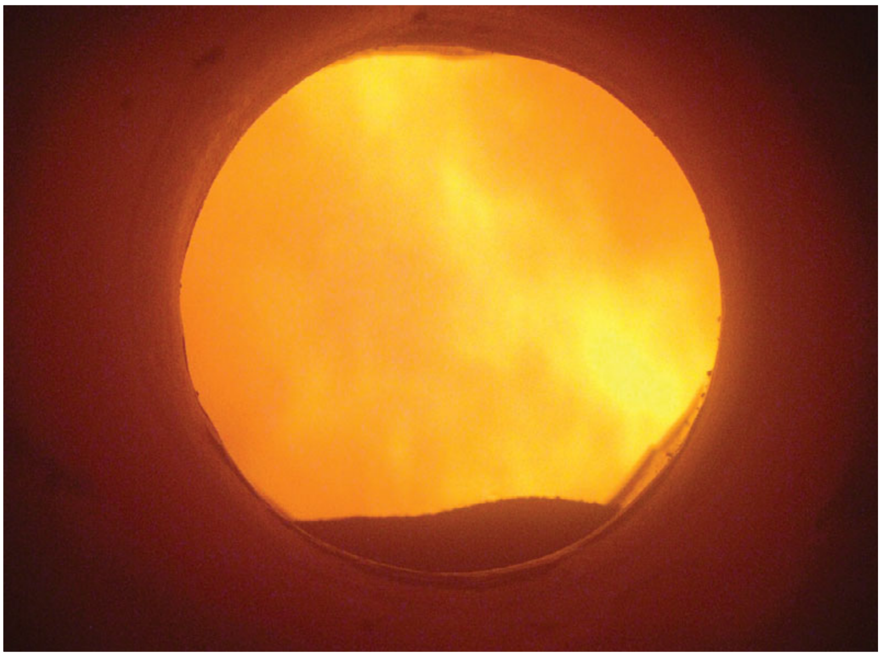

View through the sight glass of the fluidized bed incinerator at Greenway Pollution Control Centre.

supply to prevent nitrification or by adding an alkaline substance, such as sodium hydroxide, to compensate for the alkalinity consumed during nitrification.

Aerobic and anaerobic digestion also require the temperature to be controlled by modulating the heat supplied to the digester. If anaerobic digestion is used and the digester is of a sufficient capacity, methane gas produced from the process can be used as supplemental fuel for the digester heating system. However, a major concern of anaerobic digestion is that, under NFPA code 820, anaerobic digesters are classified as Class 1, Division 1, due to the presence of methane and other combustible gases. This classification requires specialized electrical and mechanical equipment to be installed, in order to prevent an explosion.

Once the sludge has been digested, the question of whether to dewater the biosolids prior to truck loading arises. Evaluating this process option is a function of the storage capacities of the digester(s) and the proximity of the land application sites to the wastewater treatment plant or biosolids facility. If a plant has large digester capacities and is relatively close to the land application sites, dewatering may not be practiced.

Dewatering can be achieved via centrifugation, pressing, or vacuum filtration, each of which has operational benefits and concerns. If the dewatered, digested biosolids are stored for more than five days, significant odour issues will arise and high levels of pathogenic bacteria could return. When finalizing a biosolids management plan, plant owners and operators must take these factors into consideration.

Incineration

Incineration of biosolids, like digestion, is a complex process that requires close monitoring by personnel and automated controls. The “three Ts” of combustion are the standard residence time (SRT) of the feed in the incineration zone, temperature of both the combustion reaction and the gases generated, and turbulence of the reaction mixture. The SRT is governed by the volume of the reaction vessel and the feed rate of biosolids, which is controlled by the sludge conveyance system upstream of the reactor, i.e., a screw conveyor or piston pump.

Operational temperature of the incinerator depends on four variables: biosolids heating value, feed rate, supplemental fuel injection rate, and rate of aeration. Turbulence of the combustion reaction is created by the rate of aeration of the incinerator, and can be controlled by trimming the air supply valves.

Prior to incineration, biosolids must be dewatered to increase solids concentration. This allows combustion to occur at lower temperatures due to minimizing the amount of water present in the reaction. The main benefit of increasing the feed solids concentration is reducing the incinerator’s fuel consumption. Digestion is not required, and in fact is detrimental to the incineration process as it decreases the biosolids heating value.

If the proper process conditions exist, dewatered biosolids cake can be autogenous. To achieve autogenous combustion, the incinerator must be a fluidized bed, combustion air must be preheated, and the biosolids must have a solids concentration greater than approximately 25%. Furthermore, air supplied to the incinerator must be controlled to create a feed-to-air ratio that allows for complete combustion.

The control of the combustion reaction determines concentrations of the gas products, which then have to be treated in a wet or dry scrubber before being emitted to the environment. Achieving complete combustion reduces concentrations of carbon monoxide, particulate matter and other undesirable compounds, thus reducing the scrubber's chemical usage.

A wet scrubber typically uses a sodium hypochlorite solution to remove pollutants. Prior to scrubbing exhaust gas, a heat exchanger can be utilized to preheat combustion air by recovering waste heat from the exhaust gas. This recovered heat can also be directed to other areas of the plant to reduce the plant's external energy consumption.

Both land application and incineration of biosolids involve complex processes that require close monitoring and control to achieve an acceptable operational efficiency. However, biosolids generated from wastewater treatment can become a sustainable energy resource.

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