Evaluation of Processes to Reduce Activated Sludge Solids Generation and Disposal

The development of sludge minimization technologies continues to advance, both for applications within the liquid treatment process and for digester pretreatment. Most waste activated sludge-reduction technologies have full-scale applications on industrial or municipal wastewater in Europe and Australasia, with a much slower implementation rate in North America. The exception to this trend is combination biological processes such as Cannibal®, which was developed in North America and has found wider acceptance. However, many technologies have a limited number of installations (e.g., chemical treatment technologies), and some technologies have shown mixed performance, particularly on applications in North America (e.g., physical pretreatment for digestion).

The research resulted in a method to evaluate technologies for their technical and economic applicability to specific wastewaters and local conditions.

This study provides valuable insight into cutting-edge research and emerging technologies associated with sludge minimization. Data analysis indicates positive results, although the performance of the same technology is often significantly different at separate facilities. This study improves the understanding of why some sludges are more susceptible to these technologies than other sludges. The success of a technology depends on understanding the mechanisms and process parameters; particular waste stream characteristics and economic conditions; the use of appropriate operational parameters, such as adequate input energy for physical processes; and the economics of heat, sludge disposal, existing infrastructure, equipment, and chemical costs.

The following list presents the technologies that were included in the evaluation, the mechanistic principle category they represent, and the associated vendor. These technologies also provided operating plant information as well as sludge samples that were used for the laboratory testing program conducted as part of this project by Dr. John Novak from Virginia Polytechnic Institute and State University.

- Biological: Combination process – Cannibal® process (Siemens AG)
- Physical: Thermal hydrolysis – Cambi® process (Cambi AS)
- Physical: Pressure release – Crown® Disintegrator (Biogest AG)
- Physical/Chemical: Chemical conditioning and homogenization – MicroSludge® (Paradigm Environmental Technologies, Inc.)

The research team also obtained and evaluated data from a Microsludge® demonstration study conducted at the Des Moines, Iowa, Water Reclamation Facility (WRF).

One goal of this research was to determine whether there were indicators either in the wastewater constituents, in the biological sludge characteristics, or in the plant operation that would provide insight into the potential for solids-reduction technologies to be successful.

BENEFITS

- Provides insight into research and emerging technologies associated with waste activated sludge reduction.
- Documents the state-of-the-art and full-scale performance by some of the technologies.
- Improves understanding of why some sludges perform better under these technologies than other sludges.
- Includes a facility sampling and laboratory test protocol to determine relevant sludge characteristics.
- Includes an MCA and life-cycle cost module for decision making that includes technical, financial, and nonfinancial criteria.

RELATED PRODUCTS

State of the Science Report: Energy and Resource Recovery from Sludge (OWSO3R07)

Energy Efficiency in Wastewater Treatment in North America: A Compendium of Best Practices and Case Studies of Novel Approaches (OWSO4R07e)

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The second goal of the study was to investigate mechanisms for solids reduction. This was conducted using data from both full-scale facilities as well as laboratory units where sludge reduction technologies could be compared with samples that were not treated or processed.

The third goal was to develop a modeling approach that could predict solids reduction if adequate data were provided. This would include distinguishing between processes that increased the rate of degradation and those that increased the extent of degradation. The model would also include processes that increased cell lysis and those that primarily solubilized particulate organic matter. To that end, this project has developed a general framework for simulating waste activated sludge reduction technologies using generally accepted and used models.

Findings and Recommendations

Sludge reduction mechanisms generally fall into the following three categories: 1) mechanisms that solubilize sludge solids and lyse cells, thereby increasing the *rate* of degradation; 2) mechanisms that render the nondegradable organic fraction degradable, thereby increasing the *extent* of degradation; and 3) mechanisms that result in the generation of less sludge by process modification. Several processes claim to render solids more biodegradable, and most of the vendors of these processes claim that both cell lysis and solubilization of particulate solids occur, including the following:

- Mechanical shear
- Sonication
- Pressure release
- Heating under pressure
- Chemical oxidation

Most sludge reduction vendors claim to both increase the rate and extent of degradation. However, it is not clear that this is accomplished based on the data available from this study. Data from other investigations have found an increase in both the rate and the extent of degradation, but it is also not clear to what extent cell lysis accounts for increases in solids reduction. For the third category, modification in the activated sludge process, usually performed on the return sludge recycle stream, can directly reduce solids (e.g., by chemical oxidation) or can solubilize solids in the same manner as mechanisms 1 and 2, resulting in rapid degradation when the recycle stream reenters the aeration basin.

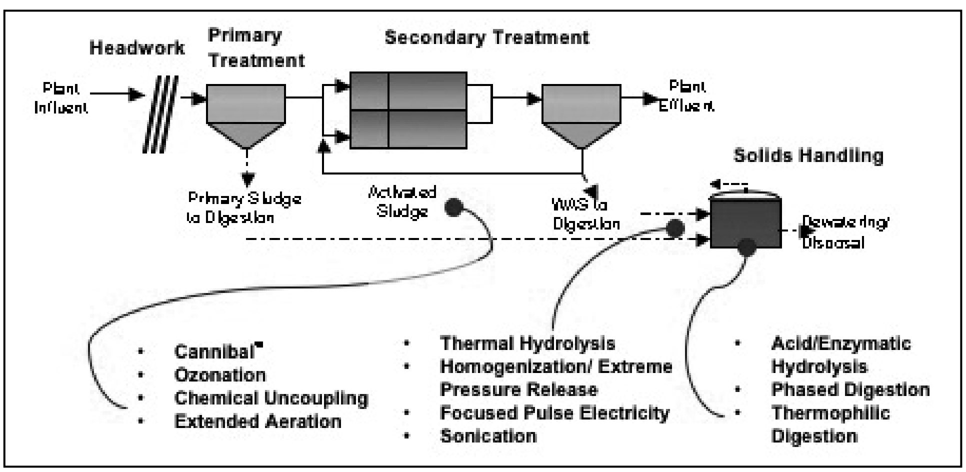

Figure 1. Examples of Waste Solids Reduction Technologies.

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6/11