NORAM Bio Systems Inc.

VERTAD™

Class A Biosolids Production

NORAM's patented VERTAD™ system is an auto-thermophilic aerobic sludge digestion process which uses an in-ground vertical shaft to produce Class A biosolids. The process occupies a minimal footprint and is competitive in terms of capital and operational costs, while significantly reducing environmental concerns regarding odour and visual impact. Vertical reactors have been used successfully in wastewater treatment applications for more than 25 years.

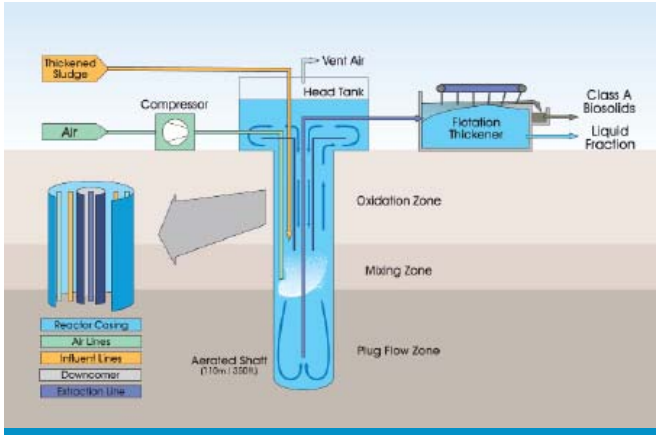
The VERTAD™ technology offers a number of advantages over alternative sludge digestion processes:

HIGH OXYGEN TRANSFER EFFICIENCY

Increased oxygen solubility at depth and a long bubble retention time results in high oxygen transfer efficiencies in excess of 50%, and significant energy savings.

CLASS A BIOSOLIDS IN FOUR DAYS

The high oxygen transfer efficiency in VERTAD™ promotes rapid digestion of secondary, or mixed primary and secondary sludge. Pathogen-free Class A biosolids are produced in less than four days – a substantially shorter time period than in competing technologies.



The VERTAD™ Process

- Sludge is digested in a sub-surface auto-thermophilic reactor 250-350 ft deep.
- The vertical reactor has 3 distinct zones:

  Oxidation Zone: The top portion of the shaft where the majority of the sludge digestion takes place.

  Mixing Zone: Feed sludge and air are introduced in the reactor mixing zone. The air provides oxygen for solids reduction, promotes mixing in the reactor, and achieves solids separation through flotation thickening.

  Saturation Zone: Stabilized biosolids withdrawn from the reactor flow down through the saturation zone where high temperature and long residence time ensure that Class A biosolids are produced.
- Class A biosolids are withdrawn from the bottom of the reactor and transferred to a thickener where rapid depressurization of the gases dissolved at depth results in effective solid/liquid separation through flotation.
- Off-gas is separated from the circulating liquor in the head tank and is treated in a fixed-film biofilter.

SMALL FOOTPRINT & MINIMAL VISUAL IMPACT

The VERTAD™ system typically uses 10-20% of the total land required for a conventional system. Self-contained and largely hidden from view, VERTAD™ eliminates the visual impact of the large surface tanks typical in a conventional sludge digestion plant.

LOW POLYMER USE

The VERTAD™ biosolids are float-thickened to between 8-12% dry solids in a thickener, through the release of gas dissolved under pressure. The thickened Class A biosolids can be dewatered to between 30-35% dry cake solids with a polymer dose of approximately 15 lb/dry ton. This significantly reduces both chemical and haul costs.

IDEAL RETROFIT FOR ANAEROBIC DIGESTION

VERTAD™ is an ideal retrofit for facilities utilizing mesophilic anaerobic digestion. Not only would the retrofitted plant produce Class A biosolids, it would also reduce the quantity of biosolids, decrease operating costs, and increase the total digestion capacity.

VERTAD™ digestion system (5,000 population equivalent)

Comparison of the VERTAD™ Process to Various Conventional Technologies

Technology	Product	VS Removal	Cake Solids	Major Off-gas	Land Use
VERTAD™	Class A Biosolids	> 40% (<4 day SRT)	> 30%	CO_2, O_2, TRACE NH_3	Low
Auto Thermophilic Aerobic Digestion	Class A Biosolids	40% (8-12 day SRT)	25-30%	O_2, CO_2, HIGH NH_3	Med
Temperature Phased Anaerobic Digestion	Class A Biosolids	~60% (>20 day SRT)	15-25%	CH_4, CO_2, H_2S	High
Anaerobic Mesophilic	Class B Biosolids	~55% (>25 day SRT)	15-25%	CH_4, CO_2, H_2S	High

NORAM Engineering and Constructors Ltd.




COMPANY PROFILE

NORAM is an engineering and technology development firm based in Vancouver, Canada. Founded in 1988, NORAM employs a highly qualified technical staff of approximately one hundred. NORAM has a global client base and has successfully completed projects on five continents.

Today NORAM is the world's leading supplier of mononitrobenzene (MNB) plants, a key intermediate in the production of polyurethane. In addition, NORAM offers sulfuric acid equipment, biological treatment facilities, energy systems, and technologies for the chemical, minerals processing, environmental, and pulp & paper industries.

NORAM offers proprietary technology to customers through engineered equipment and complete chemical plants. NORAM's core competencies include:

- Biological Treatment Technologies
- Electrochemical Systems
- Energy Systems
- Environmental Technologies
- Feasibility Studies
- Fluid Dynamics & Finite Element Analysis
- Heat Transfer Systems Design
- Nitration Technology
- Project Management
- Pulp & Paper Technologies
- Sulfuric Acid Manufacture

PARTNERING WITH INNOVATION AND EXPERIENCE

NORAM is focused on the development, commercialization and supply of established and novel processes. With its entrepreneurial culture, NORAM has a demonstrated track record of thinking outside the box to provide innovative solutions. Technologies can be evaluated and integrated into an advanced engineering solution based on first principles.

NORAM has made its mark internationally by supplying proprietary systems to various industries world-wide. NORAM can bring this expertise and innovative ideas to your projects.

NORAM has established strategic relationships with the following organizations:

- Bateman Engineering BV
- Canadian Hydrogen and Fuel Cell Association
- Eco-Tec
- First Chemical Corporation (A DuPont Company)
- FP Innovations
- Kemetco Research Inc.
- Membrane Reactor Technologies
- Ostara Nutrient Recovery Technologies Inc.
- Radient Technologies
- Siloxy Limited
- Simon Carves Limited (Punj Lloyd Group)
- The Electrosynthesis Company

NORAM Engineering and Constructors Ltd.
Suite 1800 - 200 Granville Street
Vancouver British Columbia Canada V6C 1S4
Telephone: +1 604.681.2030
Fax: +1 604.683.9164

Visit us on the internet at
www.noram-eng.com