

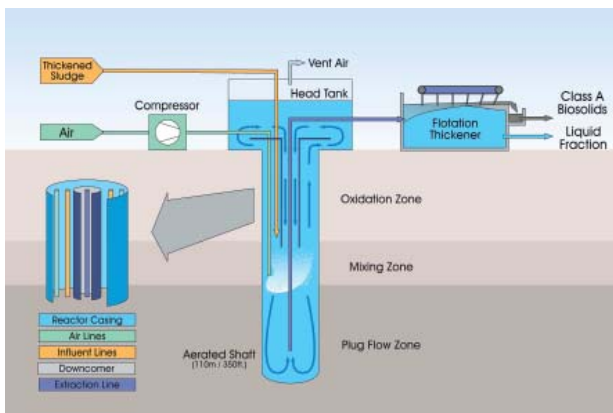
NORAM's patented VERTAD™ system is an auto-thermophilic aerobic sludge digestion process which uses an in-ground vertical shaft to produce Class A biosolids.

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.



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 - **Saturation Zone:** Stabilized biosolids withdrawn from the reactor flow down through the saturation zone where high temperature and long residence time ensure that Class A biosolids are produced.
- Class A biosolids are withdrawn from the bottom of the reactor and transferred to a thickener where rapid depressurization of the gases dissolved at depth results in effective solid/liquid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.



VERTAD™ digestion system (5,000 population equivalent)

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.

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 digester capacity.

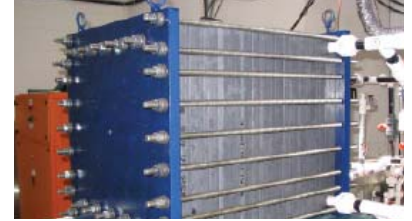
technology and engineering solutions for the process and resource industries



Nitration



Sulfuric Acid



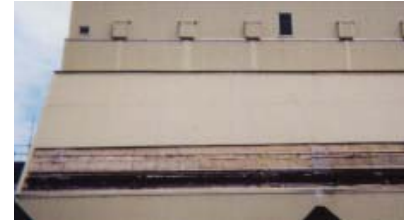
Electrochemical



Biosystems



Pulp&Paper



Environmental

Company Profile

NORAM is a private engineering and technology firm based in Vancouver BC, Canada. We specialize in the development, engineering and commercialization of new chemical processes, and in the improvement and optimization of existing technologies. Since 1988 NORAM has provided leading-edge technologies to the chemical, pulp and paper, minerals processing, wastewater and electrochemical industries.

Today NORAM is the world's leading supplier of nitration technology. In addition, we offer sulfuric acid plants, biological treatment facilities, energy systems, and technologies for the clean-tech sectors.

Our business has developed around the supply of proprietary engineering and equipment packages to our clients.

Core competencies include:

- Nitration and NO_x Technology
- Electrochemical Systems
- Sulfuric Acid Manufacture
- Biological Wastewater Treatment
- Computational Fluid Dynamics & Finite Element Analysis
- Heat Transfer & Heat Exchangers
- Hydrogen, Sulfur and Chlorine Chemistry
- Fluidised Bed Systems
- Energy Storage
- System Closure

Partnering with Innovation and Experience

NORAM works extensively with early-stage technology companies. We draw on established competencies in process design and engineering, provide custom in-house fabrication capabilities, and offer pilot plant and contract research facilities to support the commercialization process.

We've teamed up with organizations around the globe to allow project execution on 5 continents. Our strategic relationships include:

- Bateman Engineering BV
- Canadian Hydrogen and Fuel Cell Association
- ECO-TEC Inc.
- First Chemical Corporation (a DuPont Company)
- FP Innovations
- Kemetco Research Inc.
- Membrane Reactor Technologies
- Ostara Nutrient Recovery Technologies Inc.
- Radiant Technologies Inc.
- Siloxy Limited
- Simon Carves Ltd (Punj Lloyd Group)
- Electrosynthesis Company Inc.

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