



# St. Lawrence TECHNOLOGIES



## ABSTRACT

The past ten years have seen considerable sums devoted to the development of bacterial colonies and specialized nutritional additives in an attempt to improve the performance of industrial processes in bioreactors. However, the return from these bioreactors generally rests on empirical concepts regarding the operations and their efficiency is therefore difficult to predict.


The SmartSoil™ technology deals with this problem by offering platform operators an effective and modular tool that enables them to better manage their industrial bioprocesses. In fact, SmartSoil™ allows for the real-time monitoring and control of environmental conditions within the bioreactors in order to optimize the bacterial processes that dictate performance and profitability.

## INNOVATIVE TOOL



## HIGHLIGHTS

- **Technology**
  - Unique tool to monitor and control fluid flow
  - Versatile tool with multiple environmental applications
  - Innovative and patented technological components
  - Modular and flexible installation
  - Real-time and external operations management
- **Environment**
  - Innovative concept of bidirectional aeration through forced convection
  - Uniform distribution of treatment fluids
  - Applicable to large volumes of heavy fractions of petroleum products ( $C_{10}$ - $C_{50}$ )
  - Enclosed bioreactor allowing for the reduction and subsequent elimination of contaminated effluents
- **Cost**
  - Minimization of operation costs
  - Maximization of internal rates of return in capital investments



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# PROJECT OBJECTIVES

The project was intended to validate the fundamental concepts on which rests the SmartSoil™ technology for a first commercial application. Research and development were carried out in four phases:

**Phase I**  
Verification of Smartsoil™'s ability to measure and control, in real-time, the gaseous and liquid flow within various porous matrices (ETV Program\*).

**Phase II**  
Development of the SmartSoil™ technology components (software and associated units).

**Phase III**  
Experiments on components with small-scale bench tests.

**Phase IV**  
Large-scale field demonstrations.

\* The Environmental Technology Verification (ETV) Program is designed to foster the growth and marketability of Canada's environment industry by providing validation and independent verification of performance claims.



# BACKGROUND

Industrial processes in bioreactors must allow for the most efficient distribution of treatment fluids possible in order to optimize and standardize the biodegradation process.

Since the conventional application and operation of these bioprocesses is quite complex, operators often use digital models and/or empirical approaches to plan treatment and operation procedures.

This approach has drawbacks in that it reduces the efficiency and economic yield of the industrial processes. This occurs because the flow of treatment fluid within the porous medium is neglected

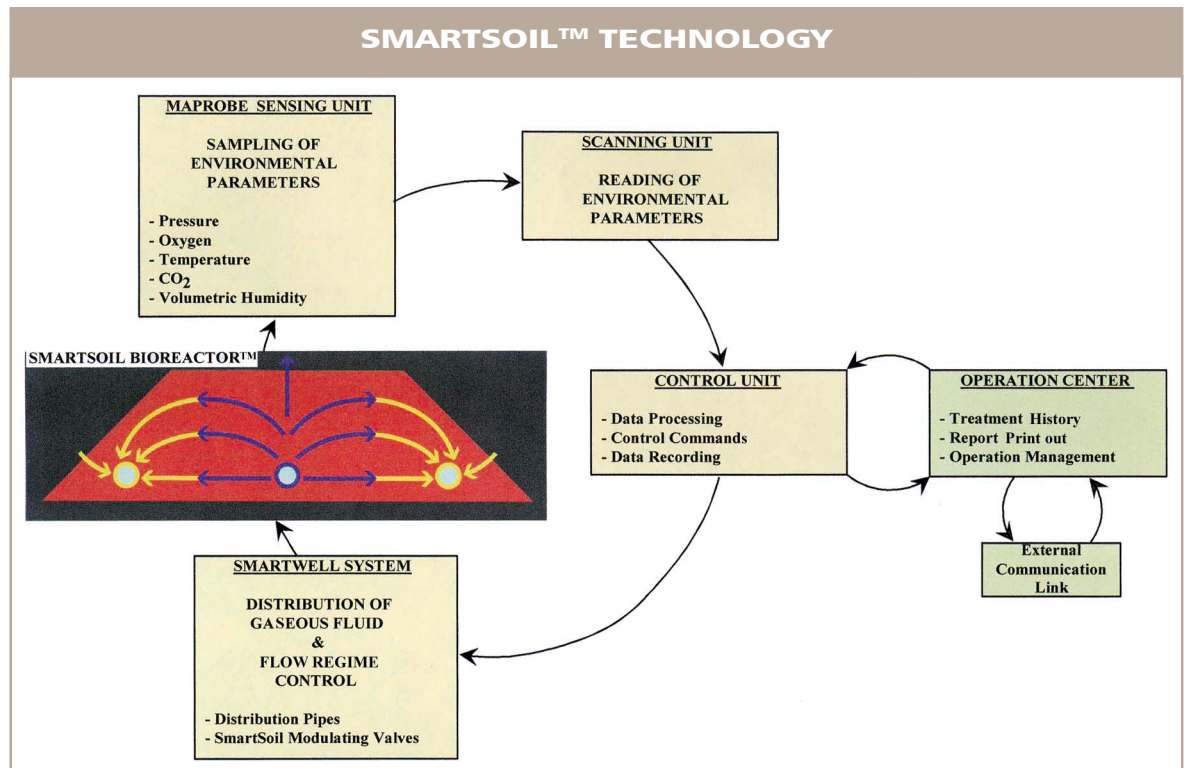
to the detriment of random variations in more conventional physico-chemical parameters.

Platform operators must therefore proceed by trial and error to acquire the experience needed to operate their bioprocesses. As such, investment returns rest on empirical concepts incapable of guaranteeing the treatment performance of their bioreactors, especially if the properties of the porous matrices vary from site to site.

# TECHNOLOGY

**SmartSoil™-Biopile**  
SmartSoil™-Biopile bioreactors provide an array of unique technological innovations:

1. An innovative design in bioreactors
2. Sequential and bidirectional forced convection aeration
3. Real-time monitoring and control of the flow of treatment fluid within the bioreactor
4. Control and optimization of biological processes with the help of the SmartSoil™ software
5. External management of treatment operations.



# RESULTS

The SmartSoil™-Biopile bioreactor functions on the concept of bioventilation in confined reactors. It was developed using experimental bioreactors of four to 1000 metric tons in size.

## PHASE I

Obtained ETV certification in June 1997 pertaining to SmartSoil™'s ability to precisely and accurately\* monitor and control on a real-time basis, the flow of steady- and unsteady-state treatment fluid injected or recovered in the porous matrix.

\* at a 95% level of confidence

## PHASE II

Finalized the modular components of the SmartSoil™ technology.

**SmartSoil™ Bioreactors:** Innovative bioreactor design with bidirectional forced convection (simultaneous injection and recovery).

**Scanning Module :**Real-time sampling and acquisition of environmental parameters.

**Control Module:** Digitization and interpretation of information using measurement and control algorithms of the SmartSoil™ operating software.

**Modulation Valves:** Real-time control of the flow rate of treatment fluids.

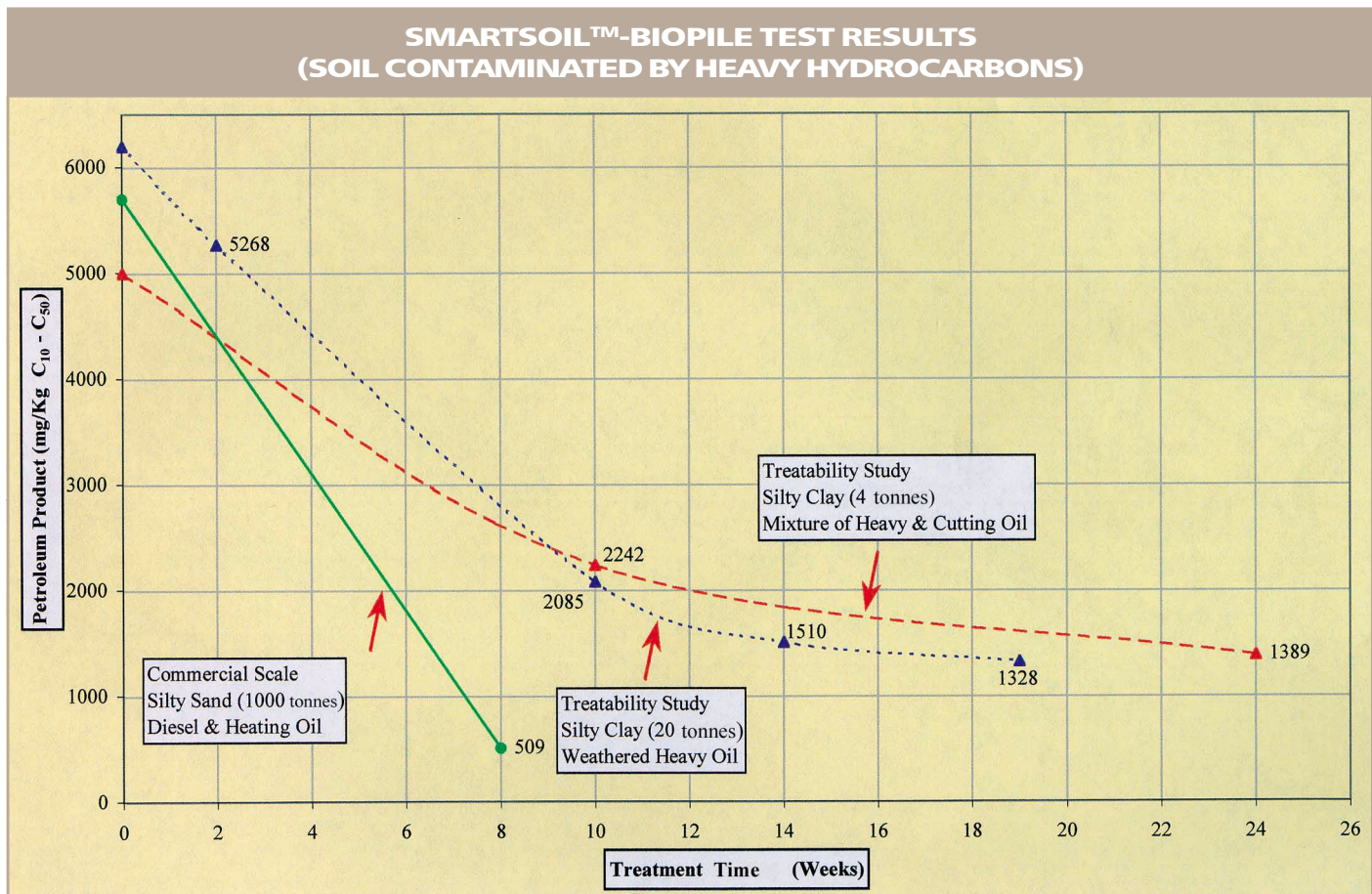
## PHASE III

Validation of SmartSoil™'s ability to standardize and optimize biological decontamination processes in silty and sandy soil. During the last experiment, the SmartSoil™ operating software recorded more than 630 000 data pertaining to the treatment fluid and the biological processes.

## PHASE IV

After eight weeks of treatment, the heavy fraction of petroleum products (diesel and heating oil) of a 1000-tonne bioreactor made up of fine silty sand was reduced from 5670 ppm to 509 ppm.

Treatment operations were externally managed by the SmartSoil™ managing software.



# POTENTIAL AND LIMITATIONS

## Potential

The measuring and controlling potential of the SmartSoil™ technology is generic and unique. Its commercial potential involves two business sectors:

### Environment :

- Composting of residual matter and explosives
- Soil decontamination
- Biofiltration of gaseous effluents
- Biofiltration of waste water

### Energy :

- Biogas (optimization of production and quality)
- Drying of waste generated by processing of forestry products
- Petroleum extraction

### Limitations

The SmartSoil™ technology requires a homogeneous or heterogeneous porous matrix. The product standardizes and optimizes complex biological processes within the matrix.

Maximum return from a SmartSoil™ investment resides in treatment platforms with large production capacities.

The potential of the technology in the fields of biofiltration and energy is about to be demonstrated for large-scale applications.

# INFORMATION

This data sheet was prepared based on the results of a technology development and demonstration project conducted by Expertises Environnementales Soconag Inc. The project was funded in part by Environment Canada, Canada Economic Development, and the National Research Council of Canada.

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