St. Lawrence TECHNOLOGIES

ABSTRACT

The management of soil contaminated with light hydrocarbons is a major environmental problem, both because of the amounts involved and the treatment required to recover the soil for use. The technology tested here consisted of thermally treating the soil in the rotary kiln at Construction Norascon Inc.'s asphalt plant in Val d'Or, Québec. The demonstration verified the treatment's effectiveness, large-scale feasibility, and its environmental and technical performance. About 650 metric tonnes of soil containing over 1% of diesel oil were treated. The level of decontamination meets required government standards for the soil's re-use as backfill.

CONTAMINATED SOIL

THERMAL TREATMENT IN AN ASPHALT PLANT OF SOIL CONTAMINATED WITH LIGHT HYDROCARBONS

MAIN FEATURES

- **Technology**
  - Thermal process using an asphalt plant's rotary kiln for soil decontamination.
- **Environment**
  - Restoration of light hydrocarbon-contaminated soil.
  - Re-use of treated soil.
- **Cost**
  - Cost is comparable to other technologies.
  - Technology is applicable in existing asphalt plants.
  - Treated soil can be added to the aggregate materials used in the production of asphalt.

ST. LAWRENCE ACTION PLAN

Environment Canada — Conservation and Protection — Québec Region
Environnement Canada — Conservation et Protection — Région du Québec

Shell Canada Limited

CONSTRUCTION NORASCON INC.

PROJECT OBJECTIVES

Some 650 metric tonnes of soil containing diesel oil was used for testing. Short trials (30 minutes) using various mixtures of soil determined the optimal grain size mixture for the long trial (3 hours). The trials evaluated the technology's environmental and economic performance based on the following factors:

- The level of removal of hydrocarbons from the soil;
- The fraction of hydrocarbons volatilized and trapped in the scrubber water;
- The treatment's effectiveness in regard to soil decontamination criteria (A, B and C)*;
- The feasibility and effectiveness of thermal treatment;
- The widespread use of asphalt plants and the modifications required to meet environmental emissions standards;
- An economic assessment of the technology.

* According to the Politique de réhabilitation des terrains contaminés, ministère de l'Environnement du Québec (1990), the soil decontamination criteria with respect to mineral oils are the following:

Criterion A: 100 mg/kg of dry matter

Criterion B: 1000 mg/kg of dry matter

Criterion C: 5000 mg/kg of dry matter

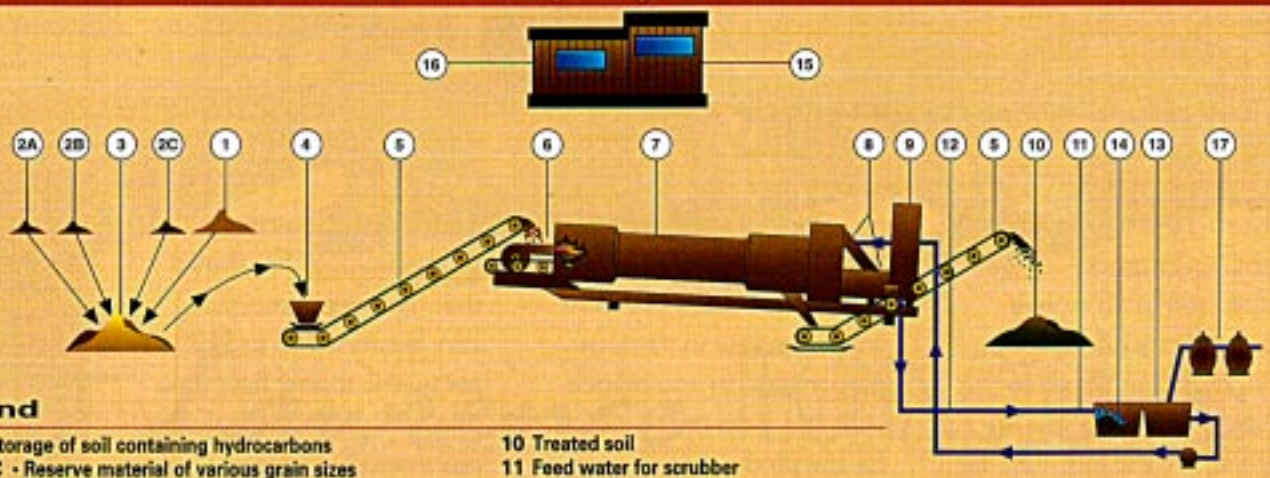
BACKGROUND

The disposal in landfills of soil whose level of contamination exceeds Criterion C* is not a viable long-term solution. Not only is the possibility of re-using this soil lost, but landfilling is only allowed under certain very strict conditions. Industrial, institutional and private sector companies are faced with this problem as large quantities of contaminated soil are generated by, among other things, the dismantling or replacement of light hydrocarbon storage tanks. The proposed technology is an attractive alternative. The temperatures reached by asphalt plant kilns decontaminate soil to below the level of Criterion B*. Furthermore, because plants of this type can be found in most regions, this techno-logy offers a locally-accessible solution.

TECHNOLOGY

The technology was demonstrated on production facilities where asphalt is produced on a continuous basis. The plant facilities, Caterpillar model SVM-1100, include a fully automated parallel flow rotary kiln, divided into three sections, with a 300 t/h capacity and a retention time of 9 minutes. The soil to be treated is introduced into the kiln's first section, which contains a burner. The soil falls in front of the flame to form a curtain which is crossed by hot air with an average temperature of 200°C. In this section, the hydrocarbons are burned, volatilized and, along with the soil's fine fraction, are carried by the hot air toward a centrifugal wet scrubber. This dust is carried by the scrubber water into a settling tank and following sedimentation, the recovered soil particles can be re-used in the production of asphalt. The treated soil is carried by the paddles of the rotary kiln toward a conveyor and accumulated for future use as aggregate. During experimentation, changes were made to the damper opening, which regulates the flow of hot air and the equilibrium of combustion gases, and to the kiln feed rate. Contaminated soil was mixed with a granulate in various proportions and the material treated was not coated with bitumen, contrary to normal kiln operating procedures.

SCHEMATIC DIAGRAM OF THERMAL PROCESS (asphalt plant)



Legend

1 Safe storage of soil containing hydrocarbons
2 A, B, C - Reserve material of various grain sizes
3 Mixture of soils 1 and 2
4 Screening < 5 cm
5 Feed conveyor and automatic weighing
6 Burner
7 Rotary kiln
8 Centrifugal wet scrubber
9 Chimney
10 Treated soil
11 Feed water for scrubber
12 Wastewater
13 Settling tanks and water make-up
14 Sludge
15 Control centre
16 Laboratory
17 Wastewater filtration system

RESULTS

The trials were subject to a complete monitoring of air, water and soil; the results are presented in the table below.

Contamination level of soil to be treated

Concentrations of diesel oil, mineral oils and greases, polycyclic aromatic hydrocarbons (PAHs) and monocyclic aromatic hydrocarbons (MAHs) in the soil were measured both before and after the treatment. The soil to be treated contained 1.23% diesel oil, 9067 ppm of mineral oils and greases, 3.43 ppm of PAHs and traces of MAHs.

Optimal mixture

Short trials (30 minutes) were conducted using varying proportions of clean and contaminated soil, stones and silty sand. The final mixture for the long trial (3 hours) consisted of 30% contaminated soil, 55% silty sand and 15% stones (0-2 cm).

Treatment of wet scrubber wastewater

The scrubber water was completely re-circulated during the trials. Water from the settling tank was treated through a sand filter and three in-line activated carbon filters, then analysed and discharged.

Re-use of fine particles

About 9 tonnes per hour of fine particles were generated during the trials. The sedimented solids in the settling tank were added to the granular material used by the plant in the fabrication of asphalt.

CONCENTRATIONS OF CONTAMINANTS IN VARIOUS MATRICES BEFORE AND AFTER TREATMENT

Matrix	Sequence	Mineral O & G[a]	Diesel oil	PAH[b] (total)	MAH[c] (total)
Mix of granulates[d]	Before	1263 mg/kg	1833.3 mg/kg	1.22 mg/kg	Trace
	After	97 mg/kg	<100 mg/kg	0.267 mg/kg	Trace
Air[d]	Before	0.091 kg/h	1.52 kg/h[e] 28 834 Nm³/h[f]	7.8 g/h 28 390 Nm³/h[f]	93.52 g/h 29 403 Nm³/h[f]
	After	1.54 kg/h	121.8 kg/h[e] 22 842 Nm³/h[f]	288.61 g/h 30 416 Nm³/h[f]	1821.35 g/h 29 338 Nm³/h[f]
Water	Before	<0.5 mg/L	<0.1 mg/L	ND	ND
	After	<0.5 mg/L	3.9 mg/L	0.020 mg/L	0.0075 mg/L
Sludge[d]	Before	<135 mg/kg	<100 mg/L	0.037 mg/kg	Trace
	After	4467 mg/kg	2700 mg/kg	9.57 mg/kg	0.34 mg/kg

ND: non-detectable
(a) Mineral O and G: mineral oils and greases
(b) PAH: polycyclic aromatic hydrocarbons
(c) MAH: monocyclic aromatic hydrocarbons
(d) Results expressed on a dry base
(e) Results of THC (total hydrocarbons) used
(f) Nm³/h = normal cubic metre/hour

POTENTIAL AND LIMITATIONS

The thermal treatment of light hydrocarbon-contaminated soil in an asphalt plant's rotary kiln reduces contamination levels to the A and B* range of the criteria set by the ministère de l'Environnement du Québec. This technology is a viable alternative to disposal of contaminated soil in landfill sites. Its future is certainly promising.

Treated soil containing a low concentration of hydrocarbons can be mixed with aggregate in va-rious proportions, in accordance with the grain size required for the production of asphalt. In some regions, very cold seasonal temperatures can hinder both plant operations and the handling of soil, thereby hindering the use of this technology.

The demonstration of this technology has shown that treatment costs may vary between $60 to $100 per metric tonne, figures that are comparable to other processes used to treat soil contaminated with light hydrocarbons.

INFORMATION

This data sheet is based on the results of a technology development and demonstration project carried out by Shell Canada Products Ltd., in collaboration with the firm Construction Norascon Inc. The project received financial support from the St. Lawrence Centre.

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St. Lawrence Technologies data sheets are intended for all companies, industries, organizations and individuals interested in new environmental technologies. They are produced by the Technology Development Branch of the St. Lawrence Centre, Environment Canada, as part of the St. Lawrence Action Plan. They serve to disseminate the results of technology development and demonstration projects conducted in the following four sectors: industrial wastewater; contaminated soil; hazardous wastes; contaminated sediment.

Data sheets may be obtained free of charge from:
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Communications La Sceau Inc.
Printed at:
Boulanger Inc.

Published by authority of the Minister of the Environment

Cat. No.: En 1-17/2/1992E
ISSN: 1188-7990
ISBN: 0-662-20088-8

November 1992

Cette fiche est également disponible en français sous le titre:
Traitement thermique des sols contaminés par des hydrocarbures légers dans une usine de fabrication d'asphalte.

Canada