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Project Summary

Pollution Control Technical Manual for Unishale B and Unishale C Oil Shale Retorting

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This, the seventh EPA-prepared pollution control technical manual (PCTM) on synfuels, describes the Unishale B and C oil shale retorting processes. This technical handbook provides process, discharge, and pollution control data in summarized form for the use of permit writers, developers, and other interested parties. The PCTMs cover a range of alternate fuel sources, including coal gasification, coal liquefaction by direct and indirect processing, and oil shale retorting.

All PCTMs are prepared on a base plant concept (coal gasification and liquefaction) or developers' proposed designs (oil shale) which may not fully reflect plants to be built in the future. The PCTMs present examples of control applications, both as individual process units and as integrated control trains. These examples are taken in part from applicable permit applications and, therefore, reflect specific plants. None of the examples are intended to convey an Agency endorsement or recommendation, but rather are presented for illustrative purposes. The selection of control technologies for application to specific plants is the exclusive function of the designers and permitters who have the flexibility to utilize the lowest cost and/or most effective approaches. Readers should be able to relate their waste streams and controls to those presented in these manuals to enable them to better understand the extent to which various technologies may control specific waste streams and utilize the information in selecting control technology for their specific needs.

The PCTMs contain no legally binding requirements or guidance, and nothing contained in the PCTMs relieves a facility from compliance with existing or future environmental regulations or permit requirements.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Overview

The EPA has undertaken an extensive study to determine synthetic fuel plant waste stream characteristics and pollution control systems. The purpose of this and all other PCTMs is to convey this information in a manner that is readily useful to designers, permit writers, and the public.

The Unishale B and C oil shale PCTM addresses two retorting technologies developed by UNOCAL (Union Oil Company of California). This manual summarizes information published by UNOCAL and others on the Unishale B and C processes. Major facility inputs and outputs published by UNOCAL were used as a starting point to develop a description of mine/retort and upgrade facilities capable of producing 83,000 barrels/day (bpd)* of syncrude from 115,000 tons/day (tpd) of 34 gallon/ton

* Readers more familiar with metric units may use the factors listed at the end of this Summary to convert to that system

(gpt) raw shale feed. The engineering design, stream compositions, and pollution control alternatives presented here are not intended to represent or reproduce exactly those proposed or employed by UNOCAL at its Parachute facility or any other such facility. The design presented here represents one of many possible configurations for an oil shale facility based on Union's technology, but in no way obligates UNOCAL to adopt the designs or pollution control options, nor does it represent EPA's endorsement of the designs and pollution control options. Unishale B or C plants proposed or built in the future can be expected to be similar in most aspects to the plant described in this document, but each can be expected to vary in some respects; e.g., mining methods, selection of particular control technologies, or methods for upgrading the raw shale oil.

This manual describes typical Unishale B and C oil shale plants, characterizes the waste streams produced in each medium, and discusses commercially available controls which can be applied to the plant waste streams. From these generally characterized controls, several are examined in more detail for each medium to illustrate typical control technology operation. Control technology cost and performance estimates are presented, together with descriptions of the discharge streams, secondary waste streams, and energy requirements.

Introduction

Background information on the development of the Unishale B and C retorting processes is presented along with a description of the site, in western Colorado, where Union has proposed building these two plants and has finished construction of a 10,000-bpd commercial size module plant.

The Union Oil Phase I and II projects are at Union Oil's Parachute Creek property in western Colorado. Phase I consists of a mine, a single retort, and an upgrading facility. The mine and retort bench are along the east fork of Parachute Creek; the upgrading facility is along the lower portion of Parachute Creek valley. The retorting and upgrading areas are connected with pipelines which run along a pipeline corridor.

The Phase I shale oil upgrading facility is about 3 mi northwest of Parachute, Colorado, and is designed to process 10,000 bpd of raw oil shale from the Phase I Long Ridge experimental shale oil plant. The Phase I mine will be at Long Ridge and is a conventional room-and-pillar (RAP) mine designed for 15,156 tpd, 5 days per week, output. Average run-of-the-mine (ROM) shale quality is 34 gpt. Primary and secondary crushing as well as raw shale feed storage are carried out underground. Retorting is conducted aboveground in a Unishale B indirectly heated vertical kiln retort.

The proposed Phase II shale oil plant, will expand crude shale oil production by 80,000 bpd, for a total of 90,000 bpd. The Phase II mining, crushing, and retorting facilities will be on Old Mountain, on the south side of the east fork of Parachute Creek and across the valley from the existing Phase I Long Ridge mine and retort bench. The proposed Phase II expansion will consume 115,000 tpd of raw shale, about 15 x 10^6 cu ft/day of natural gas, an average of 14,300 acre-ft/yr of water, and 185 MW of peak electricity to produce the 80,000 bpd of crude shale oil, 220 tpd of elemental sulfur, and 300 tpd of anhydrous ammonia by-products.

A new RAP underground mine will be constructed at Old Mountain, and will include underground primary crushing and storage facilities. The existing Phase I Long Ridge mine will be expanded in support of the Phase II activities. New materials handling and surface retorting facilities will be constructed and put into service in 20,000-bpd increments. Retorts will be of the Unishale C configuration which will include spent shale fluidized-bed combustors for additional energy recovery through combustion of residual carbon on the spent shale material. The existing Phase I upgrading facility will also be expanded in 20,000-bpd increments to a total capacity of 90,000 bpd of crude shale oil processing.

Process Flow Diagrams and Flow Rates

Forty-eight flow diagrams illustrating all operations in the Unishale B and C plant complexes are presented in the report. The integrated designs shown are based on the development plans proposed by Union Oil Company of California for the Phase II oil shale program, but other viable scenarios are possible in the areas of processing and pollution control

To understand the interactions throughout the plant complex, overall flow diagrams of both plant configurations based on the Unishale B and C retorting technologies are presented, followed by flow diagrams for individual unit processes in each configuration Flow rates for all major process and waste streams for which information either exists or was generated specifically for this document by engineering calculations and judgement are indicated on each of the more detailed diagrams, flow rates for streams of an auxiliary nature (e g., cooling water and steam) are not included in most instances

Inventory and Composition of Plant Process and Waste Streams

All but the most minor streams in the plant complex are inventoried in the report, and quantitative data are presented to define important characteristics of the streams. Detailed compositions of the major streams are presented and show changes in composition, from one point to the next, throughout the plant

The stream compositions presented were derived, to the extent possible, from pilot plant test data. In the absence of data from actual source testing, engineering analyses were performed on the technology and raw stream information from proposed industrial developments. The sources of these data, whether actual, estimated, or derived from published or unpublished information, are indicated.

The data presented are internally consistent for the overall plant complex, i.e , the principal chemical elements involved in emissions, effluents, and wastes are balanced throughout the plant. Trace elements generally are not considered because of the lack of consistent data available as a starting point The stream compositions derived by engineering analysis generally agree with the available data from published sources Therefore, the data presented, even though partly derived by engineering analysis, are believed to be both representative of the actual operations of such a plant and accurate enough to lead to relevant conclusions in analyses of various pollution controls

Pollution Control Technology

The report presents an inventory of pollution control technologies and discusses, in depth, some representative controls for each medium (air, water, and solid waste). The inventory expands beyond describing the technologies that have been proposed for use by various developers in conjunction with the Unishale B and C retorting processes That is, it discusses alternate and additional technologies that provide varying levels of control. Although the inventory is quite extensive, other possibilities may exist and should not be excluded from consideration Changes in the design of the plant complex, changes in the as-

sumptions made, and/or improved data from future testing could lead to the selection of different controls.

Each subject area for control (e.g., particulate control) begins with an inventory of available technical approaches, or technologies. Promising new control technologies not yet applied commercially, even in related industries, are also included in the inventory but are not described in detail. Such new technologies may be applicable to the oil shale industry if they are sufficiently developed and tested in the future. The inventory is followed by a discussion of the most important considerations in selecting a control. Finally, a more detailed analysis of performance and cost is presented for a few control technologies that would be appropriate for use in conjunction with the Unishale processes.

Detailed analyses estimate pollution control performance and cost. Performance estimates generally require no more than conceptual designs; however, the reliability of the performance estimates varies depending on the application. The estimates should be highly reliable where a proven technology is applied to a conventional stream for which experience exists (e.g., flue gas desulfurization) but may be much less accurate for controls which require testing and which are applied to unconventional streams (e.g., biological oxidation). All performance levels are given for instantaneous control and reflect optimal operation, which may be higher than the average level of performance actually achieved. All cost estimates are in mid-1980 dollars and are taken to the level of detail believed to be necessary to achieve ± 30% accuracy.

Process Upsets, Aborts, and Emergency Containment

A brief discussion is presented of possible process upset conditions, and information is presented on treating/disposing of wastes, off-spec products, and spill materials that may result from aborted runs or accidental discharges.

Metric Equivalents

Although EPA policy is to use metric units in all its reports, nonmetric units have been used in this summary for the reader's convenience. Readers more familiar with the metric system may use the following factors to convert to that system:

Nonmetric	*Times*	*Yields Metric*
acre-ft	*1233*	*m^3*
bbl	*0.159*	*m^3*
ft^3	*0.0283*	*m^3*
gal.	*0.00379*	*m^3*
ton	*907*	*kg*
mi	*1.609*	*km*

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The complete report, entitled "Pollution Control Technical Manual for Unishale B and Unishale C Oil Shale Retorting," (Order No PB 87-141 065 AS, Cost $42.95, subject to change) will be available only from
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