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HOT PILOT PLANT DEMONSTRATION
POT CALCINATION

Statement of Program Objectives and Responsibilities

Prepared by

Oak Ridge National Laboratory, Chemical Technology Division and
Phillips Petroleum Co., Atomic Energy Division

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A. General Objective

The objective of this joint development program is to establish the feasibility of converting a variety of high-activity solvent extraction raffinate wastes to solids suitable for permanent disposal using the pot calcination process, which consists of concentration by evaporation and thermal decomposition in situ in pots. To achieve this objective, it must be demonstrated that the pots can be filled safely with thermally stable and chemically inert solids at rates and costs permitting application to power reactor fuel processing and such that the pots can serve as final disposal containers. Operations and equipment suitable for remote, radioactive operation are to be developed.

B. General Scope of Project

1. Those engaged in this program intend to keep abreast of the progress and results of similar work being conducted at Hanford and in the United Kingdom; unnecessary duplication of that work will be avoided.

2. The design should be sufficiently versatile that calcination of the following wastes, listed in order of their priority in the program, can be carried out:

    a. Enriched uranium-aluminum alloy wastes
    b. Darex and electrolytic dissolution process waste
    c. Low-sulfate Purex type wastes
    d. High-sulfate Purex type wastes.

3. Demonstration of Pot Calcination of SIR process wastes and fluoride-containing wastes from STR, Zirflex, barium fluozirconate, and similar processes is a desirable goal and may ultimately be accomplished in this equipment. However, technology is probably not sufficiently advanced at this time to warrant installation of special corrosion-resistant equipment for this purpose although this should be considered. Replacement of key items of equipment may, then, prove necessary before pot calcination of these wastes can be accomplished.

4. Since many of the steps in the Pot Calcination Process are similar to those which could be used in other calcination processes, the design should consider the possibility of eventual parallel demonstration and comparative evaluation of other calcination processes, including a rotary kilm calciner, fluidized bed calciner with recycled fluidizing gas, or a spray calciner. Sufficient cell space should be provided so that two such calciners can be installed at the same time.

5. All processes and major variations in processes should be adequately tested through the Cold Unit Operations stage prior to being demonstrated in the Hot Pilot Plant.

   a. Hot Pilot Plant and Cold Unit Operations equipment should be similarly sized and similarly operated so as to provide a maximum degree of applicability of cold data to the Hot Pilot Plant unit.

   b. Cold Unit Operations testing should be performed on all pertinent types of waste.

6. The use of appropriate additives to the feed for the various processes should be tested in the Hot Pilot Plant following Cold Unit Operations testing.

   a. The use of additives to control the volatility of specific components of the waste should be tested. Appropriate analyses should be made to ascertain the volatility of such components as oxides of sulfur, ruthenium, cesium, and other fission products.

   b. The use of appropriate additives to various wastes to form glasses and similar low-porosity and low-leachability materials may be tested. Formation of low-porosity material in the pot by providing a vertical temperature gradient so that "glass" can form below the calcination and evaporation zones should be tested.

C. <u>Specific Objectives</u>

1. Identification and solution of operational and control problems in the conversion of liquid wastes to solids should be accomplished. Expected to be among the more significant of these problems are those associated with the feed system, measurement of the liquid level in the calcine pot, and control of the evaporator.

2. The maximum processing rates must be established for the various wastes to yield solids of high bulk density and other desired characteristics in pots of different diameters. Besides the rate of calcination, the "downtime" to change pots must be established to determine the effective production capacity of the plant.

3. Determination of properties of the calcined material.

   a. Leachability, porosity, melting point, and other properties should be determined, probably on material removed from the pot.

   b. Quantity of residual volatile material should be determined by pressure buildup. Composition of any gas necessary to vent should be determined by analysis.

   c. Pot loading of calcined material should be determined--possibly by material balance.

   d. Heat release, thermal conductivity, and localized hot spots should be determined by appropriate temperature measurements.

4. Fission product behavior during the calcination process should be studied. Ruthenium, at least under some circumstances, will be volatile during calcination. Its behavior should be carefully followed and quantitatively determined as a separate factor from entrainment. Provision should be made to measure the ruthenium content of all pertinent streams, including the calciner off-gas, pot condensate, all subsequent gas and liquid streams, and also that of the calcine.

5. Adequate de-entrainment in the various parts of the system such as the evaporator, condenser, and gas and liquid effluent stream clean-up devices should be demonstrated.

6. Adequate decontamination of effluent streams should be demonstrated.

   a. All liquid and gaseous effluent streams from the demonstrational unit (except concentrated nitric acid) should be sufficiently free from radioactivity to permit direct disposal to the ground and atmosphere, respectively.

   b. Preparation of concentrated nitric acid sufficiently free of fission products to permit reuse in a processing plant should be demonstrated to be possible.

7. Mechanical closures of pots should be demonstrated.

   a. Demonstration of a satisfactory, simple, and reliable operational connection to the pots is necessary.

   b. It is necessary to develop and prove high integrity permanent pot closure and demonstrate in the hot cell the feasibility of obtaining this closure remotely. Closures used for the demonstrational pots should be consistent with the degree of integrity required for their ultimate disposal.

8. Observation of pots during storage.

   a. Pressure and temperature transient behavior should be determined.

   b. The extent of corrosion of pots occurring during or following calcination must be determined. Devices such as ultrasonic thickness testing gauges should be considered; occasional sectioning of pots may be required to achieve this goal completely.

   c. A program of observation of pots should be established.

9. The production of a minimum volume of noncondensible off-gas shall be considered in equipment design, operations, and chemical treatment in order to minimize the gas cleaning problem.

10. Demonstrate calcination in a pot large enough to exhibit a suitable production rate, economic feasibility, and illustrate operating problems.

D. Division of Responsibility

Although this is a joint project in which pertinent ideas from either party may be advanced at any time, assignment of primary responsibility for each phase of the project to one of the participants is desirable. Occasionally a given phase must be accomplished by a truly joint effort; particularly close liaison will then be required on those phases to avoid duplication of effort. Primary responsibility for each of the various phases of this project is understood to be as follows:

Phase	Primary Responsibility for Accomplishment
1. Preparation of project objectives	Joint
2. Laboratory development work	ORNL
3. Preparation of chemical and material and energy balance flowsheets	ORNL
4. Cold Unit Operations testing	ORNL
5. Testing of special equipment to be used in Hot Pilot Plant	Joint
6. Specification of special equipment	ORNL
7. Preparation of engineering process flowsheet	Phillips
8. Detailed equipment design	Phillips
9. Detailed installation design	Phillips
10. Specification of any specific data requirements during operation	ORNL
11. Experiment design	Phillips
12. Operation of equipment	Phillips
13. Data Evaluation	Joint
14. Preparation of Reports	Both (See Section E)

E. Project Reports

It is expected that work performed on this project by either organization will be reported in the respective monthly, quarterly, and annual progress reports issued by those organizations. In addition, the following types of reports on this project are desirable.

1. Informal reports summarizing work done by each organization during the month on this project should be exchanged. It is expected that such informal reports can be distributed within ten days after the close of the reporting period and can contain more detail than is usually included in the regular monthly reports.

2. Project reports

   a. Reports describing laboratory development and/or Cold Unit Operations work and results should be prepared by ORNL.

b. Reports describing results of the Hot Pilot Plant demonstration experimental work should be prepared by Phillips

c. Over-all summary reports should be prepared by ORNL.

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