**PROOF-OF-CONCEPT TESTING OF
FLUIDIZED-BED COPPER OXIDE PROCESS**

DOE/PC/81004--T4

Contract DE-AC22-85PC81004

DE92 041292

**PHASE IV
Conceptual Design and Economic Evaluation**

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CONTRACT OBJECTIVE

The objective of Phase IV of the contract is to design a conceptual flue gas treating unit based on the fluidized-bed copper oxide (FBCO) process for a new coal-fired 500 MW(e) power plant. A technical and economic evaluation of the FBCO process that is based on the conceptual design will also be completed.

CONTRACT TASKS

- 4.0 Proposal review and negotiations
- 4.1 Definition of design basis
  - 4.1.1 Subcontractor negotiations
  - 4.1.2 Design basis formulation
  - 4.1.3 Design basis review and approval
- 4.2 500-MW(e) Conceptual Design
- 4.3 Economic Evaluation of the FBCO process
  - 4.3.1 Technical and economic evaluation
  - 4.3.2 Final report

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SCOPE OF THE WORK DURING THE REPORTING PERIOD

The scope of the work during this reporting period was limited to Task 4.0, Proposal review and negotiations, and Task 4.1, Definition of design basis. In response to the change order, Modification M012 to the contract, a cost and technical proposal was submitted to the

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Pittsburgh Energy Technology Center (PETC) on October 11, 1991. Additional information supporting the proposed cost for Phase IV was provided to the Assistance and Acquisition Department of PETC during this reporting period.

In the revised Statement of Work (SOW) for Phase IV, a cold-circulation dense-phase testing of the sorbent material is proposed. Presently, UOP does not manufacture the sorbents, SOX-3 and SOX-4, that were used in the life-cycle testing of the fluidized-bed copper oxide unit at PETC. So as an alternative to the sorbent, UOP proposed that the alumina support be used in the cold-circulation tests. Under Task 4.1, the feasibility of using the support material was evaluated in a series of attrition tests conducted on the SOX-3 sorbent and the alumina support. The testing took place during this reporting period. The objective of these tests was to examine the relative strength of the two materials.

Three different attrition tests—crushing strength, venturi index, and relative attrition—were run on the samples of the SOX-3 sorbent and the alumina support. A sample of SOX-3 was obtained from the samples of unspent sorbent left over from the life-cycle testing at PETC. Sample of alumina was obtained from the inventory of the support kept at UOP. Ideally, a fresh sample of SOX-3 and the batch of alumina used to prepare the SOX-3 should have been tested. However, getting fresh sample of SOX-3 was economically not feasible. The results of the three tests are discussed in the next sections.

Crushing Strength Test

A total of 30 pills of the sample are individually subjected to different loads to determine the crushing load at which the pills fail. The average, high, and low loads at which a pill fails are recorded. Also, the weight percent of pills that fail below a load of 5 lb is recorded.

Data for the two samples are summarized in Table 1. The table shows that the average crushing strength for the two samples is quite similar.

Table 1
Crushing Strength Data

Crushing Load	SOX-3 Sorbent	Alumina Support
Average load, lb	10	9
High load, lb	18	15
Low load, lb	2	4
Wt-% failing at <5 lbs load	3.3	6.7

Venturi Index Test

In the venturi index test, a sample of the material is carried through a venturi in air or nitrogen and impinged on a metal plate. Material from the plate is sieved to determine the amount of sample that is broken. Breakage in this test is largely due to the throttling effect.

The venturi index is measured relative to a reference material. A venturi index of 1.0 is assigned to 20% breakage of the reference material. For the samples tested, the venturi indices were 1.02 for alumina and 1.28 for SOX-3. Thus, under similar test conditions, 20% of the reference material, 20.4% of the alumina, and 25.6% of the SOX-3 material was broken.

The venturi index is highly dependent on the weight loss on ignition (LOI) of the material. For the alumina, the LOI was 2.8%; and for the SOX-3 sorbent, the LOI was 8.1%. In general, as the LOI of a material increases, its strength decreases. The LOI of a material increases if it absorbs moisture. The relatively high LOI of SOX-3 may be due to the long uncontrolled storage of the sample. Considering the difference in LOI's of the two samples, the strength of SOX-3 sorbent, as measured by this test, is quite close to that of the alumina support.

Relative Attrition Test

The relative attrition test measures relative strength of a sample compared to a reference. In this test, a known quantity of the sample and a reference material is vibrated under standard conditions. The amount of fines produced after a fixed time is recorded, and then relative attrition is calculated as the ratio of the weight percent of the sample fines to the weight percent

of the reference fines. This correlation for relative attrition is valid for a maximum LOI of 6% in the sample.

The relative attrition index for alumina was 1.0. Because of the high LOI of the SOX-3 sample, its relative attrition was not calculated. The vibratory attrition index for SOX-3 sample was 1.4%. Based on the single test performed, the difference between an attrition index of 1 and an attrition index of 1.4 is not significant.

Because of the elapsed time between SOX-3 production and testing and the high LOI of the SOX-3 sample, the two samples tested are not the ideal samples for comparison of relative strength. However, these two samples are the best available for comparison. With this caveat, the strength of SOX-3 sorbent is not significantly different from that of the alumina. Also, if UOP were to manufacture SOX-3 sorbent on a commercial scale, the manufacturing steps would be designed to keep the strength of the finished sorbent as close to the support material as possible because a wide difference in the strength of the two would mean low yields of the product. This result would be economically unattractive.

Based on the available information, a reasonable conclusion is that the substitution of SOX-3 by alumina in the proposed dense-phase transport testing will give acceptable data on the sorbent attrition rates.

Also, under Task 4.1, UOP negotiations with its subcontractor, A. E. Roberts & Associates, Inc., (AER) have been completed.

FUTURE PLANS

UOP will execute a final contract with AER, and the contract will be put in place by end of April. Work on the definition of design basis under Task 4.1 is expected to be completed in the next reporting period.

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