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ELECTROMAGNETIC MIXED WASTE PROCESSING SYSTEM FOR ASBESTOS DECONTAMINATION

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DISCLAIMER

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Electromagnetic Mixed Waste Processing System for Asbestos Decontamination

CONTRACT INFORMATION

Contract Number	DE-AC21-94MC29249
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Contractor Project Manager	Raymond S. Kasevich
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METC Project Manager	Steven J. Bossart
Period of Performance	June 9, 1994, to February 9, 1995

INTRODUCTION

DOE sites contain a broad spectrum of asbestos materials (cloth, pipe lagging, sprayed insulation and other substances) which are contaminated with a combination of hazardous and radioactive wastes due to its use during the development of the U.S. nuclear weapons complex. These wastes consist of cutting oils, lubricants, solvents, PCBs, heavy metals and radioactive contaminants. The radioactive contaminants are the activation, decay, and fission products of DOE operations. To allow disposal, the asbestos must be converted chemically, followed by removing and separating the hazardous and radioactive materials to prevent the formation of mixed wastes and to allow for both sanitary disposal and effective decontamination. Currently, no technology exists that can meet these sanitary and other objectives.

TECHNICAL APPROACH

Apply techniques that have already proved successful in the mining, oil, and metals processing industries to the development of a multi-stage process to remove and separate hazardous chemical radioactive materials from asbestos. This process uses three methods: ABCOV chemicals which converts the asbestos to a sanitary waste; dielectric heating to volatilize the organic materials; and electrochemical processing for the removal of heavy metals, RCRA wastes and radionuclides. This process will result in the destruction of over 99% of the asbestos; limit radioactive metal contamination to 0.2 Bq alpha per gram and 1 Bq beta and gamma per gram; reduce hazardous organics to levels compatible with current EPA policy for RCRA delisting; and achieve TCLP limits for all solidified waste.

INTEGRATED TECHNOLOGIES

The electromagnetic mixed waste processing system employs three patented technologies to convert DOE asbestos to a non-hazardous, radionuclide-free, sanitary waste; high-shear chemical decomposition (ABCOV Method), radio frequency heating (KAI Electromagnetic Process) and electrochemical separation. The asbestos is decomposed to an amorphous silica suspension using the (ABCOV Method) of asbestos abatement and conversion to a non-toxic material. The result is heated with radio frequency energy to remove the organic volatiles. If necessary, the contaminated asbestos may be heated to remove organics before the ABCOV Method. Radionuclides and heavy metals are separated from this suspension by an electrochemical process. Finally, the amorphous silica is solidified with sodium silicate for disposal. A simplified diagram of the proposed system is shown in Figure 1.

The ABCOV Method is a non-burning, simple and economical, chemical and mixing treatment of friable asbestos-containing material (ACM) that renders it harmless in a period of two hours or less. The ABCOV Method was developed after years of extensive research at Battelle Laboratories and Georgia Tech. It uses several chemical formulations to effectively improve the removal of asbestos-containing materials (ACM) and chemically convert asbestos into a non-hazardous substance. It offers the following advantages over conventional removal and disposal methods:

- Removal time is reduced by applying the formulation ABCOV-T directly to the ACM, achieving improved wetting and initiating the conversion process. Some studies have documented removal times to be reduced by as much as 40 percent, allowing for labor savings. In addition, after removal of ACM, ABCOV-T can be used to clean substrates of any remaining fibers, eliminating the need for scrubbing with wire brushes.

- Depending on the type of filler material in the ACM, the volume of waste may be reduced by as much as 80%. The removed ACM is immersed in a vat containing formulation ABCOV-C. After 30 or more minutes of agitation using a high-speed dispersion mixer, the mixture may be analyzed for the presence of asbestos fibers. Several previous demonstrations of the process by major utilities and federal institutions have confirmed conversion into a non-ACM substance.

- Since a hazardous substance no longer exists, it becomes unnecessary to transport the remaining material to a required ACM landfill.

Thermal processing is the most effective approach to removing organics from the mixed waste matrix. As thermal processing candidates, both direct incineration and vitrification processing would destroy any organics present in the asbestos, and, in particular, vitrification can result directly in a stable waste form for disposal. The KAI radio frequency (RF) desorption technology was selected over these processes for the following reasons:

- Incineration - a) requires more complicated licensing for on-site, mobile operations; b) requires more expensive off-gas processing/particulate collection system to contain airborne contaminants for an ALARA design for nuclear application (this includes other asbestos fibers and radionuclides); and c) may condition metals present in the asbestos decomposition residue to make radionuclide and heavy metal extraction more difficult.

- Vitrification would destroy organics condensing the asbestos and metals into a single vitrified waste form, but in so doing generates no potential waste minimization through release of a "sanitary" fraction in the form of the ABCOV product silica suspension.

By contrast, RF desorption meets both the needs of the DOE PRDA for a decontaminated, (potentially) sanitary waste form, and the EPA requirements for pollution prevention and (secondary) waste minimization in any waste treatment.

Because RF dielectric heating "couples" directly with the waste at the molecular level, it does not rely on convective or conductive mechanisms for heat transfer. Such coupling is an intrinsic advantage of both radio frequency and microwave heating approaches (for materials with which they couple and which, otherwise, may resist conventional heating due to their insulating characteristics).

Thus asbestos is, by definition, an insulation material, and so bulk-scale, thermal desorption processing by convective or conductive heating of the asbestos matrix will be extremely inefficient. Through the use of radio frequency coupling, the proposed process system penetrates the asbestos matrix effectively and results in rapid, even heating of organic molecules. Because RF coupling is a "non-invasive" heating process which injects energy directly into the substrate's atoms and molecules, RF-driven desorption reduces the risk of airborne contamination with the results:

- An ALARA design is maintained, critical for all nuclear operations;
- Man-ran exposure decreases through reduced maintenance and reduced material handling;
- Risk of asbestos fiber release is reduced.

Westinghouse technology for the various metals and radionuclide extractions includes a multi-step approach:

- Removal of metals and metallic oxides by flotation or other gravimetric approaches;
- Filtration of the solids from the processing liquor;
- Ion exchange and/or electrochemical processing to process the liquids.

The option of using electrokinetic technologies particularly electrophoretics - to replace the crude hydrometallurgical approaches for removing radio-contaminants and other heavy metals will be evaluated by treatability testing during Phase 1.

One processing alternative to address hazardous and radioactive metals is direct plasma vitrification of the asbestos matrix (without separations). While feasible (and may even be cost-effective), direct vitrification does not support direct discharge of a sanitary waste product; therefore, we have discarded it for meeting the PRDA constraints.

Another alternative is using chemical lixiviants (based on commercial mining experience) to dissolve the metal contaminants from the asbestos matrix (or its ABCOV decomposition products) as opposed to our proposed physical processing. The primary issue for chemical leaking is the potential mismatch between the contaminant lixiviant chemistry and of the ABCOV decomposition chemistry. In addition, the leaching approach may require additional solid-liquid separations to segregate the decomposition and extraction reagents resulting in:

- Risks of release/spill,
- Increased process complexity,
- Greater secondary waste generation.

Accordingly, we have discarded leaching for this specific application as well - recognizing that it may well be the process of choice for other applications.

WASTE FORMS

The potential waste forms for the stabilization operation after metals extraction from the asbestos include the following:

- A "fine fraction" consisting of metallic ions adsorbed onto the ABCOV generated silica suspension is a possible but unlikely form since we do not anticipate any chemical binding between the asbestos/silica and the contaminants. Further, we anticipate that the metallic contaminants will have reacted to metallic oxides prior to the asbestos removal and D&D operations. The contaminants are compounds of U, Ra, Th or others - all of which dissolve in the ABCOV reagent. As a result, these dissolved compounds should be separable by a solid/liquid separator.
- The "clean" or "sanitary" residue of the asbestos decomposition process - only approximately one-tenth to one-eighth of the original asbestos volume is the major constituent.
- Any ion exchange or filtration media generated during the process must be included as the process secondary waste.

Note that all of these streams are compatible with standard LLW radwaste stabilization media - grout, epoxies, polyesters, and/or silicates.

APPLICATIONS & BENEFITS

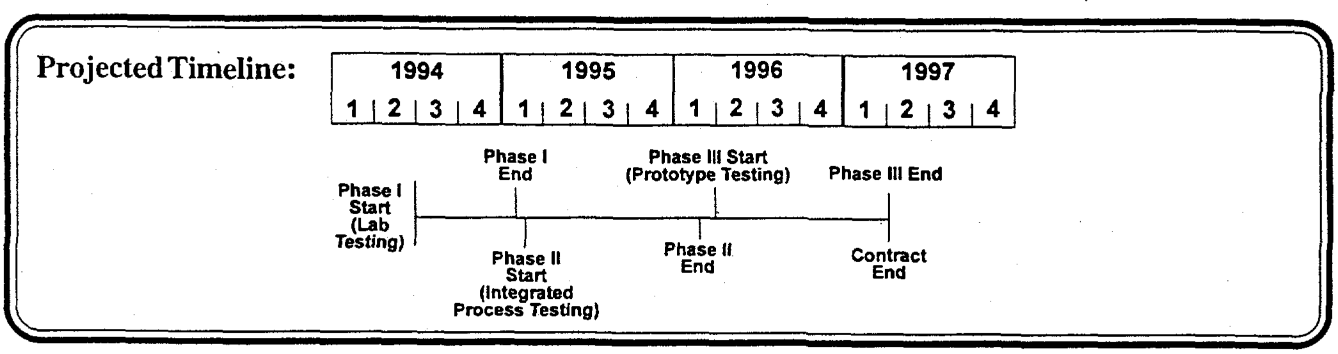
- Over 99% of asbestos converted for sanitary disposal and effective decontamination.
- Separation of radioactive and hazardous materials in the liquid phase will prevent formation of mixed wastes.
- Stabilizes hazardous and radioactive wastes according to the RCRA and radionuclide material requirements of the EPA and NRC.

- Closed system process assures that the public, worker, and environmental risks are minimized.

- Anticipated lower operating costs than comparable state-of-the-art alternatives such as plasma fired, thermal destruction combined with molten salt separation.

SCHEDULE

If fully authorized through the final phase, development of this electromagnetic mixed waste processing system would take place in three phases as illustrated in the time-line shown below. Phase 1 is a laboratory assessment in which each step of the process will be evaluated, Phase II is bench-scale testing of the integrated system, and Phase III would be the demonstration phase of the full-scale prototype system and also the conclusion of research and development. DOE's Fernald facility in Ohio is being considered for the on-site demonstration.

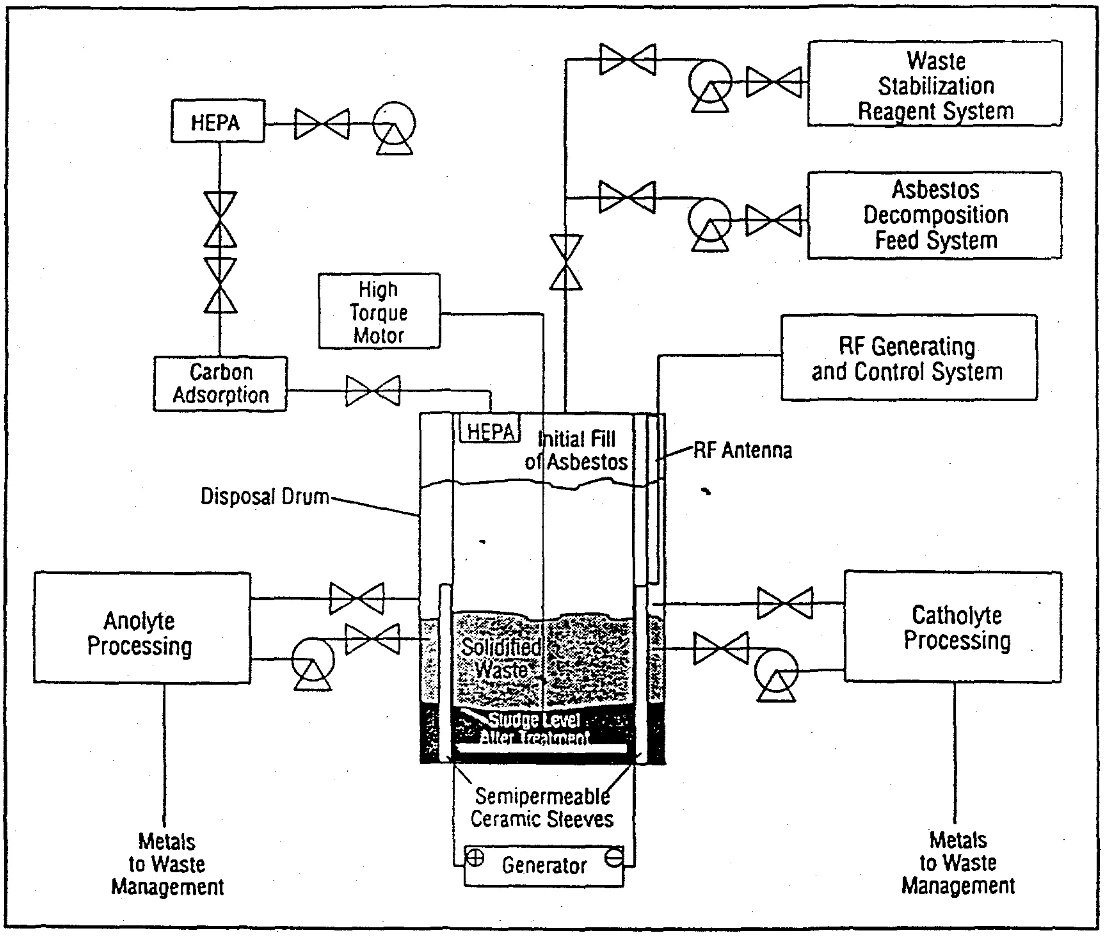


CONTACTS

KAI Technologies, Inc. is actively engaged in the innovative use of electromagnetics for this and other environmental problems. For information regarding this project, please contact:

Contractor Project Manager: Raymond S. Kasevich, (617) 932-3328, KAI Technologies, Inc., 175 N New Boston Street, P.O. Box 3059, Woburn, MA 01888-1859.

DOE's Morgantown Energy Technology (METC) supports the Environmental Management (EM) Office of Technology Development by contracting research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is: DOE Project Manager, Steven Bossart, (304) 285-4643.



HEPA
Waste Stabilization Reagent System
Asbestos Decomposition Feed System
High Torque Motor
RF Generating and Control System
Carbon Adsorption
HEPA
Initial Fill of Asbestos
RF Antenna
Disposal Drum
Anolyte Processing
Catholyte Processing
Solidified Waste
Sludge Level After Treatment
Semipermeable Ceramic Sleeves
Generator
Metals to Waste Management
Metals to Waste Management

FIGURE 1

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