Characterization of Treated and Untreated Asbestos Containing Material

A Report
Prepared For
Research and Development Branch
Consolidated Edison Co.
Of New York, Inc.
New York, NY

by

The Oxide Chemistry Group The Catholic University of America

March 2000

Technologies for the Destruction of Asbestos

Recognition of potential health associated with the use of asbestos as a thermally insulating and electrically insulating material in buildings and other structures has led to the necessity to remove large amounts of asbestos and dispose off them safely. Such operations could be greatly facilitated if an efficient and inexpensive technology for the destruction of asbestos and its conversion into non-hazardous material became available. Processes have been developed for the conversion of asbestos into an ingredient of a glass [l], a crystalline ceramic [2], or a glass ceramic [3]. Heating asbestos above 500°(C) converts it into a safe raw material for the cement industry [4]. The MAGRAM process involves reduction of asbestos to magnesium metal in a plasma furnace [5]. However, these processes all involve the use of high temperatures, resulting in high energy costs, equipment corrosion problems and a need for emissions control.

As a result, chemical processes at ambient or near-ambient temperatures have also been pursued. Strong acids, such as, 12 MHCI [6], H2SO4 [7,8] or H_3PO_4 [8], as well as the oxychlorides of such acids [8], have been used in processes of asbestos decomposition. Molten or aqueous acidic salts have also been used [9]. In recent years, interest has centered on acidic fluoride solutions [10], containing acids such as HF, HBF_4, H_2SiF_6, or acidic salts such as and alkali or ammonium bifluorides [11]. This process has been applied to radioactive contaminated asbestos [l2]. Fluorosilicic acid has also been used in other processes to decompose asbestos [13]. To a smaller extent, basic reaction media have also been applied to the decomposition of asbestos-containing waste [14]. Further development of chemical processes for the decomposition of asbestos could eliminate the dangers and costs associated in transporting and burying asbestos in secure disposal sites for hazardous waste [13]. In particular, the development of such effective decomposition techniques is necessitated by the fact that current regulations regarding the disposal of asbestos-containing wastes in hazardous waste landfills are inadequate to ensure the elimination of waterborne or airborne emissions [5].

One recent process, developed for the chemical decomposition of asbestos by ABCOV, is currently considered for application by Con Edison. The current proposal involves evaluation of the scientific and technical aspects of this process. The evaluation process will include the phases described below.

Proposed Tasks

Phase 1: Familiarization with the process

The work to be done during this phase will include a visit to Con Edison laboratories and discussion with the vendors. The perquisite for technical evaluation of the process is (a) complete identification of the reactants and products; (b) establishment of the stoichiometry of the process; (c) determination of the thermochemical characteristics of the process (endothermic or exothermic); (d) definition of the conditions under which the process takes place (i.e., reagent

concentrations, initial temperature, required size of asbestos pieces, ratio of reagent solution to weight of treated asbestos, reaction vessel, stirring, etc.). The purpose of this task is to obtain as much relevant information as possible by interaction with the vendors and observations of the process and to identify areas, if any, where more information needs to be gathered. If available data concerning the species participating in the reaction are insufficient, recommendations will be made regarding methods of completing the characterization of the reaction, in particular the nature of the products, in order to provide a basis for the next step of the evaluation. Such complete characterization may require chemical analysis as well as solid phase identification.

As an optional part of Phase 1, **evaluation of the kinetics** of the process will follow upon satisfactory identification of the reaction and will be used to establish the time necessary to convert asbestos into non-hazardous species at various degree of completion (e.g. 99% or 99.9% of asbestos destruction) and under various conditions within the range of process parameters. It will be attempted to characterize the kinetics of the reaction based on conversion-vs.-time data available to Con Edison.

Phase 1 will be concluded with a short report on the process characteristics as detailed above.

Phase 2

If the data obtained by visiting Con Edison facilities and discussions with the vendors are insufficient to establish the kinetics of the process, a set of experiments will be suggested to complete the necessary data-base. The evaluation of the kinetics will then be completed.

An in-depth literature search will be performed to supplement the technical understanding of the process and to bring insight on similar reactions.

Following the previous steps, a **review of the data** obtained in test of the process will be performed. In particular, the agreement between the experimental data and the initial model of the stoichiometry and kinetics of the process will be constructed.

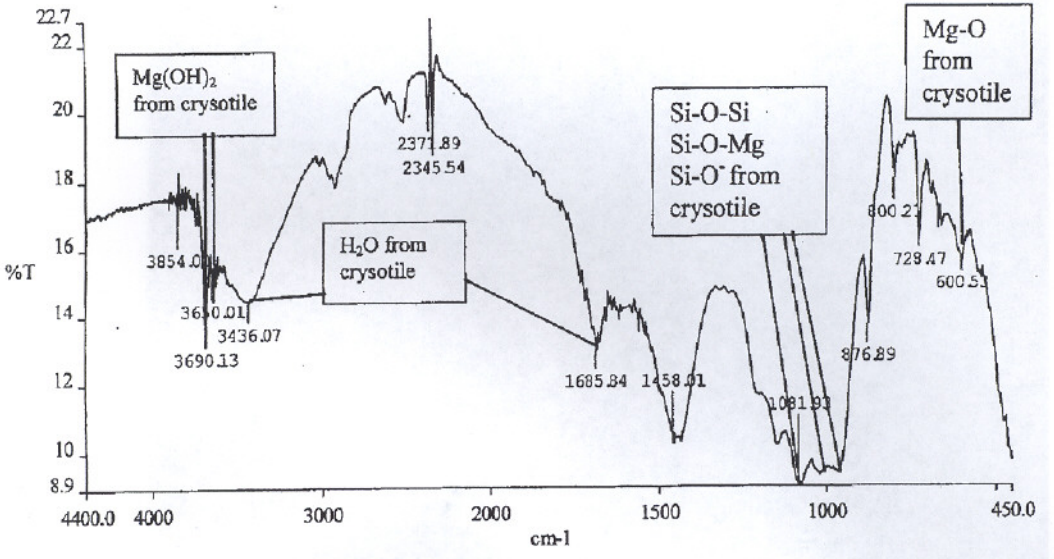
Phase 2 will be conducted with a **final report**, which will include description of the present understanding of the process, comparison between expected results and observed results, and recommendations for further studies, if necessary, to complete the database for evaluation of the process and for preparations for scaling up and full implementation.

Overview

Samples of combined asbestos-contaminated material (ACM) received from Consolidated Edison before and after treatment according to the ABCOV technology were analyzed using x-ray diffractometry (XRD) and Fourier Transform infrared spectroscopy (FTIR) in order to identify the principal ingredients of the original material and the solid product mix, respectively.

Infrared spectra of the untreated and treated ACM samples were obtained in a KBr matrix using a Fourier Transform infrared spectrophotometer. The FTIR spectrum that was obtained from the actual sample of ACM before treatment is shown in Figure 1. The various peaks in the spectrum were identified on the basis of previous literature [1, 2]. It should be emphasized that the magnesium hydroxide band around 3690 cm^{-1} as well as the silicon-oxygen bands around 1000cm^{-1} are all indicative of the presence of asbestos in the sample. The complete peak assignments are given in Table 1.

Figure 1
IR Spectrum, ACM Before Treatment



1 Sugama, T., Sabatini, R, and Petraks, L. Decomposition of Chrysotile Asbestos by Fluorosulfonic Acid. Ind. Eng. Chem. Res. **1998**, *37*, 79-88.

2 The Sadtler Standard Prism Infrared Spectra Collection, Sadtler Research Laboratories, Philadelphia, PA, 1962.

Table 1
Untreated Asbestos IR Peaks

Absorption Bands (cm^{-1})	Groups Corresponding to Peaks
3680,3640	Hydroxyl in $Mg(OH)_2$
3410,1640	H_2O
1080,1050,970	Si-O-Si, Si-O-Mg, $Si-O^-$
610	Mg-O

The FTIR spectrum of the sample treated according to the ABCOV process is shown in Figure 2. The first conclusion is that the treatment has been very effective, as reflected in the fact that all the peaks associated with the asbestos (Table 1) have disappeared. The peaks observed in Figure 2 indicate that the product mix largely consists of hydrated silica and of magnesium fluoride (sellaite). The peak assignments of the product mix are given in Table 2. The peak at 3144 cm^{-1} has not been positively identified with a specific product, but it lies in the area typical of hydrated compounds. It is likely to be associated with hydrated calcium or aluminum compounds resulting from the presence of non-asbestos fraction of the ACM during the treatment.

Figure 2
IR Spectrum, ACM After Treatment with Proprietary Chemicals