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CERMETS FOR HIGH LEVEL WASTE CONTAINMENT*

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Cermet materials are currently under investigation as an alternate for the primary containment of high level wastes. The cermet in this study is an iron-nickel base metal matrix containing uniformly dispersed, micron-size fission product oxides, aluminosilicates and titanates. Cermets possess high thermal conductivity, and typical waste loading of 70 wt. % with volume reduction factors of 2 to 200 and low processing volatility losses have been realized. Preliminary leach studies indicate a leach resistance comparable to other candidate waste forms; however, more quantitative data are required. Actual waste studies have begun on NFS Acid Thorex, SRP dried sludge and fresh, unneutralized SRP process wastes.

INTRODUCTION

The cermet waste form is designed to fix fission product wastes as small ($\sim 1\,\mu m$) particles of oxides or other stable crystalline compounds dispersed in an alloy matrix. The alloy is primarily comprised of hydrogen reducible metals already in the waste or from other contaminated sources and is tailored to be of high thermal conductivity and corrosion resistance. Simulated wastes, radiotracer-containing simulated wastes and authentic high level wastes have been formed into cermets which are now undergoing evaluation (1). As development of this waste form itself continues, processing techniques amenable to full scale hot operation are being developed and evaluated.

CERMET FORMATION

The key to the unique properties provided by the cermet waste form is a chemical coprecipitation of waste and additives from molten urea which yields an intimate and homogeneous mixture of all species present (2). Either acid wastes or simulated neutralized sludges have been dissolved in molten urea along with chemical additives and even zeolites. As this solution of waste and additives in molten urea is heated, denitration in a reducing environment occurs and finally a precipitation reaction takes place at 180°C yielding only gaseous products and a solid precipitate of hydrated oxides and amides. Calcination of this precipitate converts it to the oxide forms which, owing to the coprecipitation step, are intimately mixed. Reaction product gases evolved during precipitation and calcination are innocuous species such as CO_2, NH_3, CO, N_2, H_2O, and small amounts of HCN. Densification of the calcine and reduction of hydrogen reducible metals can be achieved by a variety of methods and sequences. Hydrogen reduction can be followed by densification, or vice versa, or both can proceed simultaneously. Hot pressing and cold pressing or extrusion followed by sintering of either the oxide or hydrogen reduced powder have been performed successfully. For continuous processing, extrusion and sintering or hot extrusion are envisioned as likely densification methods. This might be preceded by a one-step precipitation and calcination process using a rotary or spray calciner once the waste and additives are in solution in molten urea. Hydrogen reduction could be accomplished before, during, or after densification in this full scale processing conception. More detailed waste form characterization and an engineering evaluation are required to reach this level of development.

CERMET PROPERTIES

The cermet waste form possesses several unique and advantageous properties. Thermal conductivity is high (0.02-0.05 cal sec^{-1} cm^{-1} C^{-1} depending on oxide content and density), which permits higher radioactive waste loadings.

Densities of 6.2 to 8.2 g/cc and waste loadings up to approximately 70 wt. % result in volume reduction of the waste and therefore easier handling and storage characteristics. Volatility losses based on radiotracer experiments, through the entire process were 0.016% Cs, 0.23% Ru, and 0.0001% Sr; these values were most probably a result more of particle entrainment than actual volatilization. Preliminary leach results indicate leach rates comparable to other candidate waste forms. Analytical difficulties have delayed the determination of reliable, quantitative leach rates.

One of the chief efforts at present is to select and develop a densification technique that will minimize porosity in the cermet. Presently, there appears to be a transitory suboxide formation during simultaneous reduction and sintering which provides for liquid phase sintering and enhanced densification. Optimization of this sintering process will improve densities and likewise thermal conductivity and leach resistance properties.

In summary, development of the cermet has focused on its feasibility, the applicability of this process to a variety of wastes, and preliminary process engineering and characterization of simulated waste cermets. Current development work on actual waste complimented by parallel work on simulated wastes will further quantify the process and the resulting cermet properties. Although more characterization and process engineering is required, the cermet appears to be a very promising alternate waste form.

REFERENCES

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