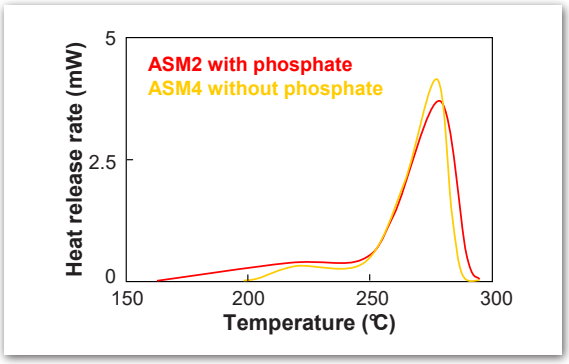
Reactivity measurement of asphalt-salt mixtures by calorimetry

INTRODUCTION

Radioactive wastes can be stored into asphalt but reactions may occur between waste, in form of salts, and asphalt. In order to explain the detailed cause of the fire and explosion of asphalt–salt mixture (ASM) that happened at a nuclear wastes processing plant in Japan on March 11, 1997, the reactivity of ASMs was measured by using a calorimeter (CALVET) and then, the CALVET data was used to calculate the SADT (self-accelerating decomposition temperature) of simulated ASMs.



Heat release rate curves representing the effect of phosphate in the waste on the reactivity of mixture (Sample mass: 0.500g, temperature rise rate: 0.01°C /min).

EXPERIMENTAL

A specific device was designed to prepare the ASM samples under different feeding rates of the waste and in different concentration of phosphate in the waste. The reactivity of four asphalt-salt mixtures (ASM) were evaluated using a heat flux calorimeter (CALVET) with high detection sensitivity of 10µW to determine the effect of feeding rate and concentration of phosphate on the reactivity of the mixtures. 0.5g of ASM was analyzed in an experimental vessel of 8.5mL volume at a heating rate of 0.01°C/min. The reference vessel contained a same mass of alumina equal to the sample mass.

RESULTS AND CONCLUSION

The initial reaction temperature of porous sample is lower (160°C) than that of nonporous sample (195°C). Moreover, at the lower temperature region, the heat release from reaction of the non-porous sample is the weakest because its specific surface area is much smaller.

Then, it is clear that the presence of phosphate influences the reactivity of simulated ASMs. The waste containing phosphate has a lower initial reaction temperature and a larger heat release than a waste without phosphate because phosphate not only increases the initial concentration of $NaHCO_3$ in the waste, but also leaves more $NaHCO_3$ in the salt particles which leads to porous structure and larger specific surface. Although not shown here, it is possible to calculate the SADT (self-accelerating decomposition temperature) of simulated ASMs by using CALVET experimental data. Check the paper mentionned below for reference.

INSTRUMENT

CALVET

Ambient to 300°C

HIGHEST HEAT MEASUREMENT ACCURACY
3D sensor based on thermocouples with Joule effect calibration.

ISOTHERMAL OR TEMPERATURE SCANNING MODES
for increased flexibility and replication of real life conditions

CONVENIENT INTERCHANGEABLE CRUCIBLES AND CELLS
to perform even the most demanding experiments using one instrument :
- high pressure (1000bar) and high vacuum
- pressure measurement and control
- mixing/stirring experiments.

EXTERNAL COUPLING CAPABILITY
designed to increase your research options including manometry, BET instrumentation, gas analyzers, humidity controllers and gas panels

Reference: Cause analysis of the fire and explosion of asphalt–salt mixture in a nuclear wastes processing plant. Jinhua Sun, Ping Lu, Kazutoshi Hasegawa, Fire Safety Journal 40 (2005) 411–424