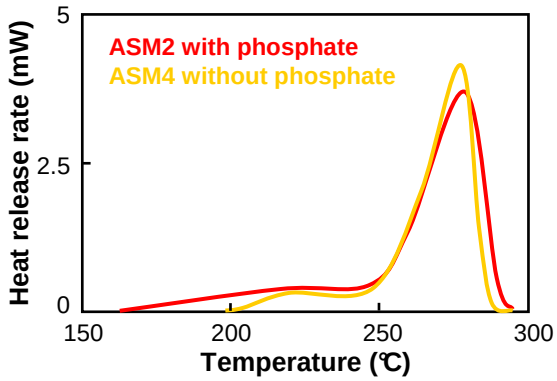
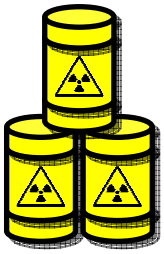
Measure of reactivity of asphalt-salt mixtures by calorimetry

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

Introduction: Some radioactive wastes are stored into asphalt but sometimes, a reaction could 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, a special experiment device was designed to prepare the ASM samples under different feeding rate of the waste and in different concentration of phosphate in the waste. The reactivity of ASMs was measured by using a heat flux calorimeter (C80) and then, the C80 data was used to calculate the SADT (self-accelerating decomposition temperature) of simulated ASMs.



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



Nuclear power plant of Golfech (France)
(From Wikipedia)

Experimental

The reactivity of four asphalt-salt mixtures (ASM) were evaluated using a heat flux calorimeter (C80) 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℃/min. The reference vessel contained a same mass of alumina equal to the sample mass.

Then, it is possible to calculate the SADT (self-accelerating decomposition temperature) of simulated ASMs by using C80 data.

Instrument
C80
20 to 300℃

Results

The initial reaction temperature of porous sample is lower (160℃) than that of non-porous sample (195℃). 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 concentration of phosphate influence the reactivity of simulated ASMs. The waste containing phosphate have 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.

For more details ask for publication B1774 and B1818