

## **FLUOROALKYL PHOSPHORUS FIRE EXTINGUISHING AGENTS**

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### **ABSTRACT**

Phosphorus compounds show extraordinary effectiveness as flame extinguishants, and there is evidence for a chemical mechanism. Most work to date, however, has emphasized alkyl phosphonates and related materials or phosphonitriles. The former compounds are flammable and the latter have low volatilities. Phosphorus compounds containing fluoroalkyl and hydrofluoroalkyl groups, however, are often nonflammable and have higher volatilities. We are carrying out the identification, synthesis, and laboratory testing of fluoroalkyl-and hydrofluoroalkyl-containing phosphorus compounds as fire extinguishants.

### **PHOSPHORUS-CONTAINING EXTINGUISHING AGENTS**

A number of compounds of silicon, phosphorus, and other materials based on chemical elements other than carbon have been examined [1]. Of particular interest has been compounds of phosphorus [2]. Phosphorus compounds appear to provide a chemical fire extinguishment mechanism, and some appear to be highly effective [3]. Much work has been performed on dimethyl methyl phosphonate (DMMP) and related compounds by Professor Elizabeth Fisher and her co-workers at Cornell [4, 5]. Though DMMP shows very promising flame suppression characteristics, this compound and most of the related compounds studied to date have some serious drawbacks. First, this and many related chemicals are flammable. Second, most of the standard phosphorus compounds studied to date, including DMMP, have low vapor pressures.

## FLUOROALKYLPHOSPHORUS COMPOUNDS

One way to address both of these problems is to work with phosphorus compounds containing fluoroalkyl or hydrofluoroalkyl groups. The presence of fluorine decreases or eliminates flammability and increases volatility. For example, tris(2,2,2-trifluoroethyl)phosphite ( $\text{P}(\text{OCH}_2\text{CF}_3)_3$ , TFEP) has a cup burner extinguishment concentration of 1.78 vol% for n-heptane fuel. This can be compared with the concentration of approximately 3 vol% for Halon 1301. TFEP has a normal boiling point of approximately 131 °C compared to 181 °C for DMMP and is non flammable.

There is still, however, a major problem with TFEP. Though the volatility is improved, it is still not nearly what one would like. For that reason, one needs to examine fluoroalkylphosphorus compounds with even lower molecular weights. This Next Generation Program (NGP) project has been designed to identify, synthesize, and test the flame extinguishment capability of fluoroalkylphosphorus compounds with estimated acceptably low toxicity, ODP, and GWP that could be used as replacements for Halon 1301.

Here we present a very brief overview of the work to date and planned future work.

### OVERVIEW

Eight fluoroalkylphosphorus compounds (Table 1), including TFEP as a baseline material, have been selected for testing and are being or have been prepared in the laboratory of Professor Jean'ne Shreeve at the University of Idaho. The status of compound acquisition is shown in Table 1. These compounds will undergo cup burner extinguishment at the Center for Global Environmental Technologies at the University of New Mexico. It is anticipated that the work will be completed by 30 June 2002.

**Table 1. Fluoroalkylphosphorus Compounds for Testing**

Compound	Status
$\text{O}=\text{P}(\text{CF}_3)_3$	6.2 g obtained 2/12/02
$\text{O}=\text{P}(\text{OCH}_3)(\text{CF}_3)_2$	5.5 g obtained 2/12/02
$\text{P}(\text{OCH}_2\text{CF}_3)_3$	13.5 g obtained 9/21/01 and cup burner run
$\text{P}(\text{OCH}_3)(\text{CF}_3)_2$	5.5 g to be supplied 5/2/02
$\text{P}(\text{OCH}_2\text{CF}_3)_2\text{CF}_3$	7.6 g to be supplied 5/2/02
$\text{O}=\text{P}(\text{OCH}_2\text{CF}_3)(\text{CF}_3)_2$	To be supplied 6/2/02
$\text{P}(\text{OCH}_2\text{CF}_3)(\text{CF}_3)_2$	To be supplied 6/2/02
$\text{O}=\text{P}(\text{OCF}_3)_3$	If possible, to be supplied 6/2/02

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