# Phosphate Esters: A Natural for Personal Care & Cosmetic Applications

Authors: Robert L. Reierson PhD., Regan Crooks PhD., Alvino Gabbianelli and Stewart Warburton, Rhodia, NJ, USA

## Abstract

Phosphate esters are versatile, multi-functional surfactants that are unique within the anionic class because of their useful combinations of properties. These properties vary as a function of structure and composition and are strongly influenced by the monoalkyl to dialkyl ratio. The monoalkyl phosphate would be preferred if detergency, foam abundance, stability and feel are desired; the dialkyl phosphate would work better for emulsification. This review will highlight products and their properties that would be particularly useful in personal care and cosmetic applications.

## Introduction

### The Natural Choice

Phosphate esters are pervasive in the chemistry of life. As dialkyl esters, they form phospholipid bilayers that serve as the walls of our cells and as monoalkyl esters (ADP, ATP, sugar phosphates), serve as critical intermediates in vital metabolic processes. In each case, the structures are appropriate to provide the properties necessary for the application.

All phosphate esters have this important functional group in common. They are bio-compatible, biodegradable, have low fish toxicity[1] and can be ultimately derived from natural, triglyceride oils. Phosphate esters are clearly a natural choice for personal care and cosmetic applications.

### Functional Surfactants

Phosphate esters are distinguished within their surfactant class because of the additional, unique properties characteristic of the phosphate group. Much can be learned from industrial phosphates, which are used in a broad range of applications because of the versatility available in structure, hence, properties. The hydroxy functional hydrophobe is typically from 1 to 30 carbons, comprised of linear or branched, aliphatic, olefinic, or aromatic hydrocarbon groups. Many are ethoxylated with the degree of ethoxylation ranging from 0 to 50 ethylene oxide units.

A distinctive feature of phosphoric acid (PA) is its tribasic structure, which confers anionic surfactant properties to both the monoalkyl phosphate (MAP) and the dialkyl phosphate (DAP). Both are produced in the commonly used phosphation processes and the net surfactant properties of the mixture are strongly influenced by the ratio between them. In the partially neutralized form (pH 6 – 8), the residual phosphoric acid serves as a buffering agent.

In addition to the surfactant properties, a significant benefit provided by the phosphate group is adhesion enhancement. Accordingly, phosphate esters are used as anti-wear, anti-corrosion and adhesion promoting additives in metal lubricants[2] and coatings[3] and as anti-stripping agents for the aggregate in asphalt[4]. Higher MAP content contributes to higher performance in these applications. Such examples illustrate additional, special functions that can be performed by properly designed phosphate ester compositions in addition to those common to the general class of anionic surfactants. Phosphate esters are truly versatile, Functional Surfactants.

Existing industrial product lines include esters prepared by both

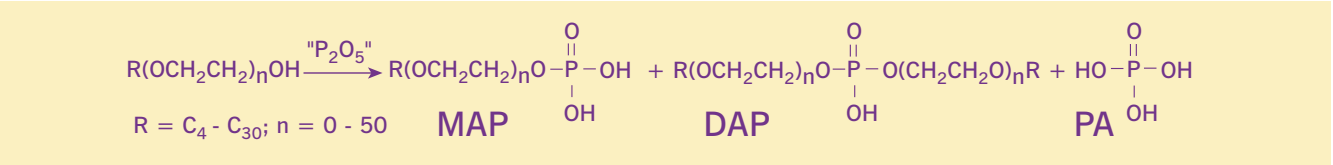


Figure 1. Phosphate Ester Product Mixture