BRIEF DESCRIPTION OF DRAWINGS

[00018] FIG. 1 is a ^{31}P NMR spectrum of Inventive and Comparative thiophosphoric acid products of the present disclosure;

[00019] FIG. 2 is a plot of active sulfur from Inventive and Comparative thiophosphoric acid products of the present disclosure;

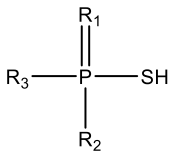
[00020] FIG 3 is an image representing the comparative reaction product between an organic hydroxy compound and phosphorus pentasulfide; and

[00021] FIG. 4. is an image representing a condensate obtained from the distillation of reaction products between the organic hydroxy compound and the phosphorus pentasulfide.

DETAILED DESCRIPTION

[00022] Disclosed herein are thiophosphoric acid products suitable for preparing improved organometallic antiwear additives and/or ashless oil-soluble phosphorus antiwear additives, the additives prepared from such reaction mixtures, and/or lubricating compositions including such antiwear additives derived from the thiophosphoric acid products herein. In one approach, the thiophosphoric acid products herein have low levels of polysulfide compounds and low levels of active sulfur as measured by triphenyl phosphine titration.

[00023] In other approaches, the thiophosphoric acid products herein may be a reaction product comprising at least a compound having the structure of Formula I



(Formula I)

wherein R_1 is sulfur or oxygen; R_2 and R_3 are, independently, one of $-OR_4$ or -OH, and each R_4 if included is, independently, a C3 to C20 linear or branched alkyl group, a C5 to C6 cycloalkyl group, a phenyl group, or a C6 to C18 alkylphenol group. In other approaches, R_1 is preferably sulfur, R_2 and R_3 are, independently, the $-OR_4$ group with each R_4 being the same or different and a C3 to C10 linear or branched alkyl group. In yet other approaches, each R_4 is preferably an isopropyl group, an isobutyl group, or an ethylhexyl group (such as a 2-ethylhexyl group). As shown in the Examples below, approaches of the thiophosphoric acid products herein have about 0.1 mmoles/gram or less of active sulfur as measured via titration