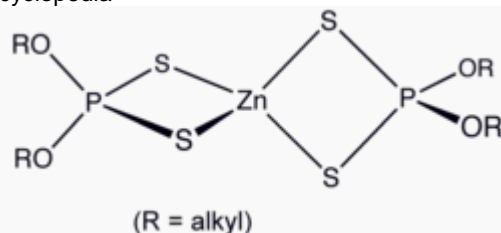


Zinc dithiophosphate

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Structure of a monomeric zinc dialkyldithiophosphate

Zinc dialkyldithiophosphates (often referred to as ZDDP) are a family of [coordination compounds](#) invented by [Castrol](#) that feature [zinc](#) bound to the anion of dithiophosphoric acid.

These uncharged compounds are not salts. They are soluble in nonpolar solvents, and the longer chain derivatives easily dissolve in [mineral](#) and [synthetic oils](#) used as [lubricants](#). They come under [CAS number](#) [\[68649-42-3\]](#). In aftermarket oil additives, the percentage of ZDDP ranges approximately between 2-15%.^[1]

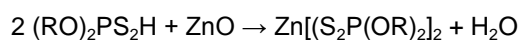
The alkyl groups can be branched and linear alkanes between 1-14 carbons length, 2-butyl, pentyl, hexyl, 1,3-dimethylbutyl, heptyl, octyl, isooctyl (2-ethylhexyl), 6-methylheptyl, 1-methylpropyl, dodecylphenyl, and others. A mix of zinc dialkyl(C3-C6)dithiophosphates come under CAS number [\[84605-29-8\]](#). List of other examples with their CAS numbers is [here](#).

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Coordination chemistry

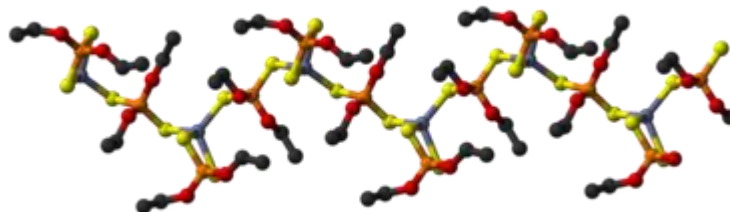
These species are produced in two steps. First [phosphorus pentasulfide](#) is treated with suitable [alcohols](#) to give the dithiophosphoric acid. A wide variety of alcohols can be employed, which allows the lipophilicity of the final zinc product to be fine-tuned. The resulting dithiophosphate is then neutralized by adding [zinc oxide](#):



In $\text{Zn}[(\text{S}_2\text{P}(\text{OR})_2)_2]$, the zinc is tetrahedral. This monomeric compound also exists in equilibrium with dimers and [oligomers](#) caused by opening of the four-membered ZnS_2P ring. Partial

hydrolysis gives the cluster $Zn_4O[(S_2P(OR)_2)_6]$, which adopts the structure seen for [basic zinc acetate](#).

Zinc diethyldithiophosphate, $Zn[(S_2P(OEt)_2)_2]$, is a polymeric solid consisting of linear chains.^[2]



Applications

The main use of ZDDP is in [anti-wear additives](#) to [lubricants](#) such as [greases](#), [gear oils](#), and [motor oils](#), which often contain less than 1% of this additive. It has been reported that zinc and phosphorus emissions may damage [catalytic converters](#) and standard formulations of lubricating oils for gasoline engines now have reduced amounts of the additive, though diesel engine oils remain at higher levels.^[3] Crankcase oils with reduced ZDDP have been cited as causing damage to, or failure of, classic/collector car flat tappet camshafts and lifters which undergo very high boundary layer pressures and/or shear forces at their contact faces, and in other regions such as big-end/main bearings, and piston rings and pins. Roller [camshafts](#) are more commonly used to reduce camshaft lobe friction in modern engines. There are additives, such as STP(R) Oil Treatment, and some racing oils such as Valvoline ZR-1, are available in the retail market with the necessary amount of ZDDP for engines using increased valve [spring](#) pressures. See "external links" in this article. The same ZDDP compounds serve also as [corrosion inhibitors](#) and [antioxidants](#).

Naming

These compounds are widely used and correspondingly have numerous names, including ZDDP, ZnDTP, and ZDP.