Bench Screening of Novel Anti-Wear Alternatives to ZDDP

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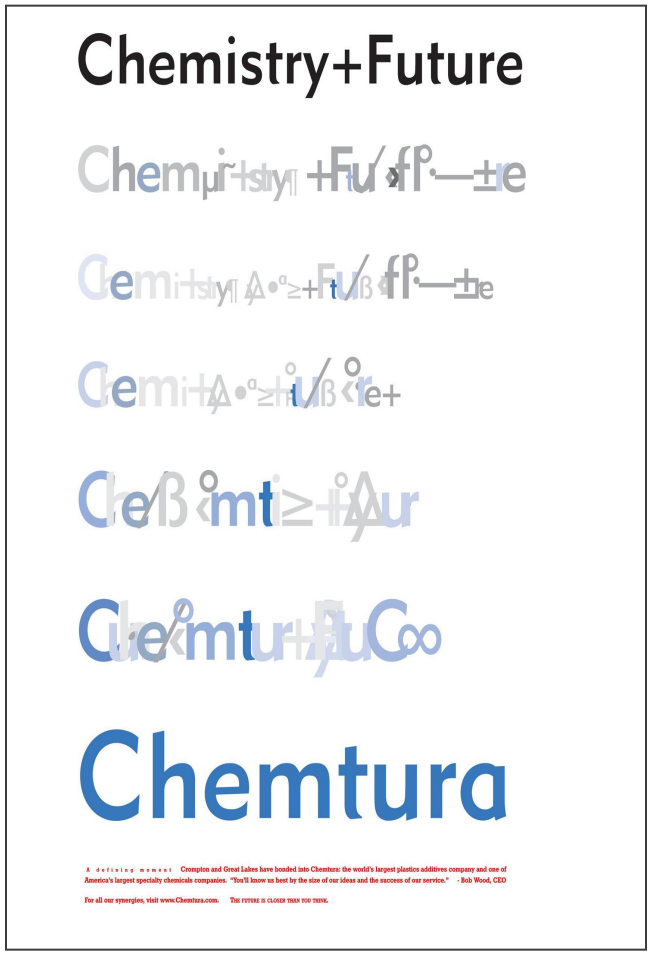
CHEMTURA – a new brand at the Oils and Additives market

The *chemical*
company
of the *future*

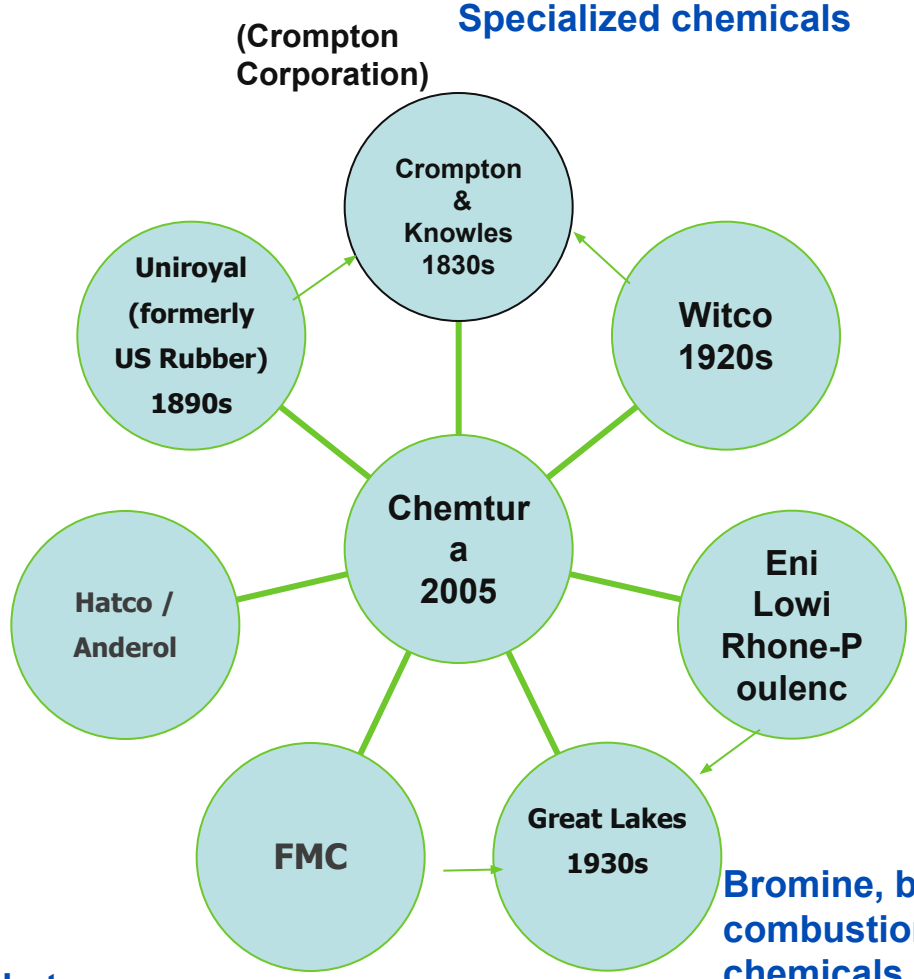


Our History

Textile machinery, dyes, polymer additives, lubricants, agricultural chemicals, urethanes…. Specialized chemicals

Chemtura

Rubber, rubber components, industrial rubber products, footwear, tires, synthetic rubber, agricultural chemicals



Carbon for tires, plasticizing agents, stearates, stabilizers, silicones … Specialized chemicals

Kaufmann Holdings was acquired in 2007. Ester lubricants – ester polyols + ready-to-use synthetic fluids

Ordinary and specialized phenolic antioxidants

Phosphates – non-combustible fluids (formerly Ciba)

Bromine, bromine derivatives, combustion inhibitors, agricultural chemicals, polymer additives, pool chemicals, household chemicals, fluorine derivatives, optical monomers

Our Additives Trademarks

Naugalube® and Naugard® antioxidants;

Calcinate™, Hystrene® and Industrene® anti-wear agents;

Lobase®, Hybase® and Petronate® sulfonate detergents;

Synton® high-viscosity polyalphaolefins (PAO);

G-2000™ high-quality lubricants;

Durad® additives based on organic phosphates;

Reolube® non-combustible lubricants and fluids (phosphates);

Reomol® and KP-140® special additives (phosphates);

ANDEROL®, AOSyn®, PQ® special lubricants;

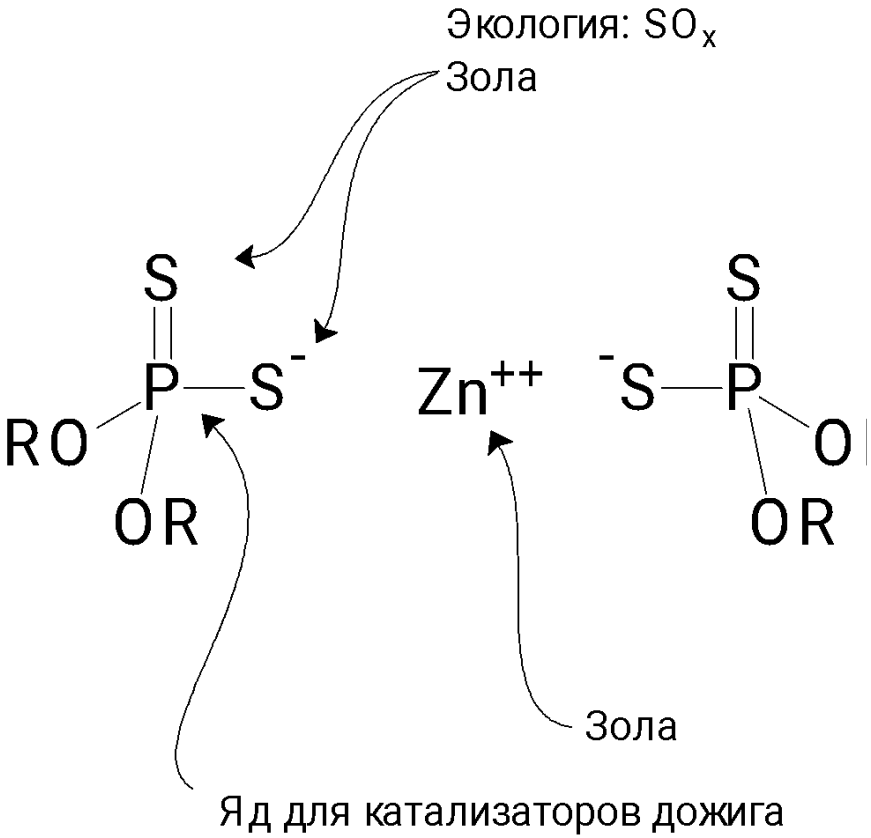
Hatcol® esters and ester lubricants (ready-to-use and basestocks);

Royco® aircraft lubricants.

EUROPE

Standard	Approval Date
Euro 1	October 1993
Euro 2	October 1996
Euro 3	October 1999
Euro 4	October 2005
Euro 5	Октябрь 2008 October

Zinc dialkyldithiophosphate (ZDDP)
- more than simply anti-wear protection



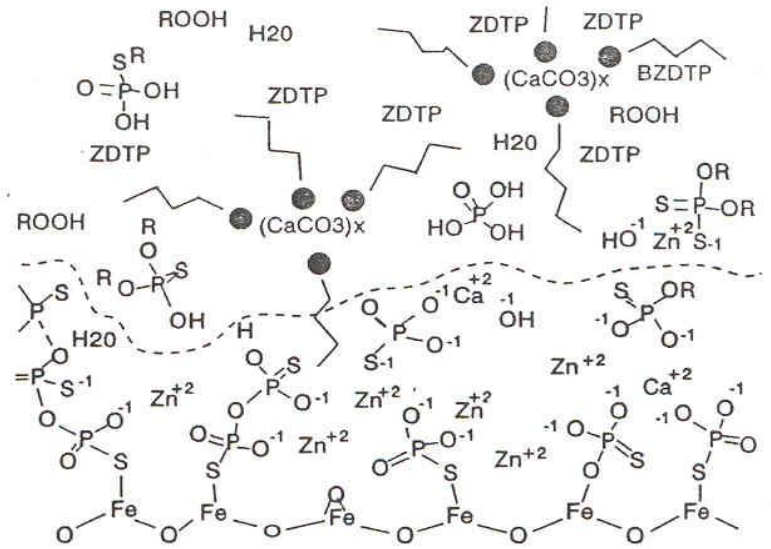
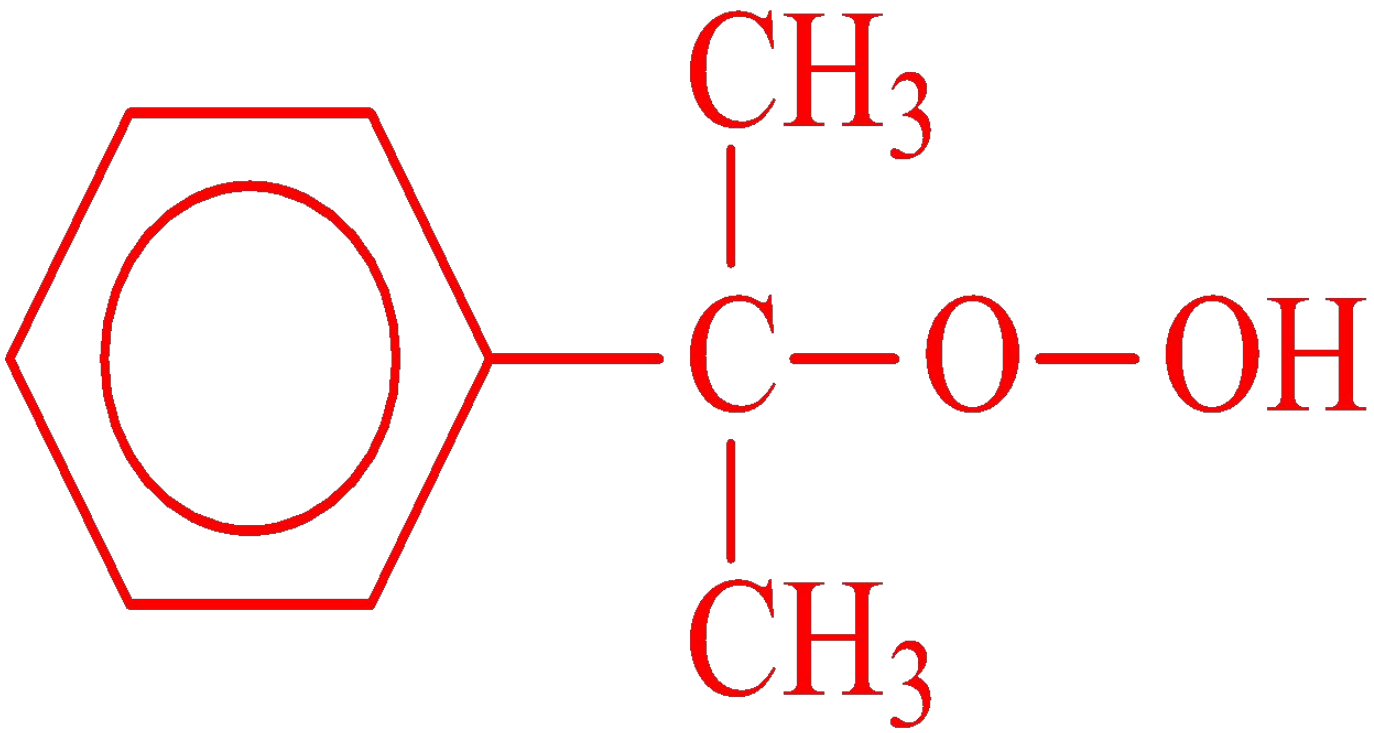


Fig 3 Artist's conception of growing film and ZDTP-rich region

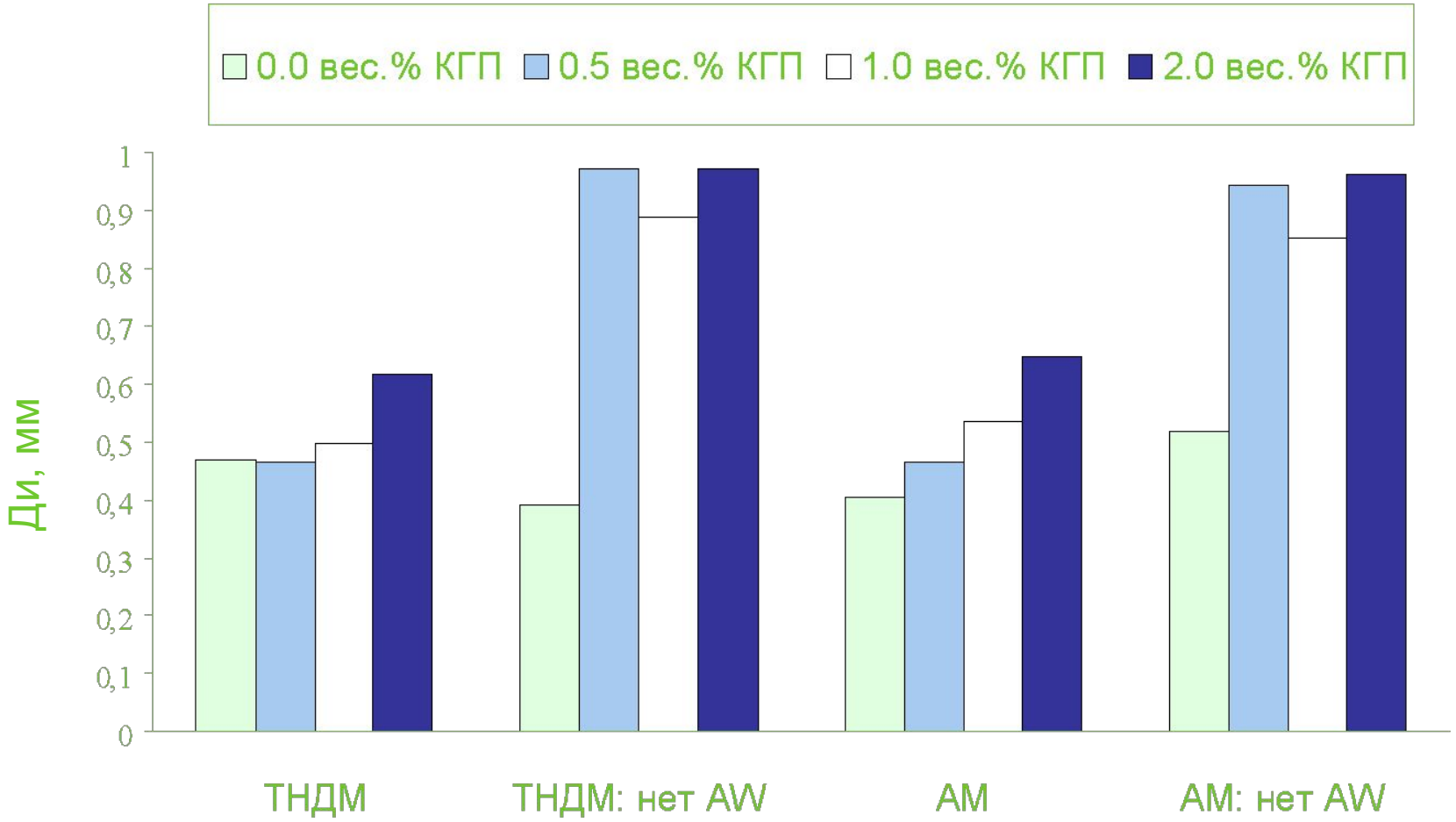
Willermet *et al*, Trib. Inter., 5/95

- Zinc is the base for the formation of tribolayers (Zinc Polyphosphate)
- ZDDP is an antioxidant
- ZDDP is a synergist for Mo-containing additives

Cumylhydroperoxide (CHP)



Effect of CHP on anti-wear properties of engine lubricants (four-ball test machine)



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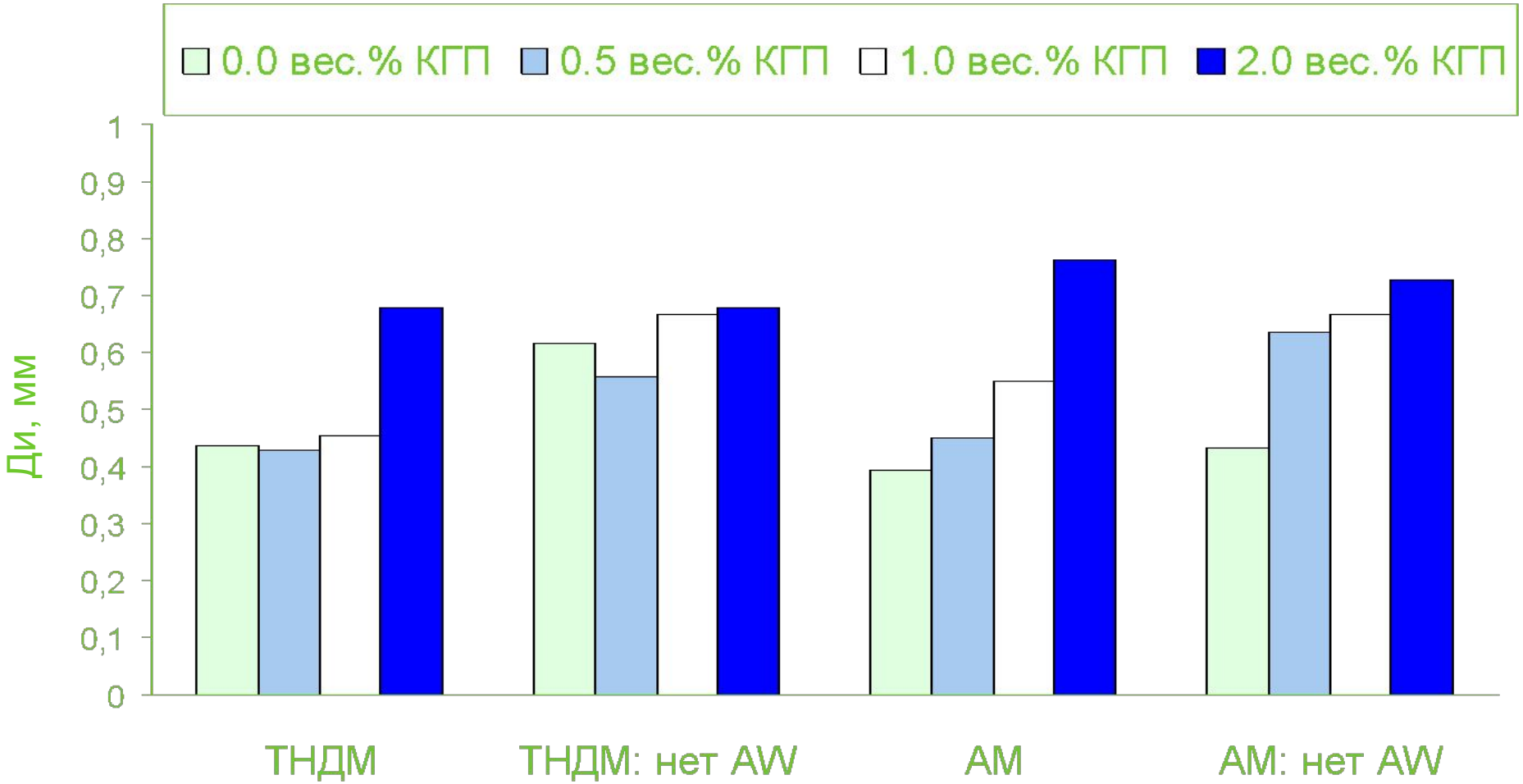
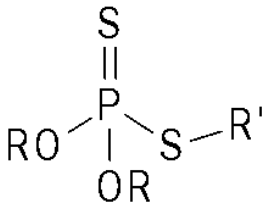
Effect of CHP on anti-wear properties of engine lubricants (Cameron-Plint)



Ashless P-containing additives



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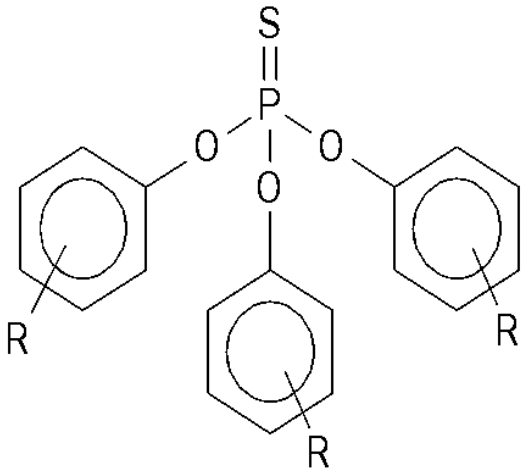

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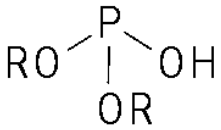

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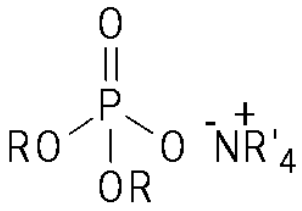
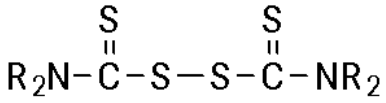


Ôî ñô àòû àì ì î í èÿ (í åò S)

Phosphorus-free additives (All contain sulfur - SOx, sulfate ash)



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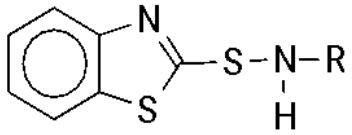

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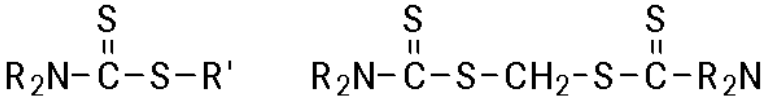

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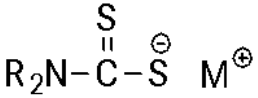
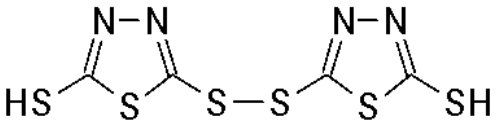


Äèòèîêàðáàìàòû (çîëüíûå)



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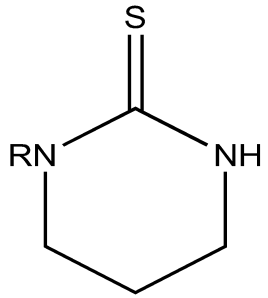
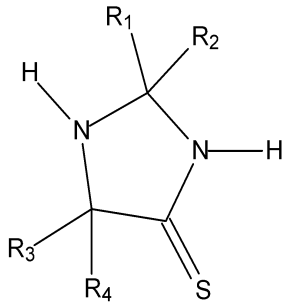
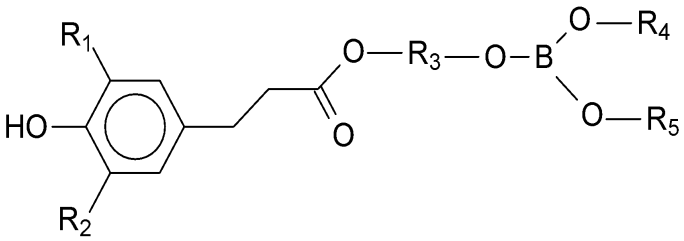
New anti-wear additives



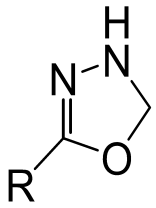
Cyclic thiourea



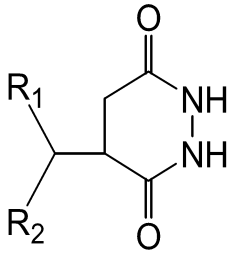
Imidazolidine thion



Imidazolidine thion

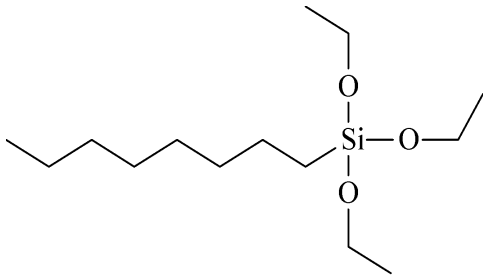


Oxamide

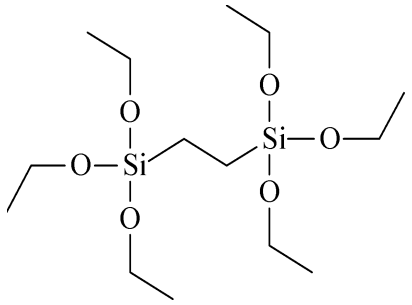


Hydrazide of succinic acid

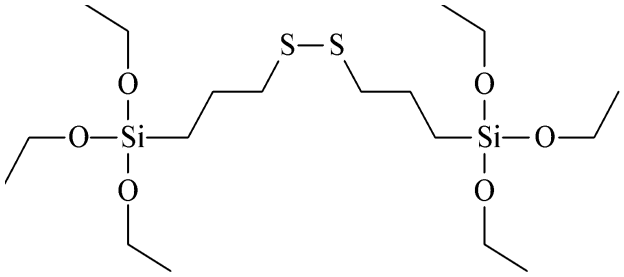
Silicon-containing compounds:
Silanes/Siloxanes



Octyltriethoxysilane

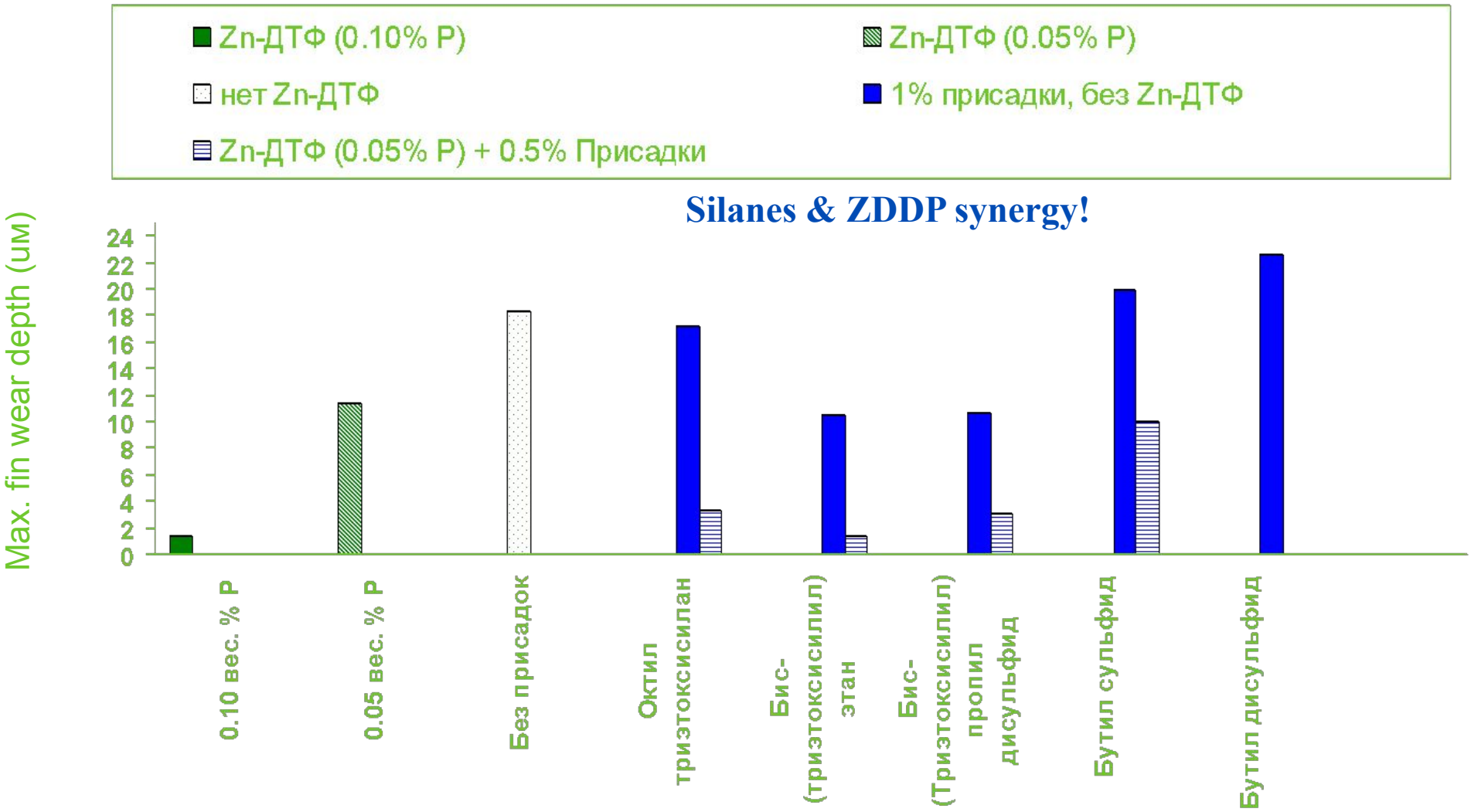


Bis-(triethoxysilyl) ethane



Bis-(truethoxysilyl) propyl disulfide

Anti-wear properties of engine lubricants containing silanes (Cameron-Plint)



Anti-wear additives based on esters

- **MLA-2837**
  - **Ashless, no S & P**
  - **Synergism with ZDDP**
  - **Free-flowing clear liquid**
  - **Non-corrosive**

Sulfur-containing anti-wear additives

MLA-2877

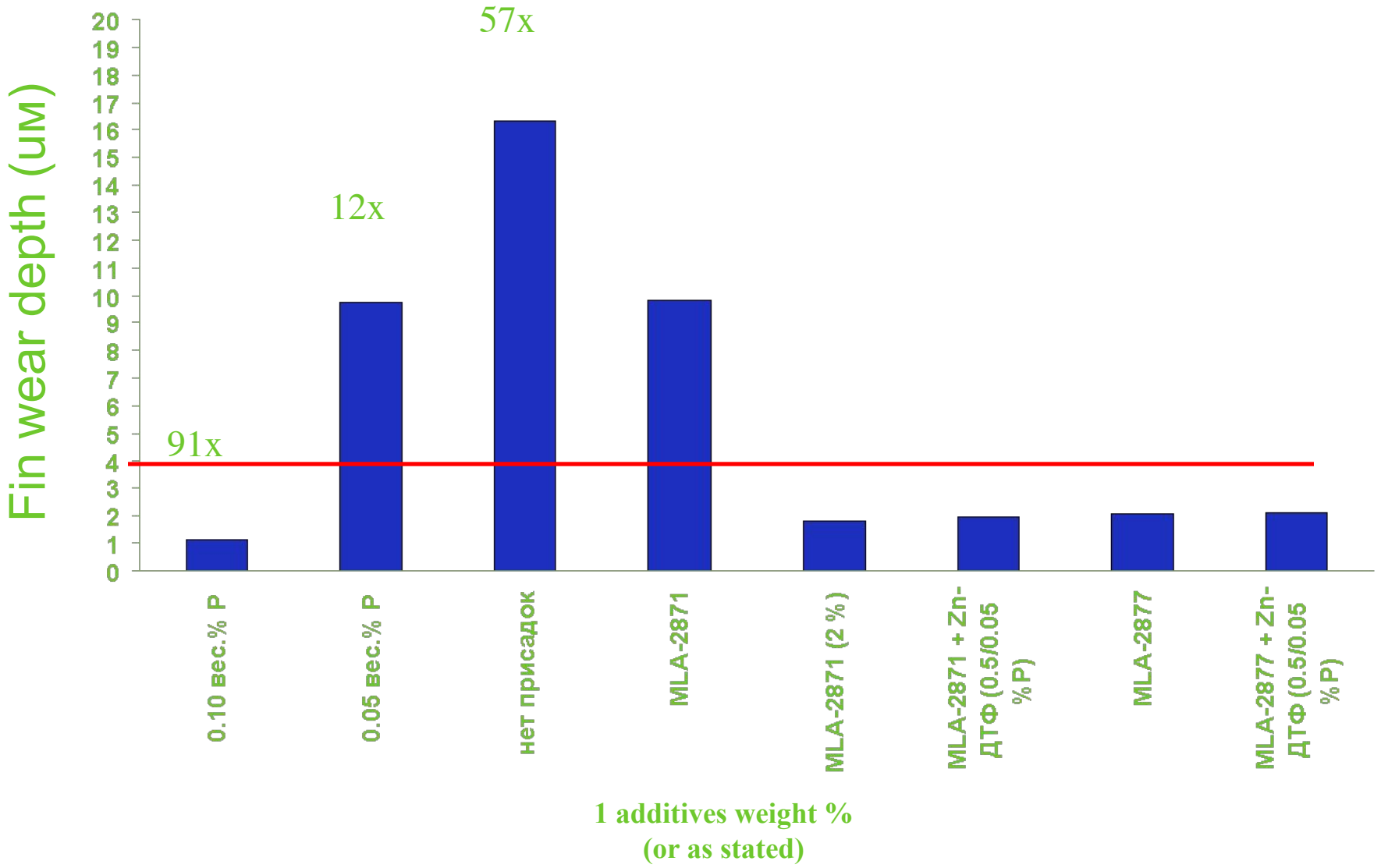
- Thiocarbamate derivative
- 12 % S
- Free-flowing yellow liquid
- Non-corrosive

MLA-2871

- S-containing heterocycle
- Synergism with ZDDP
- 22 % S
- Free-flowing yellow liquid
- Non-corrosive

Four-ball friction machine

Cameron-Plint tribometer



Selection criteria

Use conditions

- Activation temperature/ pressure

Price/Quality

Corrosive power

Volatility

Color

Solubility

Compatibility with sealants

Smell

Physical condition

Toxicity

Compatibility with packaging

Duration of action

Multifunctionality

- AO; AF; contribution to EP

Conclusions

As an anti-wear catalytic agent, CHP reliably distinguishes among lubricants with respect to anti-wear qualities in tests on a four-ball friction machine and the Cameron-Plint tribometer.

By screening various compounds, it was possible to identify several quality classes of potential anti-wear additives for engine lubricants as replacements for zinc dialkyldithiophosphate:

- **Heterocycles with Sulfur/Nitrogen atoms**
- **Esters with Nitrogen atoms (CHON)**
- **Silanes/Siloxanes**