

The Lubricity

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- Meaningful physicochemical properties of a lubricity additive.
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- Conclusions.

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French & English definitions

- The French Larousse

Lubricity is the lubricating power of an oil in thin layer which depends of its molecular structure and of its viscosity.

- The British Britannica

Boundary lubrication is determined by properties of surfaces and of the lubricants other than viscosity.

First possible gains

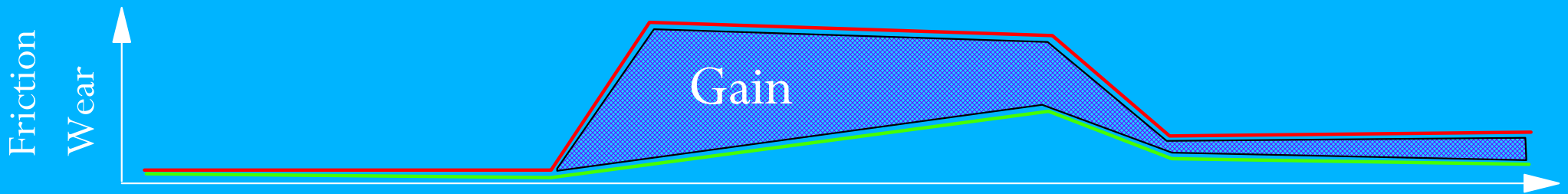


Hydrodynamic

Oil +EP

Direct contact
(EP are inactive)

Direct contact
(Active EP)



Hydrodynamic

Oil +Lubric.+EP

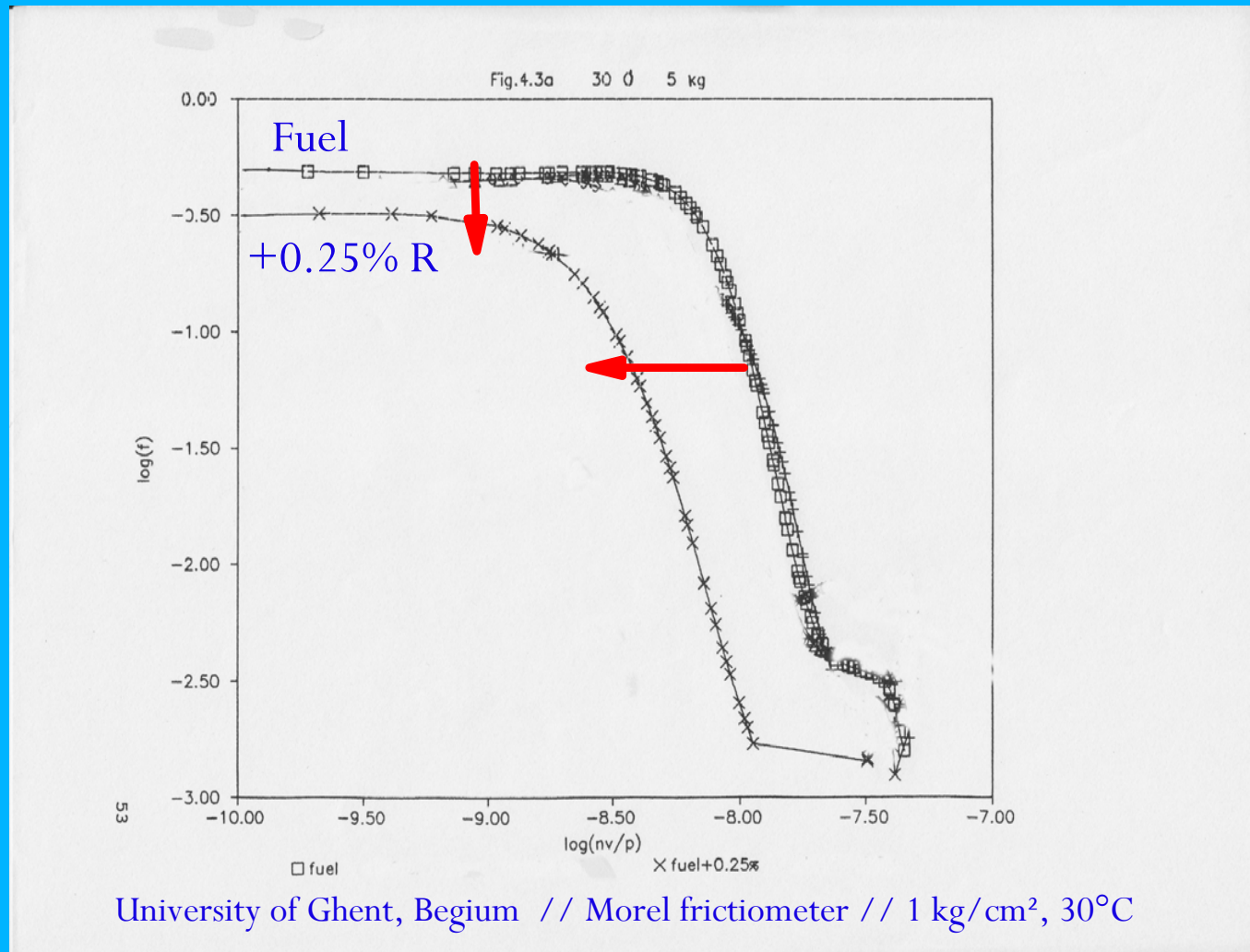
Direct contact
(Lubric.+EP)

Direct contact
(Lubric.+EP)



Second possible gains :

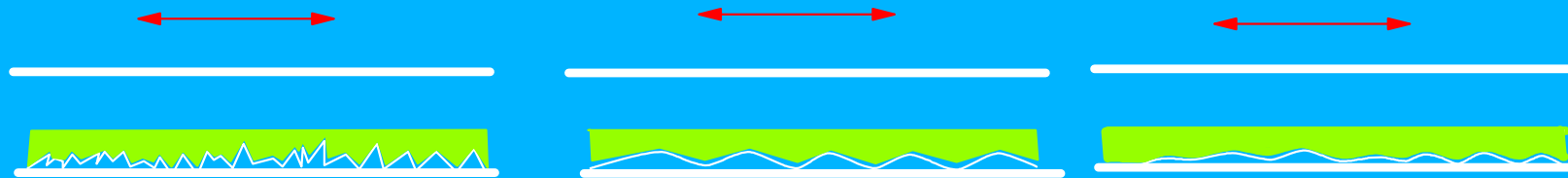
(Stribeck curves : Log friction/log(vis*speed/Pressure))



* Lower friction
in the boundary

* Early
hydrodynamisme

Third possible gain



Lamination of the asperities of the rubbing surfaces with movements and time.

Summary of possible gains

- Avoid direct contact between sliding surfaces.
- Retard the direct contact to tougher conditions where EP additives starts to act right away.
- Forms a film of intrinsic lower friction.
- Leads to early hydrodynamic regime, the regime of lowest friction and wear.
- Surface becoming smoother and more slippery.

Mechanical conditions of lubricity

- To get a lubricity film, a lubricity additive is needed.
- Lubricity lays before direct contact and in the low pressure area ($P = \text{Load} / \text{surface}$). A low load does not implies low pressure.
- Lubricity is more active in desequilibrium conditions and in conditions where any given property is variable or unstable.
- Lubricity commonly appears at start or stop of rubbing surfaces.

The lubricity film requirements

- Lubricity film needs simultaneously adhesion to the surface, thickness and film strength
 - Adhesion : very much linked to polar element and to the presence of free electrons and to hydrogen bonds. Unsaturation, presence of polar elements and of hydrogen bound are increasing adhesion.
 - Thickness is necessary to cover asperities and to reach the lamination effect.
 - Film strength is necessary for resisting on longer term. Low volatility, high temperature resistance are increasing sturdiness.

Meaningful physicochemical properties of a lubricity additives

- Viscosity ... Coverage of asperities
- Volatility ... Film strength
- Dipolar moments ... Adhesion to surfaces
- Molecular distribution ... Adhesion to surfaces
- Unsaturation ... Adhesion to surfaces
- Hydrogen bounds ... Adhesion to surfaces
- High temp. resistance ... Film strength
- Tackiness ... Adhesion to surfaces
- Spongelike stereochem. ... No competition on surfaces

Lubricity additive choice

- Laboratory wear or friction test : difficult if not impossible because measurements should occur :
 - ▶ In low pressure of contact outside of the direct contact of EP.
 - ▶ With variable conditions.
 - ▶ With repeatability.
- Intellectual choice by evaluating the physicochemical properties of additives.
- Test at the customer : the finality and matching the actual disequilibria of the given conditions.

Comparison of the 4 major lubricity chemicals

	Canola	Fatty ester	Polymerized ester	Elektrion R
Higher vis.			*	*
Lower volatility	*		*	*
Higher polarity	*	*		*
Wider Mol.distribut.	*	If natural	If natural	*
Sponge-like stereochemistry				*
Unsaturation	*	If chosen	If chosen	*
Hydrogen bonds				*
Resistance at high temp.			*	*
Tackiness				*

Conclusions

Lubricity, even if difficult to measure in laboratory, is a technical reality which leads to friction and wear reductions and which is the future of lubricants.

Most of today's lubricants are dry and lacking this outstanding property

* because the lubricant world is putting oxidation tests as a major issue leading so to saturated chemicals and

* because lubricity is often mistaken with direct contact regime. and is often mis-measured with high pressure type of laboratory testing (punctual or linear contact)