SYENSQO
ADVANCING HUMANITY

# Syensqo's Addilub AW 7400

# Low Phosphorus Anti-Wear with Superior Lubricity Performance

**September 2024**

Éder Torres
Lucas Luz

# Today’s speakers

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# Agenda

1. About Syensqo
2. What are the challenges driving Innovation in MWF?
3. How P-based polymeric additives evolved over the years?
4. Tribological performance of the P-based polymeric additives

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# A pioneering legacy and a passion for science and bonding

**1863** Solvay innovates in social welfare (paid vacations, social security, 8-hour day)

**1878** Ernest Solvay establishes the first Councils of Physics and Chemistry, which continue to bring together the brightest scientific minds today

**1911 & 1922**

**1965** Launch of PEEK, a very strong thermoplastic to replace metal for lighter, more fuel-efficient planes

**1978** First Chemistry for the Future Solvay Prize

**1990**

**2013** Solvay partners with the Ellen MacArthur Foundation: a bold step toward a circular economy

**2018**

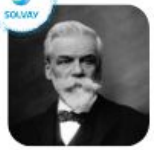
**2020**

**2022** 13 products labelled Efficient Solutions by the Solar Impulse Foundation

Prof. Katalin Karikó wins Solvay Prize on 100-year anniversary of the Solvay Conferences

**2023** Launch of Syensqo

**1863** Ernest Solvay invents a new process for producing soda ash



**1880** Solvay is the first industrial multinational operating simultaneously in the US and Europe

**1965** Development of PSU, a revolutionary healthcare polymer used for hemodialysis membranes

**1990** Rhodia, a future Solvay unit, invents precipitated silica for green tires

**2015** Solvay flies around the world with Solar Impulse

**2020** Solvay creates the Solvay Solidarity Fund, to help colleagues and communities facing hardship

**2022** Launch of our 4th Growth Platform on Renewable Materials and Biotechnology

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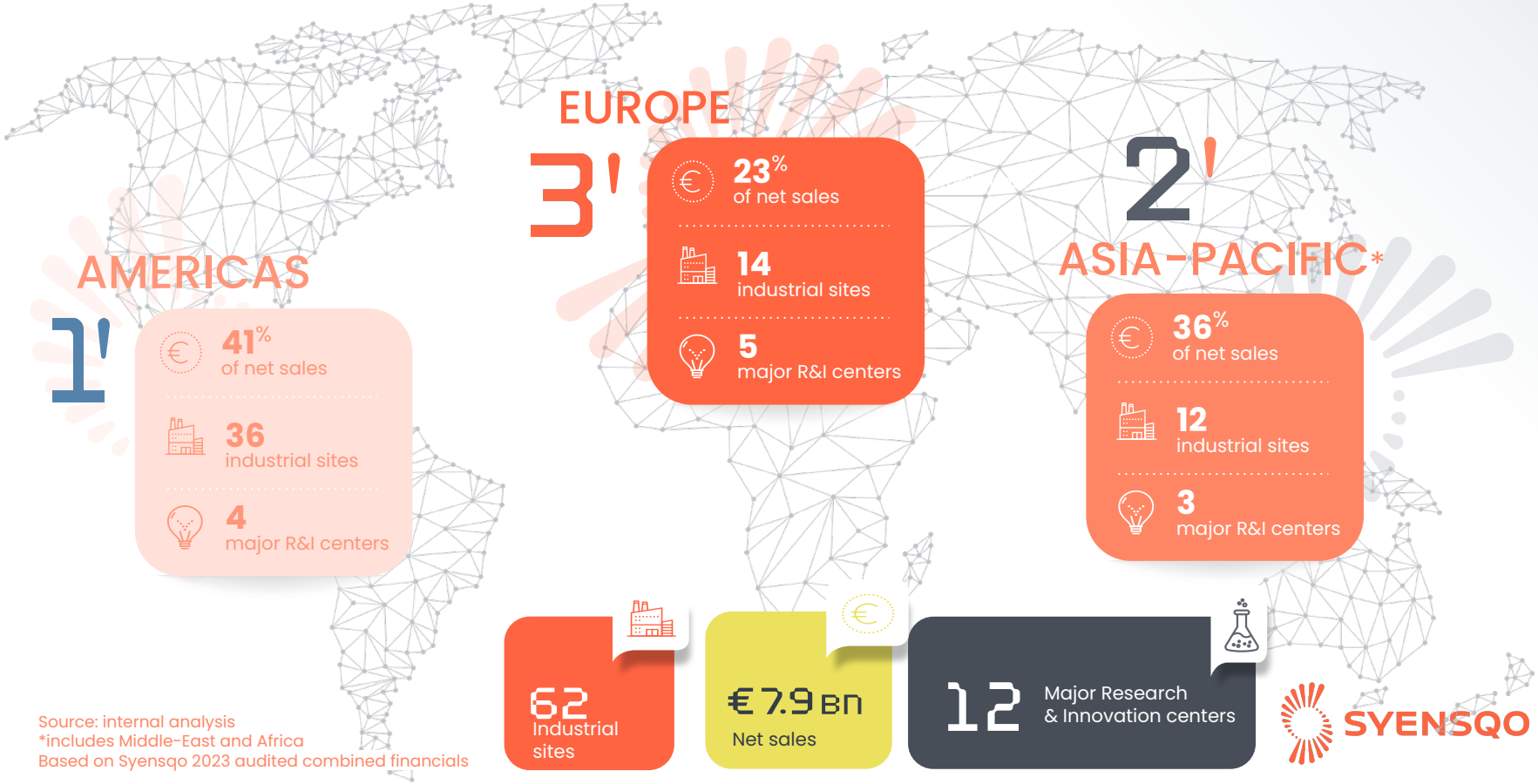
# +13,200 Employees: global & close to our customers



## AMERICAS

1'

**41%** of net sales

**36** industrial sites

**4** major R&I centers

## EUROPE

3'

**23%** of net sales

**14** industrial sites

**5** major R&I centers

## ASIA-PACIFIC*

2'

**36%** of net sales

**12** industrial sites

**3** major R&I centers

**62** Industrial sites

**€ 7.9 BN** Net sales

**12** Major Research & Innovation centers

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Source: internal analysis
*includes Middle-East and Africa
Based on Syensqo 2023 audited combined financials

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# Metalworking trends & drives

## Products designed to address key market needs

### Increase of productivity

High speed machine tools

- Low foam generation
- **High lubricity**
- **Improved anti-wear performance**
- **Improved chemical stability**

### Improved fuel efficiency

Lightweighting

- Increase of light metals in automotive and transportation
- Anti staining properties

### Human & environment solutions

Better footprint and labeling

- **Reduced toxicity and improved labeling**
- Reduced chemical dosage
- Better chemical sourcing
- **Lower P content**

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**Safer alternatives**
**without performance decline**

## ADDILUB

**1,4-dioxane free** - a safe alternative to the regulation that is likely to come.

**Reduced phosphorus content** compared to traditional phosphate esters (~90% less P than reference products)

### 1,4-Dioxane free(*)

Dioxane is considered a probable human carcinogen and is persistent in the environment.

### Low Phosphorus content

Phosphorus in metalworking fluid additives poses several challenges due to environmental, regulatory and performance-related issues

(*) < 1 ppm threshold

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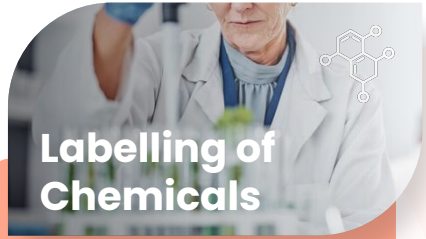
# GHS Labelling | Addilub AW 7400: label-free technology




- Changing and more stringent regulations call for versatile, simplified and low-labelling metalworking fluid additives.
- One step further with Addilub - a pictogram-free solution

## Typical chemistries(*)

**Pictograms**

**Toxicity**

H315: Causes skin irritation
H318: Causes serious eye damage.

**Eco-toxicity**

H401: Toxic to aquatic life.
H411 – Toxic to aquatic life with long lasting effects.

## Addilub AW 7400

Label free

(*) Phosphate esters & Amine phosphates

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# Polymeric P-based additives

## Patent analysis - Screening of search results

*29 patents with polymeric additives for MWF*

Antioxidant
Anti-corrosion
Mostly not P-based

*9 patents* with P-based additives *for MWF applied*

P-based polymeric additives applied as anti-wear not main novelty of patents found.


Based on the search criteria the application of P-based polymeric additives used as anti-wear in MWF formulation is novel and disruptive in the market

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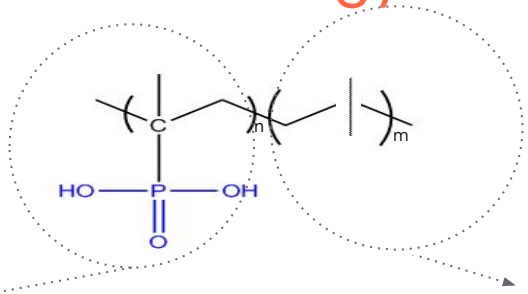
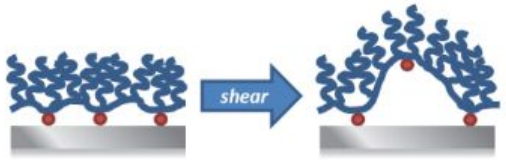
# Why is Polymeric AW technology so unique?




| Phosphorus Monomer(s) | |
|---|---|
| Anchoring group outside of the backbone | Tribofilm strength |
| Anchoring group type:<br>- Phosphate<br>- Phosphonate | Tribofilm strength, durability, thermal stability |
| % of anchoring group | Tribofilm strength |

| Lipophilic Monomer(s) | |
|---|---|
| Type of lipophilic groups | Solubility |
| % of lipophilic groups | |

| | |
|---|---|
| MW: Molecular Weight: 10-100 kg/mol | Solubility, tribofilm strength and durability |

**Low Phosphorus Polymer with anchoring groups protecting the surface and with increased hydrolysis stability compared with PE**

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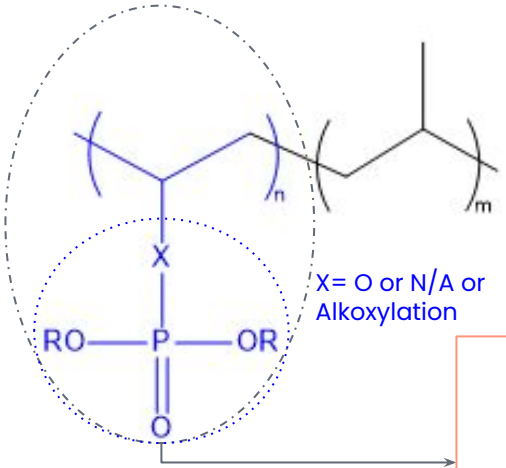
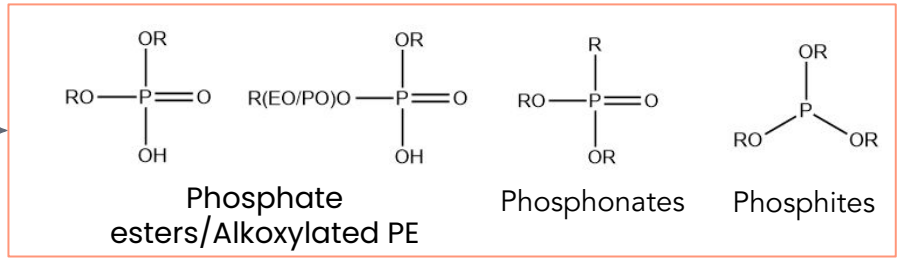
# Why is Polymeric AW technology so unique?




X= O or N/A or Alkoxylation




## Multiple options to maximize performance

Chemical flexibility to fine tune performance and develop tailor-made solutions

**Tailor-made solutions to address different types of formulations and conditions**

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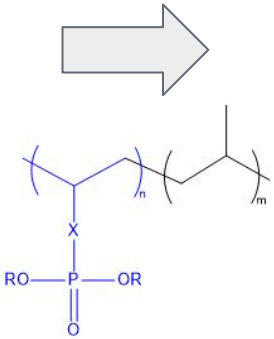
# Selecting the candidates to be tested

## Focus on tribological performance

- Tribological tests for MWF depends on the application and type of formulation

| Candidate | Chemical Nature | % P | Label |
|---|---|---|---|
| Addilub AW 7400 | P-based polymer | 0,42 | No Label |
| Addilub AW 1 | P-based polymer | 0,38 | No Label |
| Addilub AW 2 | P-based polymer | 0,38 | No Label |
| Addilub AW 3 | P-based polymer | 0,58 | No Label |
| Addilub AW 4 | P-based polymer | 0,35 | No Label |
| Reference 1 | Amine Neutralized PE | 7,4 |  |
| Reference 2 | Phosphate Ester | 5,5 |  |




Tap Torque - Forming

Falex Pin and Vee

4-ball

HFRR

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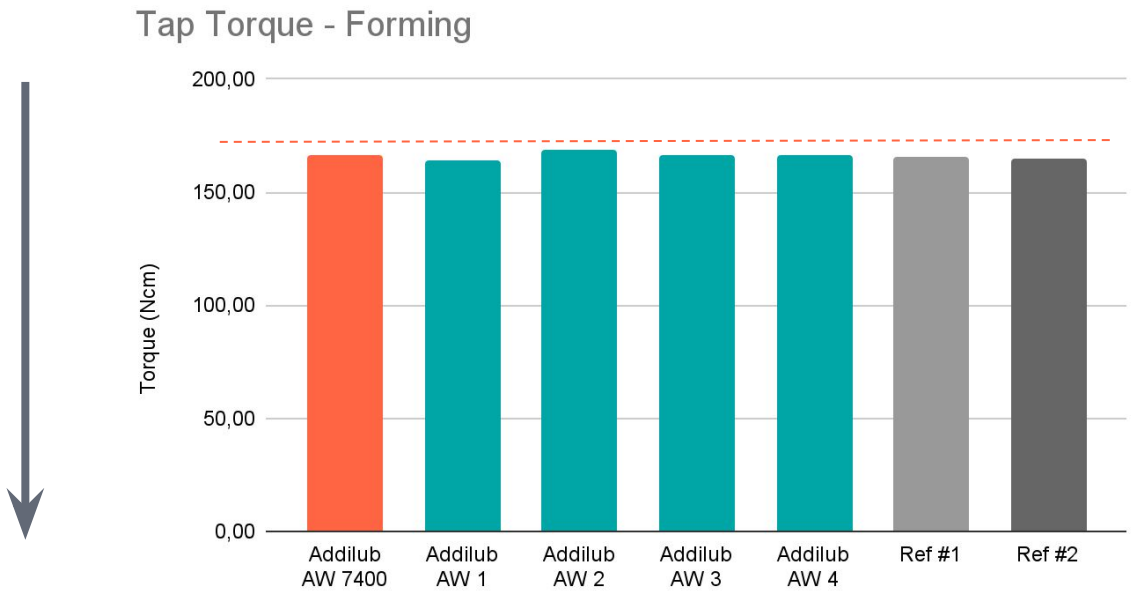
# Tap Torque - Forming
## Semi-Synthetic formulation




| Component | % (w/w) |
|---|---|
| Monoethanolamine | 3.6 |
| Triethanolamine | 8 |
| Dicyclohexylamine | 1 |
| Diglycolamine | 1.6 |
| Iso-nonanoic acid | 1.2 |
| Tall oil | 6 |
| Boric acid | 5 |
| Water | 24 |
| Naphthenic oil | 39.56 |
| Sorbitan mono-9-octadecenoate | 1 |
| Oleyl alcohol polyoxyethylene ether | 1.12 |
| Carboxylic ether | 2.1 |
| Alkamuls S 80/Rhodasurf CET 2 | 1.92 |
| Gelbotol | 1.3 |
| Biocide | 2.6 |

Testing conditions:

- 5% of additive in the concentrate;
- 5% of concentrate in DI water;
- 6061 Alloy, Tap speed = 1,000 rpm, 5 runs / sample

Overall all candidates tested have similar performance

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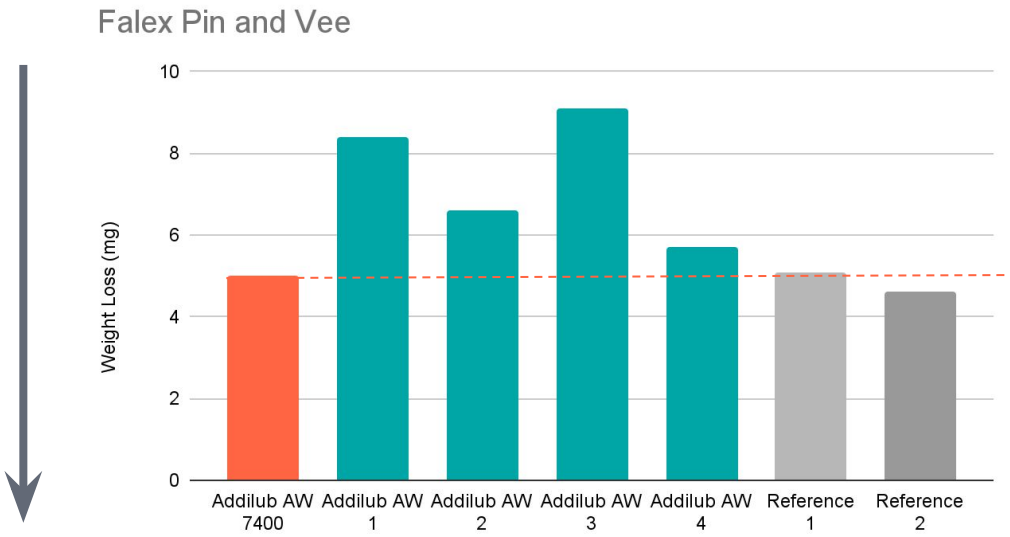
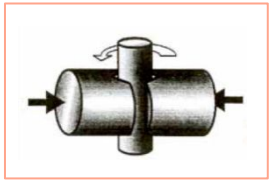
# Falex Pin and Vee
## Neat Oil formulation



Testing conditions:

- Wear method: 3 min at 100 Lbs and then 2 hours at 300Lbs
- 2wt% AW in Group II: KV100°C=9 cSt

**Addilub AW 7400 with performance similar to both references**

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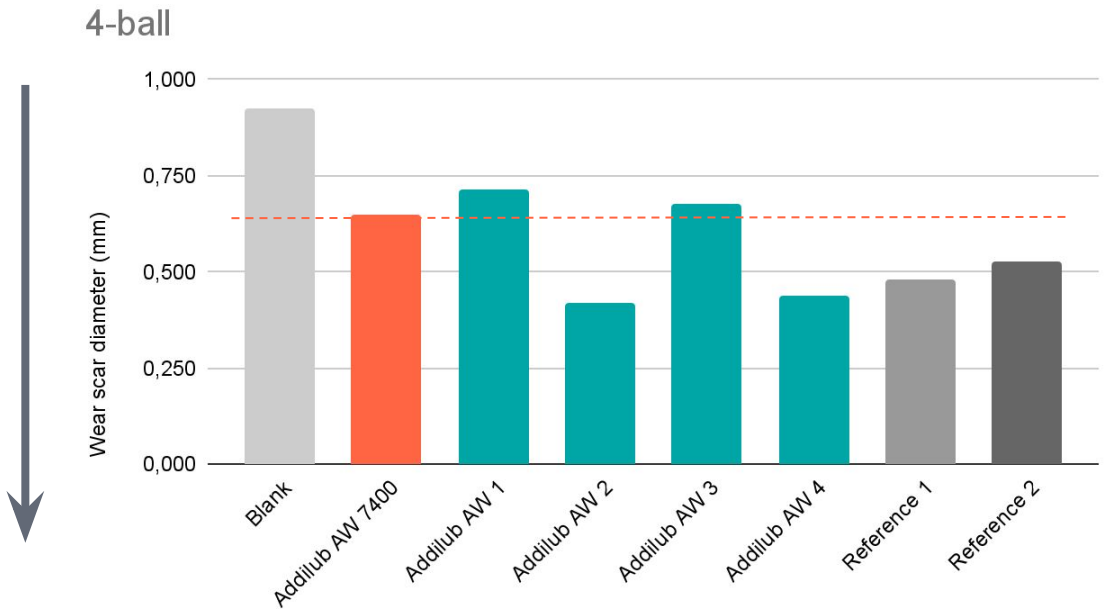
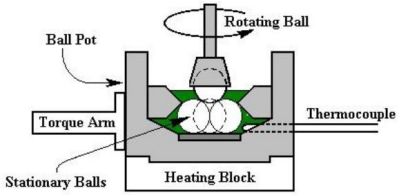
# 4-ball
## Neat Oil formulation




Testing conditions:

- 4 ball wear test - ASTM D4172:1200 rpm - 60 min - 75°C - 40kg
- 1wt% AW in Group II: KV100°C=9 cSt

Addilub AW 1 and Addilub AW 2 with performances higher than references

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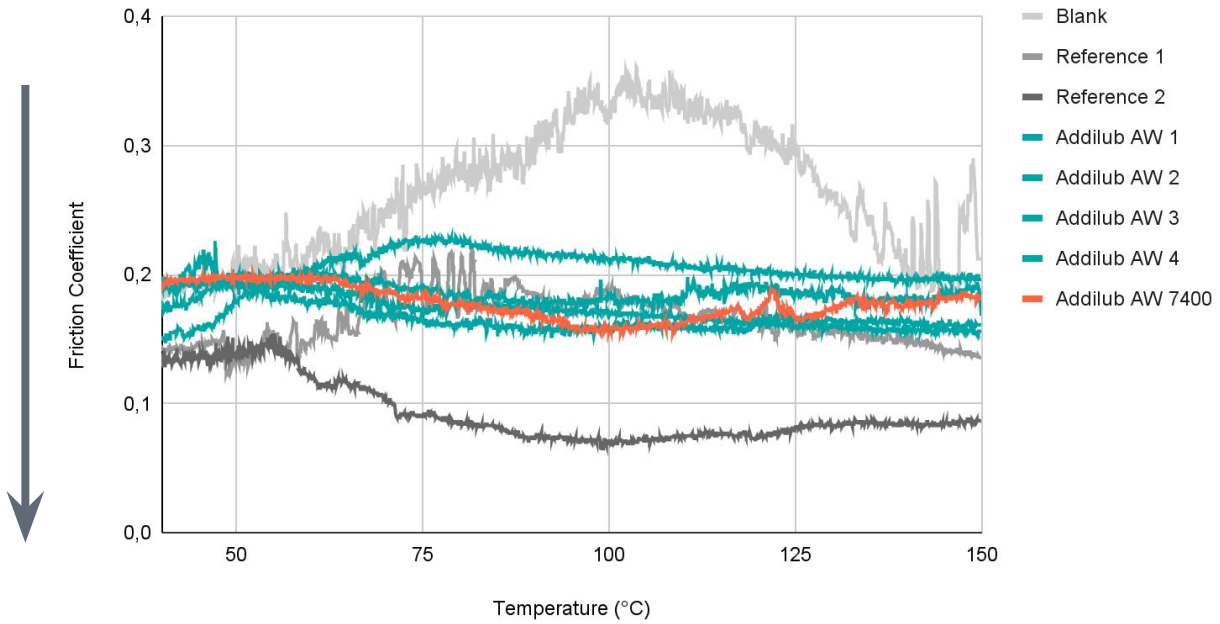
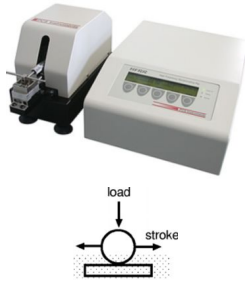
# Friction Performance – HFRR

## Neat Oil formulation




Testing conditions:

- HFRR: slide ball on disc: steel/steel: 200g – 1000 microns – 15min @ 40°C and 55min ramped to 150°C @ 2°C/min
- 1wt% additive in KV100° C=9cSt Group II

Overall similar performance to Reference #1. Reference #2 still better performance

# **Addilub AW 7400** – summary and conclusion

## Our new product ready for commercialization

| Product | Phosphorus content | Label | Tap Torque | Falex Pin and Vee | 4-ball |
|---|---|---|---|---|---|
| Addilub AW7400 (Low-P Polymeric AW) | | | | | |
| Reference 1 (Amine Neutralized PE) | | | | | |
| Reference 2 (Phosphate Ester) | | | | | |

| Excellent | Good | Fair / poor |
|---|---|---|

**Addilub AW 7400 combines performance & sustainability profile**

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# Next steps

## Going further and expanding our product offer


| Candidates | Phosphorus content | Label | Tap Torque | Falex Pin and Vee | 4-ball |
|---|---|---|---|---|---|
| Addilub AW 1 | | | | | |
| Addilub AW 2 | | | | | |
| Addilub AW 3 | | | | | |
| Addilub AW 4 | | | | | |
| Reference 1 | | | | | |
| Reference 2 | | | | | |

| Excellent | Good | Fair / poor |
|---|---|---|

Expanding our product offerings to meet diverse customer needs

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# Questions?
Get in touch

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Thank You!