

# Hybrids: future perspectives and the role of lubricants

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Presented at Lubricant Expo Europe, 18 September 2024



**Market drivers**

1



**Technical challenges**

2



**Enhancing our understanding**

3



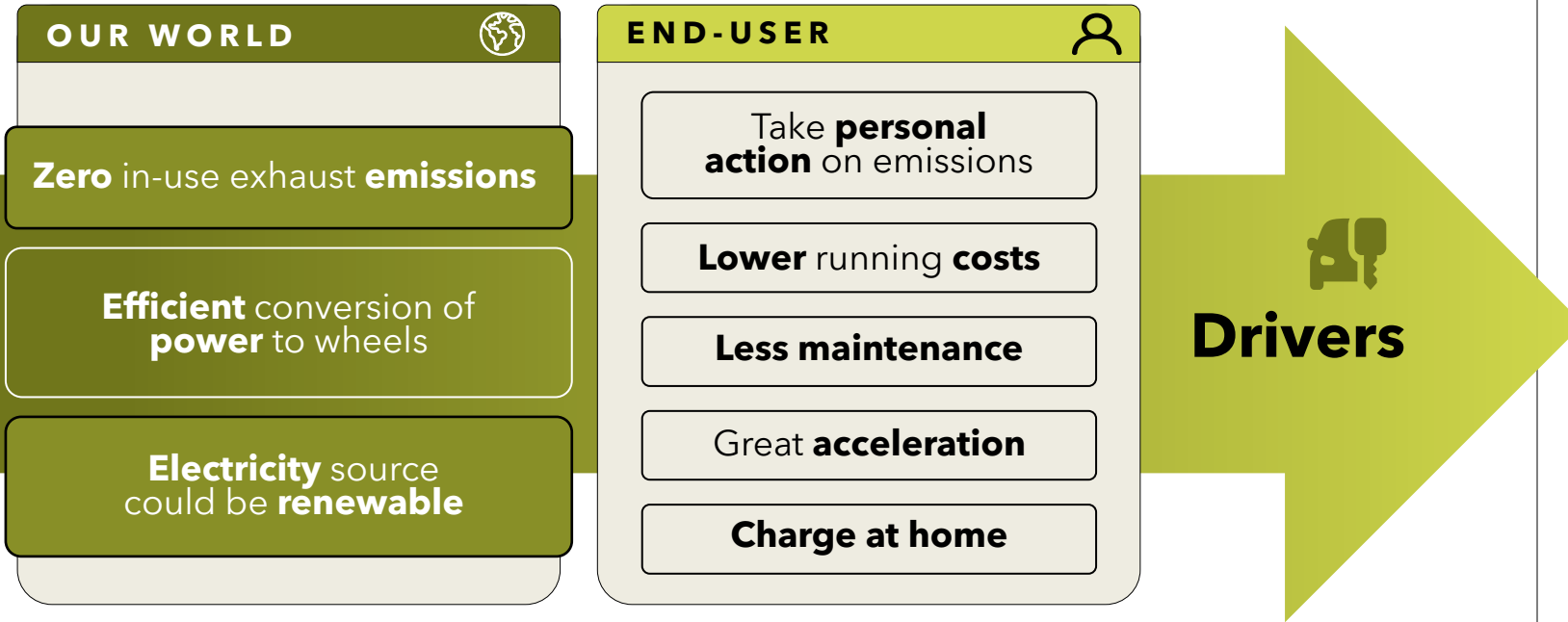
**Developing solutions**

4



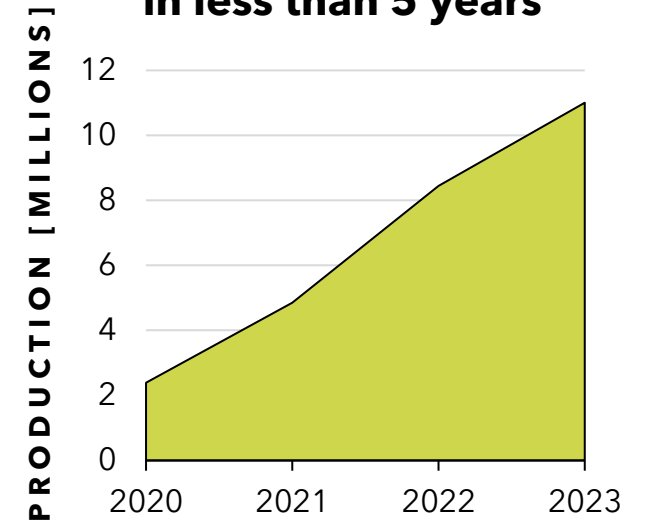
# CONTENTS

# Full-electric vehicles share is growing fast



## Global Production

**x4 volume growth in less than 5 years**



Full-electric vehicles

Shift to sustainable mobility

# Hurdles to wider adoption of full-electric vehicles remain

**High cost of ownership**



Metal availability for battery production



**Charging time and lack of infrastructure still limiting factors**



Availability / cost of renewable electricity



**Range anxiety from end-user**



Battery life

# Challenges

Shift to sustainable mobility

# The ICE is part of car manufacturers' strategies



## Stellantis

Development of full-electric along hybrid powertrains  
No cost parity for full electric vehicles in EU before 2026 at best

## Toyota

Long-lasting experience in Hybrids;  
5<sup>th</sup> generation released  
Develop several powertrain technologies in parallel

## OEM Journey toward decarbonisation

## Ford

Ford Model e and Ford Blue business units co-existing  
Focus on Hybrid expansion

## Renault Group

2 legs approach with HORSE for delivering ICE-based solutions

## Mercedes Benz

Continuation of hybridized powertrains' development

## Honda

Development of both full-electric and Hybrid powertrains

## BMW Group

Complete electrified portfolio targeted by 2030  
Supports technology neutrality

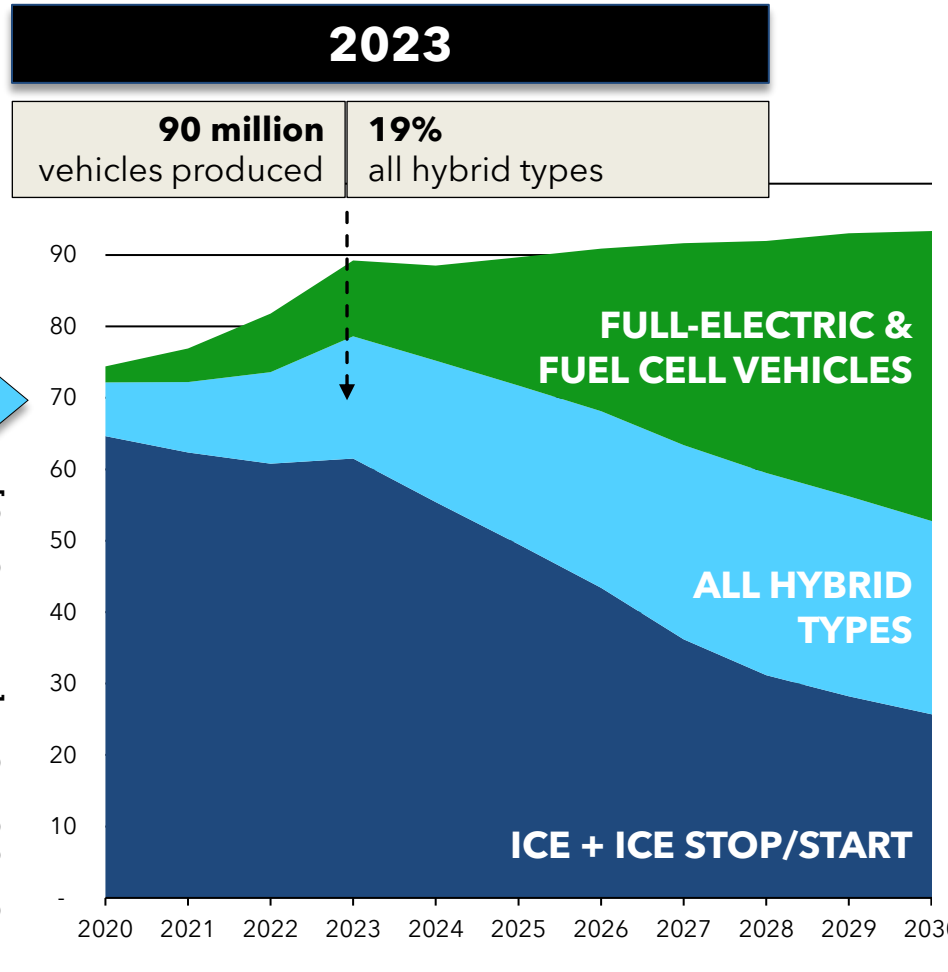
Shift to sustainable mobility



# The ICE is and will be more and more combined with an electric motor



**Hybrids** are expected to be a **LARGE COMPONENT OF THE LIGHT-DUTY MARKET** for many years to come



**By 2030**  
**>29%**  
of vehicles produced forecasted to be all hybrid types

Source: S&P Global, Light Vehicle Powertrain + Altern.Propulsion Forecast, April 2024

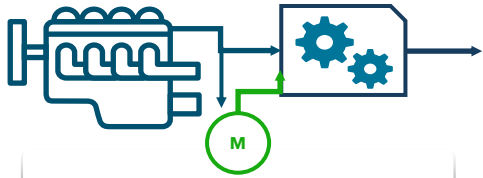
Unique Hybrid lubricant requirements



# Hybrid powertrains: a range of options

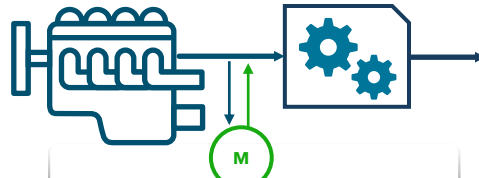
BASIC SCHEMATIC  
APPROXIMATE FUEL ECONOMY\*

MILD-HYBRID [MHEV]



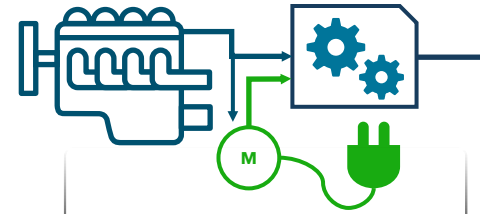
Up to 10%

FULL-HYBRID [FHEV]



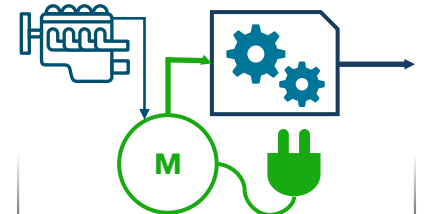
Up to 40%

PLUG-IN HYBRID [PHEV]



Up to 50%

RANGE EXTENDED [REEV]



Up to 60%

## ENERGY SAVING OPERATIONS:

ENGINE SHUTS-DOWN WHEN STOPPED

ENGINE ASSISTED BY MOTOR FOR EXTRA TORQUE / BRAKING ENERGY RECOVERED

MOTOR CAN PROPEL VEHICLE WITH ENGINE OFF

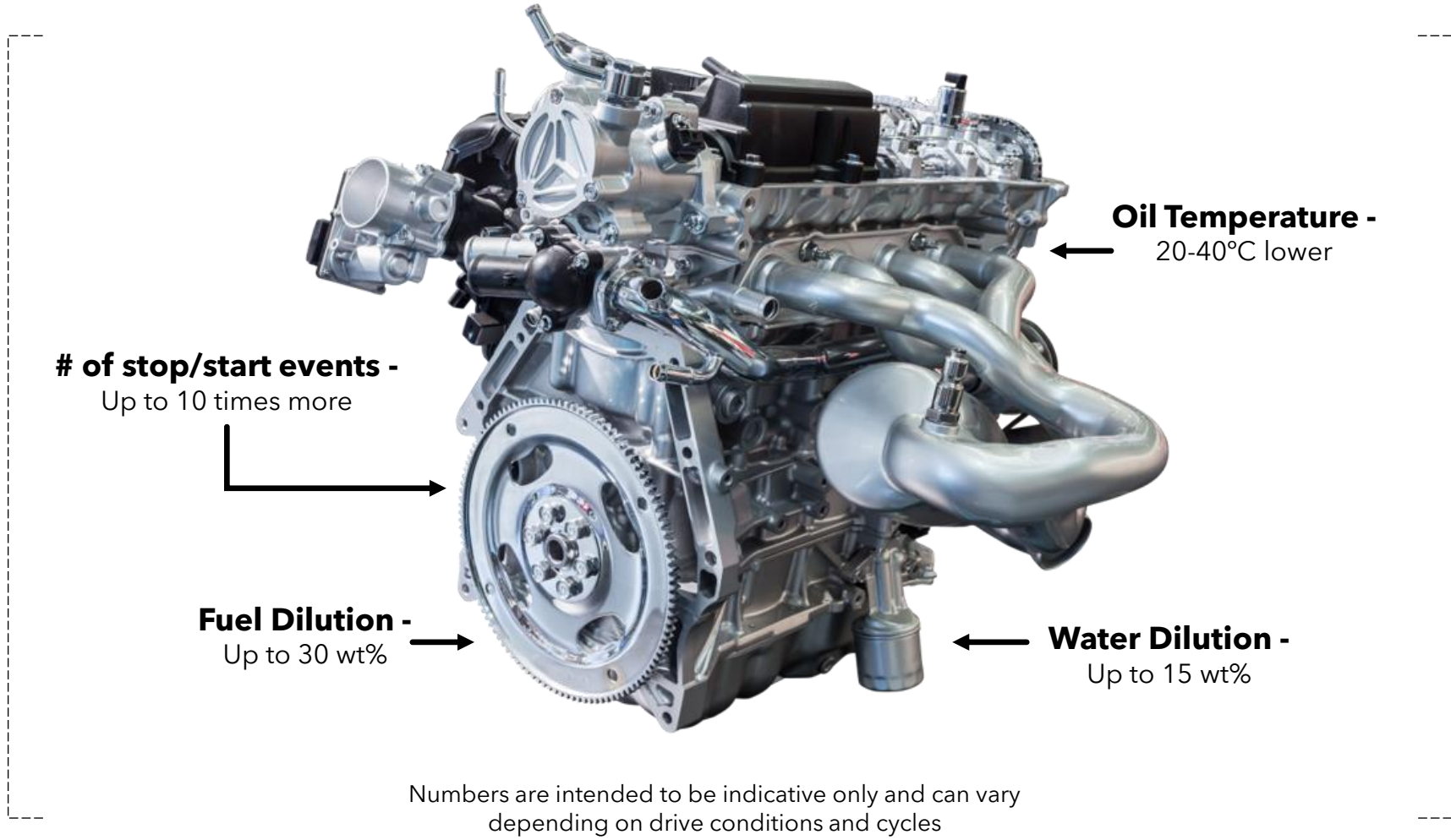
PLUG-IN RECHARGE

E-MOTOR PROPULSION ONLY

\*Typical efficiency gains to expect when taking a non-hybridised ICE as the baseline

Unique Hybrid lubricant requirements

# Hybrid powertrains promote specific technical challenges on the oil lubricating the ICE



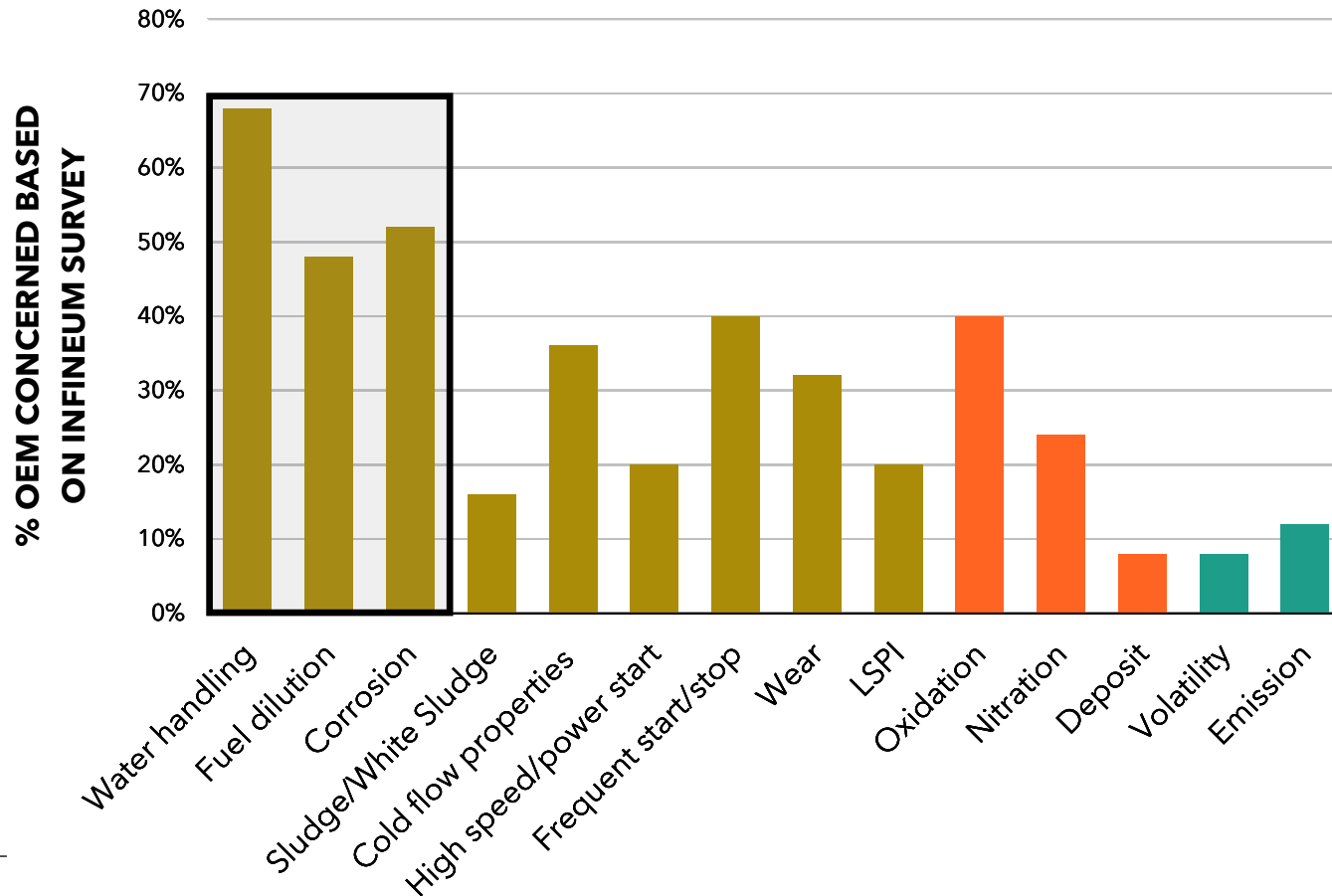
These technical challenges are not new to the ICE, but **made more severe** by its electrification





Unique Hybrid lubricant requirements

# Car manufacturers confirmed the key challenges foreseen for the lubricant

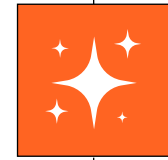


Key themes are emerging requiring fundamental understanding of the challenges to be addressed

**DURABILITY**



**CLEANLINESS**



**SUSTAINABILITY**



Enhancing our understanding

# Knowledge build via a severe field trial run on hybrid passenger cars

## 16 plug-in hybrid vehicles

on the road to test a range of Hybrid power modes and several lubricants



Severe environment with ambient temperature down to

**- 36 °C**



## Challenging urban test cycle

Stress testing the lubricant for 30,000km



Enhancing our understanding

# An adaptative approach to mimic severe yet realistic usage scenarios



3 scenarios to mimic **different consumer driving patterns**



A

## Taxi / Delivery - 80 KM PER SHIFT

6 laps then cool | 0.10% water | 10% fuel dilution



B

## Cross-city Commuter - 40 KM PER SHIFT

3 laps then cool | 0.20% water | 20% fuel dilution



C

## Forecourt - COLD START + IDLE FOR 2 WEEKS

4 cold starts then idle | 4% water | 13% fuel dilution

# Key observations - Wear

## Vehicle from field trial:

HEV = never plugged-in

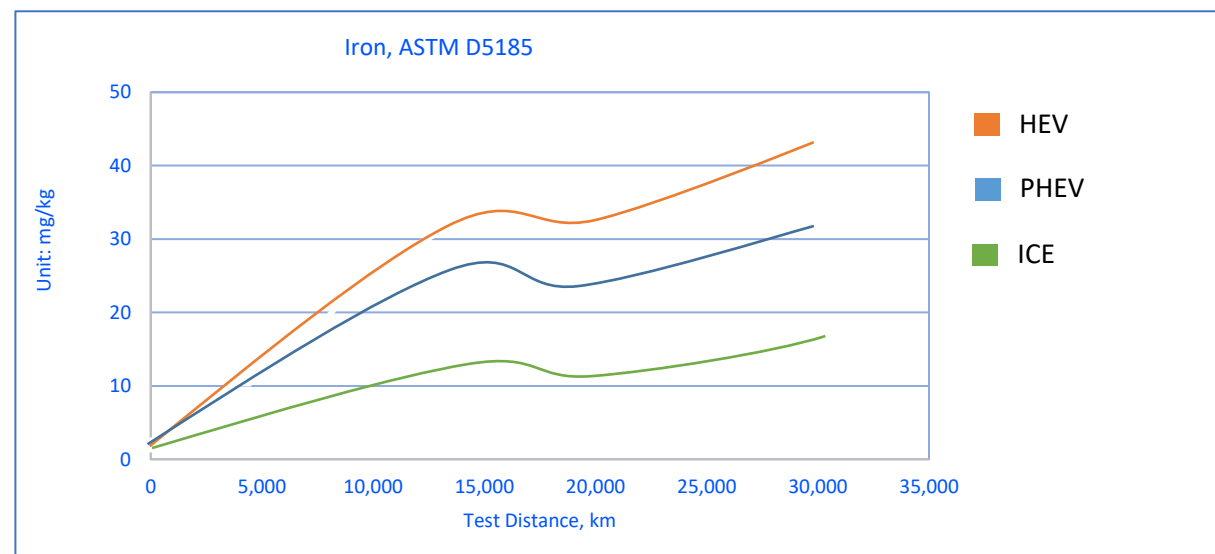
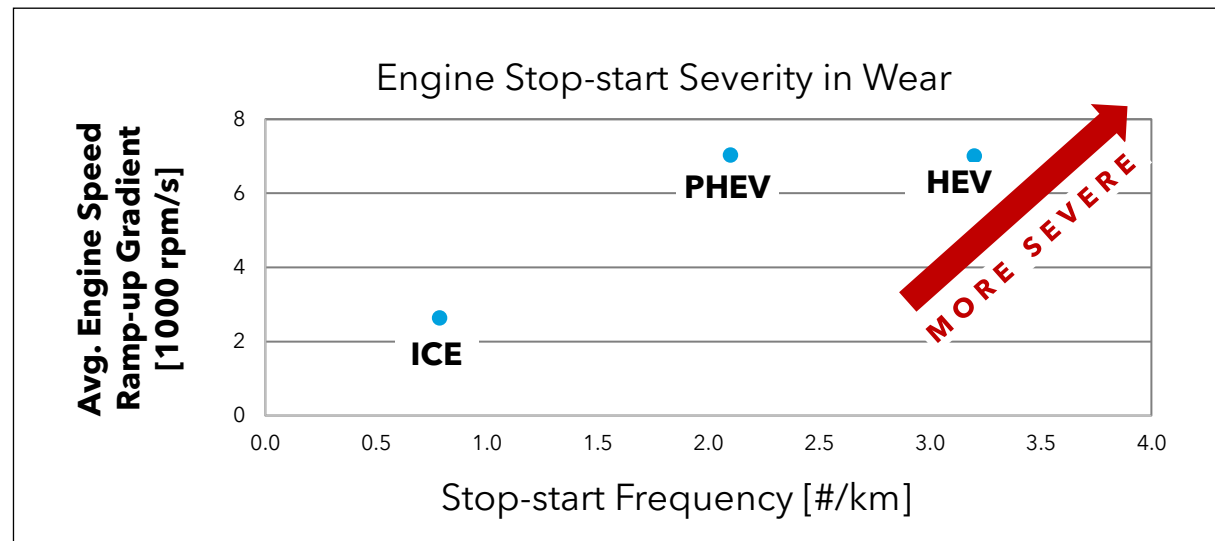
PHEV = regularly plugged-in

ICE = conventional ICE vehicle

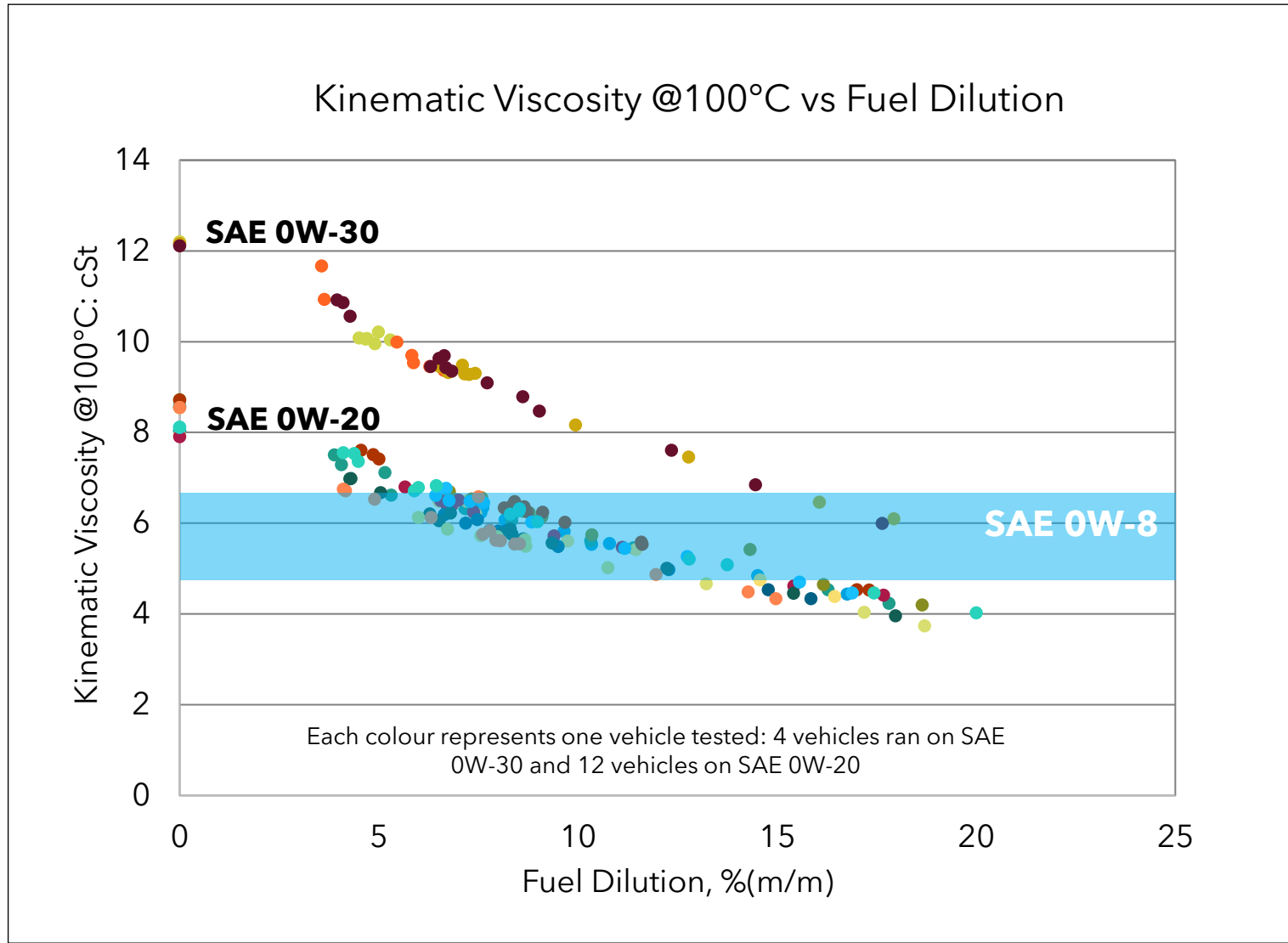
Both hybrid vehicles undergo more severe conditions vs the conventional ICE



This translates into higher wear observed via higher iron content for both hybrid vehicles



# Key observations - Fuel dilution

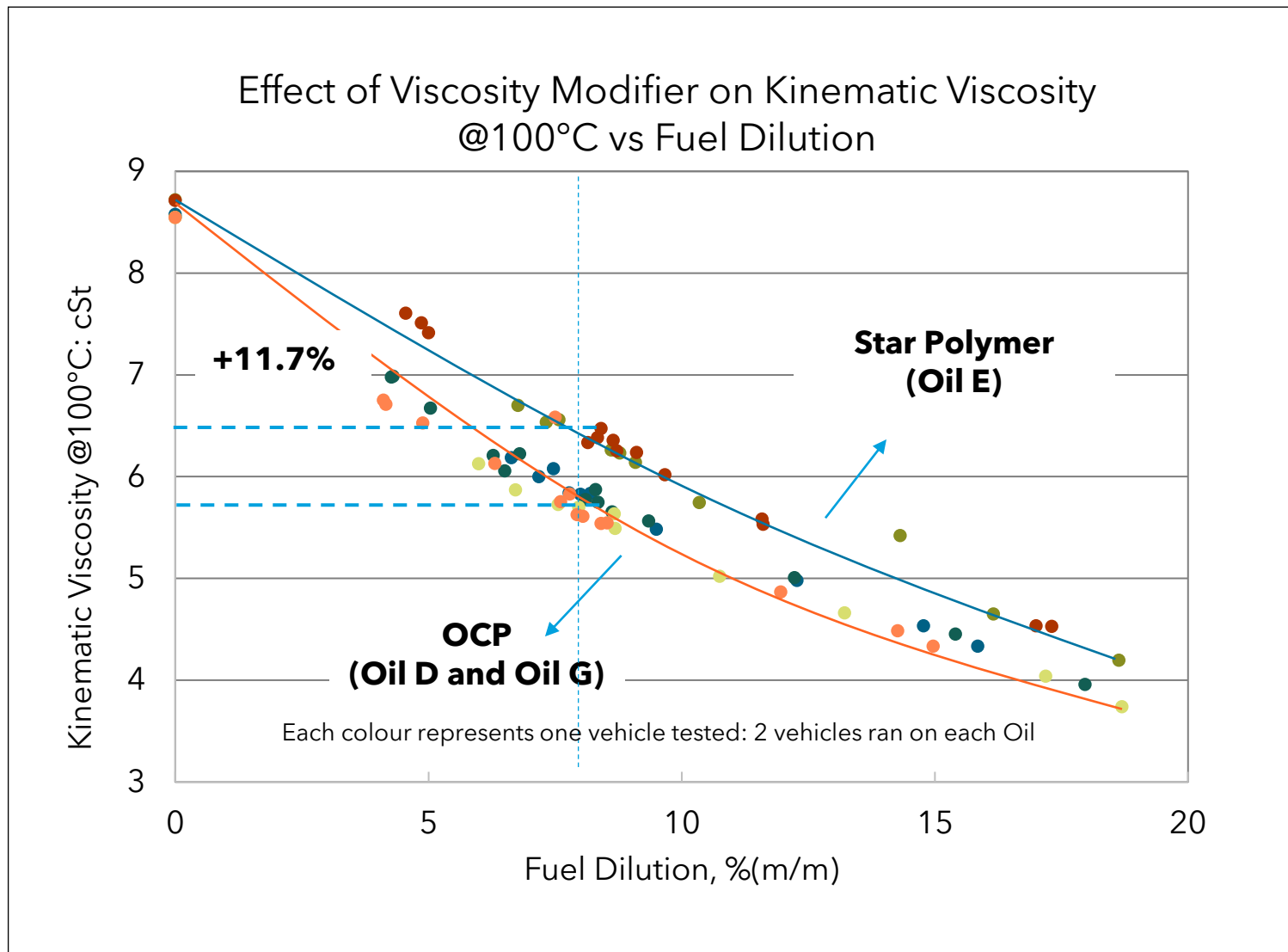


The higher the fuel dilution the lower the viscosity



An SAE 0W-20 lubricant can have KV100 equivalent to an SAE 0W-8 oil when fuel dilution exceeds 10 %m

# Key observations - Fuel dilution



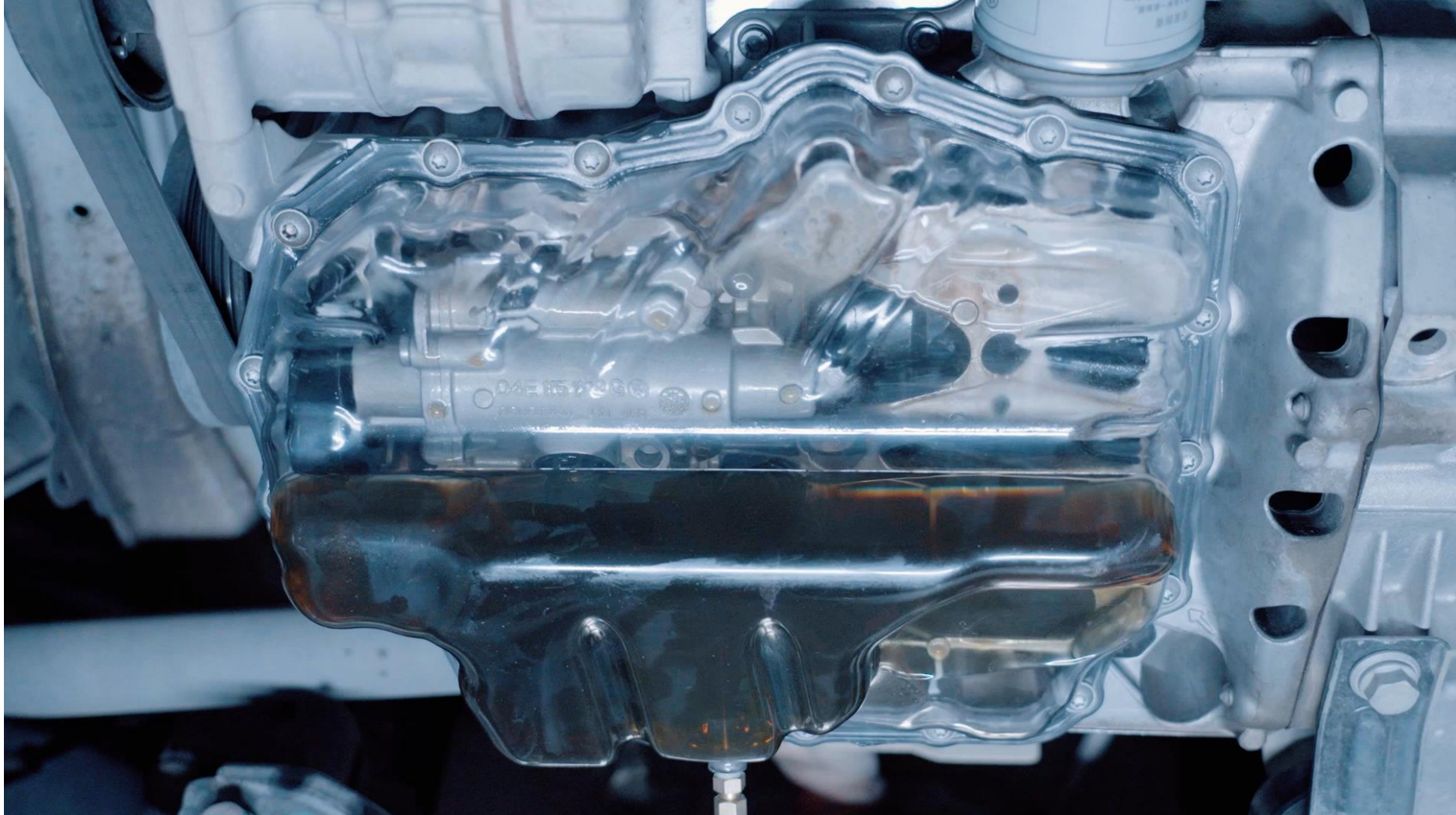
At iso-fuel dilution, the viscosity modifier also influences the resulting viscosity of the lubricant



For 3 candidates formulated at SAE 0W-20, hydrogenated styrene-diene polymers demonstrated better shear stability than ethylene-propylene co-polymers

Enhancing our understanding

# Key observations - Water entrainment



Developing solutions

# An efficient way to evaluate lubricant performance against key Hybrid challenges



The intent of the Infineum Hybrid Test Protocol is to **test products beyond industry standard tests, to specifically evaluate their hybrid capability**

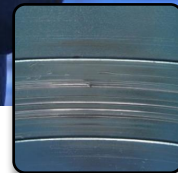
EMULSION



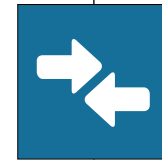
CORROSION



WEAR



3 bench tests



Good correlation with performance observed in the field trial



Easy & cheap to run



# Bench Test - #1

Modifying ASTM D7563 to assess lubricant emulsion performance



EMULSION



Poor Performance

Good Performance

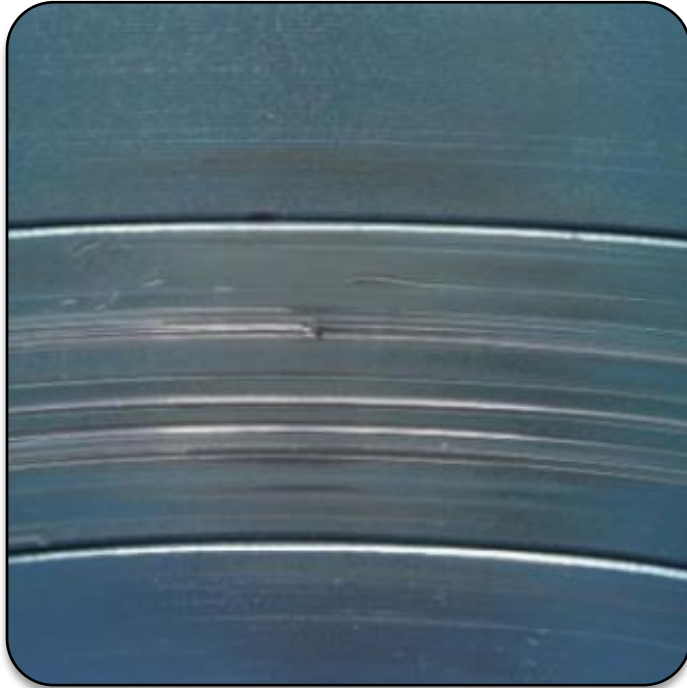
- 15 %m water combined with 15 %m fuel in oil
- Storage at 25°C for 72 h
- Evaluation based on the percentage of emulsion observed



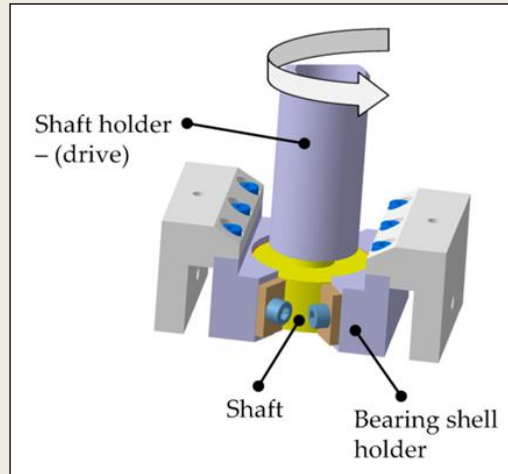
CORROSION

- 15 %m water in oil forming an emulsion
- Steel plates submerged in emulsions, dried in air and placed in humidity chamber for 7 days
- Evaluation based on a visual rating depending on the extent of corrosion observed

A bearing wear rig test to mimic the high number of ICE stop/start events

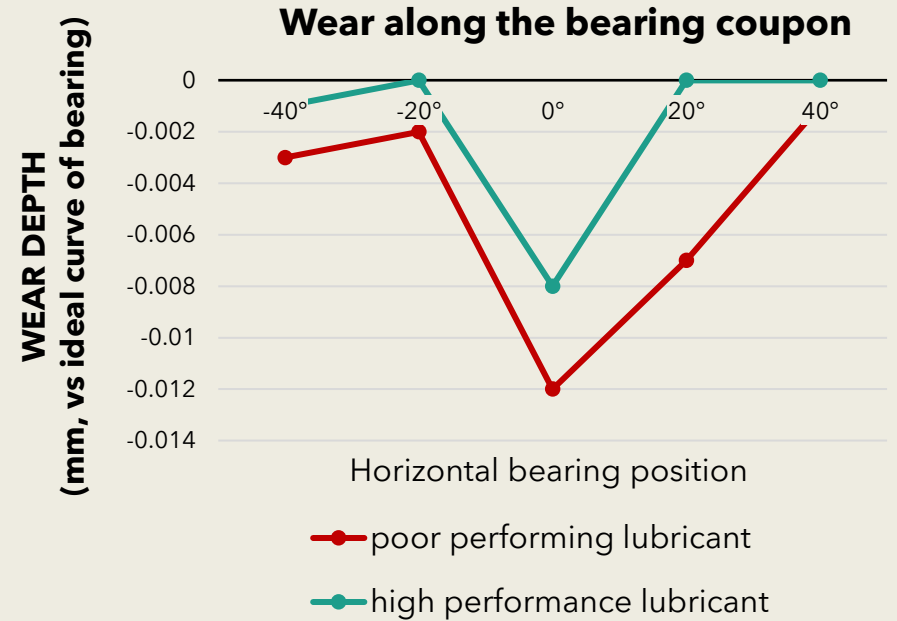


WEAR



Source: Summer et al, Lubricants 2017

- Polymer bearings immersed in lubricant, 20K stop/start cycles at 120°C



- Evaluation based on pre-and post-test bearing thickness, with several points measured along the bearing coupon

# Key take-aways



Hybrids are one attractive option for low-carbon mobility



Hybrids are not all the same



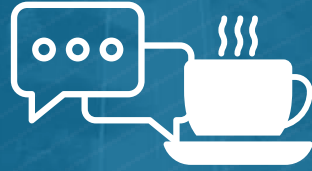
An agile field trial methodology furthered the understanding of the critical conditions



Tailored bench testing is an efficient way to develop lubricant solutions



**The ICE lubricant has an important role to play to enable the delivery of the full potential of hybrid powertrains**



# Join us at **STAND 620** for a coffee and a chat

**Please do not hesitate to reach us out for further information**

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