Society of Tribologists and Lubrication Engineers
19-23 May 2019, Nashville

Effects of Bearing Material Choice and Engine Oil Viscosity on Journal Bearing Durability in Stop-Start Environments

Presented by: Dr Jun Xu, Technologist

Author: Dr Emma Ravenhill, Associate Technologist

Performance you can rely on.

Contents

- **Introduction**
  - Importance and significance of stop-start technology for HDD
  - Trends in oil viscosity reduction
  - Impact on key wear contacts in HDD engine
- **Results**
  - Bearing test rig developed
  - Effect of start-stop technology and reduced viscosity on bearing wear for:
    - Different lubricant oil viscosities
    - Different bearing materials
- **Summary and future challenges**

Tighter legislation for on-highway emissions

2020

China: Introduced HD fuel consumption limits in 2012 (Phase 2); require 15% reduction (Phase 3)

2025

EU: 15% reduction in CO_2 emissions for new trucks and buses

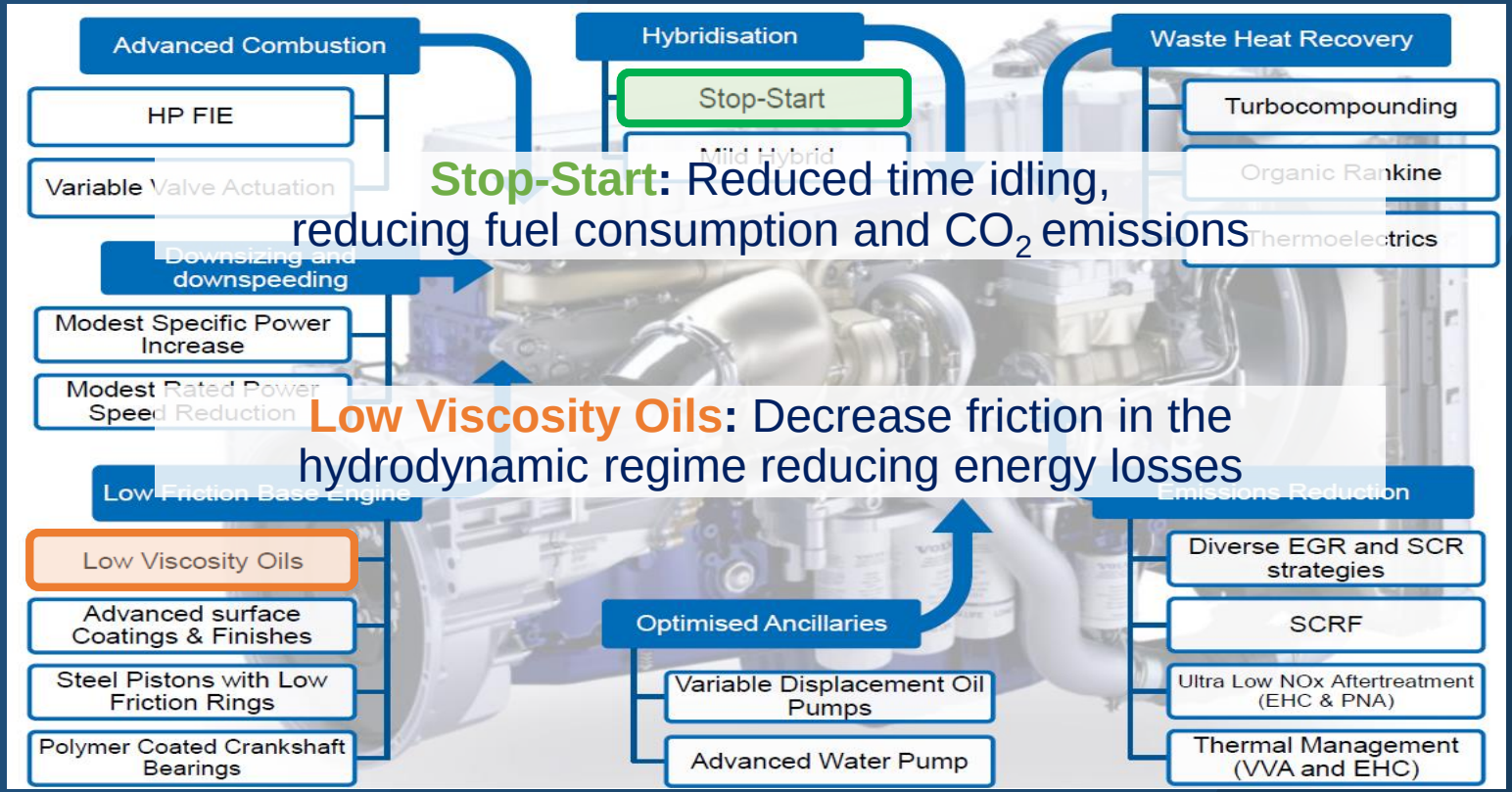
2027

US: Defined HD legislation for 2030, requiring 4-9% engine fuel consumption reduction

2030

EU: 30% reduction in CO_2 emissions for new trucks and buses

Tighter legislation for on-highway emissions



Source: Ricardo plc

Tighter legislation for on-highway emissions

Tighter legislation drives
HDD towards stop-start technology
and reduced oil viscosity

Source: Ricardo plc

Stop-start anticipated for all HDD vehicles by 2030

City-type operation:

Greater emphasis on fuel economy

Off-highway:

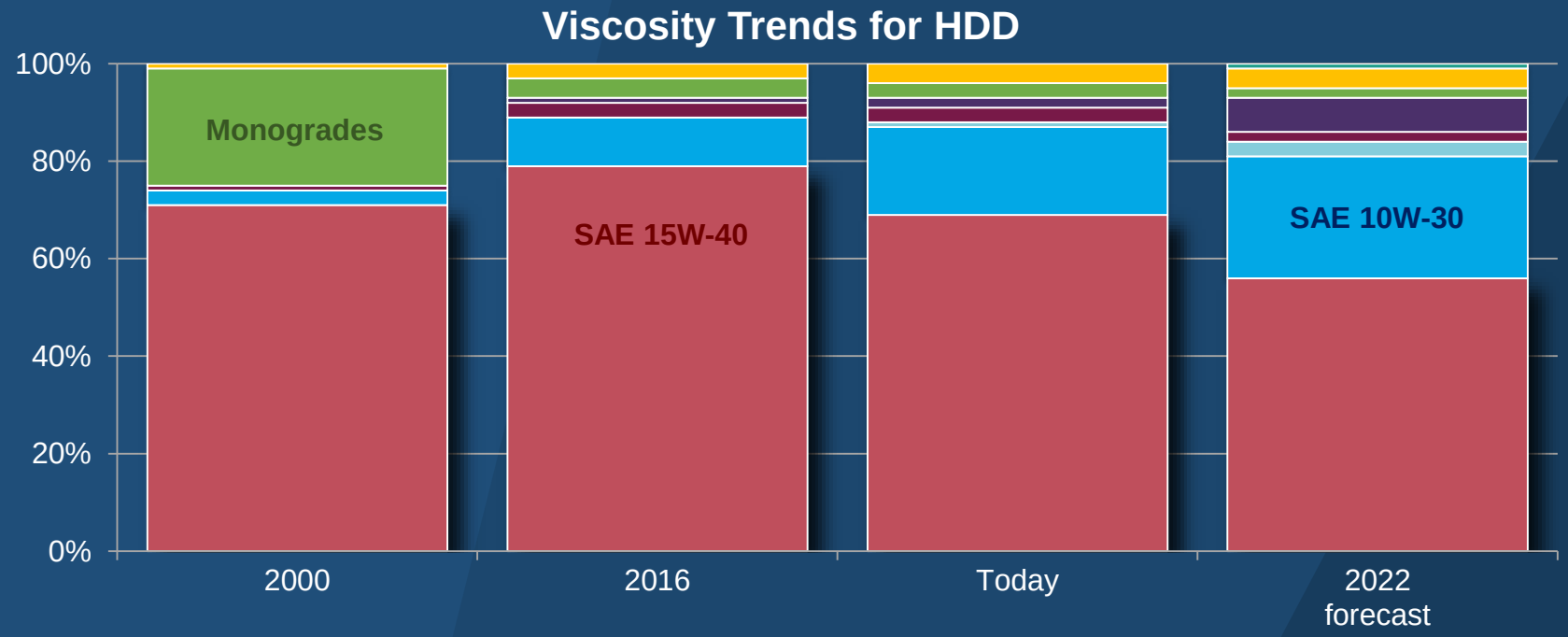
Greater emphasis on durability

Increasing benefit and propensity for stop/start

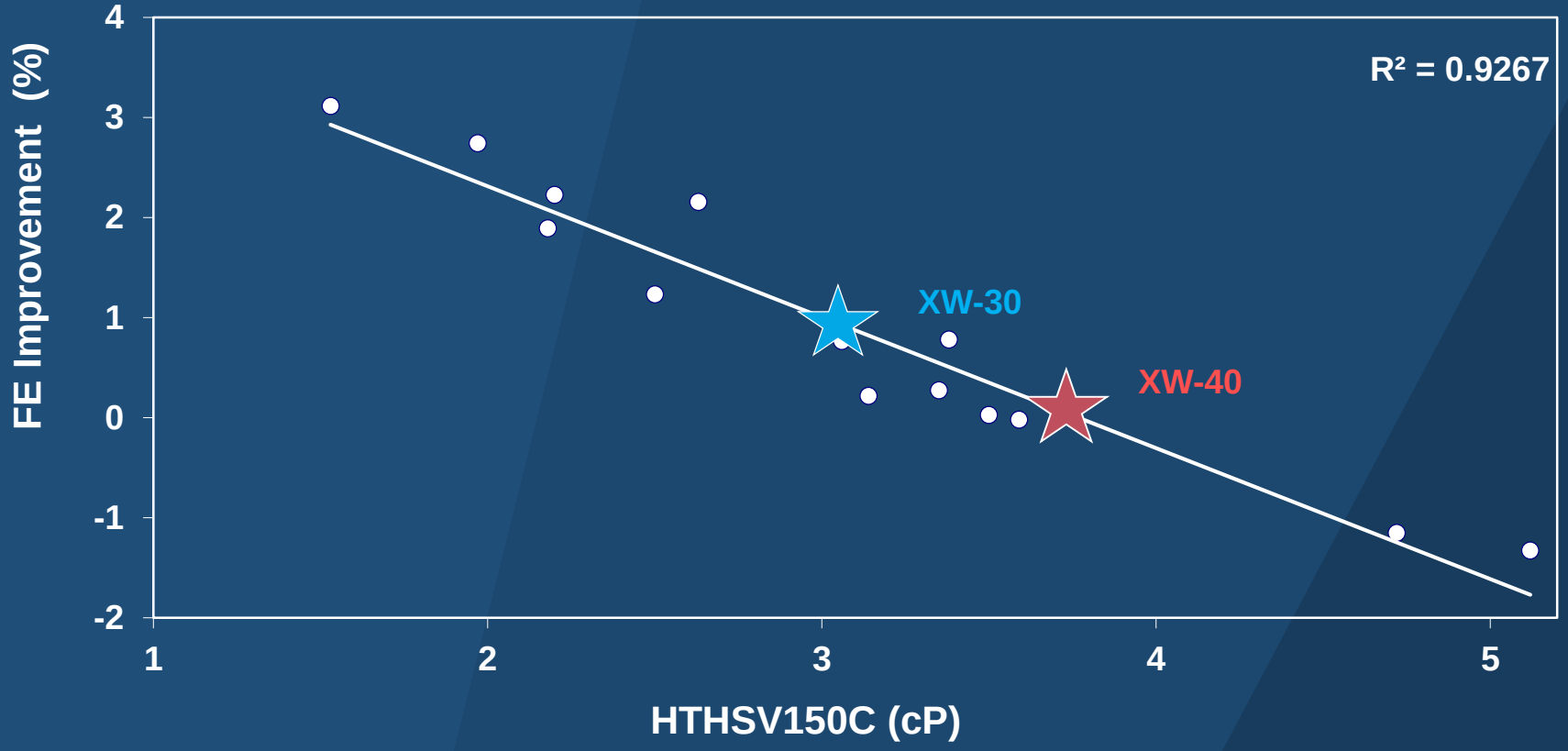
Stop-start anticipated for all HDD vehicles by 2030

Wide differentiation depending on vehicle application

Moving to **lower SAE J300 viscosity grade oils**



Moving to **lower SAE J300 viscosity grade oils**



Moving to **lower SAE J300 viscosity grade oils**

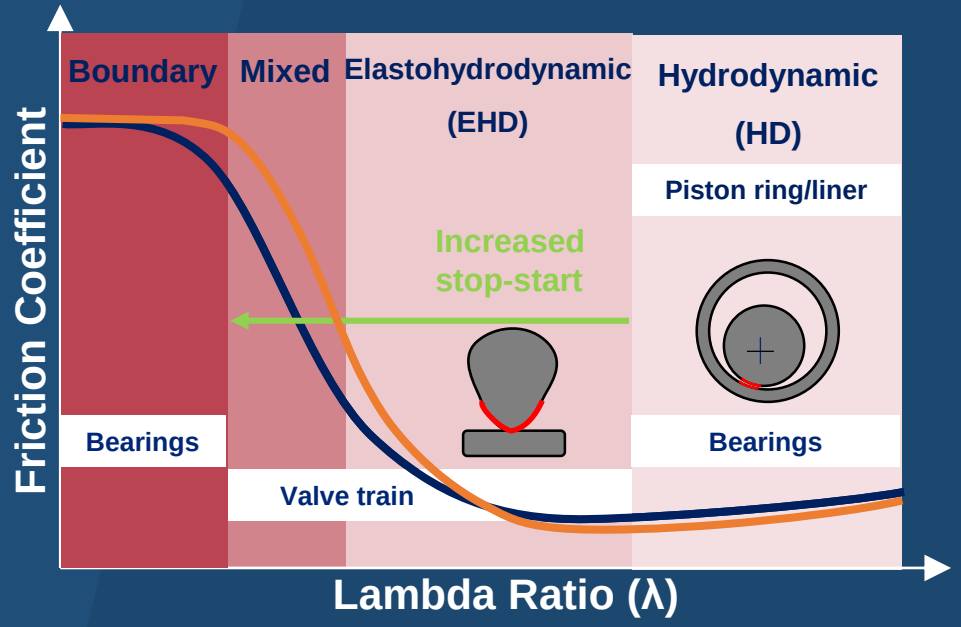
Lower viscosity grade oils reduce friction leading to improved fuel economy for the same additive package

Impacts of both **stop-start** and **lower oil viscosity**

Stop-start:
Reduced relative speed of shaft

$$\lambda \propto \frac{speed \times vis.}{load}$$

Increased periods of asperity contact



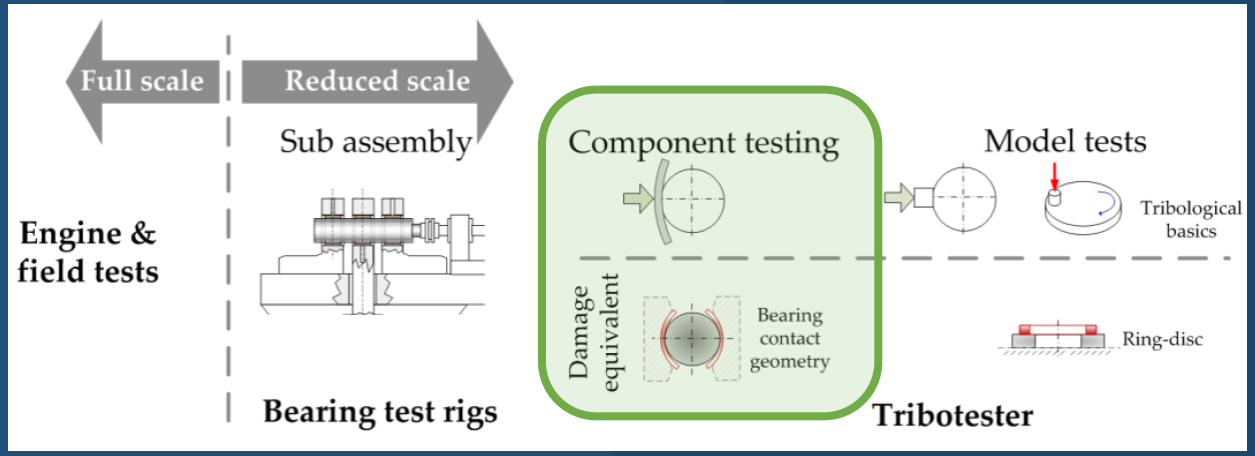
Lower oil viscosity

Decreased oil film thickness

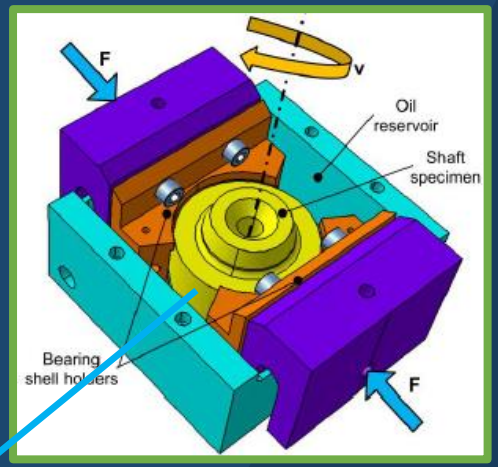
Increases mixed friction

Increased bearing wear

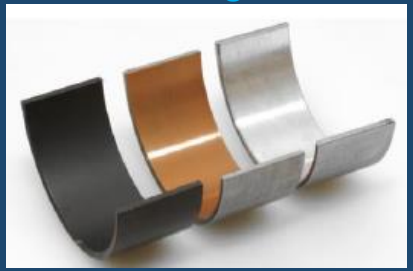
Investigating stop-start and decreased oil viscosity effects



Source: *Lubricants* **2017**, 5, 47



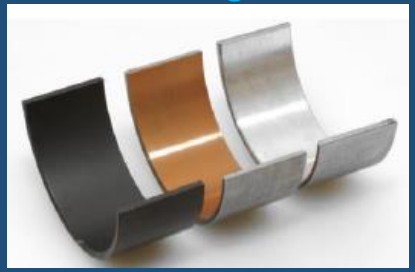
Real bearing shells:



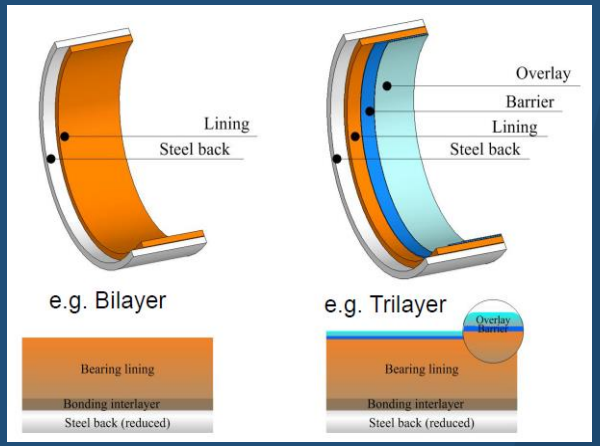
Source: F. Summer *Ecotrib presentation*, **2015**

Investigating stop-start and decreased oil viscosity effects

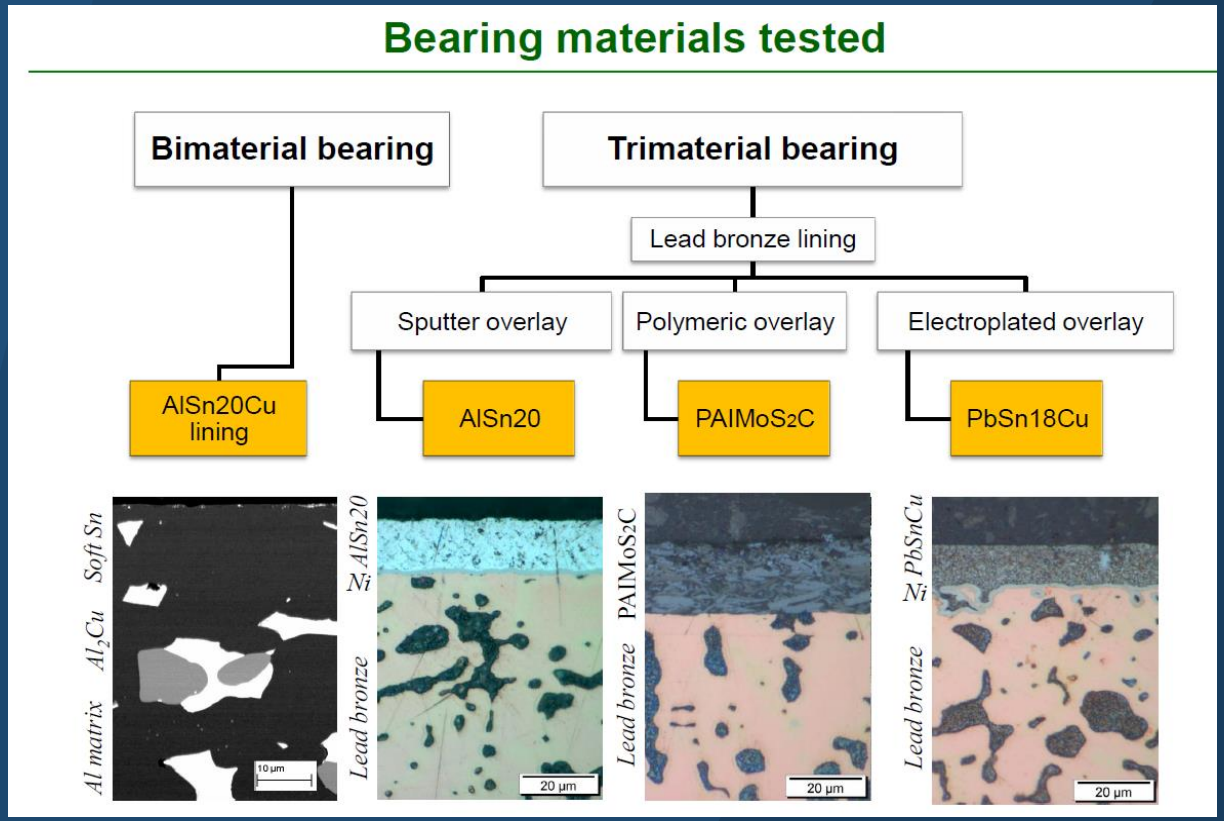
Real bearing shells:



Source: F. Summer *Ecotrib presentation*, **2015**

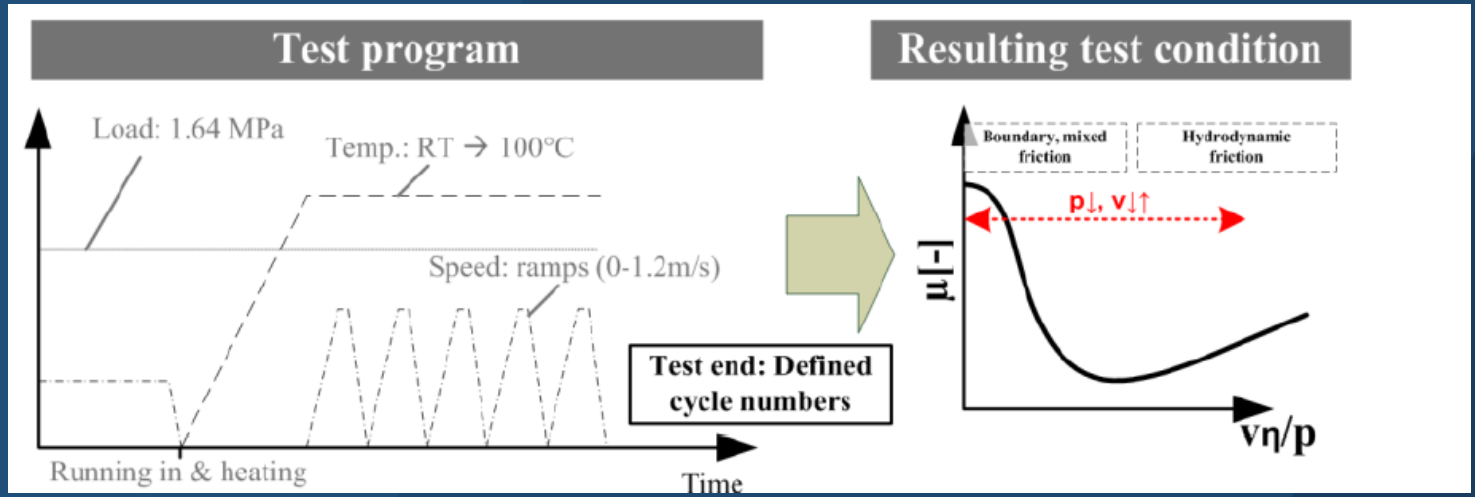


Source: F. Summer thesis, **2016**



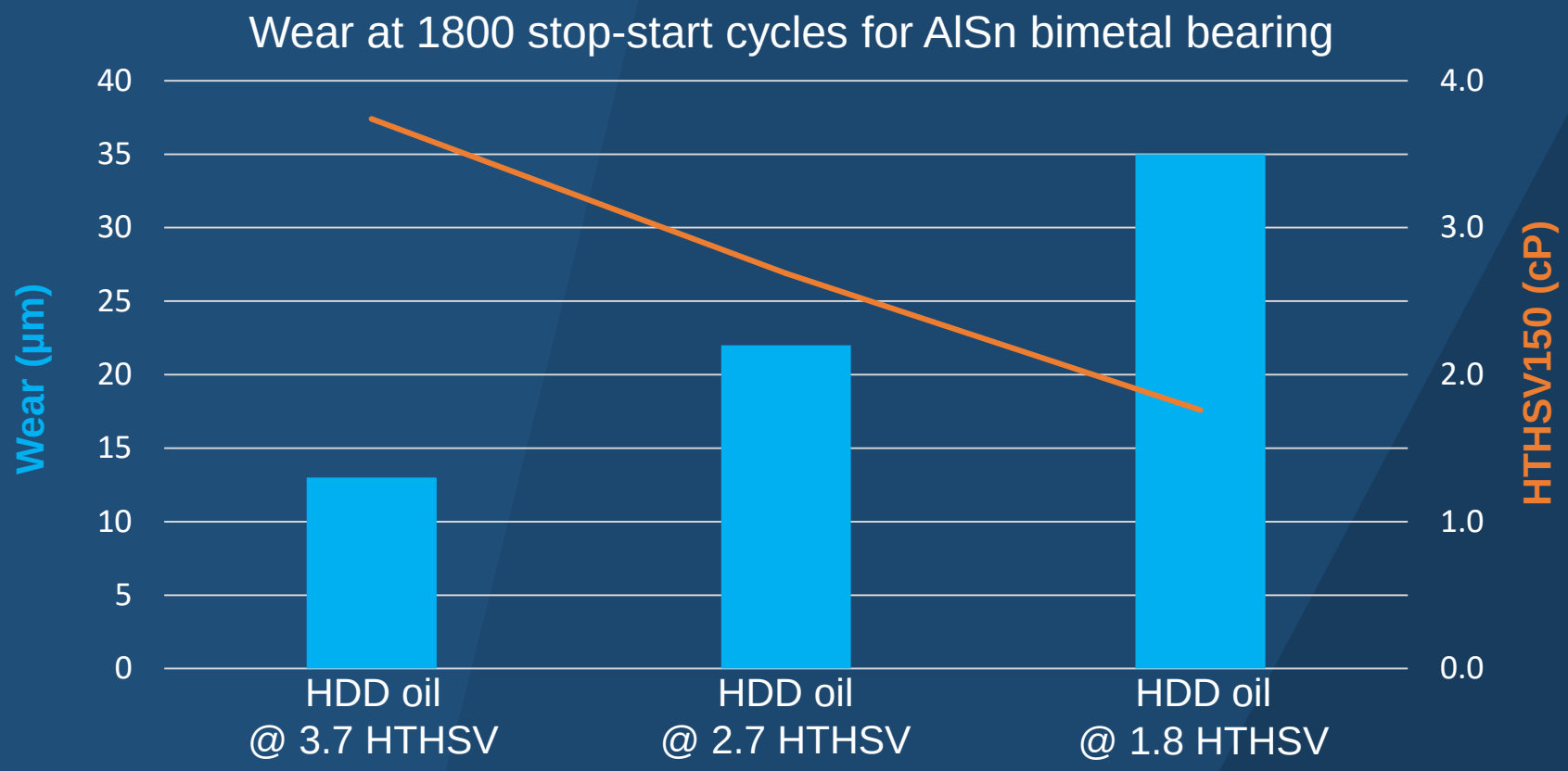
Source: F. Summer *Ecotrib presentation*, **2015**

Investigating stop-start and decreased oil viscosity effects



Source: F. Summer *OTG Symposium* **2016**

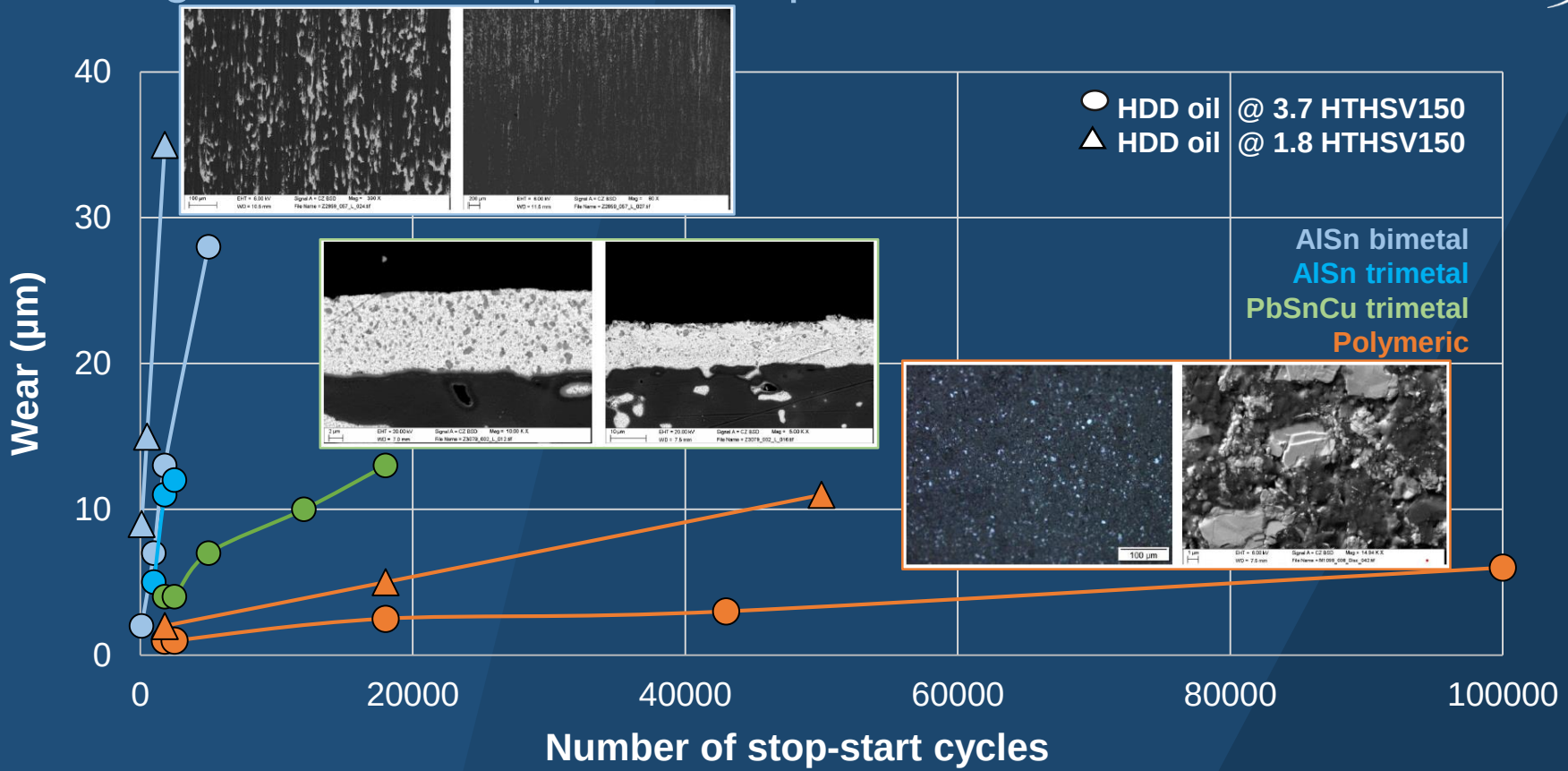
Thinner oils increases stop-start bearing wear



Thinner oils increases stop-start bearing wear

Future reductions in HTHS will have a negative impact on wear

Bearing choice and impact on stop-start wear



Source: F. Summer *Ecotrib presentation*, **2015**

Summary and future challenges

- **Decreasing viscosity** has a negative impact on **stop-start** bearing wear across all material types

- However, impact on higher cost polymeric bearings is lower than for cheaper aluminium bimetal bearings

- Therefore, as OEMs move to lower viscosity oils and stop-start becomes more prevalent in HDD, a cost-effective solution to bearing wear will be required for the 2025-2030 timeframe, via either:

  - More cost effective journal bearing material solutions
  - Additive solutions that deliver bearing durability at lower viscosities, under dynamic stop-start lubrication regimes

Time to talk?

Dr Jun Xu, Technologist

Jun.Xu@Infineum.com