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

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Performance you can rely on.



- **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<sub>2</sub> emissions for new trucks and buses

2027



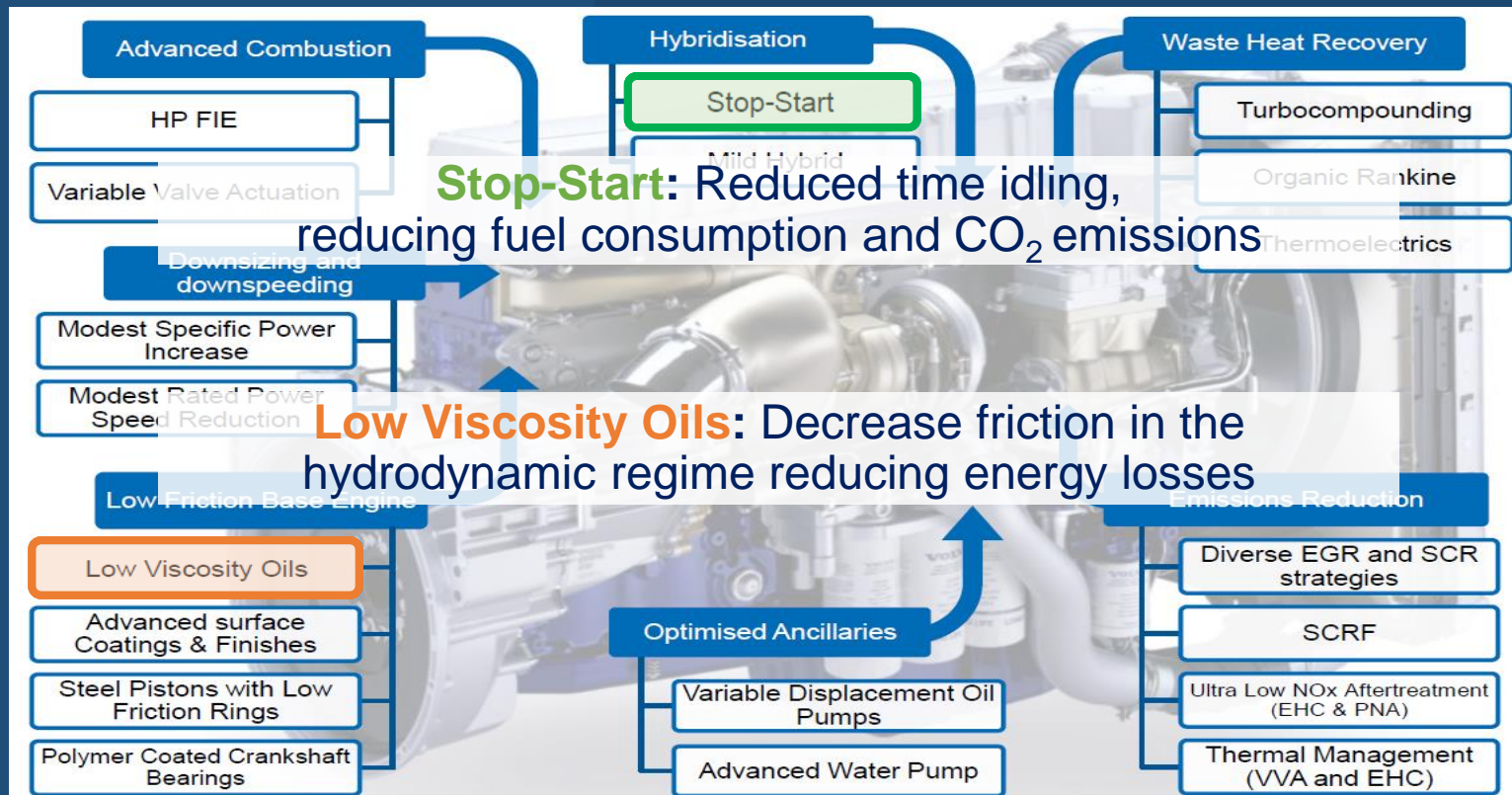
**US:** Defined HD legislation for 2030, requiring 4-9% engine fuel consumption reduction

2030



**EU:** 30% reduction in CO<sub>2</sub> 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

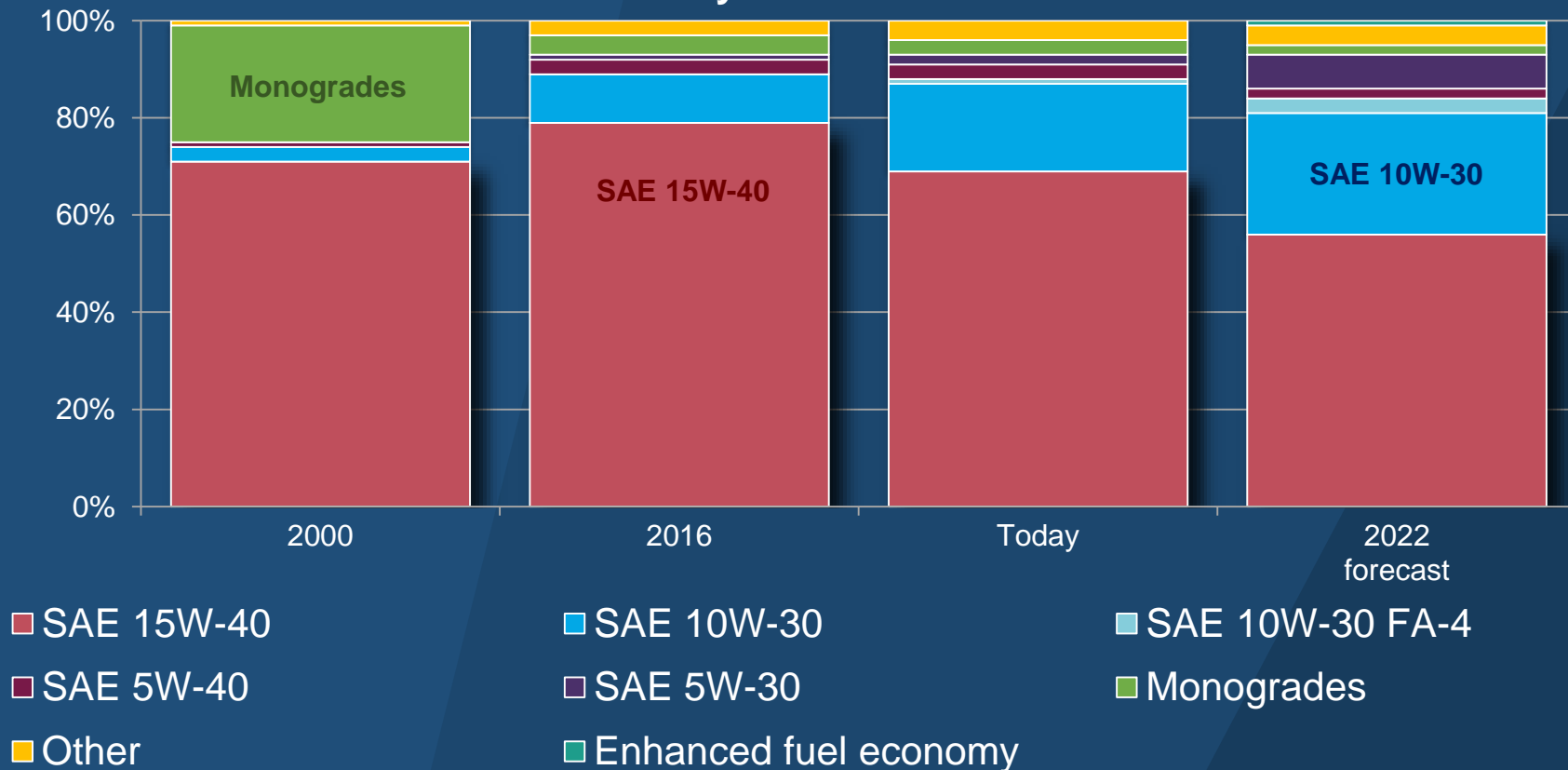


Wide differentiation depending  
on vehicle application

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

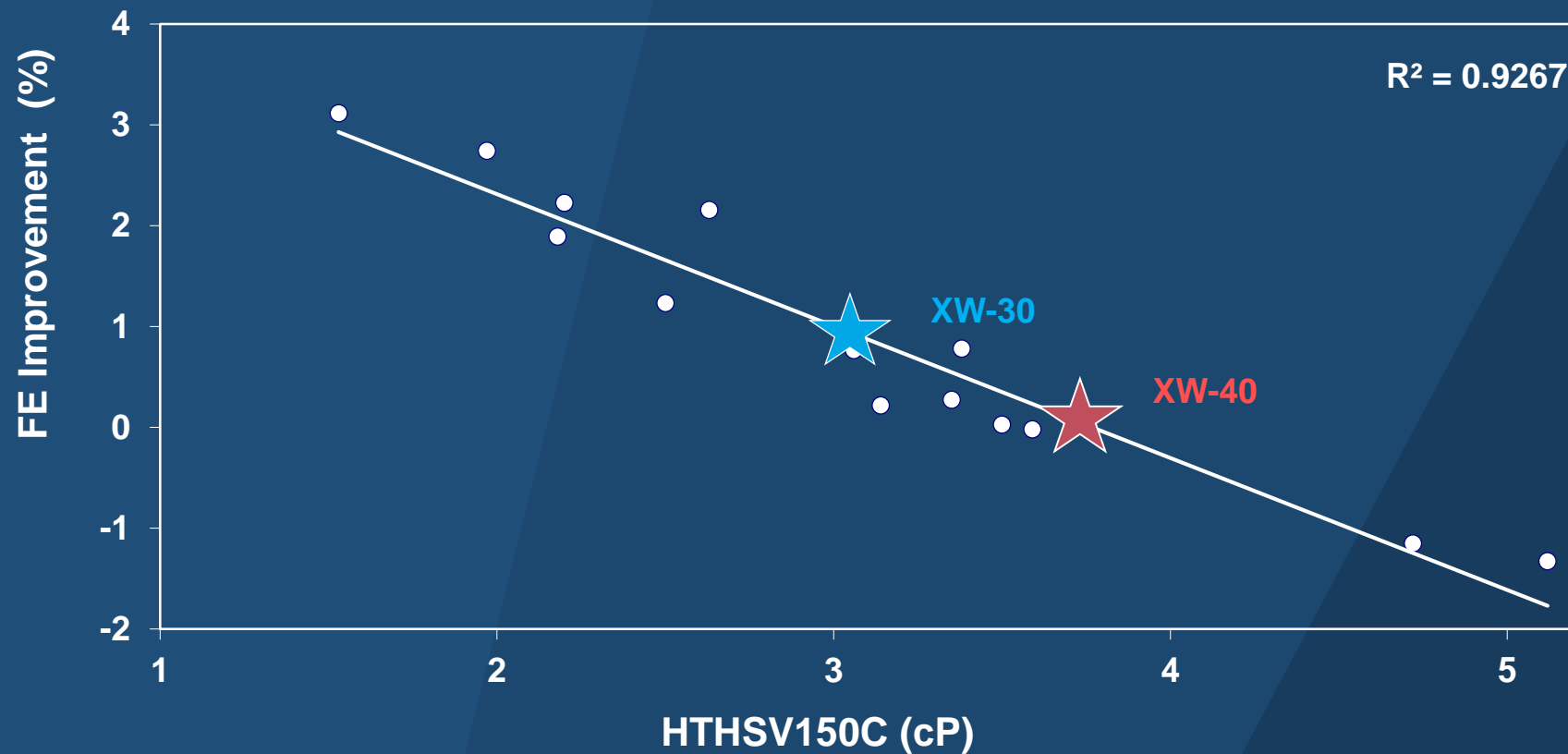


## Viscosity Trends for HDD





# 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:

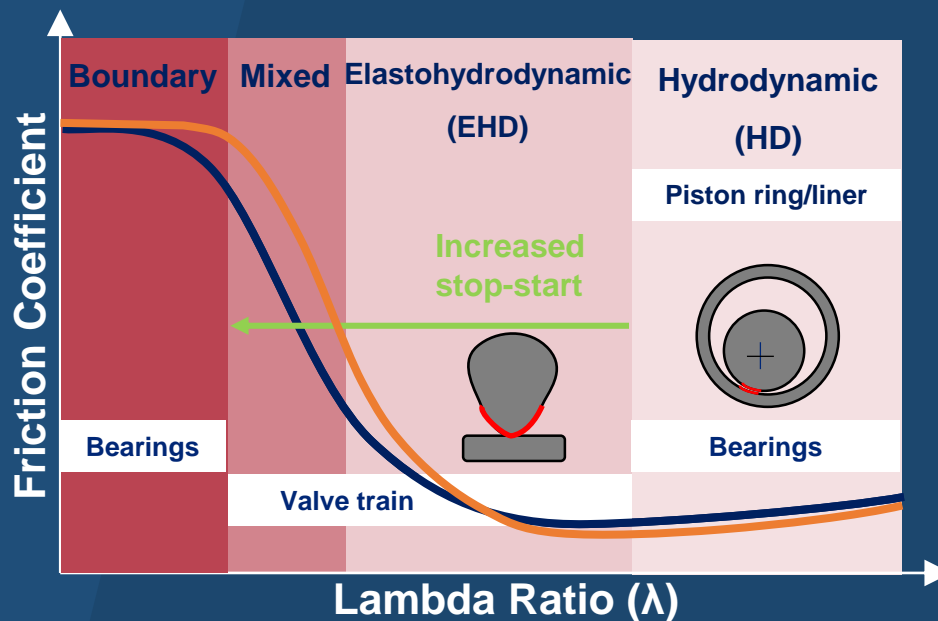
Reduced relative speed of shaft



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



Increased periods of asperity contact



## Lower oil viscosity



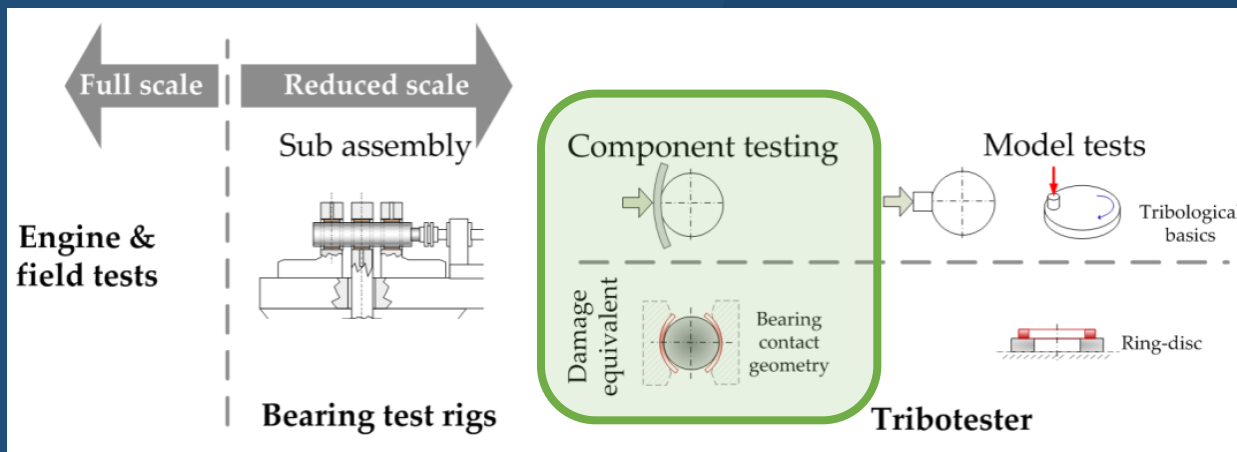
Decreased oil film thickness



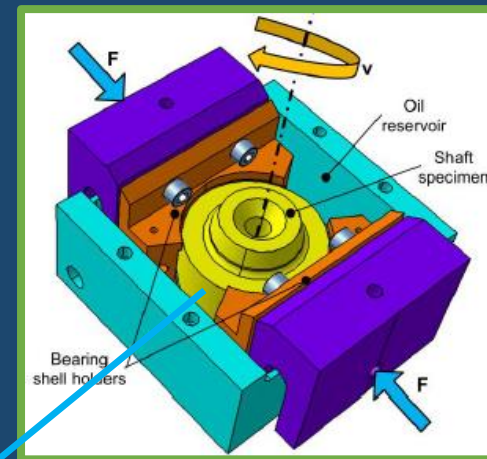
Increases mixed friction

Increased bearing wear

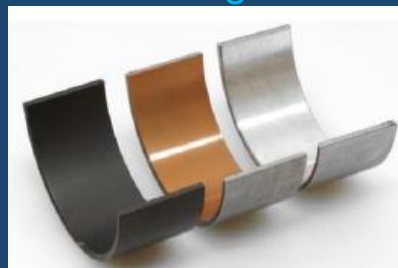
# Investigating stop-start and decreased oil viscosity effects



Source: *Lubricants* 2017, 5, 47



Real bearing shells:



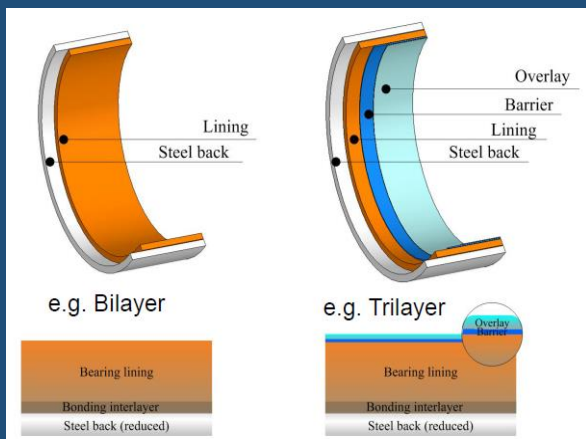
Source: F. Summer *Ecotrib* presentation, 2015

# Investigating stop-start and decreased oil viscosity effects

## Real bearing shells:

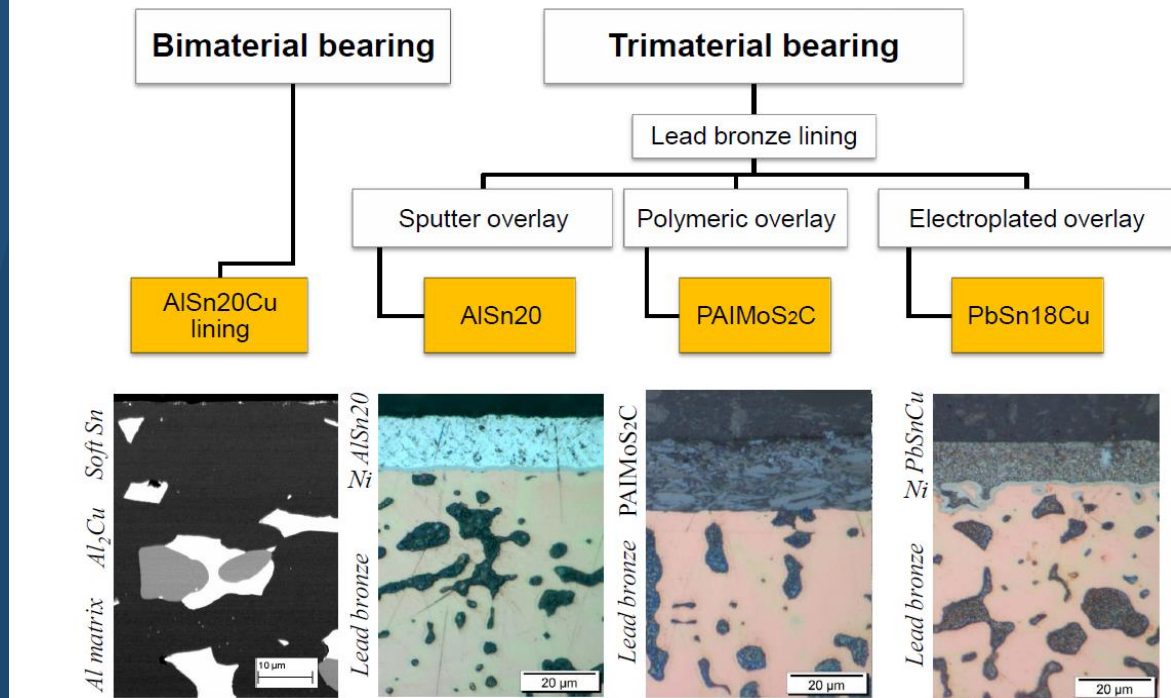


Source: F. Summer *Ecotrib presentation*, 2015



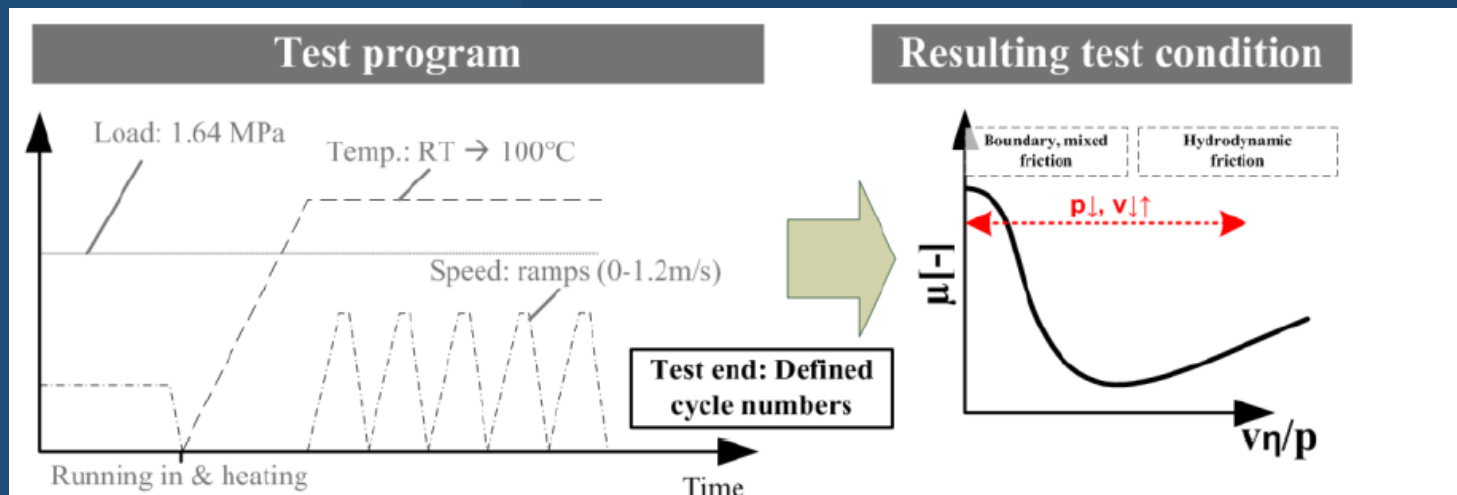
Source: F. Summer thesis, 2016

## Bearing materials tested



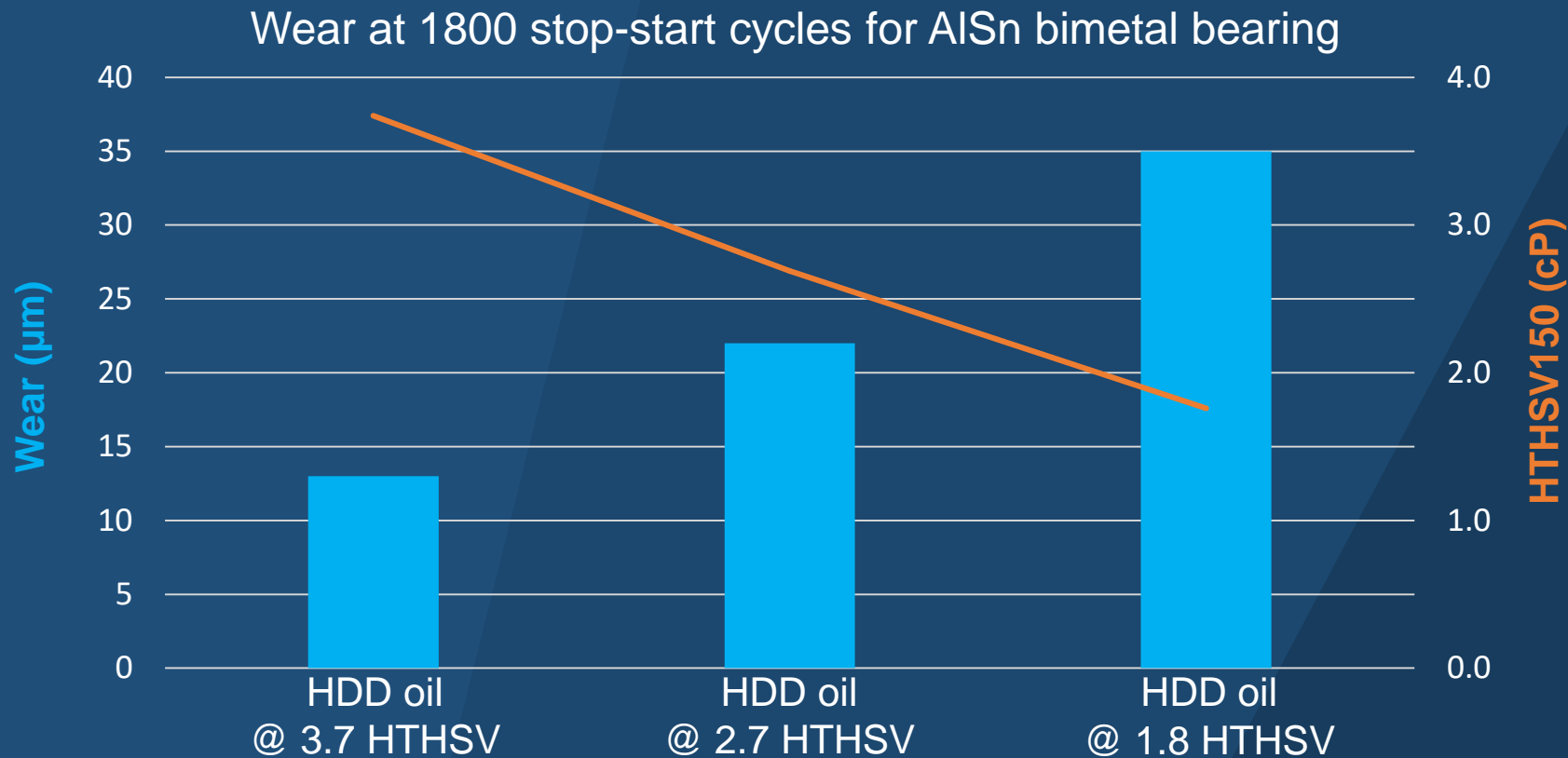
Source: F. Summer *Ecotrib presentation*, 2015

# Investigating stop-start and decreased oil viscosity effects



Source: F. Summer OTG Symposium 2016

# Thinner oils increases stop-start bearing wear



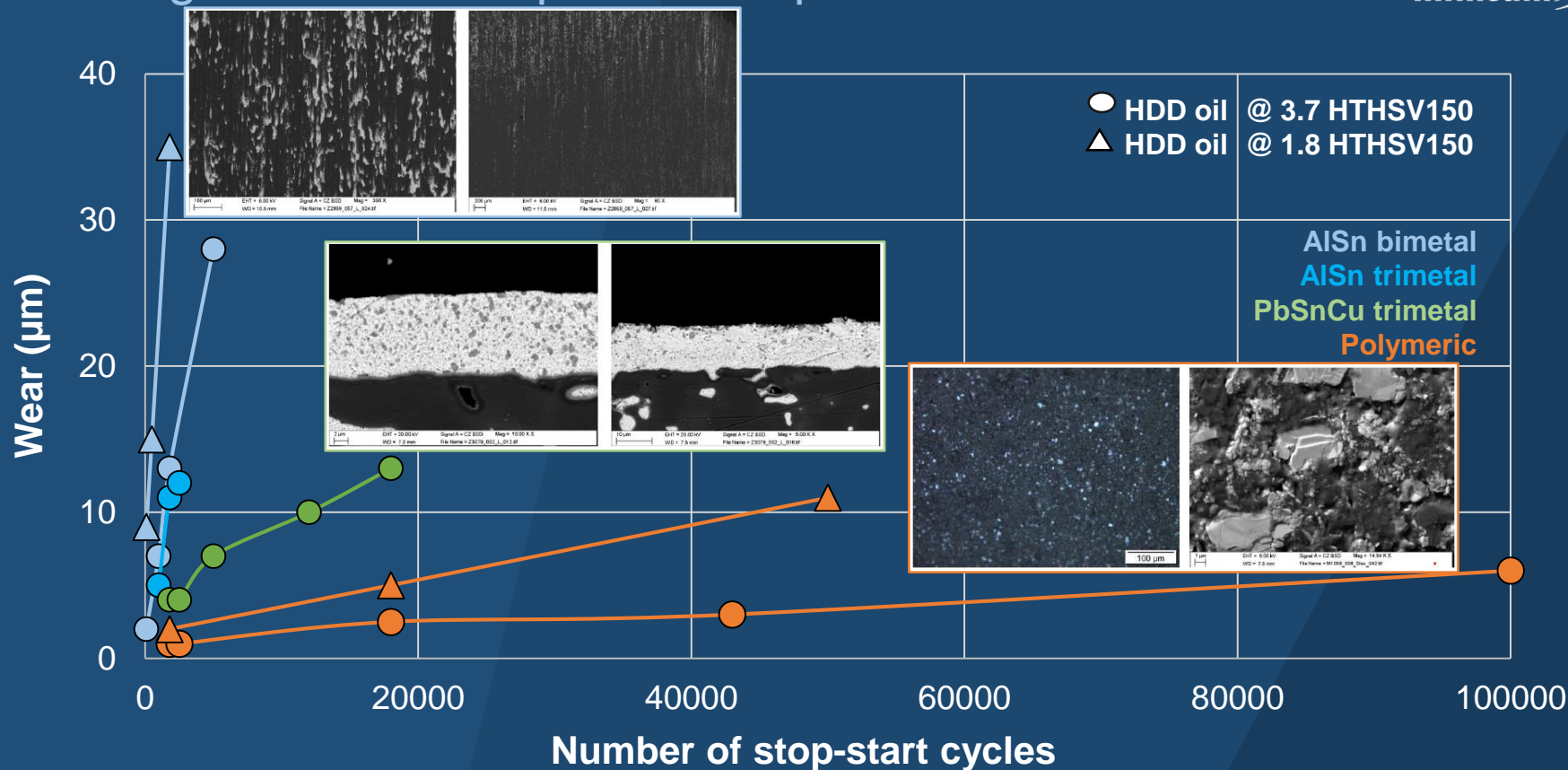
Thinner oils increases stop-start bearing wear



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?

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