

# Some tribological issues on flex-fuel engines

Dr. Eduardo Tomanik - MAHLE Metal Leve SA



FAPESP FAPESP Workshop on Ethanol Based Engines for TransportationBiodiversidade & Química Oct 4th - FAPESP - São Paulo

# Flex fuel engines – Some issues (1/3)



## Flex fuel engines – Some issues (2/3)

- Ethanol lower lubricity
- Fuel dilution on cold start
- PCP is higher and closer to TDC



# Bearing corrosion

Bearing corrosion after ethanol usage with a non-appropriated lube oil, Flex-Fuel engine. *MAHLE Performance magazine, 2009* 

### **Piston ring spalling**



Ferrarese et al. Piston Ring Tribological Challenges on the Next Generation of Flex-fuel Engines – SAE 2010-01-1529 SAE Int. J. Engines, Vol. 3, Issue 2

### Flex fuel engines – Some issues (3/3)

#### ATAQUE ÁCIDO

A explicação da VW para o desgaste prematuro b É normal, na fase fria,

### Fuel dilution on lube

pelo desaerador do cárter e volta à câmara de combustão guando o motor chega à temperatura de serviço (70 °C). Mas, se o motor não chega a aquecer, o combustivel continua no cárter - sobretudo o álcool, de evaporação mais difícil que a gasolina. Ácidos orgânicos presentes nesse álcool não queimado atacam o óleo. O novo óleo de primeiro enchimento é menos resistente ao ataque ácido que o antigo. O motor 1.0 resiste menos que o 1.6 por ter menos 5leo. Seu cárter é 0,7 litro menor.



4 Rodas, Nov 2009



À medida que não consegue mais neutralizar os ataques químicos, o óleo vai ficando contaminado. Perde suas características originais, como a capacidade de envolver as peças do motor com uma camada protetora.

### Valve Issues



Gel in the fuel pump



Cordeiro; Yoshino – SAE 2011-36-0217 Awarded as congress best national paper

Europe 2011: "Carmakers rethink sustainability approach amid E10 fuel fiasco"



# International Research on Ethanol issues

### **Ethanol dilution on Lube**



Schwarze et al. "Effect of Ethanol Fuel E85 on Lube Degradation and Wear in SI Engines" MTZ 04/2010

### **Ethanol effects on Lube and Bearings**





D. Schwäbisch et al. "The Effect of Ethanol Fuels on Lubricant and Engine Performance", ATZ



MTZ Jun/2012

# Light Vehicles Brazilian Market Trends (2014-2015)



# R&D Consortium TriboFlex Tribological Challenges on Flex-Fuel Engines

**Objective:** Structured knowledge on tribology, especially in the modelling and experimental analysis of:

- ring/lube/bore
- valve/interface/ valve seat

**Partners: USP** (Poli/LFS), UNICAMP, UFABC Petrobras, MAHLE, Fiat, VW, Renault







UNICAMP









# R&D Consortium TriboFlex Tribological Challenges on Flex-Fuel Engines

2 Main engine tribosystems were choosen:



Others can be investigated if more partners/resources appear

# R&D Consortium TriboFlex Sub-Projects

### 00- Tribological Characterization of flex-fuel engine components

0.01 – Characterization of the mechanisms of wear and of the component surfaces.

### 01- Ring-Lube-Bore Tribo system

- 1.01 Wear mechanisms on bore as function of its properties.
- 1.02 Physic Chemical interaction of oxides and lube film.
- 1.03 Study of the variation of lubricity from engine use degraded oils on the ring materials.
- 1.04 Low friction films for piston rings.

### 02- Valve-interfacial media-valve seat tribology

- 2.01 Topography and tribological performance of valves.
- 2.02 Influence of temperature and speed on the disk-plate tests.
- 2.03 A bench test reproducing the environment found on flex-fuel engines.
- 2.04 Tribological performance of metal and ceramic materials for valves.

### 03- Modeling of materials and loadings

3.01 – Modeling of materials and/or films to support the study of materials under the engine thermal /mechanical loads.

3.02 – Modeling study of the lubrication in the ring/bore to investigate the friction mechanisms.

### 04 – Formation of specialized Human resources



## Conclusions

Ethanol fuel brings both advantages and disadvantages in terms of combustion and tribology. So far, engines are mostly adapted from gasoline engines, not ethanol optimized.

More concentrated efforts on R&D are needed to fully explore the ethanol potential as engine fuel.

Better tribological understanding may also bring friction/fuel reductions.

# Thanks for the attention

eduardo.tomanik@br.mahle.com