High-speed windage power loss test rig (Bappuit) Michal Ruzek¹, Fabrice Ville¹, Philippe Velex¹, Yann Marchesse², Christophe Changenet² ¹LaMCoS, INSA-Lyon, ²LabECAM, ECAM Lyon



Objectives – Industrial context

The efficiency of a gearbox is reduced by number of factors:

- A. Load-dependent power loss:
 - Gear tooth meshing lacksquare
 - Bearing power loss
- B. Load-independent power loss:
 - Churning, oil injection
 - Pocketing lacksquare
 - Seals



Windage power loss becomes prominent when considering high-speed gear transmission.



Windage

Open test rig: high speed and moderate load (from Diab, PhD thesis).

Power loss distribution (from Diab, PhD thesis).

Introduction – Windage power loss

Main characteristics of the gear windage:

- becomes important for peripheral speed above 100 m/s
- has a roughly cubic dependence upon the speed



Measured and simulated windage power losses of different wheels (from Ruzek et al., 2019).

the most important parameter increasing the windage is the tooth geometry.

Bappuit test rig



Minimum gear clearance 9 mm

10000

8000

10,000 rpm



Spur dear

Shrouding effects on Windage power loss Single shroud Double shroud No shroud

Reduction of windage power loss when using shrouds.



systems, however less significantly.



Typical deceleration curve measured by the magnetic encoder

Windage power loss identified for a single pinion or a pinion/gear pair (from Ruzek *et al.*, 2019)

Rotation frequency [Hz]

150

Perspectives – Particle Image Velocity







Numerical prediction (from Marchesse et al., 2015).

- To use the PIV method to evaluate experimentally the air flow around the single pinion and gear pair.
- To compare measurements and numerical predictions.
- To better understand the strategies of windage power loss reductions.



LaMCoS UMR 5259

_aboratoire de Mécanique des Contacts et des Structures