DEVELEOPMENT NAD TESTING OF SELF-LUBRICATING COMPOSITE FOIL FOR BEARINGS

Chvojka M[1], **Hlaváček V**[1], **Melichar J**[1], **Mészáros M**[1]
[1]*SVÚM a.s., Polymers and Fluoroplastics Technology Department, Čelákovice, CZ,*
chvojka@svum.cz

Key Words: COMPOSITE FOIL, PTFE, PEEK, SLIDING BEARINGS, SELF-LUBRICATING FOIL

1. INTRODUCTION

This work deals with the design and testing of an innovative composite bearing material. The main focus areas are the research and development of a self-lubricating sliding bearing hybrid foil consisting of a polymer system sintered into a reinforcing mesh and further testing of bearing cases. The main requirements for composite bearing materials are self-lubrication, low coefficient of friction and long service life, taking into account the ever-increasing requirements to reduce the weight of the bearing system.

2. USED MATERIALS AND PRODUCTION OF COMPOSITE FOIL

2.1. Organic (polymeric) based materials

The polymers of poly(tetrafluoroethylene) (PTFE), poly(etheretherketone) (PEEK) were selected as the polymer compound of the "mesh-polymer" composite system. These polymers are characterized by a low coefficient of friction, good chemical, thermal resistance and some of their properties (abrasion resistance, thermal conductivity) can be further modified by the addition of fillers. On the basis of a literature search, it has been found that a suitably prepared mixture of PTFE and PEEK may exhibit better wear resistance than individual pure components. Project will also utilize special polymer poly(oxadiazole) as reinforcement material, which is modern and well-known for its mechanical and thermal resistance properties, for possible substitution of metallic reinforcement materials-meshes.

2.2. Inorganic based materials

Reinforcement mesh is mainly on metallic (bronze, stainless steel) or inorganic (basalt, glass, carbon fibers) base.

2.3. Production of composite foil

Since PTFE-based granulate cannot be processed by conventional technologies for thermoplastic polymers (due to very high melt viscosity), hybrid composite foil must be produced by sintering, therefor an optimized temperature regime has been developed to ensure good bonding of components whilst avoiding degradation of PEEK.

3. TRIBOLOGICAL TESTING

Tribological properties are tested and compared on a specially designed device (fig. 1 and 2) that works on the principle of creating a sliding radial bearing, bearing - a shaft - a housing with a bearing sliding foil (fig. 3). This system allows different load configurations by removing / replacing additional weights and simulating different radial loads on the friction node. The friction factor can be calculated from the machine constants after recording the initial speed and the deceleration time (until the rotating components stop).

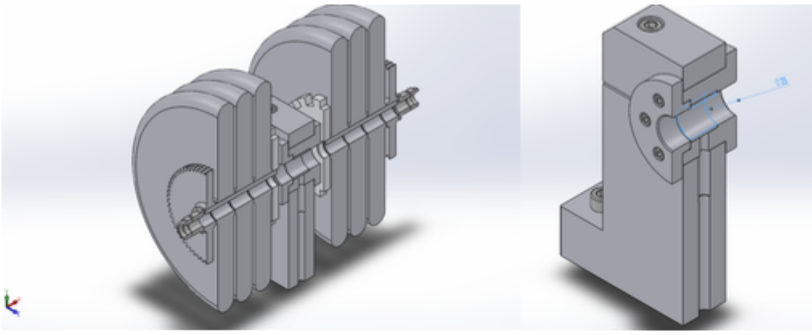

Figure 1. Tribological testing equipment development – 3D model

Figure 2. Tribological testing equipment – final design of the machine

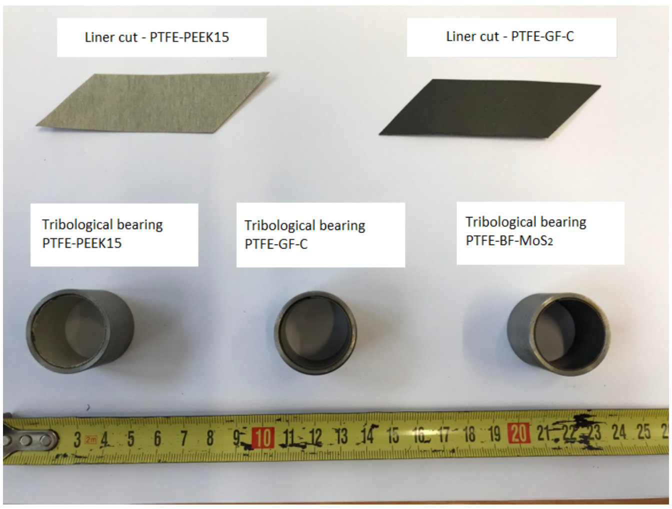

Figure 3. Self-lubricating foils samples for tribological testing

Calculation of coefficient of friction is made by this simple mathematical process:

$$\boldsymbol{f}_{(\boldsymbol{n})} = -\boldsymbol{at} + \boldsymbol{c} \tag{1}$$

$$\frac{\partial \boldsymbol{n}}{\partial \boldsymbol{t}} = (-\boldsymbol{a}.\boldsymbol{t} + \boldsymbol{c})' = -\boldsymbol{a} \tag{2}$$

$$\boldsymbol{Y} = |-\boldsymbol{a}| \tag{3}$$

$$\boldsymbol{\mu} = \frac{\boldsymbol{Ic}.2.\boldsymbol{\pi}}{\boldsymbol{F}.\boldsymbol{r}}.\boldsymbol{Y} \tag{4}$$

The calculation of coefficient of friction is based on regressive function of rotations in time (1). A derivation of this function is made to get an angle directive (2). But as the function is regressive, the directive is also negative so the absolute value needs to be done to make it positive (3). After that, the coefficient of friction can be calculated using moment of inertia (Ic), load (F) and radius of the shaft (r).

4. RESULTS

For the comparation all samples were made with bronze reinforcement mesh with the same openings and width. Neat PTFE was compared to PTFE/PEEK mixture (85/15) and these were also compared to standard production of PTFE compound reinforced with glass or basalt fibers (GF or BF) modified with tribological additives – synthetic carbon (C) or molybdenum disulfide (MoS_2). These standard compounds are daily produced and used in SVÚM for bearing products.

From the measurements made so far, it can be seen that the PTFE-PEEK15 mixture has a slightly higher friction factor, since the neat PEEK has a higher friction coefficient than neat PTFE. Neat PTFE reached the lowest friction factor, but after several measurements, the layer was damaged up to the underlying bronze fabric, so significant benefit of PEEK, inorganic and other fillers for increased abrasion resistance can be observed. So far it can be stated that PTFE-PEEK15 compound has slightly higher coefficient of friction but has much lower damage of the foil and weight loss.

Table 1. Tribological results and comparation

Material	Running time after engine disconnection t_{run} [sec]	Coefficient of friction [-]	Damage of sliding part of bearing
PTFE	64	0,1215	YES
PTFE-GF-C	60	0,1295	NO
PTFE-BF-MoS_2	59	0,1317	NO
PTFE-PEEK15	53	0,1466	NO

5. ACKNOWLEDGEMENT

This project is financed by project by Ministry of Industry and Trade and its OPPIK program with project number CZ.01.1.02/0.0/0.0/17_103/0011803 called “Kolektivní výzkum CLUTEX III” *(Collective research CLUTEX III).*