Interaction of surfaces roughness and material porosity in the lubrication of mechanical seals

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***Abstract*– In this paper, the effect of surface roughness combined with natural surface texture induced by the material porosity is studied by numerical simulation. It is shown that the combination of the two surface components really improve lubrication performance of mechanical face seals.**

Keywords—Mixed lubrication, surface texture, mechanical seal.

I. INTRODUCTION (HEADING 1)

Silicon carbide (SiC) is one of the most popular material used for friction faces of mechanical seals [1]. Depending on the manufacturing process, it can exhibit a level of porosity leading to the generation of a random surface texture on the seal surface, as can be seen in Fig. 1. Regular surface texture is known to enhance fluid film formation, reducing thus friction and wear of surfaces in relative motion [2]. The effect of surface texture can be improved when combined with surface roughness [3].

In this paper, the effect of surface roughness combined with natural surface texture induced by the material porosity is studied by numerical simulation. It is shown that the combination of the two surface components really improve lubrication performance of mechanical face seals.

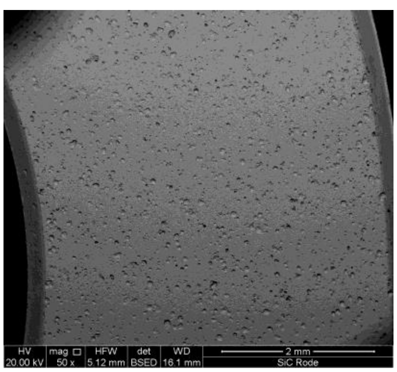

Fig. 1 SEM view of a SiC ring with natural random texture due to porosity.

II. MODEL

The configuration of the numerical model is given in Fig. 2. A smooth rotating surface is placed at a distance *h* of a rough static surface. The fluid flow in the interface is governed by the Reynolds equation including a mass conserving algorithm [3]. Pressure is imposed at the radial boundaries of the sealing interface and a periodical boundary condition is applied in the circumferential direction. It is thus possible to study a surface of limited lateral extent. The film thickness *h* is adjusted to ensure equilibrium between the closing force and the opening force due to the fluid pressure and the asperity contact pressure (see ref [3]).

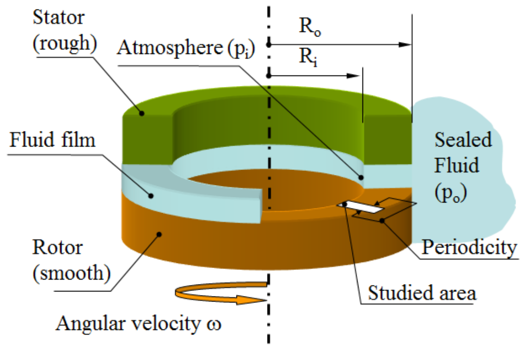

Fig. 2 Configuration of the model.

Three rough surfaces are studied:

- A distribution of random dimples (Fig. 3).
- A rough surface (Fig. 4).
- The combination of the two.

During the simulation the fluid pressure at the outer radius is 1Mpa and the rotating speed is varied.

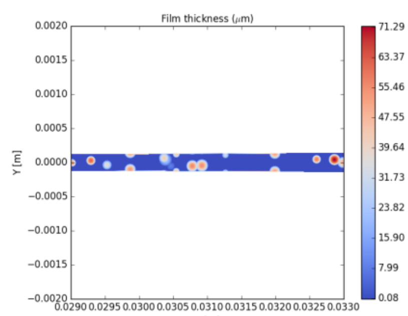

Fig. 3 Random texture distribution on the surface.

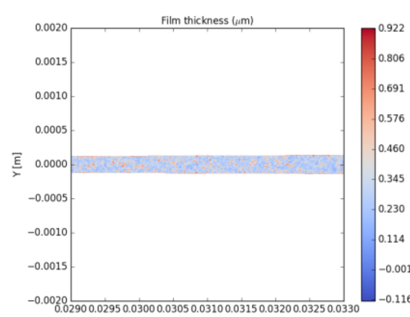

Fig. 4 Rough surface.

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III. RESULTS

Fig 5 presents the pressure distribution obtained if only the surface roughness is considered. Because of height variations due to asperities, some pressure spikes are created in the contact allowing the generation of a hydrodynamic force. The same results is given in Fig. 6 for the textured surface. Some pressure is generated at the edges of the dimples. The random distribution also help in fluid pressure development. When the roughness is combined with the texture (Fig. 7), more hydrodynamic pressure is generated, in line with the results of ref [3].

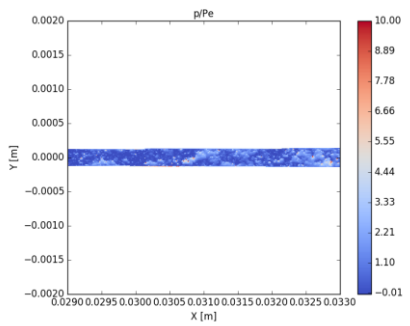

Fig. 5 Fluid pressure distribution with the rough surface at 52 rad/s.

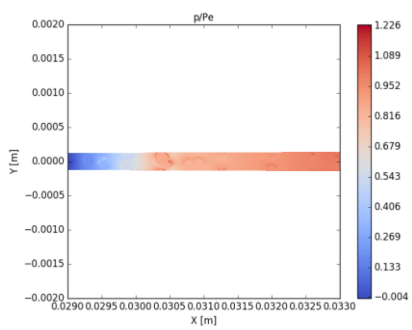

Fig. 6 Fluid pressure distribution with the textured surface at 52 rad/s.

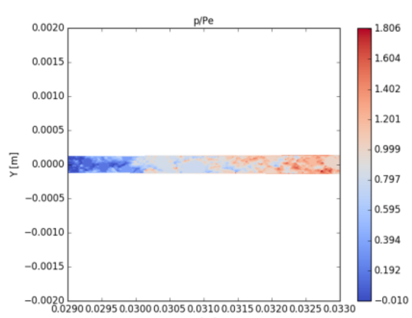

Fig. 7 Fluid pressure distribution with the rough textured surface at 52 rad/s.

The calculated film thickness is presented as a function of speed in Fig 8. This graph confirms that the interaction of surface roughness with random texture provides better performance (thicker fluid films) than with the roughness or texture only.

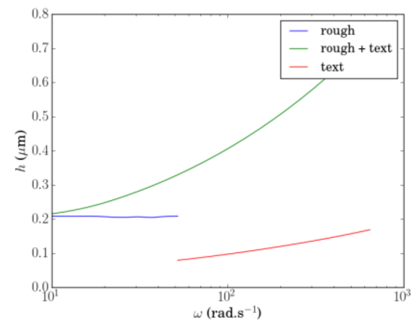

Fig. 8 Calculated film thickness for the three configurations as a function of speed.

IV. CONCLUSION

SiC is usually employed in mechanical face seals. It can exhibit a degree of porosity leading to a kind of random natural surface texture. This texture can help in hydrodynamic fluid pressure generation similarly to random surface roughness. When the two are combined, as in real situation, much better performance are obtained. It is due to the interaction of surface roughness with random surface texture.

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