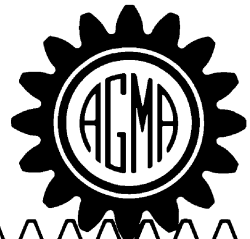


The Effect of a ZnDTP Anti-wear Additive on Micropitting Resistance of Carburised Steel Rollers

by: C. Benyajati and A.V. Olver, Department of Mechanical Engineering, Imperial College London

American Gear Manufacturers Association



TECHNICAL PAPER

The Effect of a A ZnDTP Anti-wear Additive on Micropitting Resistance of Carburised Steel Rollers

C. Benyajati and A.V. Olver, Department of Mechanical Engineering, Imperial College London

[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

Zinc di-alkyl dithio-phosphate (ZnDTP) compounds are widely used in engine and transmission oils both as anti-oxidants and as anti-wear additives. However, recent work has shown that many anti-wear additives appear to have a detrimental effect on the resistance of gears and other contacting components to various types of rolling contact fatigue, including micropitting. In the present paper we examined the effect of the presence of a secondary C6 ZnDTP in a low viscosity synthetic base oil on the resistance to micropitting and wear of carburised steel rollers, using a triple-contact disk tester.

It was found that the additive caused severe micropitting and associated wear, whereas the pure base oil did not give rise to any micropitting. It was further found that the additive was not detrimental unless it was present during the first 100 000 cycles of the test when it was found to exert a strong effect on the development of roughness on the counter-rollers. It is concluded that the additive is detrimental to micropitting resistance because it retards wear-in of the contact surfaces, favouring the development of damaging fatigue cracks. This contrasts with some earlier speculation that suggested a direct chemical effect could be responsible.

Copyright © 2004

American Gear Manufacturers Association
500 Montgomery Street, Suite 350
Alexandria, Virginia, 22314

October, 2004

ISBN: 1-55589-829-7

The effect of a ZnDTP anti-wear additive on the micropitting resistance of carburised steel rollers

C Benyajati and A V Olver

Tribology Section, Department of Mechanical Engineering, Imperial College London, Exhibition Road, London, SW7 2BX, UK

1. INTRODUCTION

Micropitting is a microscopic form of rolling contact fatigue and wear, which is most often found in ground, hard steel surfaces such as those in case-hardened gears. It is normally associated with concentrated rolling-sliding contacts under conditions where the lubricant film is rather thin compared to the height of the surface roughness.

Generally, micropitting consists of numerous small, shallow pits on the surface, each pit often having the characteristic dimension of some tens of micrometers. Despite the small size of individual pit, these pits together can form a large total area of damage so that the surface has a grey, matte appearance. For this reason, micropitting is also sometimes known as grey staining and frosting in the gear industry.

Micropitting, like other wear mechanisms, has a detrimental effect on the durability of the component. It can cause a significant material loss from the damaged surface. In gears, this can result in the loss of profile of the teeth, which may then generate an increase in noise, vibration, and dynamic loads. In more severe cases, it can even cause the total fracture of the gear teeth. Furthermore, the progression of micropitting may eventually result in large scale (macro-) pitting. It may also develop into other types of surface damage, such as scuffing.

Micropitting therefore represents a potentially severe failure mode. It has caused appreciable problems in service and has received considerable attention from tribology researchers [1-4]. Recently, a number of works have investigated the effect of lubricant chemistry on micropitting [5,6]. Cardis and Webster [6] showed that a number of additives described as 'anti-wear' promoted micropitting. However, no details of the additives used were given and the mechanism by which the presence of the additives led to micropitting was not investigated.

Here, the results of a study of the effect of lubricant composition are reported. A PAO base stock was tested on its own and with a ZnDTP anti-wear additive, which is a common constituent of engine and transmission oils. The experimental results showed that the anti-wear additive has an unfavourable effect on micropitting. A possible new mechanism that might account for the results is discussed. Some preliminary results from the present study were presented in [7].

2. TEST RIG

In the present study, a three-contact disc machine has been employed for the study of the effect of lubricants on micropitting. The test roller is a cylinder, of diameter 12.0 mm which is run against three counterface rollers ('rings') which have chamfered edges forming the 3.2 mm track width. Therefore, a *line* contact is generated between a roller and rings. In addition, both specimens have a circumferential finish at their outer diameters. A dip lubrication system is employed as a mean to supply lubricant into contacts. Furthermore, a loading method is provided by the use of a motorised ball-screw, acting through a loading arm. A schematic diagram of the test rig is shown in Figure 1, more details on test rig development and its features can be found in [7].

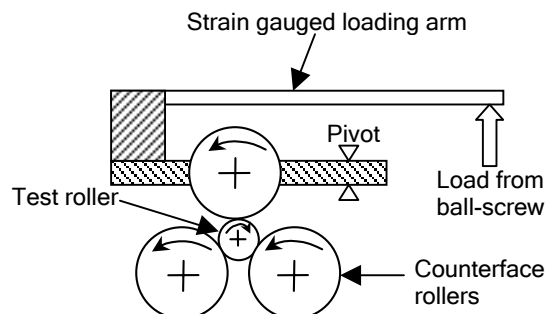


Figure 1. Schematic of test rig, showing the contact configuration and a principle of load application