



Failure of the pinion from the drive of a cement mill

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ABSTRACT

The pinion from the drive of the cement mill was failed; the teeth cracked and spall occurred on the sides of several teeth. The failure was only located on one side of the pinion. This type of failure is common with surface-hardened gears.

We have found that the failure of the pinion is a direct consequence of the incorrect geometry of the surface hardened layer. The lifespan of the pinion could have been extended if the whole surface of the faces and roots of the teeth had been hardened and if the hardening had been deeper.

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1. Introduction

In this article we describe an example of the rupture of gear teeth of a relatively large module of large dimensions that – built into reduction gears of large machinery and devices in process industries (e.g. cement mill) – also endures large loads, forces and torques [1,2].

When manufacturing gears for large modules, wear of the gear teeth faces is often prevented by surface hardening [3,4]. Little attention is usually paid to the resistance of gears against fatigue. When it comes to gear fatigue, the division, signs and amount of internal stresses acquired specifically through surface hardening are very important. The incorrect geometry of the hardened surface is the cause of improper internal stress distribution and inadequate structural strength [5].

With gears, the hardened surface area of the teeth faces often ends near the root of the teeth where the maximum tensile (positive) residual stresses occur. This is normally also the area of the largest changes of external tensile stresses due to operation of the gear. The superposition of positive stresses from both sources, in connection with additional eventual geometric stress concentrators, contributes to the formation and spread of fatigue cracks. However, since the gears frequently rotate in both directions, cracks appear in both roots of a tooth, of which one crack is usually longer.

The failure of the investigated pinion of the cement mill drive (No. 354881, tooth 28, module 36, diameter 1640 mm, width 1800 mm) occurred in the form of fatigue cracks and the spall of steel on the faces of several teeth. The failure was only located on one side of the pinion (Fig. 1). The teeth breakage began with cracking, which typically started at the roots of the teeth faces and spread outwards. The breakage resulted in transverse ruptures along the length of the teeth.

The other failure that occurred was the spall of the steel on the faces of the teeth. Such failure is caused by excessive Hertzian pressure applied to the faces, or is a consequence of the lack of compressive strength of the steel at a critical depth

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