The threaded part wear of the tensioner with lock nut

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Abstract. The tensioner with lock nut is an important part of the timing mechanism, which is often used in motorized engines. This component consists of a plurality of parts which are connected to each other by a threaded part. The threaded part of the tensioner serves to precisely adjust the position of its front part against the timing chain. This setting ensures the correct position of the guide part and thus the running of the motorcycle engine. The benefit of this research is the analysis of changes on the threaded part surface, which is important for correct working of the tensioner it is necessary that the threaded part fulfill its purpose. It is necessary to prevent its degradation or excessive wear. Scanning electron microscopy and energy dispersive spectroscopy methods were used to determine the wear of the threaded part of the tensioner. The evaluation focused on surface changes in the threaded part and the possible occurrence of foreign particles on the surface with respect to their material contrast and chemical composition.

1. Introduction
The correct operation of the motorcycle intended for driving in difficult terrain is ensured by the timing mechanism. This mechanism has an essential role in timing the movement of individual parts of the engine, thereby ensuring its functionality, safety and acceptable operating costs [1]. The timing mechanism consists of several components. One of the main components is the timing chain tensioner, which comes into contact with the timing chain slider and also with the lubricating and cooling medium. During operation, the threaded part of the tensioner may become worn, which ensures its adjustment in the correct position in relation to the timing chain tension. The threaded part of the tensioner also serves as a firm fixation of the tensioner in an optimal position. The energy-dispersion spectroscopy method was used to identify foreign particles in terms of their chemical composition on the surface of the threaded part [2].

2. Experimental material
The tensioner was made of AlMgSi1 aluminum alloy which can be cured. This material is used in products requiring a combination of properties such as low weight, good strength and corrosion resistance [3]. It is used in the manufacture of transport equipment, construction, food and chemical industry [4]. The chemical composition of the AlMgSi1 alloy is shown in table 1. The microstructure of the tensioner consists of an aluminum matrix where two types of phases are located [5]. These are phases based on Al-Fe-Mn and Al-Si-Mg elements [6]. Both of these phases form in the cast condition relatively sharp compound. The shape of these phases in the tensioner material was without sharp ends. This suggest that the material of the tensioner was heat treated to improve properties prior to
further processing. Due to its microstructure, this material is suitable for dynamically loading applications [7].

### Table 1. Chemical composition of alloy AlMgSi1.

| Element | Composition       |
|---------|-------------------|
| Si (%)  | 0.70–1.30         |
| Cr (%)  | 0.25 max          |
| Mg (%)  | 0.60–1.20         |
| Zn (%)  | 0.20 max          |
| Mn (%)  | 0.40–1.00         |
| Ti (%)  | 0.10 max          |
| Cu (%)  | 0.10 max          |
| other (%) | 0.15 max       |
| Fe (%)  | 0.50 max          |
| Al (%)  | remaining         |

3. Evaluation of the tensioner thread surface part

Subsequently, particles from the surface of samples were removed by ultrasonic cleaning in an isopropyl alcohol medium, which ensures removal of moisture and engine oil spills from operation. The tensioner thread was evaluated for its surface condition by scanning electron microscopy method with a secondary electron detector which allows the thread surface to be evaluated in connection with changes in its micro relief. In addition, a backscattered electron detector was used to provide information on the material contrast between the foreign particles and the base material of the tensioner. To accurately identify the chemical composition on the surface of the tensioner, an EDX detector was used in combination with the analysis of chemical composition in the selected area [8]. The thread surface was also evaluated in the non-etched condition in order to detect the degradation of the thread in the longitudinal direction of the tensioner. At the top of the thread were detected clogged particles of the working environment with significant material contrast (figure 1). These particles were pressed into the surface where these particles form microploughing and thereby significantly increased its micro-relief. These were mostly Fe-based oxide particles (figure 2). There was no significant occurrence of these observed particles at the top of the thread.

![Figure 1. Fe particles of the used tensioner – top of the thread.](image)
Figure 2. EDS analysis of the particles composed mainly of Fe.

The highest occurrence of foreign particles was observed on the side walls of the thread. In this area there were particles of significantly larger geometric dimensions compared to the top of the thread. These particles appear sharp-edged with comparable material contrast to the base material of the tensioner (figure 3). The particles are pressed into the surface but wear is visible by separating the base material with their sharp edges [9]. The micro-relief is significantly larger in these areas compared to the top of the thread. These were mainly Al-based oxides (figure 4).

Figure 3. Al oxides on the surface of the mounted tensioner – top of the thread.
Samples for SEM observation were metallographically prepared, polished without etching. In the next step they were metal plated with Au-Pd alloy. If such particles are pressed into a counterpart of the thread part while their location is fixed, it may degrade on multiple thread crests as the thread moves (figure 5). This degradation results in material removal and increased roughness of the functional surfaces of the thread (figure 6). The dark areas are formed by the fixation mass. The white particles are Al-Fe-Mn and Al-Si-Mg phases in the aluminum gray matrix.

4. Conclusion
The timing chain tensioner exposed to the operation is prone to surface wear on its threaded part. This part is essential for its correct functionality. The wear of the functional surfaces of the thread is manifested by the presence of foreign particles, especially on the side walls of the thread, which cause...
separation of the base material of the tensioner and significantly increase the roughness of these surfaces. Repeated movement of the threaded parts could damage the thread to such an extent that further adjustment would no longer be possible. The foreign particles causing wear of the threaded part are largely clogged on the tensioner surface by the engine oil where they normally occur, as micro-particles separated from the original material of the various motorcycle engine components. Since the threaded part of the tensioner shaft is the most damaged part of the tensioner, treatment must be taken to thoroughly clean all components of the tensioner when it is replaced. Insufficient cleaning of clogged particles on the surface of disassembled parts could significantly damage the thread of the new shaft as well as the counterpart of the thread.

5. References

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