TRIBOLOGICAL BEHAVIOR OF THE PISTON RINGS WITH DIFFERENT PROFILES OF THE CONTACT SURFACE DURING EXPLOITATION

V. Ene
Technical University of Moldova

FOREWORD

The inner combustion engine's resource also the maintenance and repairing expenses highly depend on the wear intensity of the rings' working surfaces in their permanent contact with the cylinder liners. The increase of the wear intensity is also determined by the contact's interaction particularities, lubricant's composition, constructive shape of the contact and its size, thermal regime and the lubricating regime of the contact.

In the work paper [1,2] has been studied the necessary parameters and measurements needed to execute the model experiments from which has been established the main statements of the friction processes of the lubricated contacts of different sizes, shapes and materials. The main aim of this paper is the wear intensity evaluation of the "piston ring-cylinder" couple's lubricated contact.

1. THE METHODOLOGY OF THE EXPERIENCES

To evaluate the functioning efficiency and the wear resistance of the piston rings has been effectuated model experimental attempts on the KamAZ-740 engine possessing different profiles and constructive materials of the interacting surfaces with the cylinder liners, also being aware of the constructive form of the piston [3].

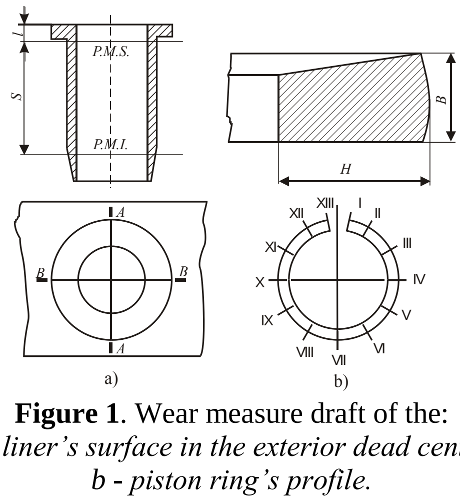

Figure 1. Wear measure draft of the:
a - liner's surface in the exterior dead center;
b - piston ring's profile.

The friction has been determined: for the cylinder in two levels A-A and B-B with the interior comparisoner in the reverse areas (*fig. 1, a*), and with micrometric indicator with a division of 0,002 mm in 12 points on the perimeter (*fig.1, b*).

The medium friction $\boldsymbol{U_r}$ and the medium friction intensity $\boldsymbol{J_r}$ of the exploited rings divided to 1000 km of the automobile's journey has been determined according to GOST 8.2072-76.

2. THE RESULTS OF THE EXPLOITATION TESTS

The draughts' sketching of the medium radial wear for the compression rings *1* and *2* of two KamAZ engines (*fig. 2*) has shown that the medium radial wear of the fire ring *1* of the engine exploited in normal conditions with the journey $\boldsymbol{L_i}$ = 142 thousand km (*fig.2, a*) is smaller than the maximum admissible wear of each point of the perimeter, excluding the areas approached to the ring-slit where the friction exceeds the allowable value (*fig. 2, curve 1*).

On the other hand the fire ring of the engine that works in tough conditions of exploitation (*fig.2, b*) having a mileage of only 70 thousand km has a much bigger wear above the whole perimeter.

Relating to the second compression ring of both engines, the medium wear on the perimeter does not exceed maximum admissible wear.

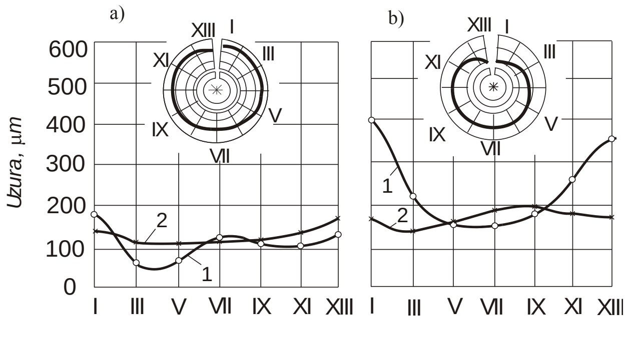

Figure 2. The wear droughts of the diesel engines' compression rings:
a - normal conditions; b - tough conditions of exploitation; 1 - first ring; 2 - second ring.

It's been noticed that the cylinder possessing the highest surface tear of the ring *1* has also the highest tear of the ring *2*. This establishes that the first compression ring is defined as responsible for the friction and wear processes, the variation carriage of which in well-determined conditions of engine's exploitation depends on the greasing conditions of the cylinder liner in the exterior dead center.

The up-risen profiles of the working surface of piston-ring (*fig. 3*) show that during the exploitation the piston ring occupies the most different positions comparing to the cylinder liner's surface therefore forming nonsymmetrical profiles in different points of the perimeter. It's not difficult to notice the satisfying correlation between the working surface wear draught and the draught of the ring's exercised pressure above the cylinder's surface.

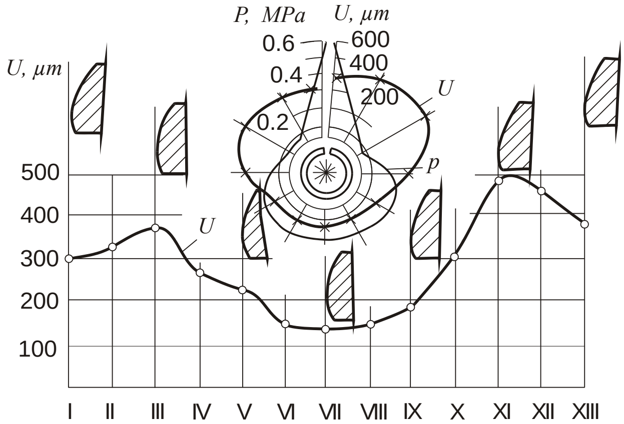

Figure 3. The compression ring's profile form and the wear draught of a diesel engine in exploitation.

Evidently it is necessary beforehand, at the stage of modeling, to create an approachable profile to an exploited one to raise the piston ring's resource and capacity of functioning.

3. COMPARATIVE EVALUATION OF EXPERIMENTAL TESTS OF PISTON RINGS WITH VARIOUS WORKING SURFACE PROFILE

Based on the analyses of piston ring's working theory and model tribo-technical attempts made on different kinds of working surface profiles, it's been motivated and agreed to use for experiments a piston ring which has two parabolic bulging sectors, jointed by a concave sector possessing constructive dimensions limited between ***h/H*** = 0,4...0,55; ***b/B*** = 0,5...0,8, which ensures more favorable greasing conditions and a bearing capacity increase of the oil coat [5].

The oil consume curves depending on the automobile's journey, that directly reflect the technical state of an engine endowed with serial rings (*1*) and experimental rings (*2*) are sketched in *figure 4*. Hence it follows that the tightness of the cylinder is better performed at the experimental engine because of smaller oil leaks (*curve 2*).

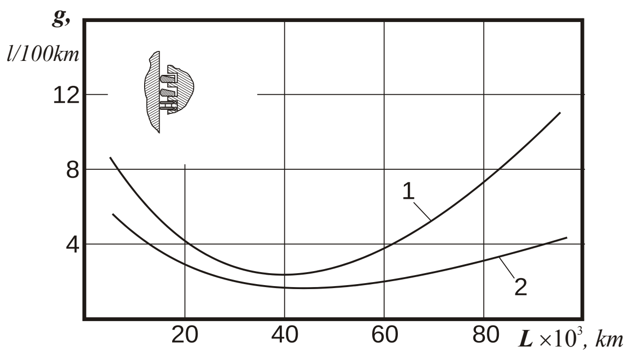

Figure 4. Oil consumption variation depending on the KamAZ's engine journey endowed with serial rings (1) and experimental rings (2).

Comparing the cylinder liners' wear curves (*fig. 5*) it can be noticed that, at the same journey, the serial ring set tears more the cylinder liner (*1*) than the KamAZ's dense chromated experimental ring going first (*2*). The wear is even smaller in cylinders with the Geotse (*3*) and Riken (*4*) firms' ring sets.

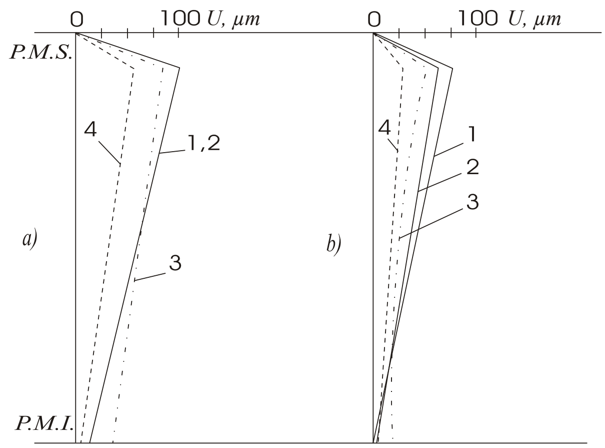

Figure 5. The wear drought of the cylinder surface of an engine equipped with:
1 - KamAZ serial rings; 2 - KamAZ experimental rings; 3 - Riken experimental rings; 4 - Geotse experimental rings.

In the *figure 6* are presented wear levels of piston rings with different profile forms: *a* - parabolic rings; *b* – double-barreled rings.

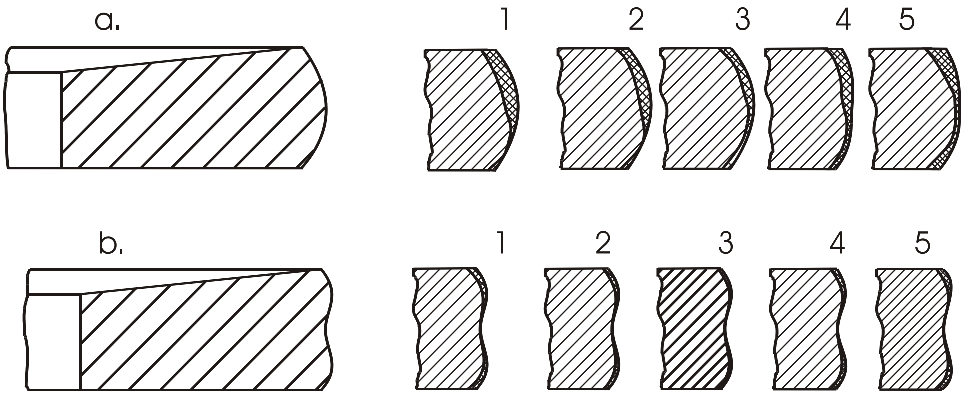

Figure 6. The rings' wear in the perimeter sectors: *a – serial rings; b - experimental rings*.

According to the images presented in *fig. 6, a* it becomes evident the bigger wear of parabolic profile rings at the superior area, closer to the combustion chamber, caused by higher pressures.

The double-barreled ring *fig. 6, b* wears more uniform due to better lubricant conditions, the inner cavity of the ring being used as a oil reservoir.

4. CONCLUSIONS

1. It makes evident that it is necessary to group successfully the favorable greasing conditions of the contact interaction between the piston rings and the cylinder liner to raise the functioning efficiency and the durability in exploitation of the piston group of the vehicle's engine as it has established to be responsible for the cylinder liner's friction and tear processes in the exterior dead point.

2. In exploitation, the engines equipped with experimental rings have proved a smaller oil consumption with 30...40% less than the normative consumption and with 20...40% than the serial made engines, while the fuel consumption diminished with 5...15%.

3. It makes evident that the utilization of experimental profile fire rings decreases the cylinder liner's surface wear by 1,5...2 times.

4. The double-barreled ring has provided a more stabile regime of lubrication near TDC even for high operating temperature and loading, with significantly reduced friction forces, wear and oil consumption;

5. The technical-economical indicators obtained during the exploitation of the KamAZ engines equipped with experimental piston rings justifies the implementation in serial manufacturing of this new prototype of high quality, durable compression piston rings.

References:

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