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Effect of different parameter of LST: an overview

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***Abstract* - Energy losses resulting from friction between contact surfaces in an internal combustion engine. Various surface treatments improve triobological performance of sliding surfaces. Some researcher studied effect of various parameters of texturing. Partial texturing reduces the friction. Dimple area ratio also greatly affects the tribological properties of the surface texture. Friction reduction effect also depends to a great extent on the dimple shapes. This paper describes the development in lst technique.**

***Index term* - LST,Dimple area Ratio,Dimple shape**

I INTRODUCTION

Reduction of engine mechanical friction increases the engine efficiency. It is a fact that a large percentage of the mechanical friction loss in engines occur on the lubricated surfaces between the skirt and the cylinder liner as well as between the cylinder rings and cylinder liner [1].The lubrication between rings and cylinder liner is effected by oil viscosity, oil film thickness, piston ring configuration, and the operational specifications of the engine. By considering energy consumption within the engine, it is found that friction loss contributes the major portion of the energy consumption developed in an engine. About two-thirds of it is caused by piston skirt friction, piston rings, and bearings, and the other third is due to the valve train, crankshaft, transmission, and gears [2]

Energy losses resulting from friction between contact surfaces in an internal combustion engine have been studied intensively by a considerable number of tribologists. Progress in this field has brought numerous economically effective solutions, which enable mass production of motor vehicles. Still, the automotive industry needs further improvements to reduce friction-related energy losses in engines and drive systems. For instance, the losses of energy generated in a piston-ring-cylinder system account for 45% of all the losses of energy due to friction in the

whole engine. Numerous reports suggest that the problem can be solved by applying porous surfaces generated, for example, by laser surface texturing [3], [4].Over the past decades, tribologists and lubrication engineers have been interested in surface modification for friction reduction and improved wear resistance. It is said that the surface is a novel material. Creating surfaces with controlled micro-geometry features is an effective method to improve tribological performance of sliding surfaces. In recent years, surface texturing has received a great deal of attention as a viable means to enhance the tribological performance of mechanical components; a large number of research studies have been carried out worldwide.[6-8].The current studies focus on the influence of texturing on the performance of various friction systems in internal combustion engines[5].

II EFFECT OF TEXTURING

Handbook of lubrication shows that optimum conventional untextured barrel-shaped piston ring was compared with an optimum surface textured cylindrical piston ring in firing diesel engine, resulting in 4 % improvement in fuel consumption with optimum flat structured ring.[9]

Marian victor [9] described in his paper that textured surfaces create a lubrication film, which produces a load carrying capacity when there is no condition for the wedge effect. it leads to an improvement of fuel consumption in the case of internal combustion engines by texturing the rings or the liner ,their durability increases. It is well known that friction forces present an essential factor in fuel consumption and performance of the engine. It was established that about 40 percent of the friction losses of the engine are due to the contact of the piston ring and liner, so a reduction of this force is crucial. The texturing of the rings has positive effects: - the reduction of friction between the piston and the rings the good functions in conditions of "starvation", because of the properties of oil retention of the dimples. By surface texturing, the friction coefficient decreases by 20 to 30 percent. Textured surfaces generate a load carrying capacity even between two parallel surfaces. The friction forces can be reduced in the case of the piston – liner contact and consequently the fuel consumption.

IIIPARTIAL TEXTURING

Laser Surface Texture on Piston Rings G. Ryk & I. Etsion [10] tested piston rings with partial surface texturing. Tests were performed on a reciprocating test rig with actual piston rings and cylinder liner segments. A comparison was made between the performance of a reference non-textured conventional barrel shape rings and optimum partial LST cylindrical shape rings. The friction tests were carried out with several values of the normal load Fe corresponding to a nominal contact pressure range from 0.1 to 0.3MPa.Typical results are found for a representative case with a nominal contact pressure of 0.2MPa.

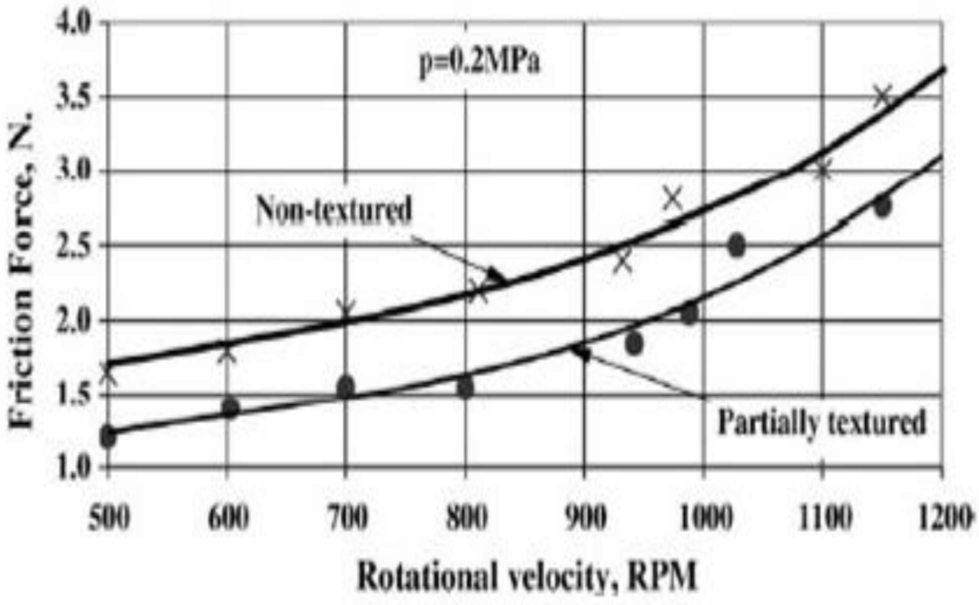

Fig.1 The average friction force vs crank rotational for external normal pressure of 0.2 MPa

The average friction force is presented versus crank rotational velocity for the reference non-textured barrel shape rings and for the partial LST cylindrical face rings Clearly the LST has a substantial effect on friction reduction compared to the non textured reference rings. The average friction obtained with the partial LST cylindrical face rings is about 20–25% lower than in the reference barrel face rings over the entire speed range from 500 to 1200 rpm. similar to the present rig test, between the performance of optimum non textured barrel shape and optimum partial LST cylindrical shape rings. It was found that the partial LST piston rings exhibited about 25% lower friction.

E.Share & I.Etsion [11] has evaluated the effect of partially laser surface textured piston rings on the fuel consumption and exhaust gas composition of a compression–ignition I.C. engine. Dynamometer tests were performed with a Ford Transit naturally aspirated 2500 cm3 engine at a wide range of engine speeds under near-half-load conditions. The effect of the LST as applied to the four top piston rings of the engine was tested by the following procedure: in order to minimize the effect of random environment fluctuations, each set of rings was tested in three different days. At each day, the same sets of engine loads and engine speeds were tested in two different procedures; an engine speed increasing test procedure, and an engine speed decreasing test procedure. Each procedure was repeated three times. At each point the engine was allowed to reach steady state conditions, which were typically attained after 20 min.A comparison was made between the performance of reference non-textured conventional barrel-shaped rings and optimum partial laser surface texturing (LST) cylindrical-shape rings. It was found that the partial LST piston rings exhibited up to 4% lower fuel consumption, while no traceable change in the exhaust gas composition or smoke level was observed.

Y. Kligerman et al. [12] developed an analytical model of partial LST flat face piston rings where only a portion of the ring face width is textured. The partial LST is based on a so-called “collective” effect of the dimples that provide an equivalent converging clearance between nominally parallel mating surfaces. The time behavior of the friction force is calculated from the shear stresses in the viscous fluid film and the time dependent clearance. An intensive parametric investigation is performed to identify the main parameters of the problem. The optimum LST parameters such as dimples depth, texture area density, and textured portion of the nominal contact surface of the piston ring are evaluated. It was found that the friction for the optimum partial LST piston rings is significantly lower than that for the corresponding optimum full LST ring. The difference varies from about 30% reduction for narrow rings to about 55% reduction in wide rings.

A.Shikarenko et al.[13] a theoretical model is developed to study the potential use of laser surface texturing (LST) in the form of spherical micro dimples for soft elasto-hydrodynamic Lubrication (SEHL). and shows that LST effectively increases load capacity and reduces friction in SEHL.

From theoretical model Y.Kligerman[14] derived that it is clear that the minimum friction force in the case of the partial LST is significantly smaller than its corresponding minimum in the case of the full LST. The advantage of the partial texturing is greater at larger piston ring widths. over 30% less friction can be obtained with the partial LST compared to the full LST. For a wider ring the partial texturing is even more efficient with 55% less friction than the corresponding full texturing case.

IV EFFECT OF DIMPLE AREA COVERAGE, DIMPLE DEPTH, DIMPLE DEPTH AND DIMPLE SHAPE.

Bogdan ANTOSZEWSKI[15] in his paper describe that the effects of laser texturing were measured at pre-determined parameters of performance of the sliding pair; the pore depth and diameter (or their ratio) and the pore area coverage were the most significant parameters of texturing. The problems to be solved in further research include determining precisely the relationships between the texturing parameters, ring geometry, and the parameters of performance of the friction system for which the desired reduction in friction occurs.

V EFFECT OF DIMPLE AREA COVERAGE

H Yu[16] developed a numerical model to study the effect of dimple shapes on hydrodynamic pressure generation. the reciprocating sliding tests were carried out under oil lubrication and face-contact conditions. Tests were conducted for rotational speeds in the range 50–500 r/min and test loads of 200 and 400 N. Dimple area ratio were varied under fixed dimple area conditions .Result shows that the optimum parameters are a dimple area ratio of 10.4 per cent and a dimple depth of 8–10 mm for circular dimples, 15.5 per cent and 8–10 mm for square dimples, and 10.4 per cent and 8–10 mm for elliptical dimples.

Yan et al. [17] also suggested that the dimple area ratio (ratio of dimples to surface areas) also greatly affects the tribological properties of the surface texture.

VI EFFECT OF DIMPLE DIAMETER

Wang et al.[18] studied the effect of dimple size on friction under line contact conditions, and the results indicated that the pattern with small dimple diameter showed a greater friction reduction effect than the pattern with the larger dimple diameter. It is seen that so far, most studies are still focused on the effect of surface textural parameters such as dimple area ratio and size.

VII EFFECT OF DIMPLE DEPTH

From numerical model H Yu[16] derived the effect of dimple depth on the average friction coefficient is shown in Fig. 7 for the specimens textured with circular dimples under different test load conditions. The figure provides all the dimple area ratios and dimple depths used in this research. The experimental results in the figure were obtained at the rotational speed of 200 r/min, and it should be mentioned that similar results were also produced under other test rotational speed conditions. The line of reference indicates the results from the untextured specimen. With a fixed single dimple area, the smallest average friction coefficient can be obtained by changing dimple depth for each dimple shape. This suggests that an optimum friction reduction effect compared with the untextured specimen can be achieved by selecting suitable dimple parameters .it is clear that all the specimens with dimple depths of 3–5 and 8–10 mm show a better friction reduction effect compared with the untextured specimen At both high and low test loads, an optimum dimple depth exists, which minimizes the average friction coefficient, and the optimum depth is around 8–10 mm.

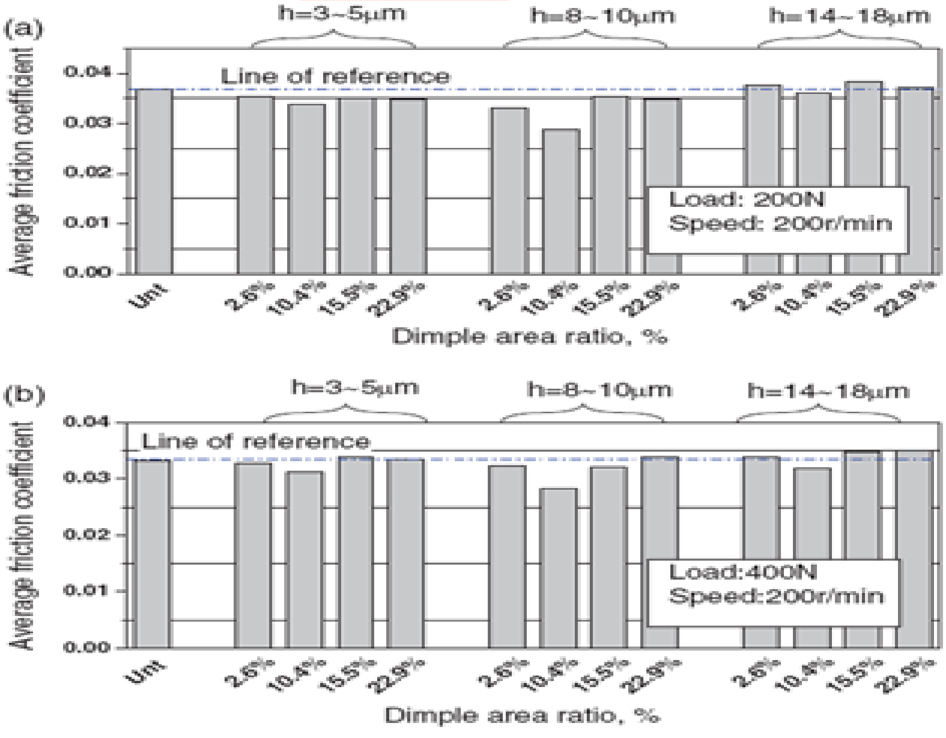

Fig-2 The effect of the dimple depth on the average friction coefficient for surfaces textured with circular dimples under different normal load.

Etsion et al.[19] studied the effect of different parameters both in theory and by experiment. The authors indicated that the dimple depth to dimple diameter ratio is the most important factor.

Brizmer[20] plot a graph from his analysis .Figure 2 shows that the friction force increases with increasing external pressure as would be expected since higher external pressure acts to reduce the clearance between the piston ring and cylinder liner. At a given external pressure, and the shown combination of L1 and *W*, the minimum friction is little affected by moderate variations of Ec(dimple depth) around its optimum value.

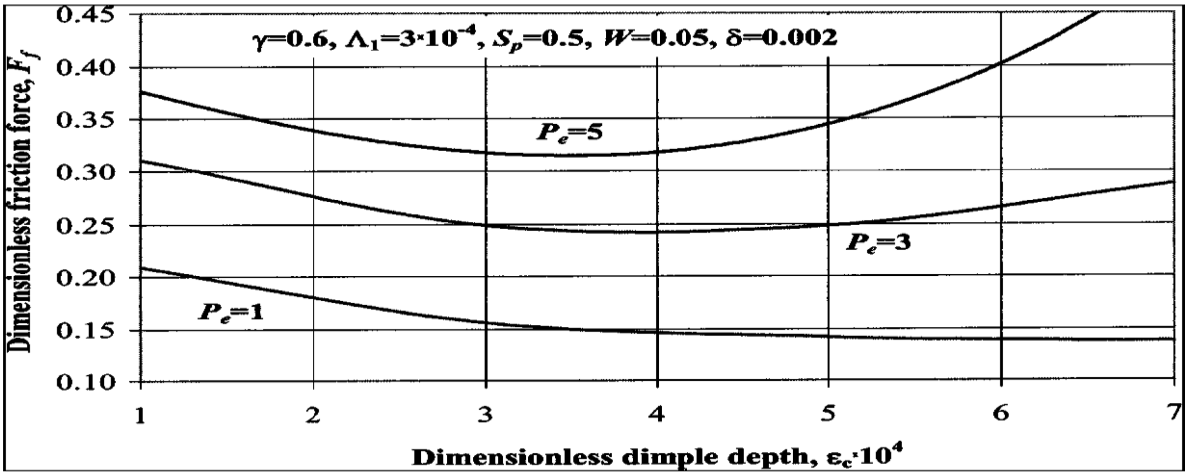

Fig. 3 Dimensionless average friction force, Ff , versus dimensionless dimple depth, Ec , for various external pressures, Pe

VII EFFECT OF DIMPLE SHAPE

H Yu, H Deng [16] **C**oncluded from numerical and experimental analysis, resulted that the friction reduction effect also depends to a great extent on the dimple shapes. Of the dimple shapes investigated in this research, elliptical dimples always showed the best results under different test load and rotational speed conditions; the square dimples performed the second best, and the circular dimples showed the worst results. Also, these test results showed a good correlation with those obtained from the numerical model. The reason for this phenomenon might be that the elliptical dimples have the largest converging wedge of all the dimple shapes used in the research, and this larger converging wedge makes it easier to generate a lubricant film between two surfaces to prevent asperity contact. result are shown on graph.

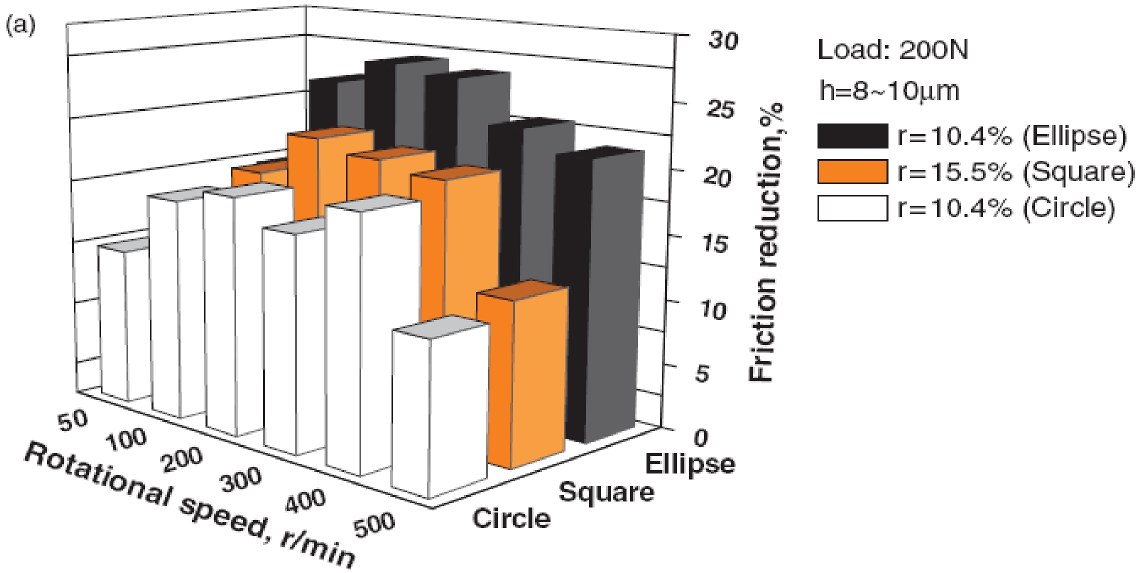

Fig. 4 The effect of dimple shape on friction reduction under different normal loads

Mohammed Yousfia[21] compares functional performances (friction coefficient) of original texture patterns (circles and ellipses) generated by an innovative honing prototype machine. For that, different honing kinematics are used in order to obtain circular and elliptical patterns at different size and aspect ratio (perpendicular ellipse axis/longitudinal ellipse axis ratio). Then, the friction performances of each generated surface are evaluated with a reciprocating ring-liner tribometer. The results show the contribution of pattern size and orientation (of major ellipse axis) on friction performances. It highlights that ellipse patterns with major axis oriented at ring sliding direction contribute the most to reduce friction coefficient.

Comparison of different texturing shapes based on a common parameter such as dimple size or area density, here too wrong conclusion are usually made regarding the optimum shape for best performance. the correct procedure for finding an optimum texturing among different shape for best performance. The correct procedure for finding an optimum texturing among different shapes is first to optimize each shape individually in form of its own optimum aspect ratio and area density and only then compare the individual optimums to find the ultimate one.[22]

VIII CONCLUSION

The effect of texturing parameters on the average friction force between two mating surface like a piston ring and a cylinder liner was analyzed by different researcher.. The following conclusions summarize the results of the present study:

1. Textured surfaces generate a load carrying capacity even between two parallel surfaces. The friction forces can be reduced in the case of the piston – liner contact and consequently the fuel consumption.
2.Partial lst show considerable reduction in friction force compare to full lst.
3 For certain dimple area coverage friction force is reduced.
4.Elliptical shape of dimple show more reduction in friction compare to circular shape.

For comparison of effect of different types of texturing correct procedure should be adopted for reducing the variation in result.

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