

## Tribological Properties of New Developed Nano boric Acid Suspended as Additive in Engine Oil

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Project number: 1501-1507 TEYDEP Tubitak Industrial-University-Civil Collaboration Program

### Abstract

Boric acid ( $H_3BO_3$ ) has always been a very important material due to its broad range of applications such as in medicine, cosmetics, automotive industry, metallurgy and also for miscellaneous purposes in other areas [1]. Erdemir *et al.* (1990) showed that friction between automobile engine parts could be greatly reduced using microscopic particles of boric acid [2].

New invention is that the suspension of nano boric acid (BA) additive added into 5W-40 fully synthetic commercial lubricating oil. This invention is confidential and realized by Murat ÖZAYMAN from Tribor ARGE Co. in Teknopark of YILDIZ Technical University in Istanbul-TURKEY. Turbiscan TOWER Stability Analyzer results proved that BA nano boric acid particles were in suspension.

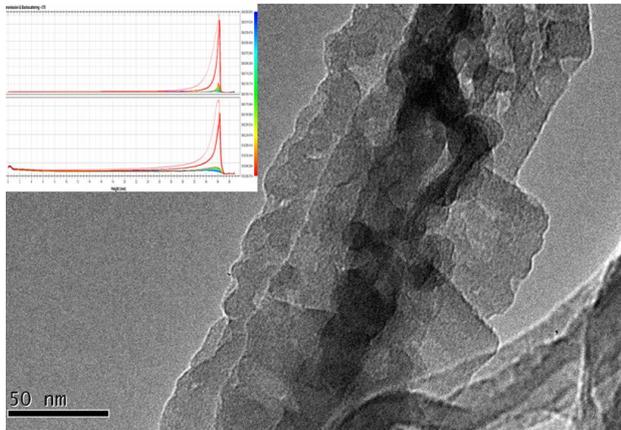


Fig.1 Turbiscan and TEM of BA prepared with Hexane.

Figure 1 proves Turbiscan (T-BS)% for suspension and shows TEM (Transmission Electron Microscopy) of BA (black patches). The size of BA varies between 50nm to the 200nm. This size is well acceptable and appropriate passing nanoparticles from engine oil filter.

In this study, real 1<sup>st</sup> and 2<sup>nd</sup> piston rings-cylinder liner specimens of Honda GX270 gasoline engine were tested with reciprocating tribometer under boundary lubrication conditions, 100C, 60N using BA particles suspended in engine oil to investigate their wear and friction behavior.

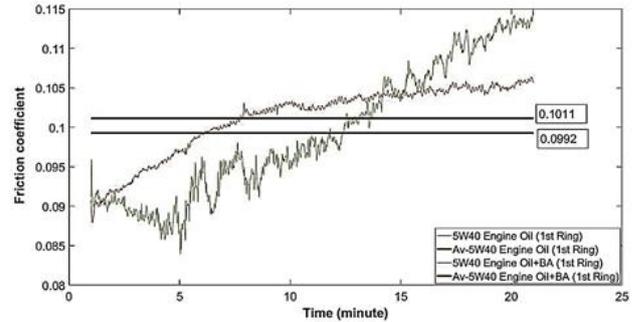


Fig.2 Friction coefficient of 5W-40 engine oil with suspended BA additive via 5W-40 engine oil for the 1<sup>st</sup> ring test.

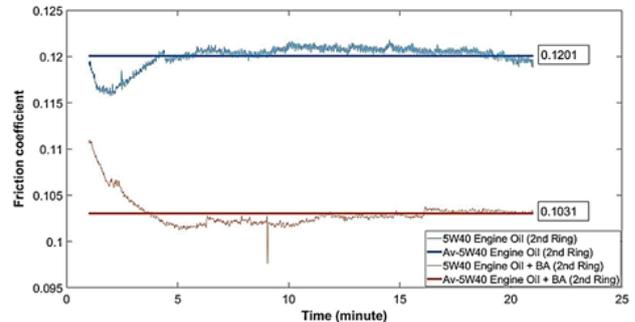


Fig.3 Friction coefficient of 5W-40 engine oil with suspended BA additive via 5W-40 engine oil for the 2<sup>nd</sup> ring test.

According to the results, it has been found that engine oil with BA showed almost similar friction results with the tests of 1<sup>st</sup> piston ring (0.1011 with BA-0.0992 non BA) (See Fig.2) and obtained less friction, better lubrication and protective performance then oil without containing BA with the tests of 2<sup>nd</sup> ring (0.1031 with BA-0.1201 non BA) (See Fig 3).

Protective layer of boric acid is well determined with B element on the surface examination with FESEM and mapping for the 1<sup>st</sup> and 2<sup>nd</sup> rings, respectively. 3D surface roughness average (Sa) of engine oil with BA was less than 5W-40 engine oil. 5W-40 engine oil is well known fully formulated oil marketed in the world.

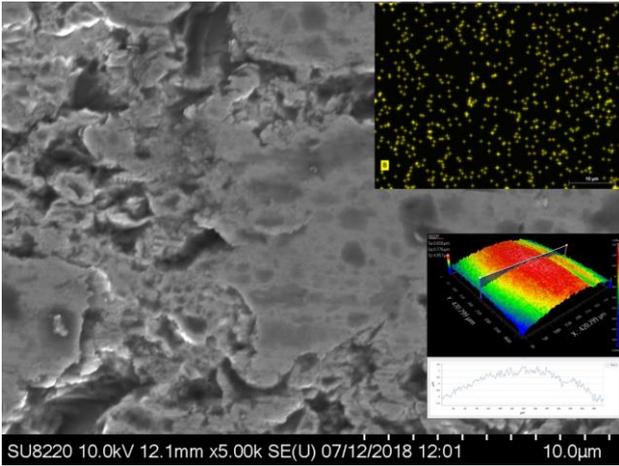


Fig.3 FESEM and 3D roughness of rubbed piston ring surface with X-Ray mapping detected B.

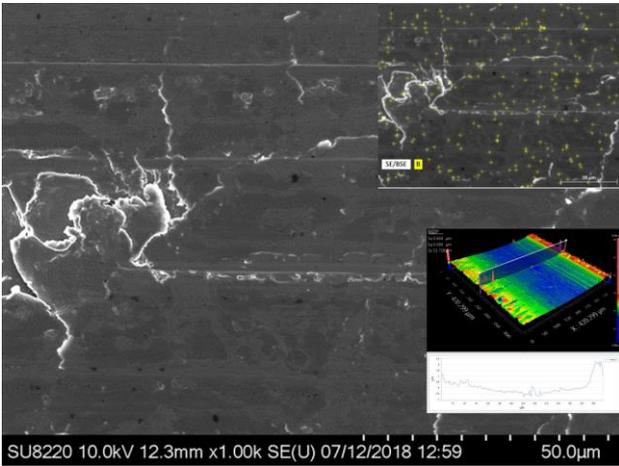


Fig.4 FESEM of rubbed cylinder liner surface with X-Ray mapping detected B.

Figures 3 and 4 are FESEM, BA mapping and 3D roughness of rubbed piston ring via cylinder liner surface with X-Ray mapping where detected B with yellow points.

There are more results showing that additive layers were formed on the rubbed surface of both piston rings and cylinder liner. Protective layers were formed as the surfaces became smooth and well degraded. Abrasive wear was obvious and clearly occurred on the surface of both piston rings and cylinder liner.

This experimental research is a part of 1501-1507 TEYDEP TUBITAK project and it contains huge detailed information. These are only experimental results of 1<sup>st</sup> and 2<sup>nd</sup> piston rings rubbed against cylinder liner. Tests also were carried out with 1<sup>st</sup> – 2<sup>nd</sup> ring of Diesel engine against cylinder liner. The same tests were also proved with another type of reciprocating tribometer using ball on disc. Engine tests will be carried out in the next step of the project.

**Keywords :** Nano boric acid, engine oil, friction, wear

## References

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