TRIBOLOGICAL BEHAVIOUR OF EN8 STEEL IN PRESENCE OF ZnO NANOFLUID

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ABSTRACT

The object of the present work is to the microstructure and tribological behaviour of EN8 steel in presence of ZnO nanofluid. For this purpose the microstructure of En8 steel after heat treatment were examined by optical microscopy and, scanning electron microscopy respectively. Thus heat treatment (heating and cooling) is used to obtain desired properties of steels such as improving the toughness, ductility or removing the residual stresses etc. It covers heat conduction ,and lubrication between two rubbing body..A technique tribological nanofluid has recently been developed to engineer the surfaces of flame hardened EN8 stainless steel to achieve combined improvement in wear and corrosion resistance. In order to evaluate the tribological behaviour of the layers produced on EN8 stainless steel dry sliding wear tests have been carried out in the present work.

Keywords: *Wavelet transforms, AWGN, Threshold, image denoising, wavelet thresholding*

I. INTRODUCTION

The term Tribology was first used in 1966 in a report of the UK Department of Education and Science. The word Tribology is derived from the greek word tribos which means rubbing. In a nutshell Tribology is “science of rubbing” It is the science and technology of interacting surfaces in relative motion and of related aspects and practices. The economic aspects of tribology are significant. Investigations by a number of countries arrived at conclusion that saving of 1.0% to 1.4% of the GNPs(Gross National Product) is possible obtainable by the application of tribological principles, often with proportionally minimal expenditure in Research and Development. The interaction taking place at the interface controls its friction, wear and lubrication behavior. In many technological applications, the surfaces used are mostly either sliding or rolling so understanding their Tribology is key to successful machine component.

II. METHODOLOGY

Wear and friction of flame harden en8 steel in presence of Nanofluid. A pin-on-ring configuration utilized in earlier studies was used to simulate the sliding wear behavior between the sheave wheel and cable. A pin on disc apparatus Fig.1 was used to investigate the dry sliding wear characteristics of the EN8 in flame hardening condition. The cylindrical test pin of 10 mm diameter and 40mm length were used against a hardened steel disc of 120 mm diameter.

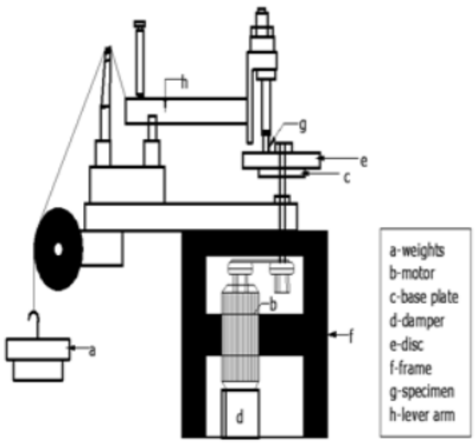


Fig.1.Schematic of pin on disc wears taking apparatus

Wear specimens of 10 mm diameter and 40 mm height were cut from as steel samples and machined and polished for wear test. Wear test were also conducted with selected varying speeds and sliding distance ranging up to 50,000 meters. The initial weight of the specimen was determined in a digital balance with a precision of ± 0.1 mg. The pin was kept pressed against a rotating steel disc of hardness 58 HRc under loaded condition. Wear tests were conducted with a variable applied pressure of 14 Mpa and a sliding speed of 0.5 m/s with a constant sliding distance of 2500 meters.

III. RESULT

(a) WEAR STUDIES

In steady state wear, it shows linear relationship between the wear volume and sliding distance. Almost a linear relationship is observed in bulk wear and sliding distance i.e. steady state wear is observed after initial running-in period of 500-1000m in almost all the case irrespective of load or sliding velocity used. The bulk wear of steel sample decreases in presence of small amount of nanofluid at the surface of sliding disk.

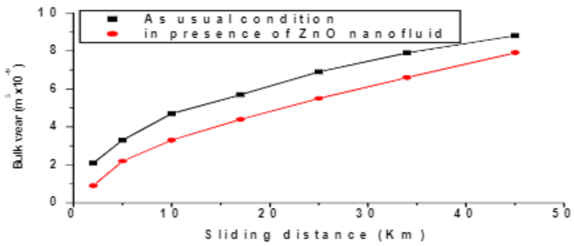


Fig.2.Variation of bulk wears with sliding distance at 3 kg load and 0.772 m/s sliding velocity for EN8 stainless steel in flame hardening for 45 sec (a) in as usual condition and (b) in presence of nanofluid

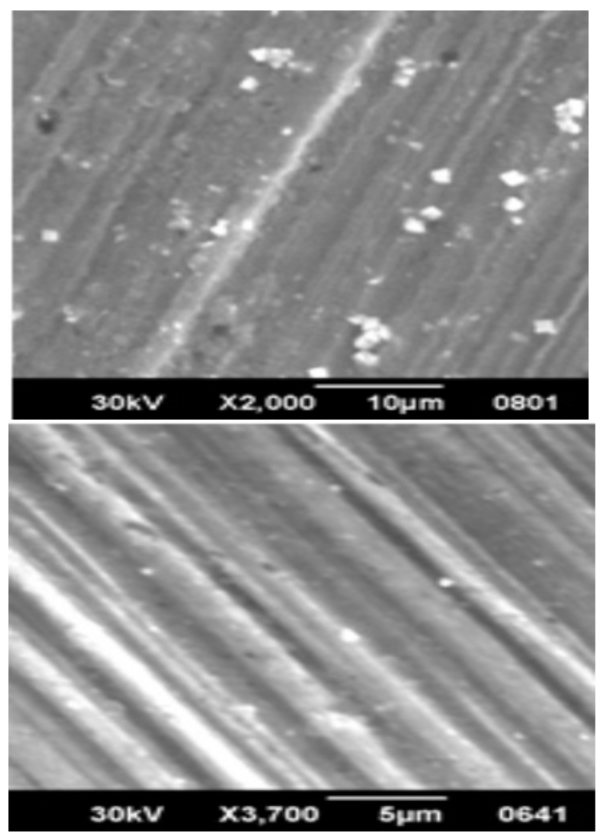
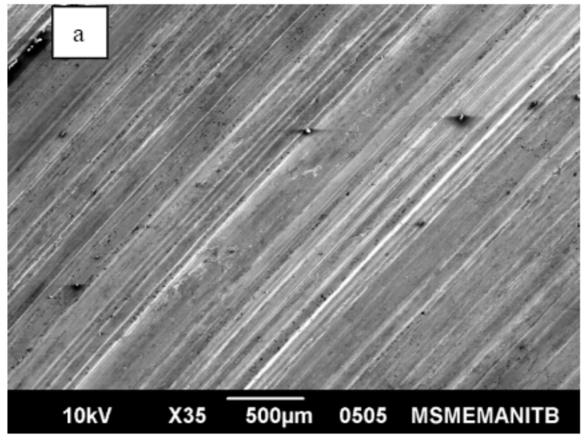
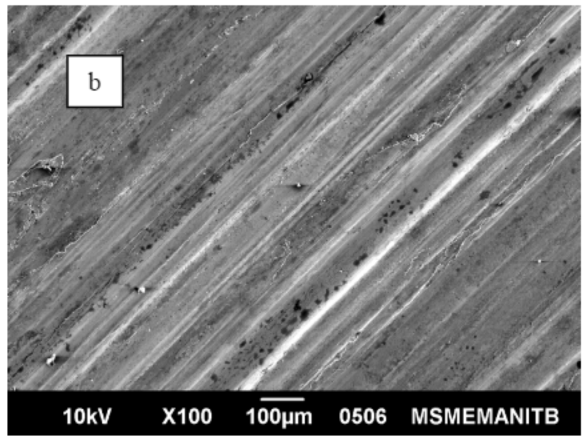


Fig 3. SEM micrographs of wear tracks of EN8 at 3 kg load and 0.772 m/s sliding velocity for EN8 stainless steel in flame hardening for 45 sec (a) in as usual condition and (b) in presence of nanofluid.





Nanofluid at the surface not only reduces the wear rate from the two contacting surface but also change the surface morphology of the rubbing surface.

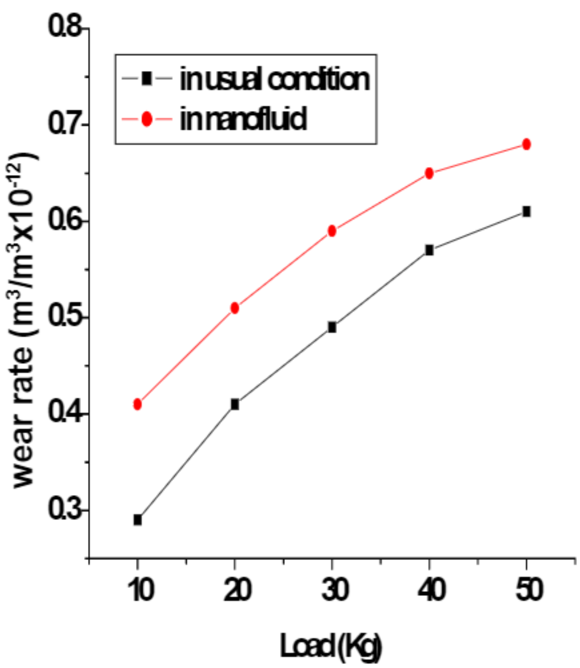


Fig 4. Variation of wear rate with load at 0.772 m/s sliding velocity **for EN8 stainless steel in** flame hardening for 45 sec (a) in as usual condition and (b) in presence of nanofluid.

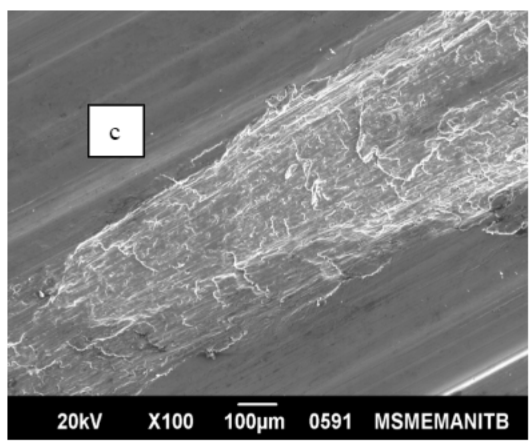


Fig 5. SEM micrographs of wear tracks of EN8 at as usual condition (a) 3 and (b) 5 kg load and 0.772 m/s sliding velocity for EN8 stainless steel in flame hardening for 45 sec (c) in presence of nanofluid.

(b) FRICTION STUDIES

(i) In dry condition

Heating the samples in acetylene flame environment materials get maximum harden and bears the maximum amount of the load during friction study. During the steady state period the friction coefficient is stabilizing.

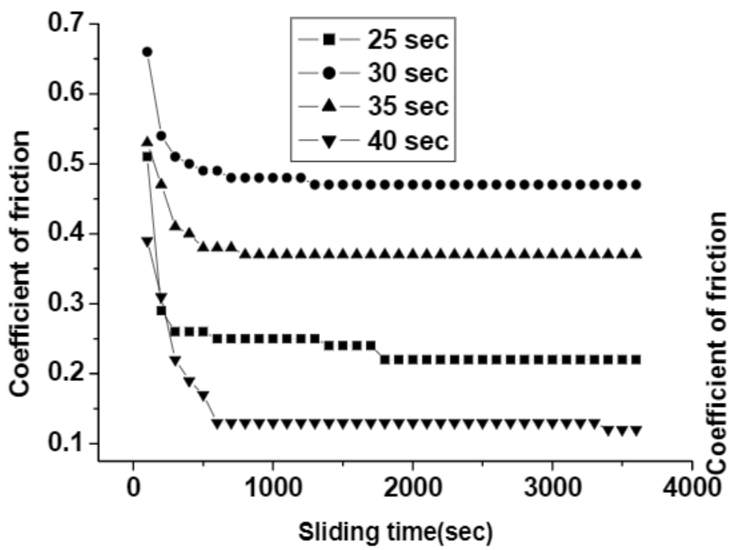


Fig.6. Friction coefficient variation of EN8 sample in flame hardening condition during sliding time at fixed specific loads and sliding speeds.

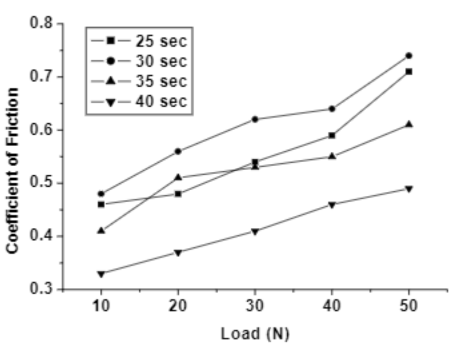
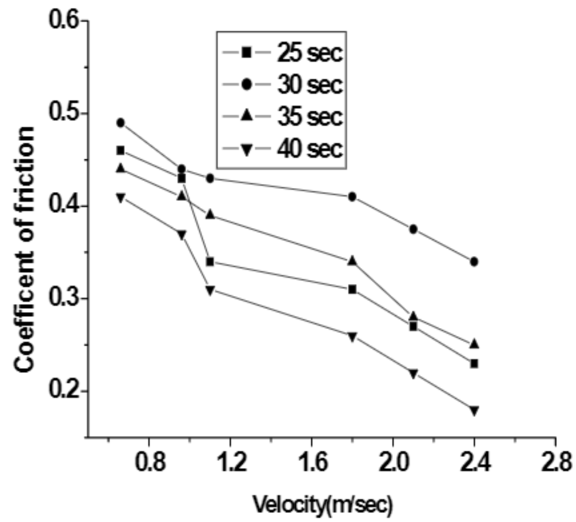


Fig 7. Coefficient of friction vs. applied load for EN 8 stainless steel



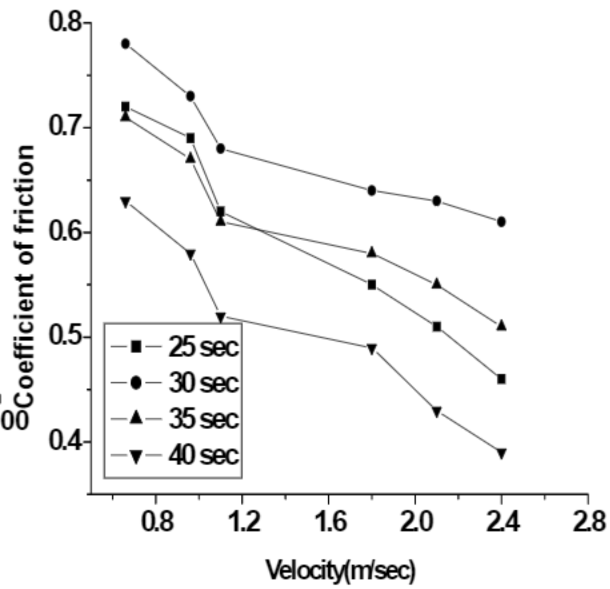
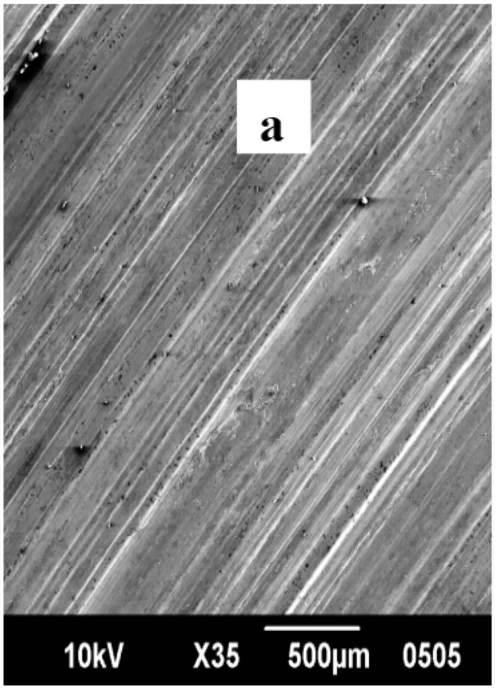


Fig8. Friction coefficient vs. sliding speed of EN8 steel at different applied loads: a) 10N (b) 50N.



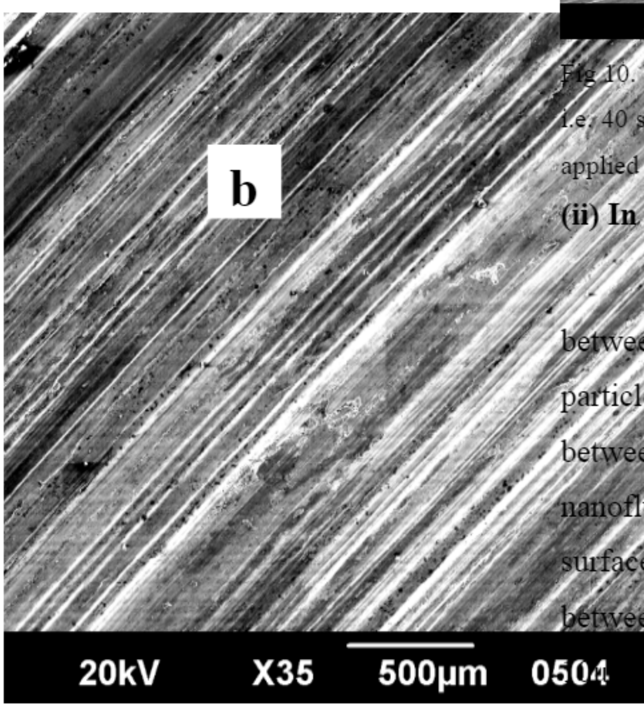


Fig. 9. Wear surface of the EN8 (in flame hardening condition i.e. 25 sec) in dry sliding condition for (a) 20N (b) 50 N of applied load and 0.26 m/s of sliding speed.

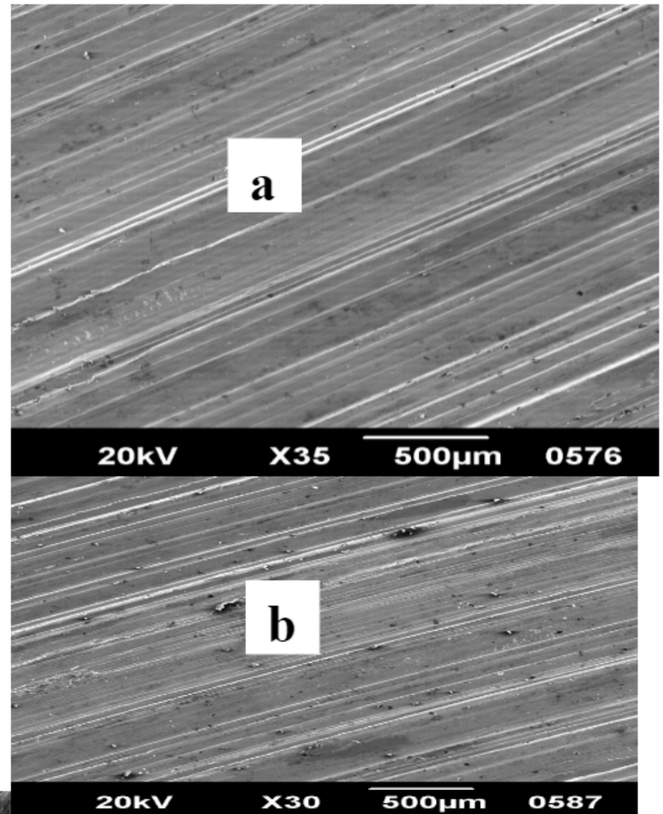


Fig 10. Wear surface of the EN8 (in flame hardening condition i.e. 40 sec) in dry sliding condition for (a) 20N (b) 50 N of applied load and 0.26 m/s of sliding speed

(ii) In lubricated condition

Lubrication reduce the frictional coefficient between the two mating surface. In this case, nano particles of ZnO in ethylene glycol act lubricant between the mating surface and known as nanofluid. The nanofluid between the mating surfaces provides the extra path to bear the load between the machining components. To say about nanofluid was used during the investigation of the results. With increase the amount of the nanofluid between the machining components, the coefficients of friction starts to reduce from 0 to 100μmL. From the study of the whole results, it has been found that there are two type of the operative mechanism is responsible for the reduction of coefficients of friction between the mating surfaces. The mechanisms responsible for reduction are to reduce the load between the machining components and high thermal conductive of used nanofluid.

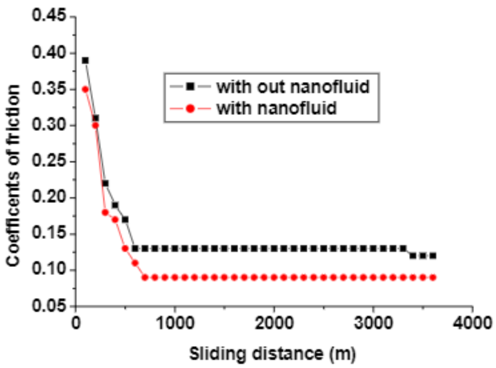


Fig.11: Friction coefficient variation of EN8 sample in flame hardening condition during sliding time at fixed specific loads and sliding speeds in presence of nanofluid.

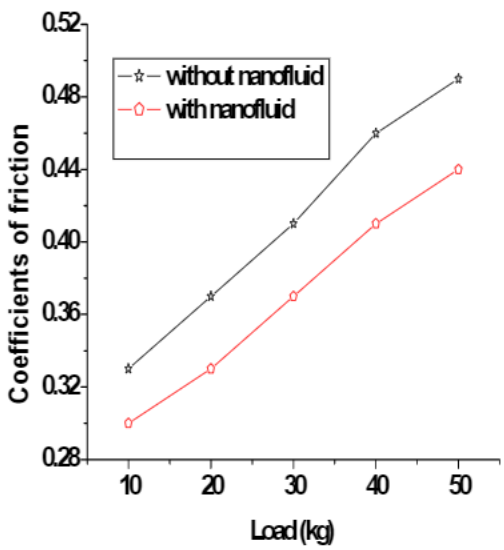


Fig. 12. Coefficient of friction vs. applied load for EN 8 stainless steel

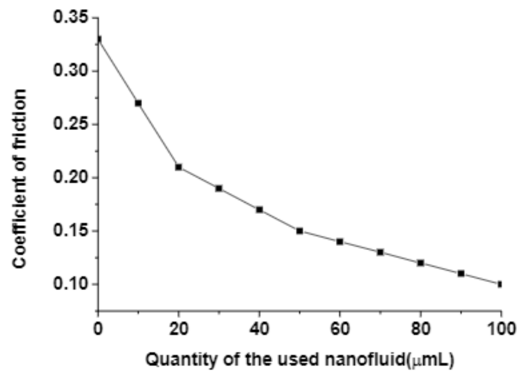


Fig. 13. Coefficient of friction vs. quantity of used nanofluid (μmL)

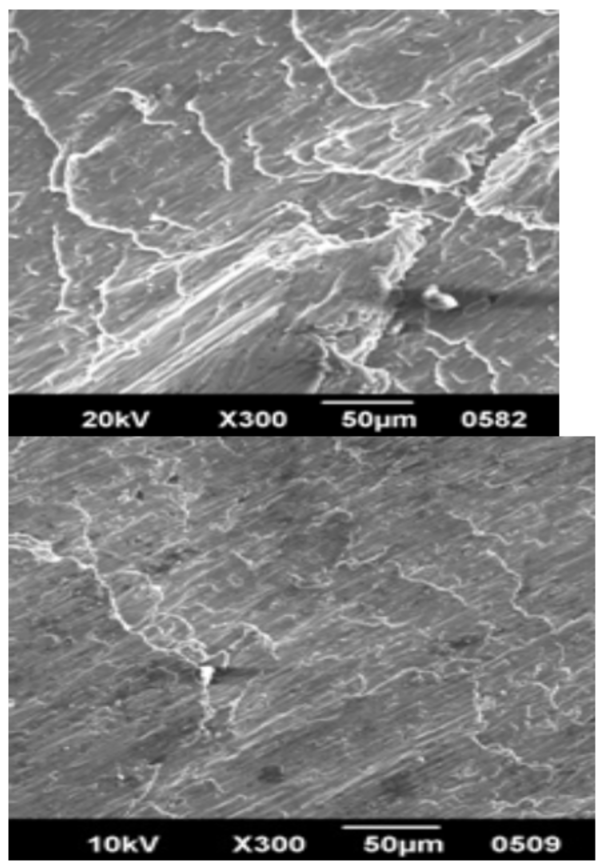


Fig 14. SEM image of Worn surface in presence of nanofluid at the different load (a) 3Kg (b) 5Kg.

IV. CONCLUSION

During this investigation, the applied load, sliding velocity and distance were constant. Initially the reduction increment in coefficients of friction is fast 50-60μmL, but later the reduction is very slow.

V. FUTURE SCOPE

From the study of the whole results, it has been found that there are two types of operative mechanism are responsible for the reduction of coefficients of friction between the mating surfaces. The mechanism responsible for reduction is reduction of the load between the machining components and high thermal conductive of used nanofluid. This type of result is never obtained in case of lubricants. Lubricants only reduce the friction between the machining components not to convey the heat from the convention processes from the mating surface to the surrounding environments.

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