ENHANCING ENGINE OIL PERFORMANCE USING NANOPARTICLES AND BIO-LUBRICANTS AS ADDITIVES

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THE PROBLEM

Environmental pollution and depletion of fossil fuel reserves by internal combustion (IC) engines[1-3].

PROPOSED SOLUTION

Optimize lubrication to reduce friction, wear. Improve fuel consumption with reduced exhaust emissions.

METHODOLOGY

Formulation of a novel lubricant using nanoparticles and bio-lubricants as additives.

3 segments of experiments:

- Nanoparticle synthesis and characterization
- Blending lubricants
- Performance tests

3 groups of sample blends:

- Mineral oil with nanoparticles
- Mineral oil with coconut oil
- Coconut oil with nanoparticles, all in various concentrations.

RESULTS

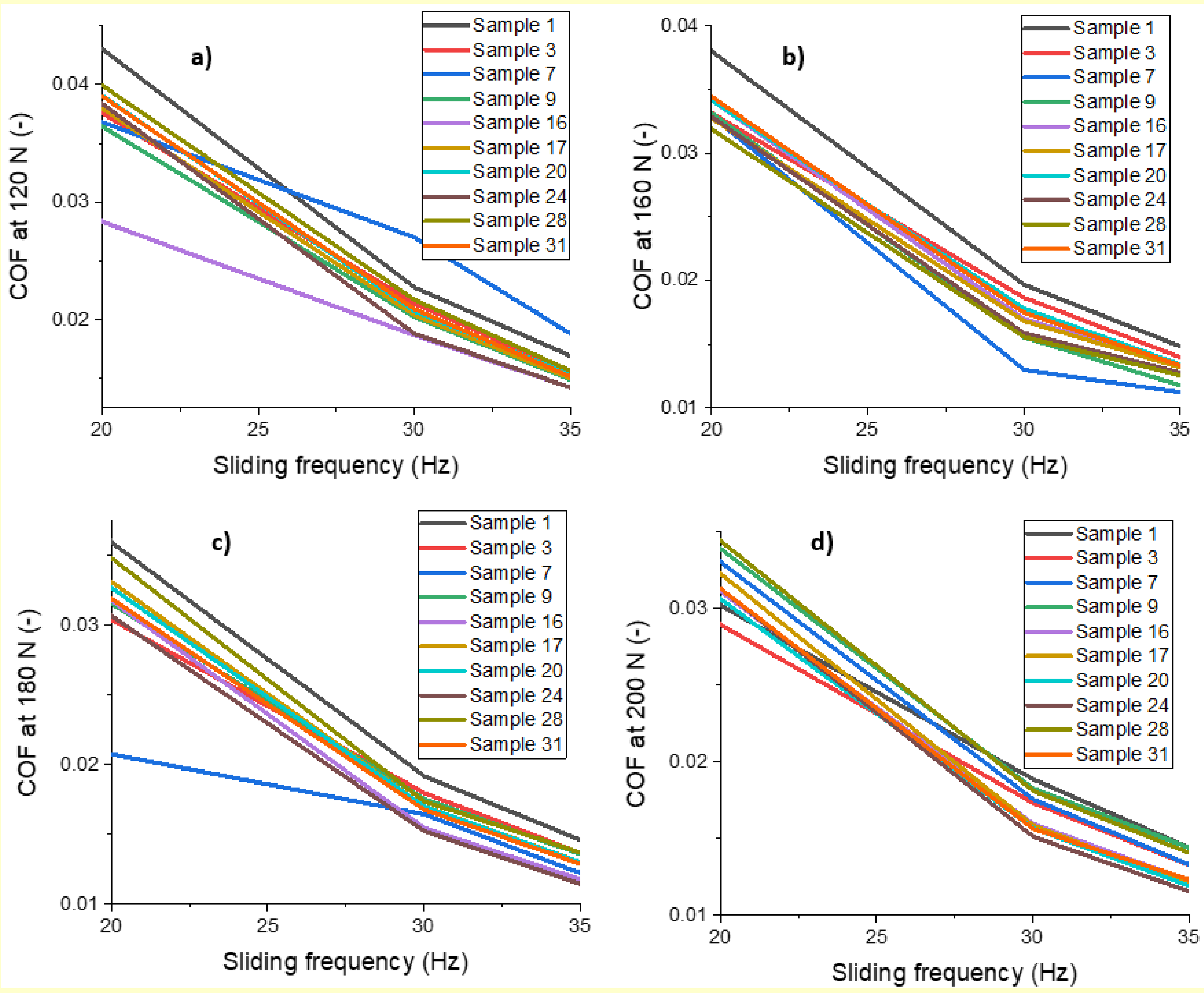

Figure 1: Friction tests phase II, using Linear Reciprocating Tribometer (LRT) with varying loads and sliding velocities @ 140⁰ C for selected blends with optimum additive concentrations.

Sample 1 – Mineral oil (15W40; reference oil)
Sample 3 – 15W40 + n-Al_2O_3, 0.1 wt %
Sample 7 – 15W40 + n-TiO_2, 0.25 wt %
Sample 9 – 15W40 + graphene, 0.1 wt%
Sample 16 – 15W40 + Coconut oil 88 v/v %
Sample 17 – CCO + n-Al_2O_3, 0.1 wt %
Sample 20 – CCO + n-TiO_2, 0.1 wt %
Sample 24 – CCO + graphene 0.25 wt %
Sample 28 – 15W40 + n-TiO_2/graphene 0.05 wt %
Sample 31 – CCO + n-TiO_2/graphene 0.05 wt %

Sample name and lubricant formulation.
Key: n – nanoparticle, CCO – coconut oil

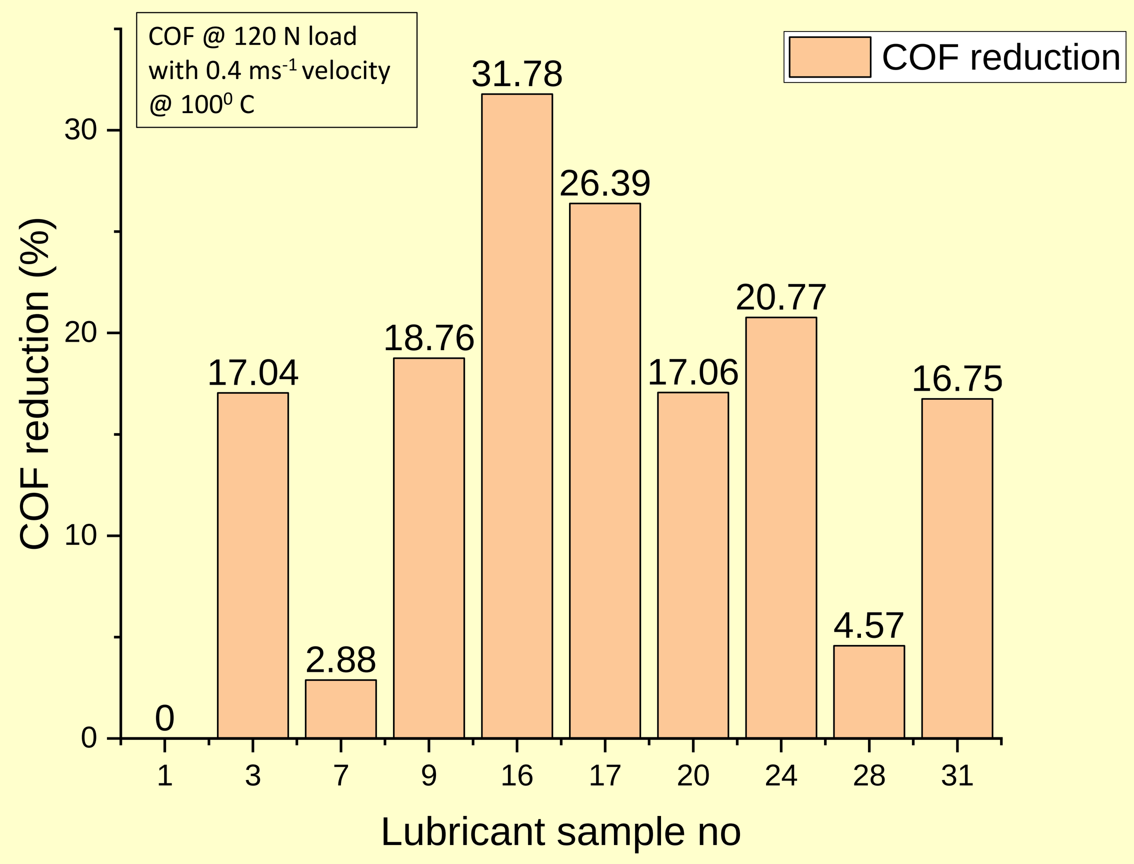

Figure 2: Coefficient of Friction (COF) reduction (%) for selected sample blends with optimum additive concentration to reduce friction, with reference to mineral oil 15W40.

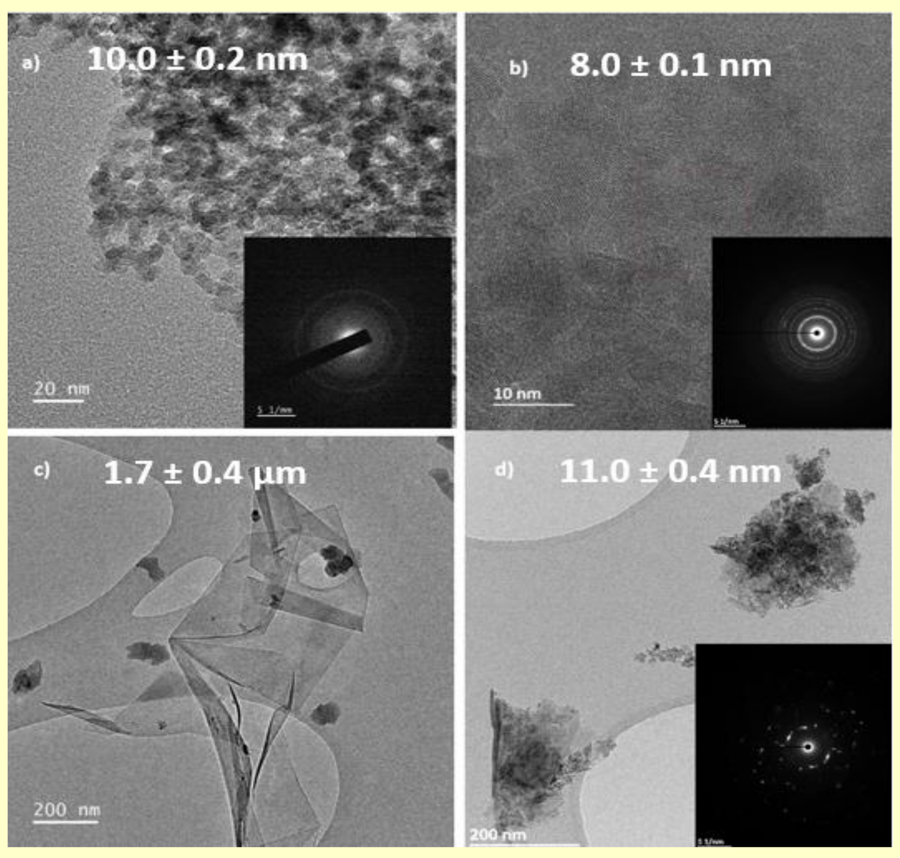

Figure 3: TEM and SAED (inset) images for a) n-Al_2O_3, b) n-TiO_2, c) graphene and d) n-TiO_2/r-GO

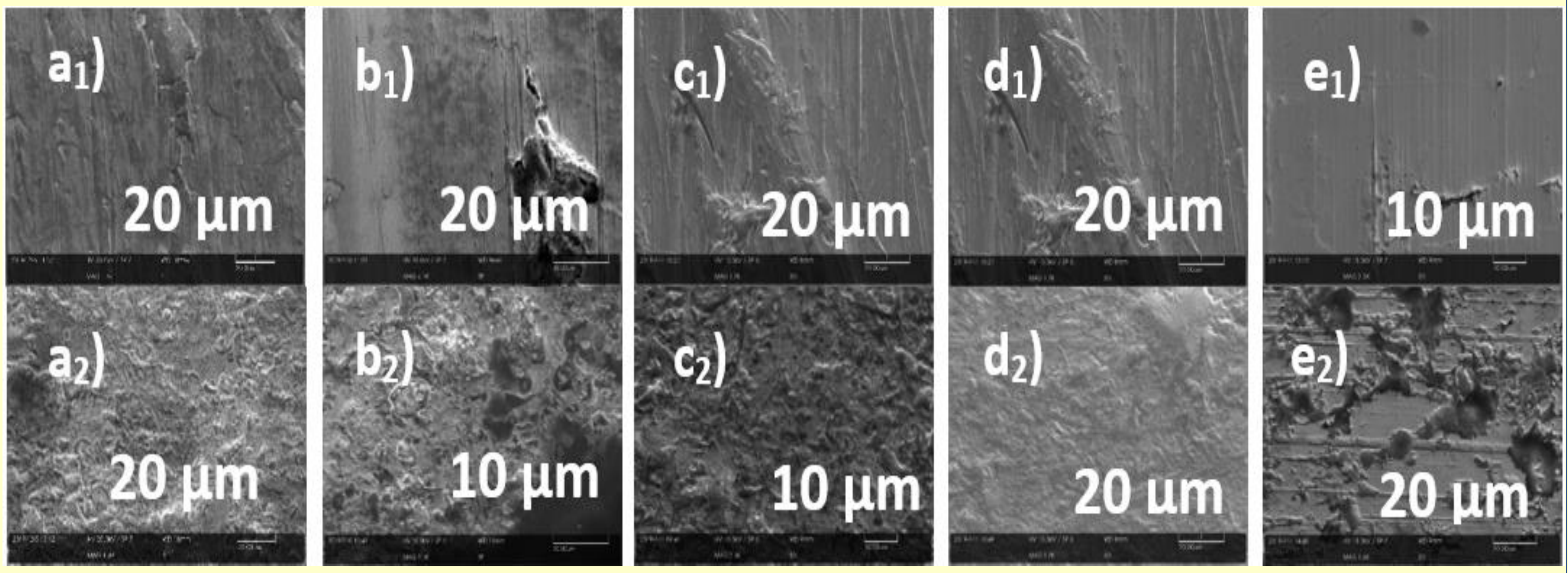

Figure 4: SEM images for wear scars of test specimens after second phase LRT tests, subscripts 1 and 2 for cylinder liner and piston ring segments respectively; a) blank (without test), b) sample 1 (reference oil), c) sample 9, d) sample 16 and e) sample 24

SUMMARY

- The research findings revealed that, the blending of coconut oil and graphene (sample 24) showed the highest performance in reducing friction and wear under simulated IC engine condition.
- Agglomeration of nanoparticles within base stocks, poor cold flow (high Pour Point) and poor oxidative stability (Total Base Number, TBN) of coconut oil are substandard; thus an optimization of these characteristics is currently underway.

ACKNOWLEDGMENT

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