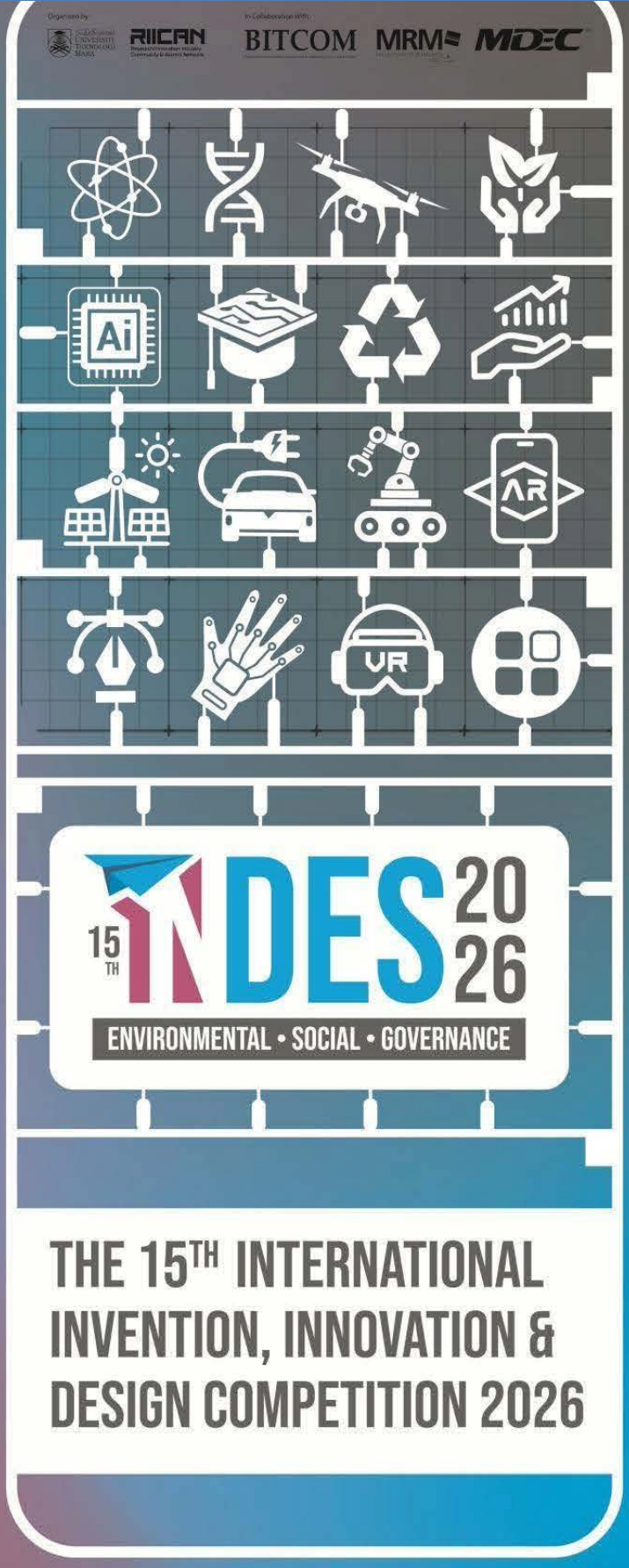

E-BOOK OF

EXTENDED ABSTRACT

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THE 15th INTERNATIONAL
INVENTION, INNOVATION &
DESIGN COMPETITION 2026

Organized by:
Office of Research, Industry,
Community & Alumni Network
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GEARBOX FRESHNESS

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ABSTRACT

Automatic gearbox fluids, or ATFs, are essential to the smooth operation and performance of vehicle gears. It is crucial for power transmission as well as lubrication, cooling, and cleaning. A significant breakdown occurred because the ATF's function failed during its operation before its life cycle ended, due to the depletion of its additive ingredients. By restoring depleted performance components (anti-wear, friction modifiers, antioxidants, detergents/dispersants, and corrosion/foam inhibitors) and stabilizing oxidation and deposit management, the developed ATF treatment oils are designed to revitalize used ATF. The ATF treatment was created using Group II 150N base oil and the necessary lubricant additives. To provide regulated heating and continuous mixing, a three-neck round-bottom flask is put in an oil bath (paraffin oil) on a hot plate magnetic stirrer. Under carefully regulated heating and stirring settings, the additives were mixed into the base oil. To further enhance the dispersion of some chemicals, small changes to the addition sequence and blending time are being examined, particularly focusing on how these adjustments can improve the overall effectiveness and stability of the final product. To ensure that the product was thoroughly mixed, its viscosity and quality were assessed using FT-IR (Fourier-transform infrared spectroscopy) and GCMS (gas chromatography-mass spectrometry). The product shows promising results when added to used ATFs with significant effects on the kinematic viscosity improvement and restoration of elements helping improve friction conditions.

Keywords: Lubricant Additives; Surface Protection; Friction Control; Wear Mechanism; Tribo-film Formation; Lubricant Additives.

1. INTRODUCTION

The continuous degradation of automatic transmission fluids (ATFs) that happens throughout service because of high temperature, shear stress, and oxidation causes increased friction, wear, and decreased efficiency. Although ATFs are vital for power transfer, lubrication, and thermal management in transmission systems, they gradually deteriorate over time. To solve this problem, additive-based formulations are utilized to improve lubricant performance and increase service life. These formulations accomplish this goal by enhancing wear resistance, friction control, and viscosity stability without requiring complete fluid replacement. Despite these advantages, it is still required to conduct systematic evaluations to determine whether treatment formulations are efficient in restoring deteriorated fluids and in interacting with currently present components. Within the scope of this investigation, a treatment oil formulation was produced and evaluated through the utilization of viscosity measurement, elemental analysis, and four-ball wear testing to evaluate its physicochemical and tribological performance. The goal is to assess whether the formulation improves lubrication behavior and lowers wear, contributing to increased gearbox reliability and a more cost-effective maintenance approach.

2. METHODOLOGY

2.1 Materials and Composition

The materials were prepared, and the composition ratio of the products can be summarized in Table 1.

Table 1: Material and composition ratio

	Ratio, %
Base oil (Group II 150N)	82
Diester	9.6
Dispersant	2.6
Calcium phenate	0.7
Magnesium sulfonate	0.3
Zinc naphthenate	0.2
ZDDP	0.7
Amine antioxidant	0.4
Rust inhibitor	0.5
Antifoam	0.02

2.2 Blending Process

According to Aidil et al. (2025), the formation of the treatment oil for automatic gearbox fluid (ATF) was accomplished by means of a regulated blending procedure. This step was taken to guarantee stability, clarity, and the appropriate dispersion of additives. Using a three-neck round-bottom flask, the Group II 150N base oil was heated to approximately 60 degrees Celsius before being stirred continuously. To enhance the solvent's ability to dissolve, dispersant and detergent additives were added and stirred for ten minutes (Ahmed et al., 2015). After that, the solution was cooled to a temperature lower than sixty degrees Celsius before the anti-wear ingredient was added, then the antioxidant was added, and the mixture was agitated for an additional ten minutes to enhance the wear protection and oxidative stability (Aidil et al., 2025). According to Costello (2017), a rust inhibitor was gradually added to the mixture to improve corrosion resistance, and a minor amount of antifoam was added to prevent foaming. Finally, the mixture was brought down to fifty degrees Celsius and let the bubbles vanish, resulting in an ATF (automatic transmission fluid) treatment oil that was transparent and stable. (Barrett & Williams, 2012) The formulation was validated by utilizing viscosity measurement as well as chemical analysis through FT IR and GC MS.

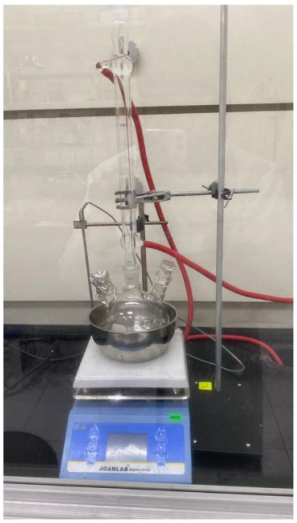

Figure 1: Blending Process

2.3 Product Verification

The product was tested for its viscosity, and the chemical bonding of the mixture was observed through FT-IR and GC-MS.

3. FINDINGS

3.1 Kinematic Viscosity, FT-IR, and GC-MS

It was observed that the product can restore used ATF to nearly its fresh condition as observed in Figure 2, Figure 3, and Figure 4.

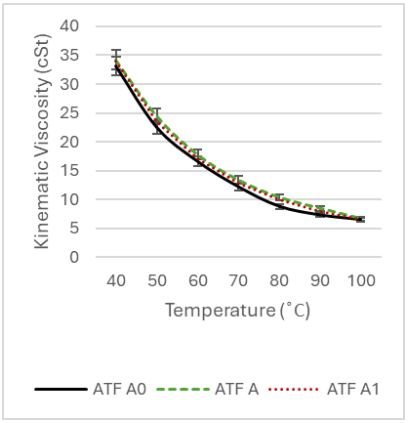

Figure 2: The kinematic viscosity of ATF

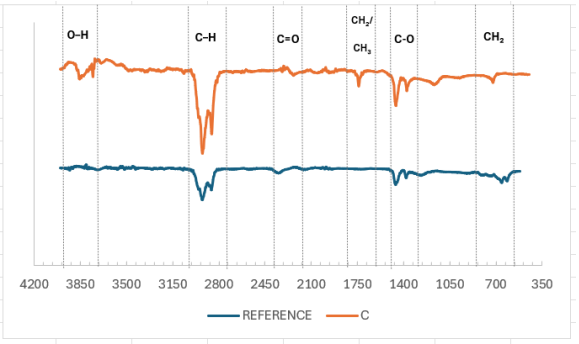

Figure 3: FTIR spectra of treatment oils

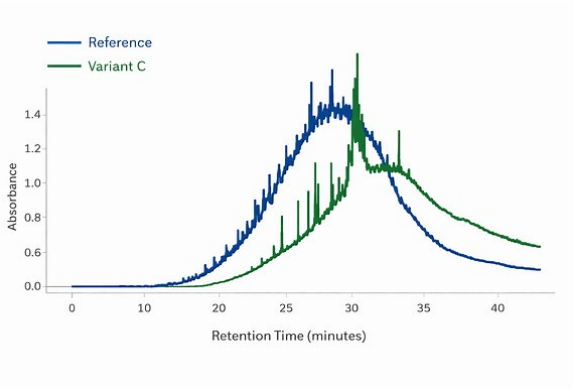

Figure 4: GC-MS spectra of treatment oils

4. CONCLUSION

The developed ATF treatment has a favorable effect on renewing worn gearbox oils by restoring lost additives and properties. The blending process ensured that the oil was stable, transparent, and thoroughly blended, and tests for viscosity, FT IR, and GC MS revealed that the additives were properly added. Overall, the treatment improved the smoothness and durability of gearboxes, providing a valuable and cost-effective method for increasing reliability and extending their lifespan.

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