

# [Experimental investigations on a diesel engine engineering essay](https://assignbuster.com/experimental-investigations-on-a-diesel-engine-engineering-essay/)

[](https://assignbuster.com/)[Engineering](https://assignbuster.com/essay-subjects/engineering/)

MULTIWALLED CARBON NANOTUBES BLENDED BIODIESEL FUELSPrajwal Tewari, Eshank Doijode, N. R. Banapurmath2, V. S. Yaliwal31Students, 2Professor, B. V. B. College of Engineering and Technology, Hubli 580031, India3Assistant Professor, S. D. M. College of Engineering and Technology, Dharwad 580 002, Karnataka, IndiaCorresponding author: nr\_banapurmath@rediffmail. com, nr\_banapurmath@bvb. eduABSTRACTExperimental investigations were carried out to determine performance, emission, and combustion characteristics ofdiesel engine using multi walled carbon nanotubes (MWCNTs) blended biodiesel fuels. The fuel combinations used forthe study were neat diesel for base line data generation, and CNT blended –biodiesel. The biodiesel was prepared fromhonge oil called Honge Oil Methyl Ester [HOME]. The MCNTs were blended with the biodiesel fuel in the massfractions of 25 and 50 ppm with the aid of a mechanical homogenizer and an ultrasonicator. Subsequently, the stabilitycharacteristics of MWCNT blended –biodiesel fuels were analyzed under static conditions. The investigation were carried out using an experimental set-up consisting of a single-cylinder diesel engine coupledwith an eddy current dynamometer loading device, an MRU 1600s five gas analyzer, a Hartridge smoke meter, and adata-acquisition system comprising a high pressure piezoelectric pressure sensor and a crank angle encoder. All theexperiments were conducted at a constant speed of 1500 rpm and the results revealed that a considerable enhancementin the brake thermal efficiency and substantial reduction in the harmful pollutants due to the incorporation of MWCNTsin the biodiesel fuels were observed. Keywords: Carbon nanotubes, Ignition delay, Diesel engine, Honge oil, HOME, Biodiesel, Ultrasonicator, Emission. 1. INTRODUCTIONThe diesel engines are considered to be fuel efficientand sturdier than gasoline engines. However, theyproduce hazardous emissions such as oxides of nitrogen(NOx), particulates of matter, smoke, and obnoxiousodour in high magnitudes. To ameliorate theperformance and to reduce the emissions from the dieselengines, various techniques such as fuel modification, engine design alteration, exhaust gas treatment, etc. have been tried. Several researchers have contributedtheir efforts on fuel modification techniques in whichsome chemical reagents are incorporated along with theconventional diesel fuel. One of the fuel modificationtechniques is the water–diesel emulsion, whichcomprises diesel, water, and surfactant in specificproportions. The water in the emulsion is suspended inthe fuel by a suitable surfactant and does not allow thewater to come into direct contact with the enginesurface [1]. Many researchers have reported on variousnano–particles for diesel engine applications. In view ofthis, many new approaches and advances innano-technology are being directed to use nano-fuel as apotential secondary energy carrier [2]. Nano particleblended fuels are known to exhibit significantlydifferent thermo physical properties when compared tobase fuels. At nano meters scale the surface – area -tovolume ratio of the particle increases considerably andthis enables a larger contact surface area during rapidoxidation process [3]. For instance, due tosize-dependent properties, energetic materialscontaining nano-particles can release more than twicethe energy of even the best molecular explosives [4]. Several studies have reported lower melting points andlower heats of fusion for decreasing sizes of metalparticles [5, 6, 7]. Yetter et al. [8] have criticallyreviewed the reports on metal nano-particlescombustion and revealed that the nano-size metallicpowders possess high specific surface area and potentialto store energy, which leads to high reactivity. In theirdetailed report on nano-particle combustion, they havestated that adding nano-catalyst to the hydrocarbonfuels (such as diesel) will reduce the ignition delay andsoot emissions. 2. USE OF MULTIWALLED CARBON NANOTUBES (MWCNT’s)Marquis and Chibante’s [10] work on carbonnano-tubes (CNT) indicated that the suspended CNT ina base fluid will enhance the surface-area-to-volumeratio and settling time. Based on the above literature onthe potential applications of CNT, Sadhik Basha andAnand [11] have experimentally investigated theperformance and the emission characteristics of a dieselengine using CNT blended diesel. They observed asubstantial enhancement in the brake thermal efficiency © IJETAE2013 73 ICERTSD2013-04-201Int. J Emerging Technology and Advanced EngineeringISSN 2250-2459, Volume 3, Special Issue 3: ICERTSD 2013, Feb 2013, pages 72-76and reduced harmful pollutants compared to that of neatdiesel. This is assumed to be due to better combustion. The same team have critically reviewed the applicationsof nano-particle/nano-fluid in diesel engines andconcluded that adding suitable proportion ofnanoparticles/CNT to the conventional fuels such asdiesel will reduce the evaporation time, which in turnfavours shorter ignition delay. Owing to the potentialproperties of nano-particles/CNT, the present work isaimed at establishing the effects on the performance, emission, and combustion characteristics of asingle-cylinder, direct-injection diesel engine usingCNT blended water–diesel emulsion fuel. Therefore, nano-particles can function as a catalyst and an energycarrier, as well. In addition, due to the small scale ofnanoparticles, the stability of the fuel suspensionsshould be markedly improved. Recently, Sajith et al. [9] conducted an experiment insingle-cylinder diesel engine by dosing ceriananoparticles (20–80 ppm) to the jatropha biodiesel andfound a significant reduction in NOx and HC levels, andimprovement in the brake thermal efficiency. They alsoobserved that adding ceria nano-particles to the basefuel acts as an oxygen buffer, which leads to highcatalytic combustion activity owing to their enhancedsurface-area-to-volume ratio characteristics [8]. Kao etal. [7] carried out an experimental investigation in asingle-cylinder diesel engine using aluminiumnanoparticles blended diesel with varying waterconcentration and found significant improvement in theperformance characteristics and substantial reduction inthe harmful pollutants level of smoke and NOx due tothe effect of improved combustion [9]. 3. EXPERIMENTAL SET UPThe experimental investigations were carried out in twophases. In the first phase, the various physicochemicalproperties of modified bio diesel were determined andcompared with those of the base fuels. The propertiesstudied were the flash point, kinematic viscosity, calorific value, pour and cloud points. In the second stepextensive performance, combustion and emission testswere conducted on a single cylinder four stroke directinjection compression ignition engine using themodified and base fuels. Figure 1 shows the schematicexperimental set up. Eddy current dynamometer wasused for loading the engine. The fuel flow rate wasmeasured on the volumetric basis using a burette andstopwatch also. The emission characteristics weremeasured by using HARTRIDGE smoke meter andAVL make equipment during the steady state operation. The tests were conducted with diesel, and HOME –nano particle blends combination and compared withdiesel operation. The specification of the compressionignition (CI) engine was given in Table 1. Injectiontiming and injection pressure for diesel and HOME –MWCNT operation are kept at their optimumconditions, viz. 23° BTDC and 230 bar for diesel and19 ° BTDC, 230 bar for HOME- MWCNT blend. Themethod of preparation of the fuels with the MWCNTalong with the experimental methods for obtaining thefuel properties are given in the Table 2 and 3. Fig. 1 Experimental set upTable 1 Specification of test rigTable 2 Material properties of nano – particlesamples used in this study. Sl. no Parameters CNT1 Manufacturer Intelligent Pvt. Ltd2 Bulk/ true density – g/cc 0. 05 – 0. 173 Average particle size (APS)- nm10 – 30Length - 1–2 µm4 Surface area (SSA) m2/g 3505 Purity - % 95Table 3 Properties of HOME - nano – particle blendsamples used in this studyType of fuel Density @15oCDiesel 840HOME 880HOME25CNT 898HOME50 CNT 900SlNoEngine specificationParameters Engine1 Type of engine Kirlosker make Singlecylinder four stroke directinjection diesel engine2 Nozzle openingpressure200 to 205 bar3 Rated power 5. 2 KW (7 HP) @1500 RPM4 Cylinder diameter(Bore) 87. 5 mm5 Stroke length 110 mm6 Compressionratio17. 5 : 1© IJETAE2013 74 ICERTSD2013-04-201Int. J Emerging Technology and Advanced EngineeringISSN 2250-2459, Volume 3, Special Issue 3: ICERTSD 2013, Feb 2013, pages 72-764. HOME – MWCNT BLENDS PREPARATIONIn the first step, the CNT are weighed to apredetermined mass fraction of 25ppm and dispersed inHOME (5 per cent by volume) using ultrasonicator setat a frequency of 40 kHz, 120W for 30 min. This, theCNT blended – HOME fuel is prepared and the sameprocess is carried out for the mass fraction of 50ppmCNT blended biodiesel fuel. 5. RESULTS AND DISCUSSIONSDuring the experiment, injection timing, injectionopening pressure and compression ratio were kept at 23oBTDC, 205 bar and 17. 5 for diesel operation and 190BTDC, 230 bar and 17. 5 for HOME – MWCNT blendrespectively. 5. 1 VARIATION OF BRAKE THERMALEFFICIENCYFig. 2 shows variation of brake thermal efficiency forHOME and HOME-MWCNTs blended fuels. TheHOME operation resulted in inferior performance dueto its higher viscosity (nearly twice diesel) and lowervolatility and lower calorific value. However the brake thermal efficiency of theMWCNTs-HOME blended fuels was observed to bebetter compared to neat HOME operation. This couldprobably be attributed to the better combustioncharacteristics of MWCNTs. In general, the nanosizeparticles possess high surface area and reactive surfacesthat contribute to higher chemical reactivity to act as apotential catalyst [22]. In this perspective, the catalyticactivity of MWCNTs could have improved due to theexistence of high surface area and active surfaces. Moreover, in case of HOME50MWCNT fuel, thecatalytic activity may be enhanced due to the highdosage of MWCNT compared to that ofHOME25MWCNT. Due to this effect, the brakethermal efficiency is higher for HOME50MWCNTcompared to that of HOME25MWCNT. The maximumbrake thermal efficiency for HOME50MWCNT is25. 0% whereas it is 24% for HOME25MWCNT, compared to 23% for HOME and 28% for neat diesel, atthe 80% load respectively. Fig. 2 Variation of brake thermal efficiency with brakepower5. 2 VARIATION OF SMOKE OPACITYThe smoke opacity for HOME and HOME-MWCNTsblended fuels shown is shown in Fig. 3. The HOMEoperation resulted in higher smoke opacity compared todiesel due to its heavier molecular structure and lowervolatility. However reduced smoke opacity is observedin the case of MWCNTs-HOME blended fuels. Thiscould be attributed to shorter ignition delaycharacteristics of MWCNTs-HOME blended fuels. Thesmoke opacity for HOME50MWCNT is 59 HSUwhereas it is 63 HSU for HOME25MWCNT, comparedto 78 HSU for HOME and 52 HSU for neat diesel, at the80% load respectively. Fig. 3 Variation of smoke opacity with brake power5. 3 VARIATION OF HC EMISSIONThe unburnt HC emissions for HOME andHOME-MWCNTs blended fuels are shown in Fig. 4. The HC emission for HOME operation is highercompared to diesel due to its lower thermal efficiencyresulting in incomplete combustion. Type of fuel Flashpoint, oCKinematicViscosity, cSt@ 40oCNetcalorificvalue, MJ/kgDiesel 56 2 -3 43HOME 170 5. 6 36. 016HOME25CNT 166 5. 7 34. 56HOME50 CNT 164 5. 8 35. 10© IJETAE2013 75 ICERTSD2013-04-201Int. J Emerging Technology and Advanced EngineeringISSN 2250-2459, Volume 3, Special Issue 3: ICERTSD 2013, Feb 2013, pages 72-76However HC emissions are marginally lower for theHOME-MWCNTs blended fuels than HOME. Thiscould be due to catalytic activity and improvedcombustion characteristics of MWCNT, which leads toimproved combustion. The HC emission for HOME50MWCNT is 58 PPMwhereas it is 70 PPM for HOME25MWCNT, comparedto 82 PPM for HOME and 32 PPM for neat diesel, at the80% load respectively. Fig. 4 Variation of hydrocarbon with brake power5. 4 VARIATION OF CO EMISSIONThe CO emissions for HOME and HOME-MWCNTsblended fuels are shown in Fig. 5. The CO emission forHOME operation is higher compared to diesel due to itslower thermal efficiency resulting in incompletecombustion. However CO emissions are marginally lower for theHOME-MWCNTs blended fuels than HOME. Thehigher catalytic activity and improved combustioncharacteristics of MWCNT, leading to improvedcombustion could be the reason for this performance. CO emissions for HOME50MWCNT are 0. 21%whereas it is 0. 3% for HOME25MWCNT, compared to0. 45% for HOME and 0. 1 for neat diesel, at the 80%load respectively. Fig. 5 Variation of carbon monoxide with brake power5. 5 VARIATION OF NOX EMISSIONFig. 6 shows variation of NOx emission for HOME andHOME-MWCNTs blended fuels. For HOME operationNOx emissions were lower as compared to dieseloperation. Heat release rates of HOME were lowerduring premixed combustion phase, which will lead tolower peak temperatures. Nitrogen oxides formationstrongly depends on peak temperature, which explainsthe observed phenomenon. Furthermore, HOME-MWCNTs blended fuels produced higher NOxemission compared to that of HOME. This is becauseof reduced ignition delay that resulted in higherpremixed combustion fraction and higher peaktemperatures observed with HOME-MWCNT blends. The NOx emission for HOME50MWCNT is 750 PPMwhereas it is 600 PPM for HOME25MWCNT, compared to 580 PPM for HOME and 800 PPM for neatdiesel, at the 80% load respectively. Fig. 6 Variation of nitric oxide with brake power6. CONCLUSIONSThe performance, and the emission characteristics ofHOME HOME-MWCNTs blended fuels wereinvestigated in a single-cylinder, constant speed, direct-injection diesel engine. Based on the experimental data, the followingconclusions have been drawn. 1. The brake thermal efficiency HOME-MWCNTsblended fuels were relatively better as compared tothat of HOME. 2. HOME operation resulted in poor performance interms of increased smoke, HC, CO emissions ascompared to neat diesel operation. 3. The NOx emissions were relatively less for HOMEas compared to that of HOME-MWCNTs blendedfuels operation. 4. Ensuring higher dispersion of MWCNTs in HOMEis still a subject of research. The study is limited tomaximum of 50 ppm of MWCN