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Noise Generated by Single Cylinder Petrol Engine

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ABSTRACT

At present, rapidly expanding environment one of the developingproblems is that of "Noise". The purpose of this Paper is to the study the harmfuleffects of noise on human beings. In India, the transportation sector is growing rapidlyand number of vehicles on Indian roads is increasing at very fast rate. This has lead toovercrowded roads and noise pollution. Engine noise is one of the major sources ofnoiseinvehicles. So, it is necessary to study noise generated by two stroke petrol engines atdifferent speeds and loads. First the sound pressure level is measure in dB (A) near theengine at four different locations at distance of 0.5m from centre of each side of anengine to find out that location where sound pressure level is maximum. Sound poweriscalculated using rectangularparallelepipedatdifferentspeedsandloads. Vibration analysis has been carried out to measure acceleration and velocity atthat location where sound pressure level is maximum. Frequency spectrum analysis isdone tomeasure soundpressurelevelin1-1octaveband. The study of noise generated by two stroke petrol engine is carried out with orwithout mufflers to check the effectiveness of the muffler. There are three differenttypes of mufflers used in this study out of which two are reflective type of muffler andoneishybridtypeofmuffler.It isfoundthat thebestmufflerisofhybridtype.

Keywords: Research Paper, Technical Writing, Science, Engineering and Technology

I. INTRODUCTION

1.1. Introduction to Noise

In our modern world, rapidly expanding environment one of the developingproblemsis thatof noise.Apart from the pure annoyance factorof noise,exposure toanintensesoundfieldoveralongperiodoftimepresentst heriskofpermanentdamageofhearing. This particularproblem isbecoming asource ofseriousconcerntoindustrialcorporations,tradeunions andcompanies.

The object of this part is to discuss the concept of noise,problemsof noise and itseffectonmanandenvironmentbothasannoyanceanda sadangertohealth.

Themajorsourcesofnoiseare:

i) Industrialnoise
ii) Trafficnoise
iii) communitynoise

Noise: Noiseisconveniently andconciselydefinedas "unwanted sound".Sound: Soundwavesare pressure variationsproducedas a resultofmechanicaldisturbanceinamaterialmedium

1.2. SoundSources

Adistinctionismadebetweenthreedifferenttypesofsoun dsources:

a) Pointsource
b) Linesource
c) Planesource

Point source: Asoundsourcecanbeconsideredasapointsource,ifitsdimensionsare smallin relationto thedistance to the receiverand it radiatesanequalamountofenergyinalldirections.Typicalpointsourcesareindustrial plants,aircraft and individual road vehicles.

Line source: A line source may be continuous radiation, such as from a pipecarrying a turbulent fluid,ormay be composed of a large numberof pointsourcessocloselyspacedthattheiremissionmaybeconsideredasemanatingfromanationallineconnectingthem.The soundpressure leveldecreases3dB,wheneverthedistancetoalinesourceisdoubled.

Planesource: Aplanesourcecanbedescribedasfollows.Ifapistonsourceisconstrainedbyhardwallstoradiateallitspowerintoanelementaltubetoproducea planewave, the tube will contain aquantity ofenergynumericallyequal to thepower output of the source. In the ideal situation there will be no attenuation along thetube.Planesourcesareveryrareandonlyfoundine.g.,ductsystems.

Whentwosourcesradiatesoundenergy,theywillbothcontributetothesoundpressure level a distance away from the sources. If they radiate the same amount ofenergy and the distance from the point of measurement to the sources is the same, thelevelwillincreaseby3dBcomparedwiththelevelcreatedbyonesourcealone

1.3. UsefulApplications ofNoise

Noiseisnotonlyhavingharmfuleffectsbutsometimesitisveryuseful.Someoftheexampleswhennoiseisuseful:

Study of heart beats: Noiseproducedby theheart beatsisvery useful todiagnosetheperson’shealthaccordingly.

Maskingeffects: Sometimes,itisnecessarythatnobodyshouldheartheconversation betweenthe twopersons. For this,maskingeffectisused.

Fore.g.,inthedoctor’schamber,doctorwantsthatnobody shouldhearhisconversationwith the patientsoDr.usesmaskingeffectbyputtinganoisierexhaustfanwhichmakenoiseoutsidetheroom.

1.4. NoiseMeasuringInstrument

Noisemeasuringdevicestypically use a sensorto receive the noise signalsemanating from a source. The sensor, however, not only detects the noise from thesource,butalso anyambientbackgroundnoise.Thus,measuringthevalue ofthedetected noise is inaccurate, as it includes the ambient background noise. There are somany different types of instruments available to measure sound levels and the mostwidelyusedaresoundlevelmeters.

1.5. Elementsofsoundlevelmeter

Microphone: Mostmeasurementmicrophonesgenerateavoltagethatisproportional to the sound pressure at themicrophone and isthe electrical analog ofsound waves impinging on the microphone’sdiaphragm.The particularmechanismthatconvertsthepressurevariationintosoundwavessignal.Differenttypesofmicrophonesare:

a) Capacitor(Condenser)Microphone
b) Pre-polarizedMicrophone
c) PiezoelectricMicrophone

Amplifier: ItamplifiesthesignalfrommicrophonesufficientlytopermitmeasurementoflowSPL.Itamplifiessoundoverawidefrequencyrange.Itmaintainstheamplification constant.

Rectifier: Itrectifiesthesignalfromanalogsignaltodigitalsignal.

1.6. IntroductionofS.IEngine

Sparkignitionengines(S.IEngine)arethosetypesofenginesinwhichcombustion of fuel takes place inside the engine cylinder. In S.I engine, the fuel isignited by the spark produced by spark plug. Since the combustion of fuel takes placeinside the engine cylinder, so these engines are very noisy. S.I engine is also known aspetrolengine.According to the numberof strokespercycle,itis divided into twotypes:

a) Twostrokeengines
b) Fourstroke engines

1.7. EngineNoise

An engine is a mechanical device that produces some form of output from agiven input. An engine whose purpose is to produce kinetic energy output from a fuelsource iscalled a primemover, alternatively, amotoris adevicewhich produceskineticenergyfrom apreprocessed"fuel"(such aselectricity, aflowofhydraulicfluidorcompressedair).

1.8. CombustionNoise

Combustionnoise is produced because ofunsteady combustion offluid and isoftwo types:turbulentcombustion noise and periodiccombustion oscillationregion.Themechanism issuchthat the pressure waves generated are so phased to the velocity fluctuations. The noisespectrum involvesonespecificfrequencyanditsharmonicsand thatfrequencyisrelated to the resonant modes of the combustion chamber. Some of the possible curesare:

1. Modificationofcombustionchambergeometry
2. Changeofair-fuelratio,burnertypeetc.
3. Changeofburningrate

1.9. MechanicalNoise

Mechanical noise is the noise which is generated by variousimpactsbetweenthe engine parts. This noise source ismore important in the higher frequency rangerather than in lowerfrequency range where combustion noise is important. There arelots of moving parts, for example, gear, valves, and rocker arms, piston and cylinderliner.Someareasfollows:

Engine clicking noise: A clicking or tapping noise that gets louderwhen yourev the engine is probably "tappet" or upper valve-train noise caused by one ofseveralthings:lowoil pressure,excessivevalvelash,orwornordamagedparts.

Collapsed lifter noise: Worn, leaky or dirty lifters can also cause valve-trainnoise.Ifoildeliveryisrestrictedtothelifters(plugged oilgalleyorlowoil pressure), thelifterswon't"pumpup"totakeupthenormalslackinthe valve-train.A"collapsed"lifterwillthenallowexcessivevalvelashandnoise.

Valve lash noise: Toomuch space between the tipsof the rockerarmsandvalve stemscanmake the valve-train noisy, and possibly causeacceleratedwearofbothparts.

Damaged engine parts noise: Excessive wear on the ends of the rocker arms,cam followers(overheadcam engines) and/orvalve stemscan open up thevalvelashandcausenoise.

Rapping or deep knocking engine noise:A deeprappingnoise fromtheengine isusually"rodsknock"aconditionbroughtonbyextreme bearingwear or damage. If the rod bearings are worn or loose enough to make a dull,hammeringnoise.

1.10. PistonSlapNoise

Pistonslapnoiseisgeneratedbythesuddenimpactofthepistontothecylinderwall is considered to be predominantdue to the higher amountof energyreleased.In the compression stroke, the connecting rod pushesthe piston upwardsovercomingthe gas force. The force actingon the pistonhas alateral componentandthe piston slides upwards on the minor thrust side of the cylinderwall. Thus, as thecrank pinpassesthrough the cylindercenterlinebefore the powerstroke. These simple models do not take into accountothers factors whichmay affectthepistonmotionsuchas:

1. Pistonpinoffset.
2. Rockingmotionofpiston.
3. Frictionsatpistonpinaswellaspiston’soutersurface
4. Pistonconfiguration,especiallyunderoperation.

5. Pressuredistributionaroundpistonduetothesqueezingmotionofoilfilm.
6. Complianceofcylinderlinerwall.

1.11. BearingNoise

Crankshaftbearingsare alwaysreplacedwhen rebuilding anengine becausethey are awearcomponent.Heat,pressure,chemical attack,abrasion andlossoflubrication can all contribute to deterioration of the bearings. The above features giverisetothenoise.Someofthefactorsthatcausebearingnoiseareasfollows:

Dirt: Dirt contamination often causes premature bearing failure. When dirt orother abrasivesfind theirway between the crankshaftjournal and bearing, itcanbecomeembeddedinthesoftbearingmaterial.Thesofterthebearingmaterial,thegreatertheembed ability,whichmayormaynotbe agoodthing depending on the size of the abrasive particles and the thickness of thebearingmaterial.

Heat: Heat is another factor that acceleratesbearingwear andmay lead tofailure if the bearingsgethotenough.Bearingsare primarilycooledbyoilflowbetween the bearing and journal.Anything that disrupts or reduces theflow of oil not only raises bearing temperatures but also increases the risk ofscoringorwipingthebearing.

Misalignment: Misalignment is another condition that can accelerate bearingwear. If the centermain bearings are wornmore than the ones towards eitherendof the crankshaft, the crankshaft may be bent or the main bores may be outofalignment.

Corrosion: Corrosion can also play a role in bearing failure. Corrosion resultswhenacidsaccumulateinthecrankcaseandattackthebearingscausingpittingin thebearingsurface.Thisismoreofaproblemwithheavy-dutydieselenginesthat use high sulfurfuel ratherthangasolineengines,but itcanalsohappeningasolineenginesiftheoilisnotchanged oftenenough andacidsareallowedtoaccumulateinthecrankcase.

1.12. SparkKnock(Detonation)

Sparkknock isa knocking, rattlingor pingingnoise thatmay be heardwhenthe engine is accelerating or is working hard under load (driving up a hill, towing atrailer, passingon the highway, etc.). Spark knockmeans the fuel isdetonating. Someofthefactorsthatcausesparkknockareasfollows:

EGRvalvenot working: TheEGRvalveissupposedtoopenwhentheengine is accelerating orlugging underaload. This allows intakevacuum tosuck someexhaustin through the EGRvalve to dilute the air/fuelmixtureslightly.Thislowerscombustiontemperaturesandpreventsknock.

Compression ratio too high: If an engine has been rebuilt and the cylindershave been bored to oversize,it will increase the engine's static compressionratio.Engines that are supercharged or turbochargedare also atmuch higherriskofdetonationbecausetheforcedairinductionsystemincreasescompression.

Engineoverheating: Iftheengineisrunningtoohotbecauseoflowcoolant,a cooling fan that isn't working, a plugged radiator, bad water pump, stickingthermostat,etc.,itmaycausethefueltodetonate.

ExhaustNoise

The engine exhaust noiseoriginatesat theexhaust tailpipe openings and istransmitted through the cabinwalls,firewall, andnose gearbay. Thisis the loudestandmostobjectionablenoiseheard.

Relationbetweennoise, enginedesignandparameters

Despite the numerous exciting forces which almost simultaneously excite theenginestructure.Sincethegasforceresultingfromcombustiontendstobethepredominantforceinmostoftheengines

Thethreebasicparametersofanengineare

1. Speed
2. Size
3. Load

1.13. Enginespeed

The engine structure characteristics can be defined by use of electro-dynamicvibration generators, and the broad response readily established as shown by the solidenvelopline.Itwillbeseenthatwhenthestructureiss ubjectedtoaconstantsinusoidal force itexhibitsmaximum response in the high– frequency range from800-2000Hz.

1.14. Enginesize

Measurement carried out on alarge numberofengineswith engine size isconsiderably less. An increase of size to ten times gives an increase of noise of 17.5dB(A). The detailed investigationsnow indicate that vibration levelsof the enginesurfaces are about the same irrespectiveof theirsize, thus the increaseofnoisewithsizeissimplyduetolargerradiatings urfacearea.

1.15. Engineload

Engine load hasno effect onnoise,which is in agreementwith the findingsthat noise is simply due to the initial ignition the fuel. Thisoccurs at the sameintensitywhethertheengineisrunningatnoloadatal lorfullload.Itcanbeconcludedthat:

a) Thegasforcedeterminestherateofincreaseofnoisew ithenginespeed.
b) Athighenginespeedsthegasforcehasalesssignifican teffectonnoise.
c) Enginenoiseisindependentofthehorsepowerprodu ced.

1.16. Mufflers

A muffler (silencer) is a device for reducing the amount of noise emitted by amachine. In internal combustion engines, the engine exhaust blows out through themuffler.

Typesofmufflers

Mufflerscanbeclassifiedinreflective,absorptiveandhybr idmufflersdependingontheworkingprinciple.

Reflective muffler: Reflective mufflers are those mufflers that uses for soundattenuationbychangingcrosssectionsintheduct.R eflectionmufflersattenuatethesoundbyreflectionandint erference.TheimportanttoolsofReflectivemufflers are analyticmodeling and evaluation ofnetwork theory.ThereflectivemufflerisshowninFig.

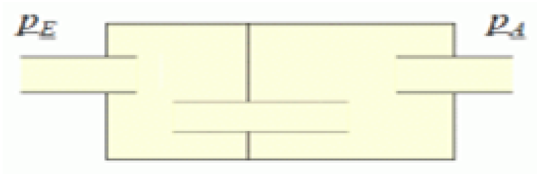

Fig.2.1ReflectiveMuffler

AbsorptiveMuffler: Absorptivemufflersarethosemuffle rsthatusesforsound attenuation by sound absorbingmaterials. Theydissipate the acousticenergy into heat energy through the use of porousmaterials asmineral fiber.TheimportanttoolsofAbsorptivemufflersareabsor bermodelingandnumericalcomputation.Theabsorptive mufflerisshowninFig.

Fig.2.2AbsorptiveMuffler

Hybrid Mufflers: Mufflers that combine the working principle of a reflectivemufflerandan absorptivemufflerare calledhybridmufflers.Thistypeofmuffleristhebestmuffl ertoreducethenoise.

In this study, three different types of mufflers are used out of which two areReflectivemufflersandoneisHybridmuffler.Silencer No.1isHybridtypeofmufflershowninfig.2.3andfig.2.4.

SilencerNo.1

Fig.2.3Hybridmufflerinclosedcondition

Fig.2.4Hybridmufflerincutcondition

SilencerNo.2

Fig.2.5Reflectivemufflerinclosedcondition

II. LITERATUREREVIEW

A lot of research work has been carried out throughout the world to investigateand analyze the noise generatedby two stroke petrolengines atdifferentloadsandspeeds and check the effectiveness of mufflers. A brief review of literature is beingpresentedhere.

2.1. **Mills C.H.G. and Aspinall D.T.** [1] discussed the various sources of the noise in I.C.enginecommercialvehicleandmethodsofnoise reductionbytheuseofhightransmission-lossenclosuresandsound-absorbentandpanel-dampingmaterialsaredescribed. Examples are given on the practical applications of acoustical treatments tothe reduction of the noise within and emitted by typical road haulage vehicles. Usefulreductionscan achieve by palliative treatmentsbut attention isdrawn to the practicalandeconomic difficulties associatedwith incorporation ofsound reducing treatmentsinproductionvehicles.

2.2. **Wonacott E.J.** [2] used the recommendations and established theory to analyze andbuild a series of efficient silencers for general vehicle and stationary engine use. Therecommendeddesignprocedurehasgenerallybeenfoundtobeflexibleinitsapplication and the silencers thusdesigned appear tohave distinct advantagesovertheir current counter parts in relation to design simplicity, ease of manufacture andconsistentattenuationperformance throughouttheir useful life.The resultsofthesetrials are described togetherwithdetailsofmanufacturing and testingproblemsthathasbeenexperiencedinbuildingsuchunits.

2.3. **Bryce W. D. and Stevens R. C. K.** [4]identifiedandunderstand thenoise sourcesthatcontributetotheexhaustnoiseofaircraft gasturbineengines,controlledexperimentshave been carried out to study the noise characteristics of amodel turbo-jetexhaustsystem.Thenoisedatahavebeenrelatedto measurementsoftheaerodynamic conditions in the model and, with the aid of specific diagnostic tests, thepredominantnoisemechanisms are considered to have been recognized.Thenoiseradiation, above thatof the jet,is attributed primarily to dipole sourcesgenerated bytheturbineoutletstruts,thetransmissionofthisnoisebeingmodifiedbyductpropagationandnozzleimpedanceeffects.

2.4. **Jha S. K.** [5] studied the characteristics of noise and vibration in a motor car. Thepredominant frequency regionsinwhich noise levels are high are established. It isshown that themajorpart of the sound energy lieswithin the frequency region below20Hz and iscausedmainlyby roadexcitationbeing transmitted through thewheeland suspension system. The predominant noise in the audible range lies within 30-300Hz frequency band and is produced primarily by body resonances excited by variousengine harmonics. The vibrational and acoustical behavior of the car body at some ofthesecriticalfrequenciesisalsodiscussed.Finally,itisshownthatbystructuralmodificationasubstantialnoisereductioncanbeobtained.

2.5. Mugridge B. D. [6] concerned with the reduction of noise from automotive coolingsystems. A comparison is made between the use of axial flow and centrifugal fans andformulaepresentedforobtainingtheoctavesoundpowerforeachtypeoffan.The disadvantagesofcentrifugalfaninstallationsarehighlightedandaxialfandesignconfigurationsareexaminedwiththeobjectofprovidingoptimizedsystems.Experimental results are presentedfordifferent axial fansandcomparisonsmade ofthe noisemeasurementswith the ingested flowdistortionsmeasured bymeans of ahotwire anemometer.The resultsindicate thelimitsofmaximumnoise reductionwhichmanufacturersmayexpectusingexistingfandesignsandalsoindicatethemethodsforachievingmaximumnoisereductionfortheseconfigurations.

2.6. NakraB.C.,SaidW.K.andNassirA.[11]experimentedonreactivetypesofmufflers- and theircombinationswith absorption types,inordertodetermine theirnoiseattenuationcharacteristics.Testswerecarriedouton atest rig,with aloudspeaker as ainput source aswell as afourcylinderdieselengine.The frequencyspectraofattenuationlevels,obtainedexperimentally,werecomparedwithcorresponding theoreticalpredictions.

2.7. Lim M.K. and Low C.S. [15] designedanengine cylinderpressure dampingdeviceto reduce engine noise by controlling the sharp pressure rise excitation applied to theengine structure by the combustionprocess. The device isa small pistoncontrolledbya spring and dashpot system concerned to the engine cylinder by mounting it on top ofthe cylinderhead.Lab testsshow that therewas asignificant reductioninenginesurface vibrationandnoiseradiated,particularlyathighfrequenciesabove4000Hz.

2.8. Tandara V. [16] studied the radiator fan noise. The combustion engine is only one ofmany vehicle noise sources. Every combustion engine has inner and external noisesources. The coolingfanscanbe importantnoise sources. They are installed to coolthe engine,encasementand the inside of the car. The influence offans is greatin caseofhighambienttemperature,lowtravelingspeedandfrequentstoppages.

III. EXPERIMENTAL SET-UPANDMEASUREMENTS

3.1. ExperimentalSet-up

To study the noise generated by an engine, the parameters like sound pressurelevelarerequiredtostudyindifferentconditionslikespeedandload.Experimentalsetupofsingle-cylindertwo-strokepetrolengineisshowninfig.3.1.

Fig.3.1S. IEngine

3.2. Measurements

Measurement's procedure of different noise parameters contains calculation of soundpower, measurement of sound pressure level at different locations (A, B, C, D and E),measurement of acceleration and velocity for vibration analysis and measurement ofsoundpressurelevelforfrequencyspectrumin1-1octavebandarediscussedbelow:

3.2.1. Measurement of Sound Power: Calculation of sound power is done by twomethodsrectangularparallelopipedandhemisphereparallelopiped.Inthepresentwork,rectangularparallelepipedmethodisusedbecausemaximum dimension of an engine is greater than 1m. In this method, the first step is tomakeagridaccordingtothedimensionsofengine. Lengthbreadthandheight ofengine are 2.86m,2.84m and1.66m.Thegridismade byplacingan engine atcenter positionandwith the helpofwire at requiredpositionsmarkthedifferentpoints.Thereare17Gridpointsformedasshowninfigure 4.2. Sound pressure level can be measured for every grid point for differentspeedsand loads. Speed can be changed by rotating awheel and adjust thevalue of speed as 1100,1500,1900,2300 RPM. Similarly, load can be changedwiththehelpofspringbalancei.e.byrotatingthewheelinclockwisedirection.Value of load ischangedin the stepofone i.e. from 0to 6kg.Value ofSound pressure level ismeasured in A-weighting at slow response.ThemeasureddataforSPLisgivenfrom

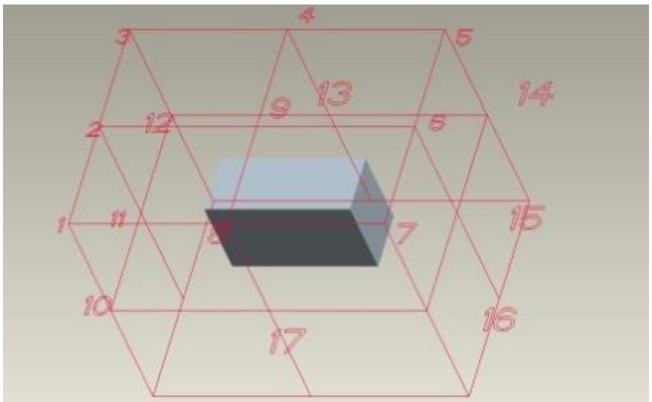

Fig.3.2.1Showing17gridpoints

3.2.2. Measurement ofSoundPressure Level at differentpointsnear Engine:Sound pressure level is measured at five different locations out of which fourlocations(A,B,Cand D)are at adistanceof0.5m from center ateach sideof an engine.The fifth location (E)istaken atexhaust.ThesemeasurementswillhelptofindoutthatlocationwheremaximumSoundpressurelevel occurs.

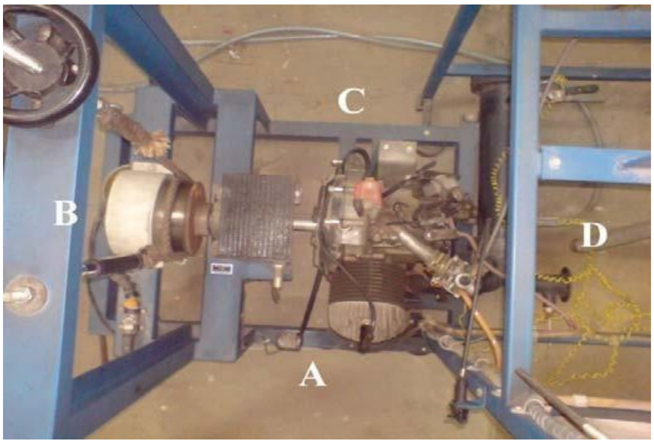

Fig.3.2.2 LocationofpointsA,B,CandD

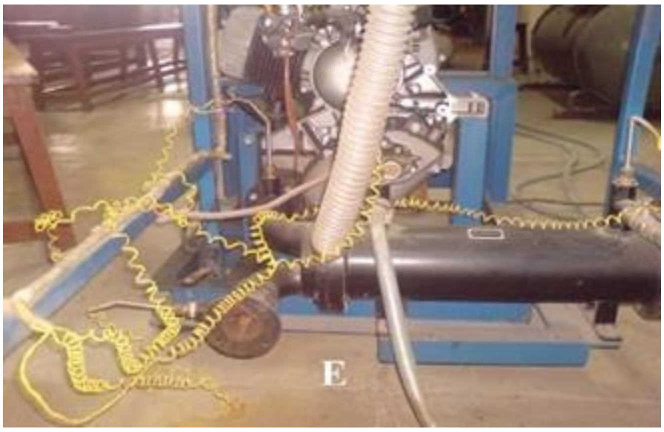

Fig.3.2.3LocationofExhaustpoint„E"

3.3. Measurement for Vibration analysis:One ofthemain causesofnoise isvibration. So, it is necessary to study the vibration analysis. Acceleration and velocityweremeasuredinvibrationanalysisbyavibrationmeasuringinstrument.Thisinstrumentgivestheresultsforaccelerationinm/s2andvelocityinmm/satanyfrequency between 20Hzto 20 kHz.Thisinstrumenthasfine scale for adjustingfrequency to a finer value. It also has a filtration device which gives reading for 1/1octave band and 1/3 octave band. It consists of a pick-up made up of magnet which isattachedtothemachinebody.

Fig.3.3VIBRATIONMEASURING INSTRUMENT

Acceleration and velocity were measured at that location where the value of soundpressure level is maximum i.e. at location B. The vibration pick-up is attached to thefoundationnearlocationB.

3.4. MeasurementofSoundPressureLevelforFrequencySpectrumin 1-1Octave band: The value of sound pressure level at 1-1 octave band gives themaximumandminimumvalueatparticularfrequency.

Fig.3.4Soundlevelmeter

IV. RESULTSANDDISCUSSIONS

After all the measurements, it is required to analyze the data by comparing thedifferentnoiseparametersatdifferentspeedsandloads withsilencerandwithoutsilencer.Analysisisdoneforacousticpower,soundpressurelevelatdifferentlocations(A, B,C,D and E),acceleration and velocity forvibration analysis andsoundpressurelevelforfrequencyspectrumin1/1octaveband.

Ananalysisofthecollecteddataindicatesthefollowingresults:

1). **AcousticPower:**Valueofacousticpowerwithoutsilencervariesfrom102.4dB(A) to 120 dB(A) for 0 to 6 kg load and for speed 1100 to 2300 RPM. It variesfrom 102.4 dB(A) to 115.9 dB(A) for load 0 kg when speedvaries from 1100 to2300RPM and102.4dB(A)to 107.7dB(A)forspeed1100RPMwhenloadvaries from 0 to 6 kg. Forsilencer1, it variesfrom 94.2 dB(A) to 106.8 dB(A)for0to6kgloadandforspeed1100to2300RPM. Itvariesfrom94.2dB(A)to 102.1 dB(A) for load 0 kgwhen speed variesfrom 1100 to 2300 RPM. It variesfrom94.2dB(A)to98.7dB(A)forload1100RPMwhenloadvariesfrom0to6kg. For silencer 2, It varies from 94.8 dB(A) to 109.2 dB(A) for 0 to 6 kg load andforspeed 1100 to 2300 RPM.It varies from 94.8 dB(A) to 104.3 dB(A)forload0kg when speed varies from 1100 to 2300 RPM. It varies from 94.8 dB(A) to 99.7dB(A)forload 1100RPMwhen loadvariesfrom 0 to 6kg. Forsilencer3, itvariesfrom 94.4 dB(A) to 107.1 dB(A) for0 to 6 kg load and for speed 1100 to2300 RPM. It varies from 94.4 dB(A) to 102.5 dB(A) for load 0 kg when speedvaries from 1100 to 2300 RPM. It varies from 94.4 dB(A) to 98.9 dB(A) for load1100 RPM when load varies from 0 to 6 kg. Acoustic power varies linearly byincreasingloadandspeed.

2). **Sound Pressure Level at Exhaust:**ValueofsoundpressurelevelatExhaustvaries from 98.8 dB(A) to 114.6 dB(A) for without silencerfor 0 to 6 kg load andforspeed 1100 to 2300 RPM.It varies from 98.8 dB(A) to 109.6 dB(A)forload 0kg when speed varies from 1100 to 2300 RPM. It varies from 98.8 dB(A) to 103.4dB(A)forload1100RPMwhenloadvariesfrom 0to6kg.Forsilencer1,it variesfrom 85.3 dB(A) to 97.5 dB(A) for 0 to 6kgload and for speed1100 to2300 RPM. It variesfrom 85.3 dB(A) to 92.9 dB(A) forload 0 kg when speedvaries from 1100 to 2300 RPM. It varies from 85.3 dB(A) to 89.8 dB(A) for load1100 RPMwhen load varies from 0 to 6 kg. For silencer 2, it varies from 86.9dB(A)to100.6dB(A)for0to6kgloadandforspeed1100to2300RPM.Itvariesfrom 86.9 dB(A) to 95.8dB(A) forload 0 kg whenspeed variesfrom 1100to 2300 RPM.

3). **Sound Pressure Level at location A:** Value of sound pressure level at location Avaries from 89.9 dB(A) to 106.5 dB(A) for without silencerfor 0 to 6 kg load andforspeed 1100 to 2300 RPM.It varies from 89.9 dB(A) to 102.3 dB(A)forload0kg when speed varies from 1100 to 2300 RPM. It varies from 89.9 dB(A) to 95.8dB(A)forload 1100RPMwhen loadvariesfrom 0 to 6kg. Forsilencer1, itvaries from 81 dB(A) to 93.6 dB(A) for 0 to 6 kg load and for speed 1100 to 2300RPM. It varies from 81 dB(A) to 89.1 dB(A) for load 0 kg when speed varies from1100 to 2300 RPM. It variesfrom 81dB(A) to 85.6 dB(A)forload 1100 RPMwhen load varies from 0 to 6 kg. For silencer 2, it varies from 81.5 dB(A) to 95.9dB(A) for0 to 6kg load and for speed 1100 to 2300RPM.Itvariesfrom 81.5dB(A) to 91.1 dB(A) for load 0 kg when speed varies from 1100 to 2300 RPM. Itvariesfrom81.5dB(A)to86.3dB(A)forload1100RPMwhenloadvariesfrom0 to 6 kg. Forsilencer3, it varies from 81.2 dB(A)to 93.8 dB(A)for0 to 6 kgloadandforspeed1100to2300RPM.Itvariesfrom 81.2dB(A)to89.3dB(A)for load 0kgwhen speedvariesfrom 1100to 2300 RPM.

4). **Sound Pressure Level at Location B:**Value ofsoundpressure levelatlocationBvaries from 90.3 dB(A) to 106.9 dB(A)forwithout silencerfor0to 6 kg loadandforspeed1100to2300RPM.Itvariesfrom90.3dB(A)to102.7dB(A)forload0kgwhenspeedvariesfrom1100to2300RPM.Itvariesfrom90.3dB(A)to96.2dB(A)forload1100RPMwhenloadvariesfrom0to6 kg.Forsilencer1,

5). **Sound Pressure Level at Location C:**Valueofsoundpressurelevel atlocationCvaries from 90.2 dB(A) to 106.8 dB(A)forwithout silencerfor0 to 6 kg loadandforspeed1100to2300RPM.Itvariesfrom90.2dB(A)to102.6dB(A)forload0kgwhenspeedvariesfrom1100to2300RPM.Itvariesfrom90.2dB(A)to96.1dB(A)forload1100RPMwhenloadvariesfrom0to6 kg.Forsilencer1,it varies from 81.3 dB(A) to 93.9 dB(A) for 0 to 6 kg load and for speed 1100 to2300 RPM. It variesfrom 81.3 dB(A) to 89.4 dB(A) forload 0 kgwhen speedvaries from 1100 to 2300 RPM. It varies from 81.3 dB(A) to 85.9 dB(A) for load1100 RPMwhen load varies from 0 to 6 kg. For silencer2,itvaries from 81.8dB(A) to 96.2 dB(A) for 0 to 6 kg load and for speed 1100 to 2300 RPM. It variesfrom 81.8dB(A) to 91.4dB(A) forload 0kgwhen speedvariesfrom1100to2300 RPM. Itvariesfrom 81.8 dB(A) to 86.6 dB(A) forload 1100 RPMwhenload varies from 0 to 6 kg. For silencer3, it variesfrom 81.5 dB(A) to 94.1 dB(A)for0to6kgloadandforspeed1100to2300RPM. Itvariesfrom81.5dB(A)to89.6dB(A)forload 0kgwhen speedvariesfrom 1100 to 2300RPM. Itvariesfrom81.5dB(A)to86.2dB(A)forload1100RPMwhenloadvariesfrom0to6kg.SPLatlocationCalsovarieslinearlybyloadandspeed.

V. CONCLUSION AND SCOPEFORFUTUREWORK

5.1. Conclusion

The object of the presentwork is to collect the data based on two parameters i.e. loadandspeed.Thepresentworkconcludesthefollowing points:

a) Available data concludes that the best silencer for this Engine is silencer1which isHybrid type of silenceras
b) discussed in chapter 3. The result showsthatthedifferencebetweenwithoutsilenceranddsilencer1isaround14dB

c) Datafromfrequencyspectrumconcludesthatthemax imumdBisat63Hz.
d) ItisobservedfromresultsthatvalueofSoundPressure Levelvarylinearlywithrespecttoloadandspeed.
e) ThemaximumdBnearthe Engine is atlocation Bshowing in Fig.5.2. ShaftandBearingsarealignedatlocationB.
f) ValuesofAccelerationandVelocityaremaximumatfr equency500Hz.

5.2. Scopeforfuturework

The presented work can be extended byworking upon different points. Someof themarelistedbelow:

a) AproperSilencercanbedesignedtoreducemorenoise fromanEngine.
b) Itis concluded from results that the maximum dB isat Frequencyof 63Hz.By using an intensity probe, parts will be found where the maximum SoundPressureleveloccursatparticularfrequency.
c) Toreducemorenoise,foundationofanEnginewillbed esignedproperly.

VI. REFERENCES

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