Assessment of Effect of Back Pressure and Gas Flow Dynamics of Exhaust Pipe of a Two-Stroke Engine on Its Performance Characteristics

[1]KENNETH .O.ENEBE, [2]EJEHSON PHILIP SULE, [3]ASHA SATURDAY, [4]OGBOMIDA ZEMOYA OGBEMUDIA, [5]ONUOHA EVARISTUS IROEME

[1]Agricultural Machinery and Equipment Development Institute (AMEDI), Mbutu, Aboh Mbaise, Imo State.Nigeria
[2 ,3&5] Scientific Equipment Development Institute SEDI, BOX 3205, Enugu, Enugu State, Nigeria
[4]National Engineering Design And Development Institute, NEDDI , Nnewi, Anambra State, Nigeria.

Abstract:-**The dynamic effect of compression and expansion waves in the cylinder and exhaust system must be carefully managed through tuning for improved engine performance; empirical techniques have been used by authors to check the effects the geometrical dimensions of the exhaust system on the engine performance. Careful design of the exhaust and inlet manifolds enables the engineer to manipulate the engine performance characteristics. Engine performance characteristics are dependent on gas dynamic processes in the intake and exhaust systems as well as backpressure control. The geometrical configuration and optimization of the exhaust pipe system was designed with incorporation of divergent and convergent channels and analyzed with CAD and CAE at a speed of 10,000RPM and tuning of these geometric parameters of the exhaust pipe with respect to a two-stroke single-cylinder engine. This increase in the back pressure heralded from geometric tuning of the exhaust pipe leads to optimum engine performance characteristics. The torque and power characteristics can be ascertained from the airflow values of delivery ratio; trapping efficiency and charging efficiency were also deducted directly .simulation results were presented for air flow can be used to deduce the Peak power, specific fuel consumption improved exhaust emission characteristics, sound characteristics and smoothness. The configured exhaust system would be found to improve fuel economy of the engine and improve engine emissions, with an improved power output and noise reduction from the waves of the flow.**

Index Terms- **geometrical tuning, divergent and convergent channels, back pressure effect, exhaust pipe system, improved engine performance characteristics.**

1. INTRODUCTION

The exhaust ducting of an engine has a physical geometry that depends on whether the system is tuned to give high specific power output or is simply to provide silencing of the exhaust pressure waves to meet noise and environmental regulations. In the 1950's, an engineer by the name of Walter Kaadan was consulted by motorcycle racers, asking him to help them squeeze more power and speed out of their motorcycles. After some experimentation, he found that the 2- stroke engines in motorcycles were affected by its exhaust characteristics. He found that by varying the length of straight exhaust pipes, the performance also changed accordingly. After further experimentation, he found that a divergent cone instead of a straight pipe worked better, and this heralded the arrival of the 2-stroke tuned pipe Two-stroke motorcycles are more commonly use than four-stroke because they are small and cheap. Because they are less expensive than other vehicles, they play an important role in the country's transport sector. They are very visible in most cities and major towns of the country providing an alternative mode of transport for short distances (3). Vehicles are one of the dominant sources of urban pollution in developing world that threatens both people's health and economic activities [4]; [5]. While this is common to growing urban areas throughout the world, it is particularly severe in Nigeria where majority of vehicles are two-stroke motorcycles [3]. The demand for owning a motorcycle is on a soaring path [3]. It is clearly observed that the population of all types of motorcycles is growing fast to the extent that besides goods and parcels, passengers are also moved by such mode of transportation in Nigerian cities and towns [3]. The main air pollutants in the exhaust effluent from motorcycles are carbon monoxide (CO), unburned hydrocarbon (HC), oxides of nitrogen (NOx) and white smoke emitted from two-stroke motorcycles. Two-stroke motorcycles are reported to emit as much as 5 times more HC and 1.5 times more CO emissions per kilometer driven than do four-stroke motorcycles and even cars [4]. However, in Nigeria, due to excessive use of poor quality lubricant oil, adulterated gasoline and poor engine maintenance, they emit more [1]. much research work has been conducted to reduce these exhaust emissions so that the engine will conform to all prevailing and future environmental legislations [6]; [7]; [8]; [9]; [10]. To comply with these emission regulations, stratified scavenging [11]; [12] has become one of the most popular design approaches on newly developed small two-stroke engines. Exhaust after-treatment by catalyst [13]; [14] is another technique that is used to reduce exhaust emissions. In some cases fourstroke engines [15] have been substitutes for the two-stroke engine. In future, it is likely that the automobile industry will improve catalytic converters form use on all motorcycles [16]. Currently, BMW and Yamaha both produce a motorcycle that uses a computer controlled catalytic converter [10]. It is still in the early stages of development and improvements to it will likely follow. However, this three-way catalyst system adds approximately one thousand dollar ($1000) to the cost of a motorcycle, and the package does not perform well under vibration [10]. Another technique to reduce exhaust emissions on two-stroke engines that was proposed by Blair (1996) is to use exhaust tuning. Traditionally, exhaust system on an engine was purely to remove exhaust gases from the cylinder and expel them to the environment and also muffle the sound. This traditional type of exhaust system has worked well throughout the years but could be improved. The primary method of doing this is to optimize the way the exhaust gases are able to escape. The main goal of tuned exhaust is to efficiently evacuate the exhaust gases from the cylinder. The bottom line is that with a tuned exhaust system, suctioning out and emptying out of the cylinder are effectively carried out. The engine gets a better complete combustion of fuel. The effect is that it will take fewer throttles to get the same revolution per minute. This means less fuel flow [17].

2.PROBLEM STATEMENT

Two- stroke engines are characterized to have high emission rate of greenhouse gasses as they cannot be used in an enclosure or in a motor cycle park due to the emission of carbon monoxide that is dangerous to human beings, and too much noise emanating from it uses. Besides the fuel consumptions and low power band when being run in certain condition ,it is imperative to design , tune and optimized the exhaust system to yield good engine performance characteristics and emission lean of or without dangerous gases like CO with good and cool sound production

3.SCOPE

This paper tends to exhibits the effect of increase in back pressure of an exhaust pipe system as it affects two-stroke engine performance characteristics and noise reduction with improved sound from the engine with the use of a knowledge base soft wares-SolidWorks 2012 . the two-stroke engine has the inestimable advantage over its four-stroke engines in that the exhaust system could be "choked" at a particular location to provide that tuning that would yield a high power output

4.AIM AND OBJECTIVES

The objectives of this work are:

1. To design and optimize the geometry exhaust pipe for use on two-stroke cycle engine,for optimum performance of engine through geometrical configuration.

2. To investigate the effects of back pressure system on compression two-stroke cycle engine
3. To Study the effect of Converging and diverging exhaust pipe sections on the two stroke Engine.
4. To design and optimize the length and diameter stinger the convergent cone length and convergent level, belly length and diameter ,and divergent length and level of divergent

5.SIGNIFICANT

This is to give design with the use of CAD and CAE of an exhaust pipe system that will improve the performance characteristics of a two-stroke engine of a motor cycle in any drive condition.

6.EXHAUST PIPE SYSTEM MATERIALS

Materials commonly used in competition for header and exhaust systems, depending on the requirements and operating temperatures of the exhaust gases this depends on the engine capacity and efficiency of combustion. Inconel tubing is commonly used. The name "Inconel" is a registered trademark of Special Metals Corp., the term has become something of a generic reference to a family of austenitic nickel-chromium-based super alloys which have good strength at extreme temperatures and are resistant to oxidization and corrosion. This excellent high-temperature property made Inconel offers increased reliability in header systems and exhaust system. The high-temperature strength ability can enable weight-reducing designs, for a given reliability requirement, Inconel allows the use of much thinner-wall tubing than could be used with other materials. Inconel tubing is quite expensive because of this uniqueness.Certain Inconel alloys retain very high strength at very high temperatures. One of the favorites for header applications is Inconel-625, a solid-solution alloy containing 58% Nickel, 22% Chromium, 9% Molybdenum, 5% Iron, 3.5% Niobium, 1% Cobalt. It has good weldability using inert-gas-shielded-arc processes, and good formability in the annealed condition, and has a lower thermal expansion rate than the stainless alloys commonly used in exhaust systems. Weldability and formability are both important because of the somewhat limited availability of Inconel tubing sizes, which often makes it necessary to form tubing sections from sheet. The yield strength of this alloy at 650 °C (1200°F) is 345 MPa (50 ksi), while at 870°C (1600°F) it is a remarkable 276 MPa (40 ksi). As with many metals, the high-temperature strength diminishes as the amount of time the parts are exposed to extreme temperatures increases. There are several austenitic stainless alloys which are commonly used in exhaust systems. They are 347, 321, 316 and 304 in order of reducing temperature capabilities. Besides, special variations in the basic alloy chemistry (carbon, nickel, titanium and niobium) are available to enhance the high temperature strength of these alloys. The locally available materials for making headers and downpipe exhaust system

I. Cast iron
II. Mild steel
III. 18-8 stainless unpolished
IV. 18-8 stainless ,oxided
V. AISI 304 St. Steel heated to 5008C

Their emissivity(ϵ) pipe material at any temperature T_P

Cast iron aged at 6008C $\epsilon = 0.5 + (T_P - 273)/2860$ (i)

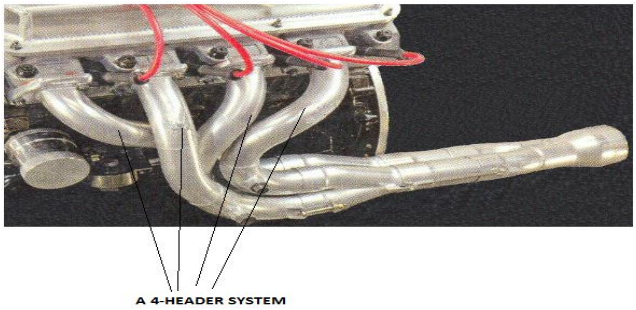
Mild steel lightly aged $\epsilon = 0.17 + (T_P - 273)/6950$ (ii)

18-8 stainless, unpolished ϵ =0.22

18-8 stainless, oxidized $\epsilon = 0.86$

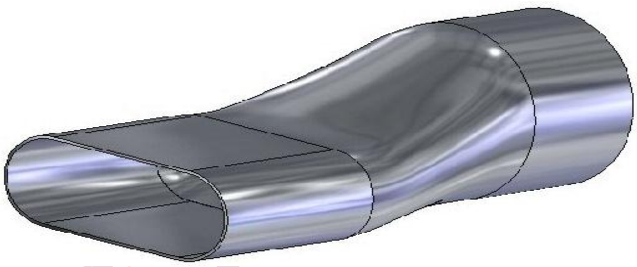
AISI 304 St. Steel heated to 5008C $\epsilon = 0.54 + (T_P - 273)/2860$ (iii)

I. HEAD PIPE OF POWER BIKE



II.4-CHAMBER PIPE HEAD

III. PIPE HEADER SYSTEM(CAD)



IV. Exhaust configuration system **(CAD)**

Fig .1 head pipe and exhausted configuration system

7.TAPER LENGTH DEVELOPMENT

Taper cone development starts from knowing the two diameter Do & Di and the length which is the height

Consider

$\alpha = tan^{-1}\left(\frac{d_1 - d_0}{2h}\right)$ (iv)

$Circumference\ of\ a\ circle = 2\pi r = \pi D$ (v)

This is generated from the sector of a circle of diameter D

Length of sector , l

$l = \frac{\theta}{360} * 2\pi r$ (vi)

The radius (r) becomes the slanting height of the cone

$\theta = 2\alpha$ (vii)

As a truncated cone

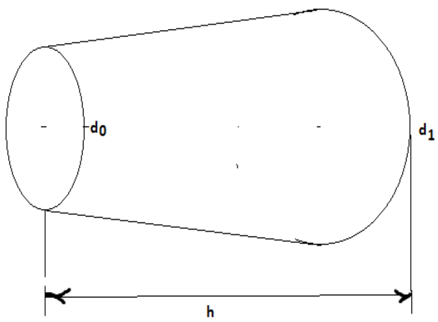


Fig2. Truncated cone frustum developed from a sector of a circle with radii representing the slanting height

8. DESIGN

DESIGN MODEL

The critical design can be made when exhaust-open period and the pressure pulse speed inside the exhaust system are known.

$V_{EX} = [401.8(T_{EXH} + 273)]^{1/2}$ (1)

Where V_{EX} Local speed of sound in the pipe (m/s),Tex is Exhaust temperature (ºC)

$L_t = \frac{83.3 V_S \theta}{N}$ (2)
$\pi R^2 L_t = 2C$ (3)
L_t=length of extended pipe
θ=exhaust port duration in crank (degrees)
N= Desired rotational speed
R=pipe radius
C=Engine capacity per cylinder
θ and N were obtained from the engine specifications

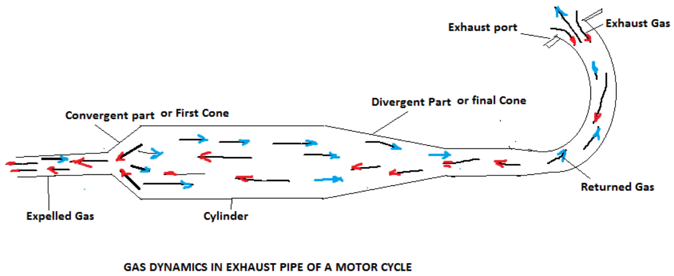


Fig 3. Schematic diagram showing the flow of gases in exhaust pipe system

Backpressure has a major effect on performance of two stroke engine. The pressure in two-stroke engine can be considered atmospheric when the cylinder filling (scavenging) is superimposed to the exhaust phase, that is with the exhaust port opened to the external atmosphere. The effectiveness of the cylinder filling with fresh charge depends on small differences of pressure, and the two stroke engine can only tolerate small amounts of exhaust back pressure

9.PICTORIAL VIEW OF KINDS OF TUNED EXHAUST PIPE SYSTEM

i.

ii

a. pictorial view of a tuned exhaust pipe

b. power bike tuned exhaust system

fig 4.pictorial view of the tuned exhaust system

10.EXHAUST PIPE SYSTEM DIVISION

a. HEAD PIPE: Tapered head pipe is relatively costly and hard in its manufacturing process and has proven to enhance performance and ease turning in main areas of interest from low to mid rpm power especially proven to be best in racing applications. Bottom-end power is found with larger head pipe than the peak power.

b. CONE: the cones are the Divergent and convergent parts of the exhaust pipe system. The length, volume and taper angle of the first cone (divergent) influence the amount of peak power of the Engine. A high peak power is produced with short, steeply (sharp) taper cone of divergent but in bikes gently tapered first cone (divergent) helps for smoothness that peak power, cause peak power would not be applied for a longer time and distance.

c. BELLY: This is the cylindrical section between the Divergent cone and convergent cone. It is characterized as the mid section where the length or volume adjustments are made to compensate for less than ideal head pipe. This mid section can be enlarged, shortened or lengthened to bring about same results in most designs

d. FINAL CONE : Controlling the power after the peak power, the over revolution (speed) or over run is the influence or is made possible by the convergent part of the turning section, a relatively longer, gently tapered converging cone will give more overrun while a short and steep cone give less overrun. Lost of over run and not losing much top end is critical in engineering design in this regard.

e. STINGER: The tail pipe or stinger is important as its length and size have influence on the pipe power and bottom end as well as engine's resistance to holing pistons. Smaller stinger diameter produce more peak horse power but increase likelihood of melted pistons because they bottle up the exhaust heat. Big stinger diameters boost bottom end at expense of peak power. Over size diameters must perform once at all engine speed due to insufficient pressure. Stinger has important effect on length of the pipe and volume as longer stingers help low and mid range power

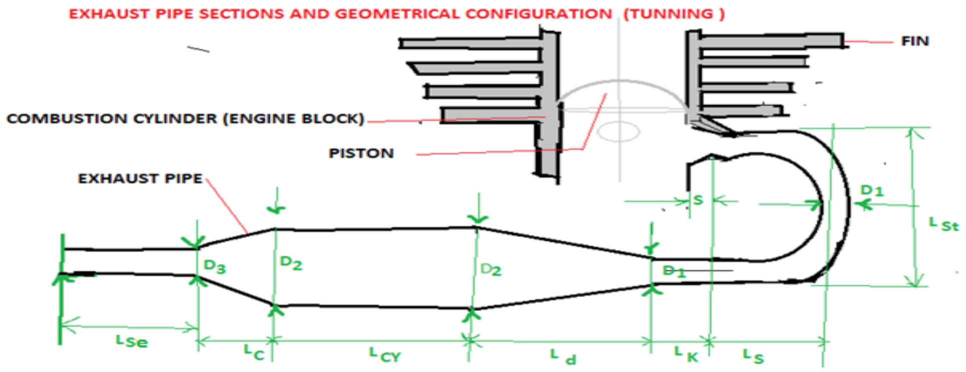


Fig.5. Exhaust system and configuration for a motor cycle (bike)

L_{Se} = stinger length

L_C=Length of first cone (convergent cone)
L_{CY}=Length of cylinder or Belly
L_d=Length of divergent cone(megaphone)
L_S , L_{Se} are length of the sections of head pipe and tail or stinger pipe
For accurate taper (∞) angle
Calculation of taper angle α
Divergent parts
Head pipe

$\alpha_0 = tan^{-1}\frac{D_0-D_1}{2L_S}$ (4)

Megaphone

$\alpha_1 = tan^{-1}\frac{D_2-D_1}{2L_d}$ (5)

convergent

$\alpha_2 = tan^{-1}\frac{D_2-D_3}{2L_C}$ (6)

S = total exhaust angle...
T = total scavenging angle
D_1 = exhaust pipe internal diameter
N = turning RPM (speed)
$A = S - \tau/2$ (7)
T_r time of reflection prm
$T_r = A/6N$ (8)
Sonic speed C_1
$C_1 = 20\sqrt{T_1}$ (9)
T_1 = absolute temperature in K
Hence,
$2L_{col} = C_1 T_r$ (10)
From the diverging part at angle α^0
$D_1 = \sqrt{(6(D_1)^2)}$ (11)
$t_g\,\alpha^0/2 = \frac{D_2-D_1}{L_D}$ (12)
If $\alpha = 8^0$
$\alpha^0/2 = 4$
$C_2 = 20\sqrt{T_2}$
$B = A + T$ (13)
$t_C = B/6N$
$L_{tot} = C_2\,t_c/2$ (14)
$L_C = \frac{D_2-D_1}{2t_g 7.5}$ (15)
$L_{Ct} = D_2/2t_g 7.5$

$L_{tot} = L_c + L_d + L_{cy} + L_{ct}/2 + s$ (16)
Length of the tail part of the exhaust syatem
$L_{Tail} = 12D_3$ (17)
$L_d > L_c$

11.SOUND PRODUCTION IN THE EXHAUST STREAM WAVE PROPAGATION IN THE PIPE

The analysis of the acoustics are analysed base on the presure waves propagation in the exhaust pipe system and are simplified tersely as follows.

The acoustic wave equation is base on the following assumptions by Kinsler ,E.L.et .al , 1982

1. The fluid is compressible (desity changes due to pressure variation)
2. The fluid is invisid (no viscous dessipation)
3. There is no mean flow of the fluid
4. The mean density and pressure is is uniform throughout the fluid.

$\frac{1}{c^2}\frac{\partial^2 P}{\partial t^2} - \nabla^2 P = 0$ (18)
$c = \sqrt{k/\rho_o}$ (19)
C=speed of sound in fluid medium
ρ_o=mean exhaust mixture density
K=bulk modulus of the exhaust mixture(fluid)
P=acostic pressure($= P(x, y, z, t)$)
t=time
For pressure harmonic variation and propagation in a geometrically configured exhaust pipe system
$P = \bar{P}e^{j\omega t}$ (20)
P=harmonically varying pressure
$\bar{P}$=amplitude of the pressure
j=$\sqrt{-1}$
ω=$2\pi f$ (21)
f=frequency of oscilation
Reducing the equation Helmholtz equation
$\frac{\omega^2}{c^2}\bar{P} + \nabla^2\bar{P} = 0$ (22)
Sound pressure level is given by
$L_{sp} = 20log\left(\frac{P}{|P_{ref}|}\right)$ (23)
L_{sp}=output sound pressure
Log=logarithm in base 10
P_{ref}=reference pressure with a default value of $20\ X\ 10^{-6}$

12.Models

The equations necessary for this analysis are

(i) Heat transfer equation
(ii) Fraction in the pipe

In the simulation work, accurate measurement and calibration and sound knowledge of Engine performance and its performance at various RPM of the particular engine are necessary but this work is done base on 3 major conservation equation

Hence continuity and momentum equation becomes

Continuity equation
$\frac{\partial(\rho u)}{\partial x} = -\frac{\partial \rho}{\partial t}$ (24)
Momentum equation
$-\frac{\partial \rho}{\partial x} = \partial\, Du/Dt$ (25)
Where,
$Du/Dt = \partial u/\partial t + U\partial u/\partial x$ (26)
$1\Big/\frac{\partial(\rho u)}{\partial t} + {}^{u}/_{\rho} + \partial u/\partial x = 0$ (27)

$1\Big/\frac{\partial(\rho u)}{\partial t} + \partial u/\partial t + U\partial u/\partial x$ (28)

Sonic speed for a given gas stream pressure wave in the pipe at pressure P_1 density and antropys.
$a^2 = (\partial P/\partial \rho)s$ (29)

Recall

$a^2 = KRT$ (30)

And assuming the gas is deal

$a^2 = KP/\rho$ (31)

The conservation condition necessary for the turning

$\frac{P}{P_{ref}} = \left(a/a_{ref}\right)^{2k/(k-1)}$ (32)

P_{ref} & r_{ef} reference values for pressure and speed

From continuity equation, expressing it in terms of some speed a and u

$1\Big/\frac{\partial(\rho u)}{\partial t} + {}^{u}\!/_{\rho} + \partial u/\partial x = 0$ (33)

$1\Big/\frac{\partial(\rho u)}{\partial t} + \partial u/\partial t + U\partial u/\partial x$ (34)

$2/(K-1)a\,\partial a/\partial u + \partial u/\partial t + U\partial u/\partial x = 0$ (35)

For momentum

$2/(K-1)a\,\partial a/\partial u + \partial u/\partial t + U\partial u/\partial x = 0$ (36)

This equation is reduced to ,after differentiating a with respect to t

$da/dt + (K-1)/2\, du/dt = 0$ (37)

For x + field the slope becomes

$dx/dt = u + a$ (38)

$da/dt + (k-1) = 2\, du/dt$ (39)

With a slope of

$dx/dt = u - a$ (40)

For a non-dimensional form, the equation are generalized as

$A = a/a_{ref}$ (41)

$U = U/U_{ref}$ (42)

$Z = aAt/L = \left(a^2\, t/a_{ref}\right)/L$ (43)

As the Riemann variables

$dX/dZ = U + A$ (44)

As the position characteristics

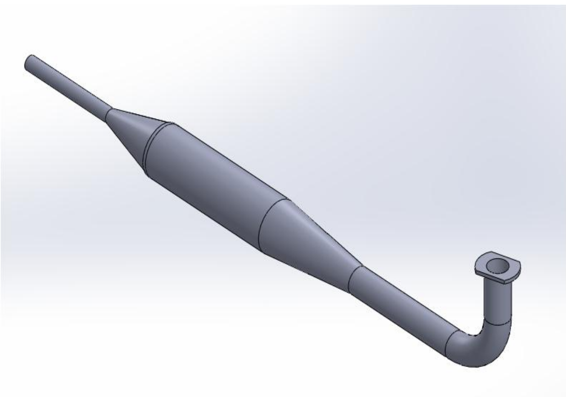
From

$da/dt + (K-1)/2\, du/dt = 0$ (45)

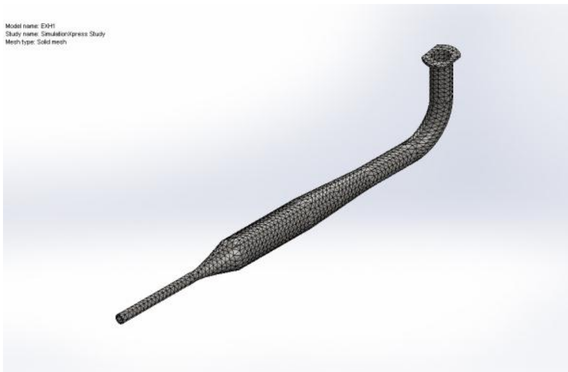
Integrating the equation

$A + (K-1)/2u = \lambda$ (46)

λ. is a constant existing at any point along the position characteristic and A & U can be varied along a position characteristics within the restraint imposed by the relation.



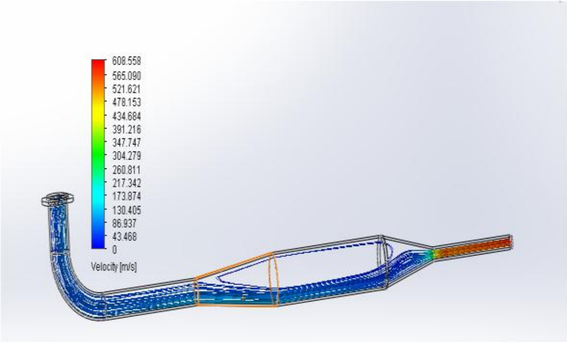
a.Model of the exhaust system

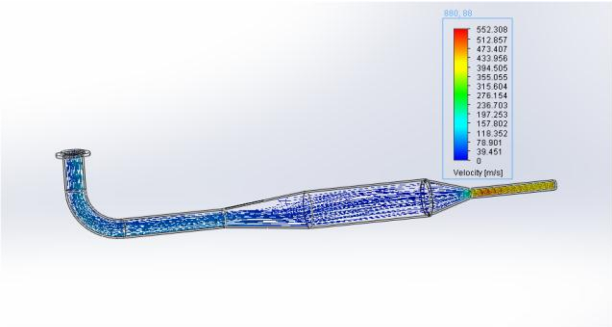


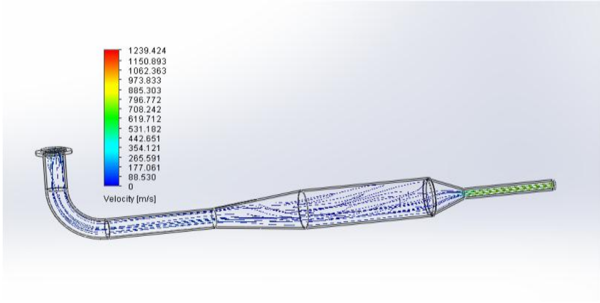
b.Meshing of the exhaust pipe

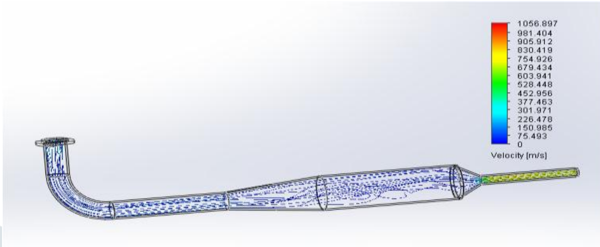
Fig 6. Exhaust system model

13.VARYING TAPER OF THE FIRST CONE


i


ii


iii


IV

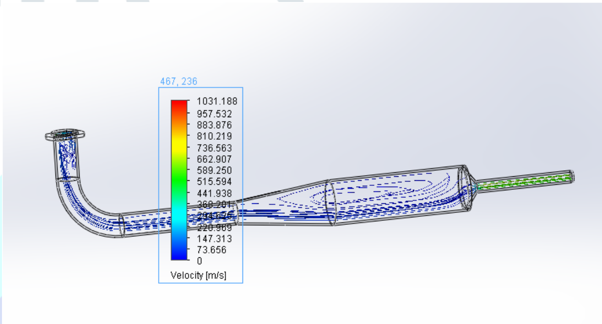
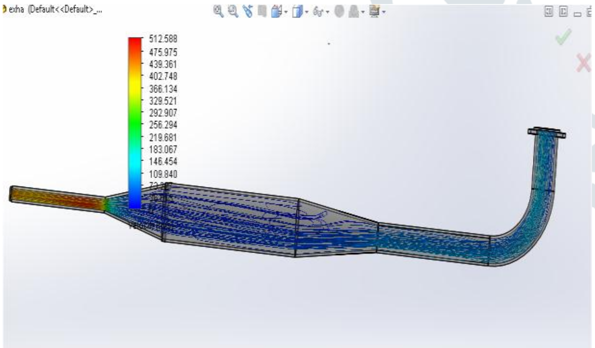
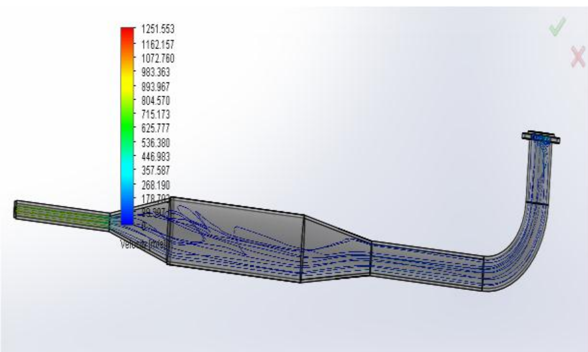
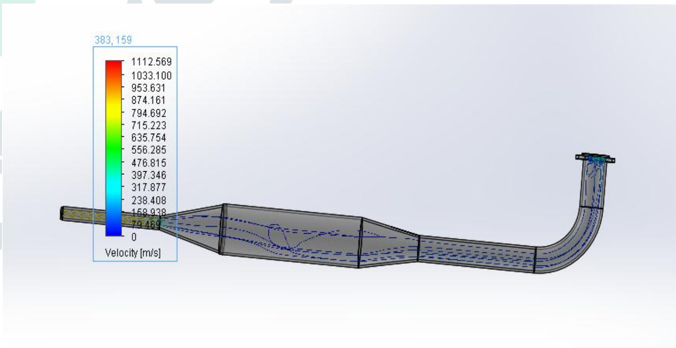

V

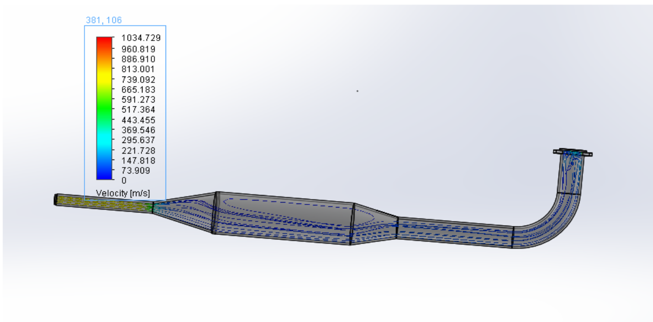
Fig7. Angle of taper variation of the first cone

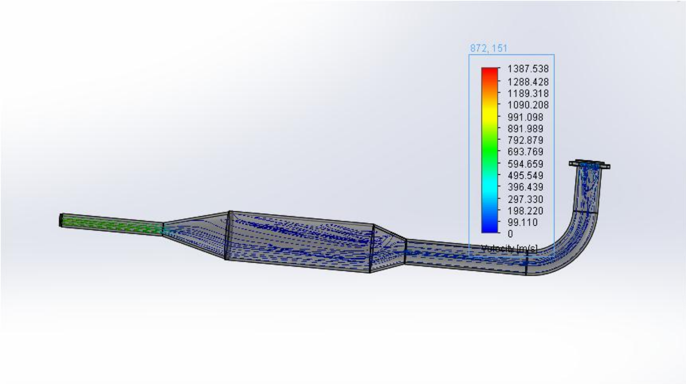
14.ANGLE OF TAPER VARIATION OF THE MEGAPHONE


a


b


c


d



e

fig 8 taper angle variation of megaphone

TABLE1:EFFECT OF ANGLE OF TAPER VARIATION OF FIRST CONE ON GAS FLOW

First cone Taper angle α^0	Velocity of gas at exhaust ms^{-1}
14	521.621
18	554.308
23	708.242
32	754.926
52	810.218

TABLE2:EFFECT OF ANGLE OF TAPER OF THE MEGAPHONE ON EXHAUST GAS FLOW

Megaphone Taper Angle α^0	Velocity of gas at exhaust ms^{-1}
9	475.975
10	715.173
13	794.692
16	813.001
22	891.989

TABLE 3.EFFECT OF ANGLE OF TAPER OF GAS FLOW AT THE MEGAPHONE

Megaphone taper Angle α^0	Velocity of gas at megaphone ms^{-1}
9	502.789
10	489.395
13	456.874
16	396.789
22	376.785

The megaphone is used in the pipe for the process of reflection is gradual and the particle velocity is reduced and build up pressure. This ensures that the bulk of the gas energy is transmitted back to the port so that the greater power output is possible as returning wave stream in the simulated works involving megaphone. This back pressure increase is controlled by the level of taper of the first (convergent) cone compensatively by increasing the gas particle velocity and dropping the pressure as the gas flows into narrower part. In a two stroke Engine, the burnt gas is exhausted from the cylinder primarily by the pressure difference between it and the atmosphere, rather than by the motion of the Piston.

15.GRAPH

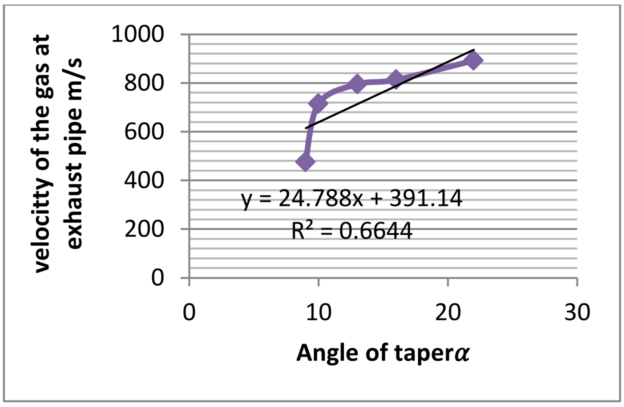


Fig9 .effect of angle of tapper of the first cone on gas flow at exhaust

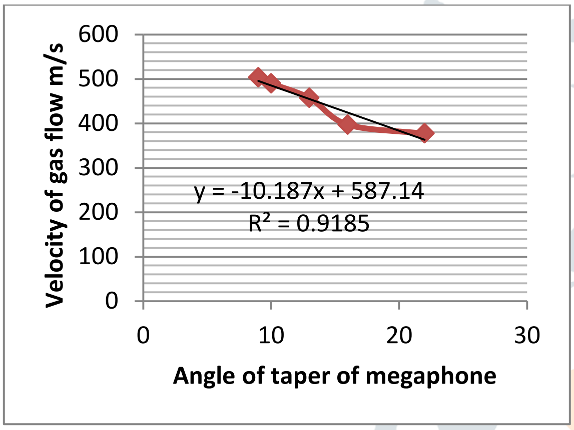


Fig7. effect of angle of taper variation of the megaphone of gas flow at exhaust.

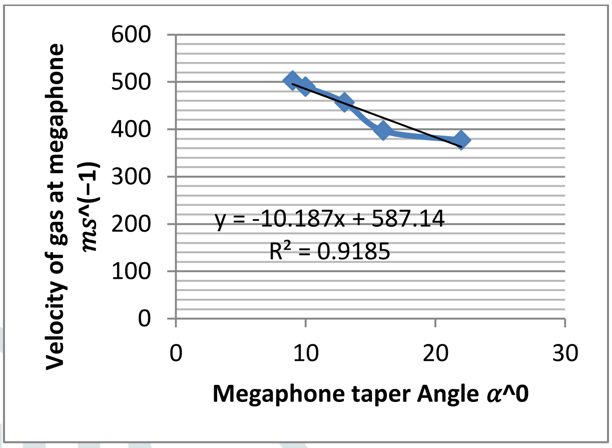


Fig 8. Effect of megaphone taper angle on gas flow at the megaphone

16.DISCUSSION

Angle of taper of the first cone plays a significant role in back pressure increase of the exhaust system.Pressure waves reflected back towards the start of the exhaust pipe will be the opposite of the original waves that they reflected from, so they will also be negative pressure waves. Therefore, by gradually increasing the diameter of the tube, a gradual, more useful negative wave can be generated to help scavenge, or pull spent gasses out of, the cylinder. [20]. If a divergent cone is put on the end of a straight pipe, it will lengthen the returning wave, broadening the power band and creates a rudimentary expansion chamber. In short, when the negative wave reaches the exhaust port at the correct time, it will pull some of the exhaust gases out the cylinder to help the engine to scavenge its spent exhaust gas. And a divergent cone at the end of the straight (parallel) "head" pipe broadens the returning wave which are not strong and longer more likely to find the exhaust port open and be able to pull out the exhaust gases. In straight pipes, the total length of the pipe with a divergent cone welded on determines the timing of the return pulses and therefore the engine speed at which they are effective. The divergent cone’s critical dimensions are where it starts (the distance from the exhaust port to the start of the divergent cone is called the "head" pipe), while the length of the megaphone (divergent Cone) and the rate at which it diverges from the straight pipe determine the intensity and length of the returning wave--A short pipe which diverges at a sharp angle from the head pipe gives a stronger, more straight-pipe like pulse. Conversely, a long, gradual divergent cone creates a smaller pulse of longer duration. In addition, the negative wave is also strong enough to help pull fresh mixture up through the transfer ports. [20] While adding a divergent cone to the head pipe produces great tuning advantages, it has its limitations as well. The broader negative wave from a megaphone can still arrive too early and pull fresh mixture out of the cylinder. However, putting another cone, reversed to be convergent, on the end of the first divergent pipe will reflect positive waves back up the pipe that will follow the negative waves back to the exhaust port, and if properly timed will stuff the fresh mixture that was pulled into the pipe back into the exhaust port right as the piston closes the port.[20]. In addition to head pipe length, divergent and convergent cone lengths, an expansion chamber has three more crucial dimensions. The length of the straight ’belly’ between the divergent and the convergent cones, the length of the tailpiece ’stinger’ and the diameter of the belly section. The stinger acts as a pressure bleed, allowing pressure to escape from the pipe. Back pressure in the pipe, caused by a smaller-diameter or longer stinger section, helps the wave action of the pipe, and can increase the engine’s performance. This, presumably, happens since the greater pressure creates a more dense, uniform medium for the waves to act on. Waves travel better through dense, consistent mediums. For instance, you can hear a train from a long way away by putting your ear to the steel railroad track, which is much denser and more uniform than air. Or at mid night on a tared road if you lie on the road pavement put your close to the surface you will hear sound even footsteps of people more than a kilometer away because the air on the surface of the road pavement is denser than layers above ,hence waves like sound waves travels faster in denser medium. Snakes use this to detect vibration or movement of preys or predators. But it also causes the engine to run hotter, usually a very bad characteristic in two-strokes. [20] The length of the belly section governs the relative timing between the negative and positive waves. The timing of the waves is determined by the length of this characteristically straight pipe (Belly section). If this is too short, positive waves have a shorter distance to travel, and return to the exhaust port sooner. This is good if the engine is running at a higher speed, bad if you want to ride on the street. The diameter of the belly section is crucial for a factor-ground clearance. It's hard to keep big, fat pipes off the ground, though V-Fours have solved that for now since two of the pipes exit directly out the back. [20]. Ground clearance is the height of the engine bottom plate (crank case) from the ground. A low ground clearance suffer motor cycle on undulating roads characterize with bumps and pot holes. A complete two-stroke pipe has a properly tuned header, convergent, belly, divergent and stinger sections--a difficult process to mesh successfully. Modern pipes generally have a gently divergent head pipe to keep gas velocity high near the port, a second cone of "medium" divergence, and a third divergent cone with a strong taper. A belly section connects to multi-angled convergent cones, which should exit in a straight line into the stinger for good power. It is necessary therefore to design an exhaust system that will satisfy good peak power, high speed, good sound characteristics on street, high way and hilly roads through optimization of geometric parameters of the first cone(convergent),cylinder length(Belly),the megaphone(divergent cone) and the stinger length.

17.CONCLUSION

A good design of the chambers of an exhaust pipe system is paramount to be design with suitable software and utilized the CAD and CAE tool for flow and heat analysis with appropriate suitable boundary conditions. A good design of exhaust pipe system is governed with a specific power, sound, and emission etc. that are desired by the designer. This becomes necessary to begin a design of an exhaust system for any particular engine. There are many factors that govern how the chambers should be designed, for example if you raise the exhaust port, you will move the power band to higher RPM's, and by lengthening the chambers you will move the power band to lower RPM's. A good chamber will give lots of power over a wide RPM-range.A poorly designed chamber will have a weak pressure wave that won't suck the charge out of the cylinder, and in turn won't push much fresh charge back into the cylinder, producing less horsepower, wasting fuel and increasing pollution.[21] The length, volume and taper of the first cone strongly influence the amount of peak power the engine will produce. A relatively short, steeply tapered, first cone, creates high peak power with sacrifices at other engine speeds. Pipes on Open-class bikes usually have gradually tapered first cones because smoothness, rather than peak power, is of more benefit. The optimization of the stinger length, convergent cone length and level of convergent, belly length and diameter, and the divergent cone length and level of divergent for good engine steady performance characteristics in all drive conditions. However ,it should be noted that tuning an exhaust pipe system of an engine will alter its original design performance characteristics as a constraint is introduced into the system obeys the le'chatelier principles,'when a constraint is introduced in to a system the system equilibrium shift to annul the effect of the constraint'. Hence ,since more work will be done by the engine more heat will be generated ,thus the means to dissipate this additional generated heat is necessary to be designed and incorporated else it will put the engine into great ruin as it may affect it over hauling time ,its cylinder or piston or the life span of the engine. Excessive backpressure can negatively affect performance, as it can lead to reduction power and increase in fuel consumption, exhaust temperatures and emissions. It will reduce exhaust valve and turbocharger life. The exhaust backpressure should be kept within specified limits for acceptable performance characteristics of the engine and those engines subject to emissions legislation.

18.ACKNOWLEDGMENT

The authors would like to thank National Agency for Science and Engineering Infrastructure (NASENI),Abuja,Nigeria, and our respective branches in this research and development agency are also acknowledged.

REFFERENCE

[1] O. Obodeh, and A.D. Ogbor (2009) ,Improving the Performance of Two-stroke Motorcycle withTuned Adjustable Exhaust Pipe Research Journal of Applied Sciences, Engineering and Technology 1(2): 59-65, 2009

[2]Rajashekhar sardagi,and kallurkar shrikant panditrao (2015).Performance study of two stroke engine on converging and diverging Exhaust pipe. Proceeding of NCRIET-2015 & Indian J.Sci.Res. 12(1):235-237, 2015

[3]Faluyi, S.O., S.O. Awoku and S.O. Adebayo,(2006). Comparison of the headway distribution of automobile vehicles and motorcycles plying major roads in Ado-Ekiti, Nigeria. J. Applied Sci., 9(1): 6274-6285.

[4]Vorsic, A.M. and M. Weilenmann, (2006). Comparison of real-world emissions from two-wheelers and passenger cars. J. Environ. Sci. Technol., 40(1):149-157.

[5]Houston, R. and S. Ahern, (2007). A fresh approach to the design of clean engines for the performance motorcycle market, SAE Technical Paper No. 2007-32-0001.

[6]Sawada, T., M. Wada, M. Noguchi and B. Kobayashi,(1998). Development of a low emission two-stroke cycle engine, SAE Technical Paper No. 980761

[7]Hanawa, S.S., (2004.) Paradoxical approach to improve fuel economy of small practical motorcycles, SAE Technical Paper No. 2004-01-0989

[8]Kashani, B.O., (2004.) The improvement of combustion process and reduction of unburned hydrocarbon emissions in a two-stroke motorcycle. Iran. J. Sci. Technol. Trans. B, 28(B4): 505-508

[9]Korman, M., M. Hirz, K.F. Winkler and W . Kaiser, (2006.) Exhaust em ission reduction in sm all capacity two- and four-stroke engine technologies, SAE Technical Paper No. 2006-32-0091.

[10]Winkler, F., O. Schögl, R. Osw ald and R. Kirchberger,(2006). Development of a low emissions two-stroke engine with low pressure fuel injection, SAE Technical Paper No. 2006-32-0065.

[11]Bergman, M., R.U.K. Gustafsson and B.I.R. Jonsson, (2003). Performance evaluation of a 25 cc stratified scavenging two-stroke engine. SAE Technical Paper No. 2003-32-0047

[12]Bergman, M. and J. Berneklev, (2006). A novel method of tuning a stratified scavenged wo-stroke engine. SAE Technical Paper No. 2006-32-0055.

[13]Merkisz, J. and P. Fu, (2003). Investigation of catalytic converter from modified catalytic layer (Pt, Pd, Ru, CeO2-0.25ZrO2-0.75/Ru) of nanoparticles spherical shape arrangement. J. Kones Int. Combustion Eng., 10(3- 4): 201-210

[14]Arnby, K., J. A ssiks P. Carlsson, A. Palmqvist and M. Skoglundh, (2005). The effect of platinum distribution in monolithic catalysts on oxidation of co and hydrocarbon. J. Catalysis, 233: 176-185.

[15]Ahern, L., (2003). Fuel Economy Advantages on Indian 2- Stroke and 4-Stroke Motorcycles fitted with Direct Injection, SAE Technical Paper No. 2003-26-0019

[16]Maus, W. and R. Brück, (2005). The future ofheterogeneous catalysis in automotive applications: Turbulent catalytic for spark-and compression ignition engines. VDI- Fortschritt-Berichte, Reihe, 12(595): 297-319

[17]Bassett, M.D., R.J. Pearson, N.P. Fleming and M. O'Brien, (2001.) Simulating the effects of gas dynamic phenomena on the performance of internal combustion engines. SAE Technical Paper No. SAITS 01187

[18]Blair, G.P.,(1996). Design and simulation of two-stroke engines. SAE Technical Paper No. R-161, ISBN 1- 56091-685-0.

[19]Kinsler ,E.L.et .al , (1982) .Fundam ental of acoustics, John wiley and Sons,New York pp.98-123 [8]
[20]Eric Murray, How 2-Stroke Engines Work, & Why You should Care .
[21]Skalman Racing, Building Your Own Expansion Chambers .