ABSTRACT

Compressed Natural Gas (CNG) fuel has long been used in the Malaysia transport industry due to its numerous advantageous properties. CNG fuel engine considered a low carbon dioxide (CO_2) emission producer presents itself a viable alternative to gasoline/ diesel fuel engines. Previous studies show that the transport industry contributes a huge percentage of CO_2 emission to the environment. Therefore, this study investigates the amount of CO_2 emission that can be reduced when using CNG as an alternative fuel. Performance tests were conducted on a carburetor and injector car engine using both gasoline (petrol) and CNG fuel separately. These tests were done at a variable engine speed ranging from 1000 to 3000 rpm while the exhaust gas emissions were analyzed. Although the general exhaust gas emissions were measured, the focus was on CO_2 emission and the results showed that using CNG as an alternative to petrol reduces about 0.9kg/L of CO_2 exhaust gas emission. Formulas collected from previous researches, were used in analyzing the possible amount of CO_2 emission that can be reduced by the year 2020 in the Malaysia transport industry. This analysis was necessary to encourage the total acceptability of CNG fuel usage in the transport industry. However, from this study, it was found that the possible amount of CO_2 emission that can be reduced with the use of CNG vehicle by the year 2020 would be about 4,018,546-tonsCO2 emissions as against an estimated 3,058,254 CNG vehicles. Therefore, with this level of increase Malaysia could meet up with other higher CNG users around the world, like Iran and Pakistan.

ABSTRAK

Bahan api Gas Asli Mampat (CNG) telah lama digunakan dalam industri pengangkutan Malaysia kerana sifat-sifat yang banyak berfaedah. Enjin CNG mengewarkan peleponsan karbon dioksida yang rendah (CO_2) Sebagai alternatif kepada bahan api enjin petrol / diesel. Daripada kajian literatur, didapati bahawa industri pengangkutan menyumbang 45% daripada pelepasan CO_2 kepada alam sekitar. Oleh itu ,dalam kajian ini jumlah pelepasan CO_2 boleh dikurangkan apabila menggunakan CNG sebagai bahan api alternatif . Ujian prestasi telah dijalankan pada enjin kereta karburetor dan penyuntik menggunakan kedua-dua petrol (petrol) dan bahan api CNG secara berasingan, ini dilakukan pada perbagai kelajuan enjin antara 1000-3000 rpm manakala pelepasan ekzos dianalisis untuk karbon dioksida (CO_2) dan gas lain-lain. Tumpuan adalah pada pelepasan CO_2 dan keputusan menunjukkan bahawa menggunakan CNG sebagai alternatif kepada petrol akan dapat mengurangkan kira-kira 0.9kg / L pelepasan gas CO_2 di ekzos. Data dan pelbagai resolusi eksperimen yang dikumpul daripada kajian terdahulu , telah digunakan dalam menganalisis jumlah kemungkinan pelepasan CO_2 yang boleh dikurangkan sekiranya terdapat kadar peningkatan sebanyak 15% di kalangan pengguna kereta CNG di Malaysia pada tahun 2020. Ini adalah untuk menggalakkan jumlah kebolehterimaan daripada penggunaan bahan api CNG dalam masyarakat Malaysia memandangkan hasil kajian ini,yang menjelaskan jumlah kemungkinan pelepasan CO_2 boleh dikurangkan dengan peningkatan penggunaan kenderaan CNG pada tahun 2020 adalah di anggarkan kira-kira 4018546 ton berdasarkan dijangka 3058254 kenderaan menggunakan CNG. Dengan tahap ini jangkaan peningkatan di Malaysia boleh mencapai tahap pengguna NGV yang lebih tinggi dikalangan pengguna di seluruh dunia , seperti di Iran dan Pakistan pada masa kini.

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Odeta Prosper

Malaysia, December 2013

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LIST OF SYMBOLS AND ABREVIATIONS

%	Percentage
Vol	Volume
ppm	Parts Per Million
mg	Milligrams
m^3	Meter Cubed
g	Gram
Kg	Kilogram
L	Liter
Km	kilometer
Gt	Giga tons
P	pressure in KPa for normal conditions, this is 101.3KPa
MW	Molecular weight of exhaust constituent
R	Universal gas constant (8.3144 km / kmole K)
T	Temperature in degrees Kelvin, this is 273.15^{o}K (0o C) for normal conditions
VOC	Volatile organic compound
CO_2	Carbon dioxide
CO	Carbon monoxide
NOx	Nitrogen oxide
O_2	Oxygen
HC	Hydrocarbons
H_2O	Water vapour
SO_2	Sulphur Dioxide
SF_4	Sulfur hexafluoride

HFCs	Hydro fluorocarbons
PM	Particle matter
A/F	Air/fuel ratio or Lambda
NV_x	Number of New Vehicles or New NGV Vehicles
LS_a	Amount of fuel liter spent per year (5 x 360)
ER_b	Emission reduction (kg/L) (0.9 kg/L)
VR_c	80% of total vehicles on the Road (All vehicle type except Motorcycles)
CNG	Compressed natural gas
NGV	Natural Gas vehicle
GHG	Greenhouse gas
Cu ft	Cubic feet
MT	Million metric tons
TPES	Total Primary Energy Supply
IEA	International Energy Agency
SEA	South-east Asian
PGU	Peninsular Gas Utilization
NGDS	Natural Gas Distribution System
MAA	Malaysian Automotive Association
MOFs	Metal – Organic Frameworks
CDC	Central device communicator
S.H.E	Safety, Health and Environment
BEA	BOSH Exhaust Analyzer

LIST OF FORMULARS

CONVERSION EQUATIONS

1. From % vol to PPM = value x 10^4 PPM

   = Percentage Volume Units of Parts per Million (%Vol ppm)

2. From PPM = Mg/L Milligrams per Meter Cubed (mg/m3)

   $$Mg/m3 = ppm \times \frac{P \times MW}{R \times T}$$

   Where:

   P = pressure in KPa. For normal conditions, this is 101.3KPa

   MW = Molecular weight of the exhaust constituent.

   R = Universal gas constant, 8.3144 kNm / k mole K

   T = Temperature in degrees Kelvin, this is 273.15^{o}K (0^o C) for normal conditions.

   Therefore,

   Mg/m^3 = ppm x mg/m^3conversion factor

   Where the conversion factor is: 1 ppm CO_2 = 1.963 mg/m^3

3. From Mg/L to Kg/L = x 10^{-6}

4. CO_2 emission (Kg/L)

EMISSION REDUCTION EQUATION

Using Tier 2, we generated this equation:

$$CO2\ Emission\ Reduction = \sum NV_x \times LS_a \times ER_b \times VR_c$$

Where,

NV_x = Nos. of New Vehicles or New NGV Vehicles

LS_a = Amount of liter spent per year (5 x 360)

ER_b = Emission reduction (kg/L) (0.9 kg/L)

VR_c = 80% of total vehicles on the Road (All vehicle type except Motorcycles)