Econo Power Car

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Abstract

Nowadays the fuel energy is consumed more than it was used in the past and most of energy used comes from petroleum which is not reusable. Moreover, the crude oil which is raw material to be refined is likely to take place in nature; it usually takes a long time. Therefore, this natural resource must be used efficiently to maximize its benefits. Construction of Econo Power Car will be one of many methods to decrease the energy consumption. The objective of research aims to influence parameter effecting to the fuel consumption such as engine system, transmission system suspension system and fuel injection system. Furthermore, the Econo Power Car is estimated to cooperate with 11th Honda Econo Power. To achieve this, the effects of fuel consumption parameters are investigated using experiments. For the suspension system, the wheel resistance and the rolling resistance are decreased by wheel angle modification and changing the wheel bearing. Moreover, the engine is adjusted by the fuel injector addition. For the economical experiment in the 11th Honda Econo Power, the By Part Team (RMUTP Team) has the consumption 843.443 kilometer/liter and within 4th order from 347 teams by the invent higher education of competition and type of 125cc. The winner team has the economize statistics 999.746 kilometer/liter. As a result, influence parameters of fuel consumption are wheel resistance and engine system which is good knowledge for the development of the Econo Power Car in the future.

Key words: Econo Car, Econo Power Car

1. Introduction

Currently, the world is confronted with many problems such as the fossil fuel depletion, global warming, air pollution, rain acidification. One of the reasons is exhaust gas from the power plant [1]. In America, power energy of vehicle is 1/7 of proportion of using total energy. Moreover, 2 in 3 of pollution become from internal combustion engine [2].

These problems can partially be mitigated by the development of the fuel economy vehicle. The solar cell was used to instead of the engine for energy source into electric car [3]. However, the electric car has a limit in speed and duration of using. In addition, the compressed air engine that consists of high and low pressure state expander based on thermodynamics and mechanical power was studied to use in small vehicle [4]. But the mechanical efficiency of the prototype engine is very low compares to the theoretical isothermal efficiency. Therefore, the internal combustion engine still plays a role in power source of vehicle. The economy vehicle was established to maximize benefits of fuel consumption by modified engine and its carburetor [5].

The aim of this study is to investigate and evaluate significant parameters of fuel consumption and design vehicle structure for high efficiency.

2. Theory

2.1 Gasoline property

Table 1. Gasoline property [6]

$C_nH_{1.87n}$		
Molecular Weight	110	
Specific Gravity	0.72-0.78	kg/m^3
Heat of Vaporization	305	kJ/kg
Specific Heat Capacity of Vapor	1.7	kJ/kg K
Specific Heat Capacity of Liquid	2.4	kJ/kg K
Lower Heating Value	44.5	MJ/kg
Higher Heating Value	47.3	MJ/kg
Storichiometric (AF)	14.6	
Storichiometric (FA)	0.0685	

2.2 Works

When several forces act on a particle of mass *m*, a force does work only undergoes a displacement in the direction of force. If the force moves along the path to new position, the displacement is ***S*** and ***V*** is the velocity of the particle therefore the work ***U*** is defined by Newton's first law, above equation may also be written [7] as

$$U = F_t.S \qquad (1)$$

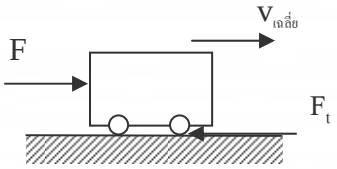

Fig. 1 The movement of particle

2.3 Power and energy demand of wheel resistance

Power demand of wheel resistance in order to set a vehicle in motion is determined by the resistance forces on the road that have to be overcome. When ***F*** is forces act on a particle, and ***V*** is the velocity of the particle. Therefore, the power and energy demand of wheel resistance are [8]

$$P_w = F.v \qquad (2)$$

2.4 Fuel consumption

The fuel consumption is defined by

$$R_F = \frac{S\rho_F}{V_F} \qquad (3)$$

where: R_F = fuel consumption(km/hr)
S = distance (m)
ρ_F = density of fuel (g/cc)
V_F = mass of fuel (g)

2.5 Fuel efficiency

Efficiency of the output and in a reciprocating of most vehicle are Fuel efficiency (η_F) or engine efficiency (η_e) at the crankshaft indicated work which multiply by transmission efficiency. Then, the result proportionally is compared by higher heating value of some gasoline engine [9]. As a result of the actual work available at the crankshaft, there is merely 25% of power unless 5% must be lost for the resistance, 30% for cooling system and 45% for exhaust gas. In consequence, the adjustment of the engine for high performance as much as possible will lead to progress of fuel consumption.

2.6 Resistance forces of the vehicle movement

The resistance forces that act on a vehicle moving at the constant speed can be determined by summation of wheel resistance and aerodynamic drag [8]. This force corresponds to the resistance forces of the vehicle movement:

$$F_t = R_r + R_a = K_r W + \frac{1}{2}\rho v^2 A C_d \qquad (4)$$

where: F_t = resistance forces of the vehicle movement

R_r = wheel resistance
K_r = wheel resistance coefficient
W = gross weight
ρ_a =density of air
v = velocity of air
A = cross section area
Cd= aerodynamic drag coefficient

3. Conceptual Design

The development of Econo Power Car aims to emphasize at point of engine, fuel injection, transmission and suspension system.

3.1 Aerodynamic drag analysis

As a result of the body is set with fiberglass handles feature and aerodynamic figure designed by computer programs to reduce aerodynamic drag. Only 0.296 m2 for cross section area and 0.3 for aerodynamic drag coefficient were constructed underneath 1.181 kg/m3 for density of air at 25°C of temperature and velocity of vehicle movement 25 kilometers/hour.

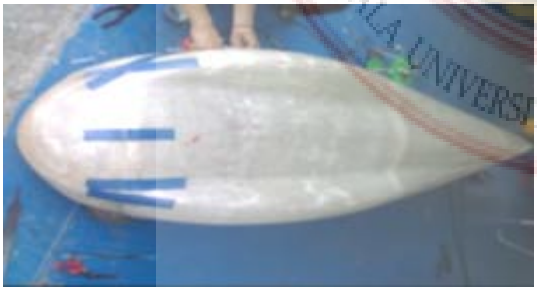

Fig. 2 fiberglass handles feature

Consequently, equation (2) and (4) were used to obtain both aerodynamic drag Ft = 229.19 N and power and energy demand of wheel resistance Pw = 1.591 kilowatts based on aero dynamics drag coefficient, Cd = 0.20 [10].

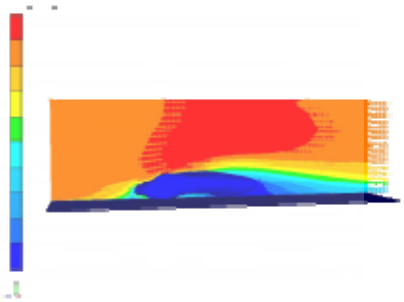

Fig. 3 Computer aid design of aerodynamic drag

3.2 Structural design

Principle of dimension design of Econo Power Car mainly was considered by driver's shape while driving device and positions of wheel were installed. The wheel base and body length can define at 1,611 millimeters and 3,143 millimeters respectively as Fig. 4. Also the design of tread width on the front wheel depends on driver's leg wide and turning radius of the car. The tread width on the front wheel at 504 millimeters was obtained for the body design. Beside, the height of body was determined at 317 millimeters obtained from driver's height.

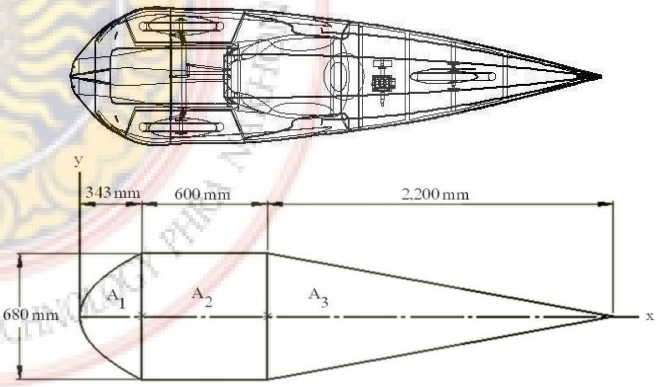

Fig. 4 Dimension of the Econo Power Car

As a result of structural design, the water drop shape was used to build in the body Moreover, all dimensions and positions were designed base on aerodynamic principle

leading to the aerodynamic drag as least as possible.

3.3 Center of gravity

One of crucial factors for fuel economics is center of gravity designs. For the conceptual design, the triangle parabolic and rectangle shape were combined to be the body of Econo Power Car. The center of gravity of 1,180.52 millimeters in longitudinal and 251.29 millimeters in crosswise were determined. In addition, the position of the wheels were defined and described in the Fig.5.

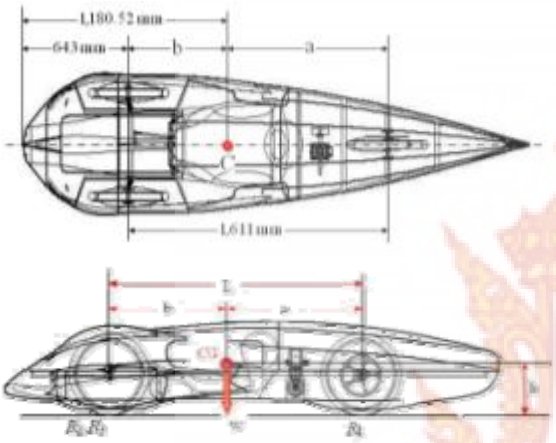

Fig. 5 center of gravity

3.4 Wheel alignment

One of the serious for adjustment in Econo Power Car is wheel alignment because most of frictions are generated from rolling resistance. To reduce the resistance forces, the camber and toe angle were set at the zero of value as Fig.6. Moreover, the wheel alignment is sensitive to driving contest and feasible to error in anytime. Therefore, the investigations of wheel alignment have to be reviewed before driving contest at all times.

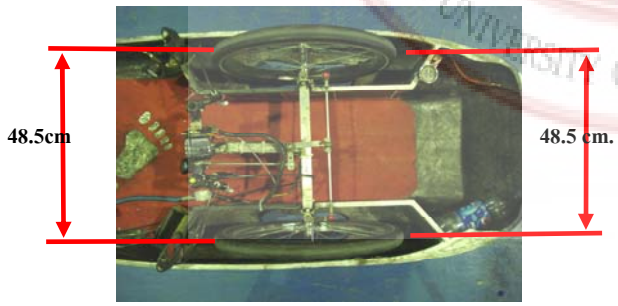

Fig. 6 zero of toe angle wheel

3.5 Steering wheel system designs

The design of steering wheel system was intended to ackerman type which is the minutest of resistance force for the Econo Power Car. For the design, the steering angle is showed as Fig 7 and the inner and outer steering angle are defined at 18° and 16.79° consecutively

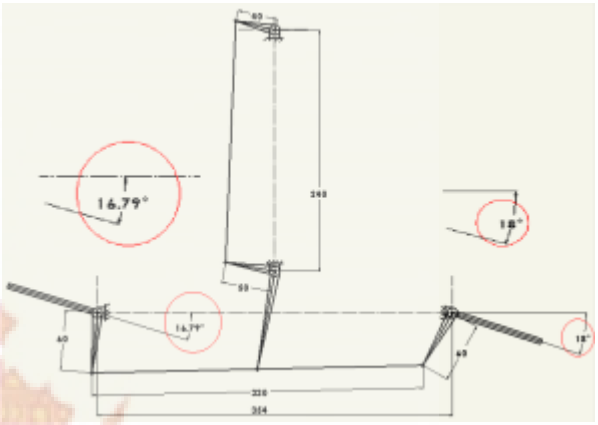

Fig. 7 Steering wheel

3.6 Engine

The engine is the most of importance for the development of the Econo Power Car. In addition the automotive engineering knowledge, the engine modify of the Econo Power Car must be set under control of the contest rule. Therefore, all parts in the engine were adjusted and developed to economize fuel and install for 4-storke engine of the wave 125 I type as Fig. 8.

Fig. 8 The modified engine

The modified engine is 124.5 cc of combustion chamber capacity while cylinder side, stroke and combustion ratio are 50 millimeters, 62.9 millimeters and 10.53:1 respectively. Furthermore, the ignition

system was modified with 0 bTDC and twin spark plug of CDI system.

3.7 Fuel injection system

As a result of the rule of the Econo Power Contest, all of cars that use fuel injection system do not use fuel pump for the contest.

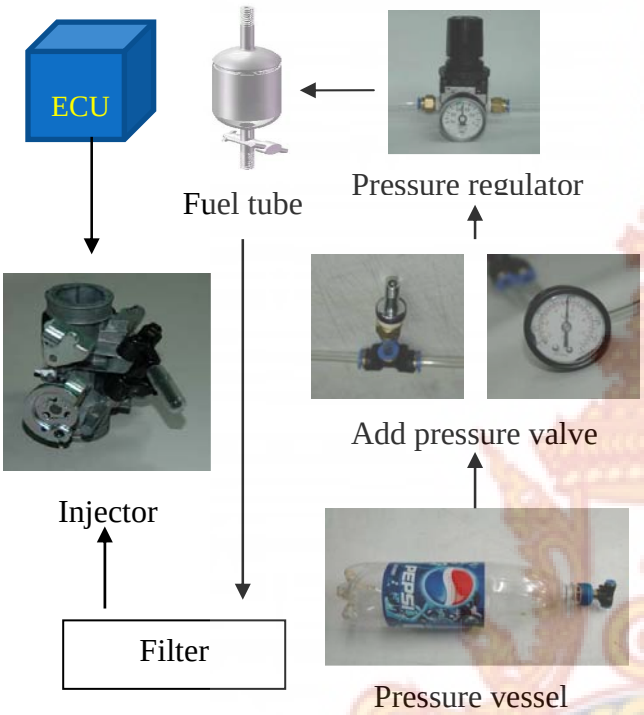

Fig. 9 Injection system

Hence, the bottle of soft drink was applied as pressure vessel to accumulate 5 bars of the air pressure for the injection system as Fig.9. In consequence of the testing result, the appropriate pressure to overcome the least of fuel consumption is 2-3 bars of the air pressure.

3.8 Ideal fuel consumption analysis

As a result of using michelin tire for bicycle model, the Econo Power Car was running on the test road under condition as table 2.

Table 2. Test Condition

Test Condition		
Gross Weight	90	kg
Fuel Consumption Efficiency	31.5	%
Distance of Testing	9000	m
Constant Speed	25	km/hr

Then the Econo Power Car accelerated from 0 to 25 kilometer/hour of velocity into 5 second they were able to move on 17 meters of distance. For calculation, net driving force (combined resistance forces) was 252 newtons and consumed 1.551 grams of fuel and ideal statistic was 4178 kilometers/liter. At the time of 83 kilograms of weight reduction and running on test condition, the Econo Power Car consumed 1.445 grams of fuel and ideal statistic was 4484 kilometers/liter which was increased 306 kilometers/liter.

Fig 10 The Econo Power Car

However, practically driving behavior on the running contest, the engine must be started and accelerated within 5-7 seconds thus turned off over and over in constant speed condition which was conflict for power and energy demand of the engine.

4. Result

4.1 The 1st provincial state contest result

For the developments of the Econo Power Car, the running contest was taken place on landing ground of Ratchaburi and the distance of running contest was 10823 meters. For the driving process, the engine must be started and accelerated within 7 seconds thus turned off 20 times per contest. From the first driving contest result in Table 3 indicate that the engine consumed 12.731 grams of fuel and statistic was 630.09 kilometers/liter. As a result, the 1th provincial state contest result would be recorded and able to develop for next contest.

Table 3 The 1st provincial state contest result

On.	Start (Time)	Time of Accelerate (second)	Average Velocity (km/h/)	Fuel Consumption (km/liter)
1	20	7	25.35	630.62
2	20	7	25.30	637.59
3	20	7	25.45	617.59
4	20	7	25.32	634.59
Average			25.36	630.09

From the 1st provincial state contest result, the Econo Power Car was remodified in some system such as transmission, suspension, engine and fuel injection systems. For transmission system, transmission ratio was changed to appropriate for driving condition depending on each contest. In suspension system, un-tread of tires was used to be fully performance for economizing energy. Beside, bearing wheel was rechecked and changed and wheel alignment was adjusted. In addition, the combustion chamber was redesigned by reducing combustion volume and increasing stroke for the engine system. Moreover, fuel injection system was remodified by setting pressure at 2.5 bars of the air pressure to reduce fuel injection and appropriate for reducing combustion volume.

For the developments of the Econo Power Car, the 2nd provincial state contest result, the running contest was taken on the same place and overcame the statistic was 834.36 kilometers/liter with 26.59 kilometers/hour of average speed as show in Table 4.

Table 4 The 2nd provincial state contest result

On.	Start (Time)	Time of Accelerate (second)	Average Velocity (km/h/)	Fuel Consumption (km/liter)
1	20	7	26.54	677.63
2	20	7	25.49	731.93
3	20	7	26.89	741.56
4	20	7	26.36	774.68
5	20	7	25.15	475.10
6	20	7	25.30	480.62
7	20	7	26.51	825.26
8	20	7	26.59	834.36
Average			26.10	692.64

4.2 The 11th Honda Econo Power Contest result

The 11th Honda Econo Power Contest was taken place on ground of 11th regiment of infantry, Bangkok and the distance of running contest was 10750 meters and 10 rounds of running contest. There were 347 teams of competitor for higher education level. For this challenge, the By Part (RMUTP Team) was able to keep 750.10 kilometers/liter of fuel consumption at 26.82 kilometers/hour for the rehearse day. For truly contest day, the By Part (RMUTP Team) was able to keep 843.443 kilometers/liter as 4th order from 347 teams. By means of the winner team was able to keep the economize statistics 999.746 kilometer/liter.

Fig. 11 The accepting award

5. Conclusion

For the developments of the By Part (RMUTP Team), the influence factors are handled to minimize fuel consumption such as appropriating transmission ratio, using un-tread of tires, adapting combustion chamber, enhancing fuel injection system and setting bearing wheel and wheel alignments. All above-mentioned, they cause to fuel consumption ratio. For the air resistance force, it cloud not be corrected while contesting because of depending on the body designs. Therefore, the air resistance is serious factor for design step before building the Econo Power Car. There are good knowledge for the development of the Econo Power Car in the future.

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