Comparitive life cycle costing for of a gasoline and a hybrid car

Entertainment, Movie

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ABSTRACT

The depletion of the fossil fuels is emerging as a concern for the whole world. The major sources for the consumption of this fossil fuel are our vehicles that use much of the oil for their operation. The need has been felt to devise the alternative fuel for our vehicles which should be the sustainable option so that it does not contribute to the environmental impacts rigorously. The objective of the comparative analysis is to know the feasibility of the hybrid car against the petrol car.

The procedure adopted for the comparative analysis is to do life cycle costing of both the engines by considering the cost, benefits, maintenance and repairs for both the engines. The weight scoring model was also developed to analyze the feasibility of both the engines on the grounds of terms like safety, comfort, emissions and incentives. After completing the comparative analysis the life cycle costing model and the weight scoring model yield the results which were analyzed and the necessary recommendations were made.

The results of the comparative analysis revealed that though the Hybrid cars initially cost more, but if they are run for more than 20, 000 miles than the total cost per mile is less than the petrol cars. Also weighing model for both the cars gives more weightage to hybrid cars in terms of emissions and incentives.

KEYWORDS: Life Cycle costing, alternative fuels, hybrid vehicles, petrol engines.

LITERATURE REVIEW

Today the major problem the whole world is facing is the depletion of fossil fuels. Most of the vehicles run on these fossil fuels.

It is estimated that if the consumption of these fossil fuels continues at the same rate then by the end of 2030 the fossil fuels will get reduced by 50% of the current value and the prices will increase by $10/ gallon (Kibert, 2008). To overcome this problem a lot of automobile companies are working on the new design of engine which will work on some other source of energy other than fossil fuels. So hybrid model cars were developed keeping in mind of these problems.

The first hybrid car model was developed by Dr Ferdinand Porsche in 1902 using a petrol engine, rotating at a constant speed to drive a ynamo, which charged the accumulators (www. wikipedia. com; 10, 2008). These accumulators fed current to electric motors contained within the hubs of the front wheels. Before this several advancements were made in non-gasoline motors, mainly electric cars (www. wikipedia. com). Such non-gasoline car was invented somewhere around years from 1832 and 1839, by Robert Anderson of Scotland and his electric carriage (www. wikipedia. com; 10, 2008). After that several car manufactures have been working on differenttechnologyfor a long time and recently hybrid cars were developed (www. wikipedia. com; 10, 2008).

Hybrid cars are vehicles driven by hybrid engines, which are any engine that combines two or more sources of power, generally gasoline and electricity (Lipman, et. al, 2003). There are two types of gasoline-electric hybrid cars; the parallel hybrid, and the series hybrid. Both of these use gasoline-electric hybrid technology (Lipman, et. al, 2003). In parallel hybrid cars, the gasoline and electric motors work together to move the car forward. In series, the gasoline engine either directly powers an electric motor which in turn powers the vehicle or charges the battery that will in turn power the motor(Lipman, et. l, 2003). Both these type of hybrid cars use another technology called Regenerative braking which stores the kinetic energy that is created while braking. This energy is stored in a battery which runs the electric motor. (Lipman, et. al, 2003)

PROJECT SUMMARY

This project was based on the life cycle costing and the comparative analysis of the hybrid engines and the petrol engines. The goal of the project was to calculate the total cost of both the engines during their life cycle and to analyze their performance and the impacts of environments.

The first objective was to develop the life cycle cost model for studying their performance withrespectto the annual mileage and the total cost per year spent on both type of cars. The second objective was to develop the weight scoring model for both types of cars to analyze them on the grounds of safety, comfort, emissions, and incentives. Life cycle model for both the cars were developed using the cost components like depreciation, fees and taxes, finance, fuel, insurance, maintenance , and repairs. All the data for these

cost components for both types of engines were collected from the company websites and the EPA website.

After the collection of these data, the life cycle cost model has been used for calculating the total life cycle cost for hybrid as well as petrol engines. The results were analyzed for both the alternatives and the conclusions were made. Weight scoring model was also developed for the comparative analysis which included the components like safety, comfort, emissions, and the incentives. The relative weights for these components were assigned according to the priorities from the consumer point of view. The rating points were also assigned and both the cars were rated according to the aforesaid components.

The sources for the data were the company websites and the EPA websites for the emission data was also cited. The results of the Weight scoring model were then analyzed and the final conclusions were made. The comparative study for both the cars revealed that the hybrid cars are more efficient in terms of long term usage than the petrol cars.

CASE STUDY DESCRIPTION

Many car manufactures are working on this hybrid technology to improve the fuel consumption and decrease the emission levels and Honda is one of the leading car manufacturers who have released different hybrid models into the market (www. onda. com; 11, 2008). One of the models of Honda is “ The Civic Hybrid 2008” which is the latest model which uses hybrid technology for propulsion, which is taken into study (www. honda. com; 11, 2008). The

Civic Hybrid 2008 uses gasoline and electric power train for the propulsion. The engine is a 1399cc, 4 cylinder aluminum-alloy engine which supplies a power of(www. honda. com; 11, 2008). The electric motor supplies a maximum of 158 volts (www. honda. com; 11, 2008). The functioning of the system at various stages is different and is explained below.

STARTING: The car uses an IMA (Integrated motor assist) system motor to start. If the IMA battery-pack charge is too low or if it’s very cold outside, the system has a separate battery and starter motor to back it up. (www. honda. com; 11, 2008)

ACCELERATION: When extra acceleration is needed, while passing or climbing up an inclined region, the IMA System’s electric motor adds its torque automatically to the engine’s to give extra power. (www. honda. com; 11, 2008)

CITY CRUISING: At steady speeds below 35 mph on level roads and under light throttle, fuel injection is ceased and the car is propelled olely by the electric motor. (www. honda. com; 11, 2008)

HIGHWAY: At higher cruising speeds, the gasoline engine provides the motive power. The motor has been developed in such a way that it reduces the fuel consumption to particular levels. (www. honda. com; 11, 2008)

BRAKING: The cars IMA System tap’s the kinetic energy that is produced in the vehicle, when brakes are applied. During that period, the system’s motor

turns itself into a generator, and helps in slowing down the car while at the same time it builds up the energy stored in the batteries. www. honda. com; 11, 2008)

AT A STOP: When stopped, the gasoline engine automatically shuts off. When we lift our foot off the brake, and the engine restarts automatically. (www. honda. com; 11, 2008) These setups have been made to increase the vehicle performance and make them fuel efficient. The benefits of the refined gasoline electric power train are fuel economy andenvironmentfriendly emissions. This vehicle is certified by Environment protection agency (EPA) and passes all the regulation of EPA 2008 for environment.

This car is also equipped with the rating of Advanced Technology of Partial Zero Emission Vehicle (AT-PZEV) which is the most stringent emission standards of United States which in turn is certified by California Air Resource Board (CARB). The technology being new is expensive and the initial cost for hybrid car is high as compared to the petrol engine cars. But if compared the life cycle cost is considerably less as compared to petrol engine due to the benefits of low emissions and fuel economy of the hybrid cars. (www. honda. om; 11, 2008) The petrol version of 2008 Honda civic sedan which is currently out in the market, is a normal car that runs on a gasoline engine. The engine is a 1799cc aluminum-alloy which produces(www. honda. com; 11, 2008). Gasoline or petrol engines are basic internal combustion engines which run on volatile fuels. They use air and fuel mixed together and a spark plug which produces the

fire for combustion. The energy that is created is used to run the drive shaft which in-turn runs the wheel (www. wikipedia. com; 10, 2008).

Petrol engines were developed by the engineers Gottlieb Daimler and Karl Benz (both from Germany) in 1885 who both together started the Daimler-Benz car plant (www. wikipedia. com; 10, 2008). Gasoline engines are the widely used internal combustion engines which have been under constant improvisation to improve their efficiency and to reduce the emission levels from them (www. wikipedia. com; 10, 2008). Different industries have been working towards that and Honda is one of the industries who have taken serious steps to reduce the emission levels from normal gasoline engines. www. honda. com; 11, 2008) These are the two products for which the life-cycle cost model analysis is going to be created.

LIFE CYCLE COST MODEL DESCRIPTION

The Life Cycle Cost (LCC) model for comparative analysis of hybrid and the petrol cars was based on following cost components:

- Depreciation
- Insurance
- Financing
- Taxes and fees
- Fuel
- Maintenance
- Repairs

The source for developing the model was (Shtub, et. al; 2005). LCCcars = LCCdepreciation + LCCinsurance+ LCCfinancing+ LCCtaxes and fees+ LCCfuel + LCCmaintenance+ LCCrepairs.

The LCC model for car is the summation of the all the cost components which will yield the total life cycle cost (Shtub, et. al; 2005). The assumptions that have been made are in terms of time frame and the cost components are as follows:

Time frame: The time frame for calculation has been taken as 5 years. All the data for the cost components are based on 5 years.

Depreciation: it is the value of the vehicle which declines as the vehicle gets older. The age of the vehicle is related to the number of miles it has travelled. For both the cars it the average of 15, 000 miles per year is being considered.

Insurance: It is the average annual insurance that has been taken into account. The premium charged per year for the insurance of the car has been taken from the website of Honda company for the Louisiana state.

Financing: This is the interest expense on a loan in the amount of true market value purchase price + destination charge + base sales tax & initial fees (www. honda. com; 11, 2008).

1. The values for these expenses are considered for Louisiana region assuming the 10% down payment and a loan term of 60 months.

2. Taxes and fees: we have included base sales taxes, license and registration fees in Louisiana region (www. dmunds. com, 11/2008).
3. Fuel: Assuming 45% driving on freeways and 55% driving in city we have collected the data for the fuel from www. epa. gov.
4. Maintenance: We have considered both the scheduled and the unscheduled maintenance in this cost components.

Repairs: the estimated expenses for repairs that do not come under the manufacturer’s warranty for five years, is taken as repairs. (www. edmund. com; 11, 2008) The life cycle costing has been done for three conditions and they are:

1. Condition 1: cost component data for USA
2. Condition 2: cost component data for Louisiana.
3. Condition 3: distance travelled is 10, 000 miles with a 55% driving in city and 45% driving on freeways.

CHECK LIST MODEL DESCRIPTION

The weighing model that has been created has taken into consideration of few factors which are not taken into account by many car owners. Factors like safety, comfort, and emissions do not play a significant factor for many people who plan to buy a car. This motivated us to create the scoring model for these factors. For the Honda civic Dx (2008 model) and Honda civic hybrid (2008, model) safety, comfort, and emissions are taken into account and the relative weights are given.

The safety features are good for the in the midsize segment with disc for the front, 4 wheel ABC and the airbags for the head, and side (www. honda. com; 11, 2008). But these can be improved to the next level by adding the disc brakes to all the wheels and by increasing the number of airbags. The comfort level is taken into consideration as some people spend more time in the car driving around, so the comfort level plays an important part. The next criteria are the emission levels of the car which is taken into consideration for analyzing the environmental impact of them.

The last criteria is the incentives that are being offered for the buying a hybrid cars. The source for developing the weighing model was (Shtub, et. al; 2005). On the basis of the above criteria the weighing model has been developed and the results were analyzed to make conclusions.

RESULTS

Life cycle costing Model 1: Honda Civic Dx 4 door Sedan Condition 1: cost component data for USA Maximum or manufacturer’s suggestion retail price: $ 15, 810. Owner ship: 1-5 years. Cost componentsCost ($) Depreciation 10, 112 Fees and taxes 730 Finance 2331 Fuel9945 Insurance8348 Maintenance1720 Repairs643

Total life cycle cost37645 Note: The miles driven are kept constant and the values are tabulated for USA Source: www. autochannel. com, www. honda. com, and www. edmunds. com for cost component data except for the fuel data. www. epa. gov - fuel data. Condition 2: cost component data for Louisiana. Maximum or manufacturer’s suggestion retail price: $ 15, 810.

Owner ship: 1-5 years. Cost componentsCost ($) Depreciation 9002 Fees and taxes 1407 Finance 2963 Fuel8478 Insurance10119 Maintenance2934 Repairs625 Total life cycle cost35528 Note: the above values are taken for Louisiana region Source: www. utochannel. com, www. honda. com, and www. edmunds. com for cost component data except for the fuel data. www. epa. gov- Fuel data. Condition 3: distance travelled is 10, 000 miles with a 55% driving in city and 45% driving on freeways. Maximum or manufacturer’s suggestion retail price: $ 15, 810. The car has driven for 10, 000 miles (55% city and 45% freeways) Owner ship: 1-5 years.

Cost componentsCost ($) Depreciation 8851 Fees and taxes 1194 Finance 2405 Fuel6568 Insurance6759 Maintenance1176 Repairs564 Opportunity cost2999 Total life cycle cost30, 518 Note: the cost per mile for 10, 000 miles is $. 1, for 15, 000 miles is $. 48, and for 20, 000 miles $0. 46. Source: www. autochannel. com, www. honda. com, and www. edmunds. com for cost component data except for the fuel data. www. epa. gov- Fuel data. Model 2: Honda Civic hybrid 4 door Sedan Condition 1: cost component data for USA Maximum or manufacturer’s suggestion retail price: $ 22, 600. Owner ship: 1-5 years. Cost componentsCost ($) Depreciation 11993 Fees and taxes 1974 Finance 4117 Fuel6155 Insurance10622 Maintenance2932 Repairs625 Total life cycle cost38478 Note: The miles driven are kept constant and the values are tabulated for USA Source: www. utochannel. com, www. honda. com, and www. edmunds. com for cost component data except for the fuel data. www. epa. gov - Fuel data.

Condition 2: cost component data for Louisiana. Maximum or manufacturer's suggestion retail price: $ 22, 600. Owner ship: 1-5 years. Cost componentsCost ($) Depreciation 13128 Fees and taxes 511 Finance 3331 Fuel6846 Insurance9252 Maintenance1920 Opportunity cost3857 Repairs679 Total life cycle cost39525 Note: the above values are taken for Louisiana region Source: www. autochannel. com, www. honda. com, and www. edmunds. com for cost component data except for the fuel data. ww. epa. gov - fuel data. Condition 3: Distance travelled is 10, 000 miles with a 55% driving in city and 45% driving on freeways. Maximum or manufacturer's suggestion retail price: $ 22, 600. The car has driven for 10, 000 miles (55% city and 45% freeways) Owner ship: 1-5 years. Cost componentsCost ($) Depreciation 12189 Fees and taxes 1157 Finance 3615 Fuel4536 Insurance7491 Maintenance1402 Repairs596 Opportunity cost3212 Total life cycle cost34198 Note: the cost per mile for 10, 000 miles is $. 68, for 15, 000 miles is $. 51, and for 20, 000 miles $0. 47.

Source: www. autochannel. om, www. honda. com, and www. edmunds. com for cost component data except for the fuel data. www. epa. gov - Fuel data. Sensitivity analysis The data used for sensitivity analysis was miles per year travelled and the increment taken for it was 5000. For Model 1: Honda Civic Dx 4 door Sedan No of milesCost per mile($)Data source 100000. 61www. epa. gov 150000. 48www. epa. gov 200000. 46www. epa. gov 250000. 47www. epa. gov For Model 2: Honda Civic hybrid 4 door Sedan No of milesCost per mile($)Data source 100000. 68www. epa. gov 150000. 51www. epa. gov 200000. 47www. epa. gov 50000. 45www. epa. gov The

initial cost for the petrol engine may be less than the hybrid cars but after 20000 miles of running hybrid cars are more fuel efficient than the petrol engines. After performing the sensitivity analysis we observed that initially the cost per mile for petrol is less than the hybrid cars, but as you increase the number of miles after 20, 000 miles hybrid cars become more fuel efficient. The breakeven point on the sensitivity graph shows the changing nature of fuel efficiency for hybrid cars and petrol cars. Weight scoring method (Shtub, et. al; 2005).

Weighing model for Honda civic DX 2008: For all criteria and the relative weight the values are assumed according to the priority of consumer. CriteriaRelative weightExcellent 30(assumed)Good 20(assumed)Fair 10(assumed)Poor 0(assumed)Factor score safety. 3v6 Comfort. 2v2 emissions. 4v2 incentives. 1v0 total1. 0010 Source: www. autochannel. com, www. honda. com, and www. edmunds. com for criteria data except the fuel data and www. epa. gov for fuel data. Weighing model for Honda civic hybrid 2008: For all criteria and the relative weight the values are assumed according to the priority of consumer.

CriteriaRelative weightExcellent 30(assumed)Good 20(assumed)Fair 10(assumed)Poor 0(assumed)Factor score safety. 3v6 Comfort. 2v4 emissions. 412 incentives. 1v3 total1. 00v25 Source: www. autochannel. com, www. honda. com, and www. edmunds. com for criteria data except the fuel data and www. epa. gov for fuel data. The weighing score model shows that for hybrid cars the factor score is more than the petrol car and the reason is the hybrid cars are more emission free than the petrol car, also the

criteria of the incentive for hybrid car makes it more preferable for the customers.

The hybrid cars have a 25-100% federal tax credit which could move people towards buying the hybrid cars which are environmentally friendly as compared to petrol (www. honda. com; 11/2008) . Conclusions After carrying out the life cycle costing, sensitivity analysis, and the weight scoring the following conclusions can be reached: Though the petrol cars are cheaper than the hybrid cars but the life cycle cost of hybrid cars after 20, 000 miles makes it the better option. Due to the depletion of fossil fuels, petrol cars do not serve to be the best option. Hybrid cars produced less emission than the petrol engines so they are environmentally friendly cars which makes them a sustainable product. The incentives offered by the federal state government for buying the hybrid car may serve as a good step towards motivating people to go for hybrid option

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