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Emissions of Chinese New Energy Vehicle and the Development Recommendations

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Abstract

In this paper, by analysis of emissions throughout the life cycle of new energy vehicles, pointing out that new energy automobile emissions is not only arising in its using process but also including emissions from its production process. Finally concluded that China's development of new energy vehicles is inevitable, but it should be strictly controlled of critical emissions during its life cycle.

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Keywords: new energy vehicles; emissions; suggestions;

1. Introduction

United Nations Development Programme (UNDP) put new energy into the following three categories: large and medium hydropower; new renewable energy sources, including Small-hydro, Solar, Wind, Modern biomass, Geothermal, Ocean (tidal energy); traditional biomass.

Conventional energy means technically more mature and has been large-scale used energy. New energy usually refers to small-scale used energy under research and development. Therefore, coal, oil, natural gas and hydropower are considered as medium-sized conventional energy, and solar energy, wind energy, modern biomass, geothermal, ocean energy and nuclear energy, hydrogen energy as a new energy [1, 2].

According to the definition of new energy sources, we can intuitively believe that cars using new energy as the main power fuel can be called the new energy vehicles. Otherwise, the Chinese Ministry of Industry and Information issued "new energy vehicles manufacturing companies and product access management rules" ([2009] No. 44) on

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June 17. 2009. State Department issued "energy saving and new energy automotive industry development plan (2012-2020)" on June 28, 2012[3], and said that the new energy vehicle is defined as the cars which use unconventional vehicle fuel or use conventional fuel but adopt new vehicle power unit, integrate the advanced technologies of power control and drive of the vehicle with new technology, new structure and new theory. New energy vehicles including hybrid electric vehicle, pure electric vehicles, plug-in hybrid and fuel cell vehicle, hydrogen-based fuel-cell car, and other power car. According to these two views, it is obvious that electric car is within the scope of new energy vehicles.

2. Car's emission

How do we determine the amount of vehicles emissions traveling one kilometer in the end? Now many people say that electric vehicles are zero-emission vehicles, in fact, which emission is zero during the use phase. However, we should focus on the emissions during the production and decommissioning phases of a vehicle. Typically the life cycle of the vehicle consists of the following stages, namely the procurement and processing of raw materials, parts manufacturing, vehicle assembly, vehicle use, scrap recycling. The stage before using the vehicle is referred to as the vehicle production phase, then we can analyze the energy consumption and emissions of the vehicle during the stages of production, use, scrap.

2.1. Production Stage

A vehicle is composed of thousands of parts and components, the main components manufacturing and production processes consump the largest energy and generate the largest gas emissions, mainly in the following stages, namely batteries, motors, tires, wheels and frame welding production. Parts are made in an assembly plant, then assembled into a car. Production stage is the largest energy consumption stage.

2.2. Using stage

Energy consumption of using phase of vehicle is mainly fuel or electricity. Fuel consumption causes exhaust emissions in urban used vehicles. Electricity generates by the solar power or by thermal power, hydroelectric power, wind power, it is conversed from coal, water, wind, solar and other energy. Thermal power plant causes exhaust emissions in its location while produce electricity.

2.3. decommissioning stage

Large number of scrapped vehicles generate solid waste, recycling its scrap material will produce exhaust emissions, the following described separately recovered from vehicles scrapped links.

3. Two aspects cannot be ignored

3.1. Emissions of power plant

As mentioned earlier, in China, after decades of energy structure adjustment, and still have 70% of electricity is produced by thermal power plants. Now, a total of 15 national grid to provide services for different regions. Electricity in some areas still local small-scale, low efficiency of power plants, has not been incorporated into the national grid.

3.2. Battery production and recycling issues

Battery production and recycling process included three stages: 1) mining and smelting; 2) cell production; 3) heavy metals recycling. Production and recycling process does not take full advantage of heavy metals, and pollutant will be released into the environment.

The length of each of the important parts of the vehicle life time can be predicted during the whole life，can travel many kilometers can be foreseen, the average number of passengers is basically the life cycle can also be obtained through the survey, the vehicle's energy consumption per kilometer can be calculated . Someone has calculated that based on Table 1 on bus fuel, fuel cars, bicycles, electric bicycles, for example, comparison of energy consumption and emissions of vehicles lifecycle.

Table 1. Different modes of transportation per passenger kilometer traveled energy use and emissions [3].

	Energy use (kWh/100 pax-km)	CO2 (g/pax-km)	SO2 (g/pax-km)	PM (g/pax-km)	CO (g/pax-km)	HC (g/pax-km)	NOX (g/pax-km)	Pb (g/pax-km)
car	140	306	0.689	0.277	10.06	1.67	1.32	0.300
bus	13.06	48.4	0.022	0.065	0.159	0.015	0.270	0.0016
bicycle	4.88	4.70	0.014	0.059	-	-	-	0.000
Electric bicycle	6.12	22.08	0.123	0.125	-	-	0.027	0.1244

The above data has not yet considered the factors in the process of infrastructure, plant construction, logistics and transport, or secondary production costs. At present, many cities are ready to build charging stations, charging piles, etc. These infrastructures will consume a lot of energy. If these emissions are allocated to life cycle of the vehicle, and energy consumption that one passenger traveled per kilometer will increase. This problem need further research.

4. The impact on human health

As can be seen from the above analysis, the new energy vehicle pollutants mainly come from two aspects, one is the air pollution caused by coal-fired power, on the other hand is heavy metal pollution caused by the production of the battery recycling process.

4.1. Impact of coal-fired power

Pollution in coal-fired power plant is emitted into the atmosphere, such as Sulfur compounds, nitrogen oxides, this type of pollution can be obtained by intake fraction. Intake fraction is a dimensionless parameter, the calculation formula:

$$\varepsilon = \frac{I}{E} = \frac{\int (\sum P_i C_i B_i) d_t}{\int e d_t} \tag{1}$$

As can be seen from the above equation (1), intake fraction concerned with and population (Pi), population exposure (Ci, g/m3), and respiratory rate (Bi, m3/s). The greater intake fraction is, the greater impact people affected by air pollution. This number can be calculated by means of the relevant data [5].

4.2. The impact of heavy metal emissions

Currently, the new energy vehicles use lithium batteries, whose components include lithium, nickel, chromium and other heavy metals. Heavy metals will be finally released into the environment when the battery fails. It is imperative to carry on the study of the problem.

According to statistics, MAO Jian Su estimated the resource efficiency of lead in 1990-2000, is the only average of 0.9 lt/t, and lead emissions rate averaged about 0.26 1t/t, that is, every ton of lead will have 0.261t lead emissions into the environment [4]. In recent years, with the improvement of the production process, the index declined. However, due to imperfect industry regulation, legal and other related issues, heavy metal emissions remain high,

there has been a lot of major environmental pollution incident: 2009 Baoji lead poisoning, Loudi chromium waste event, Liuyang cadmium poisoning cases, 2011 Zijin Mining event, illegal dumping of chromium residue, and Qujing, Hechi Longjiang cadmium pollution events.

Chromium is an essential trace element, but excessive intake of chromium cause large harm to the human body. If we chronically intake large amounts of trivalent chromium, it is prone to some chronic oxidative diseases such as diabetes, high blood pressure. The toxicity of Toxic hexavalent chromium, is about 100 times than trivalent chromium. Clinically, the damages usually show in three aspects: the first is skin damage, dermatitis, and pharyngitis; the second is the damage of the respiratory system, and the causes of pneumonia, bronchitis and other diseases, the third is the damage of the digestive system. Excessive intake of hexavalent chromium lead to serious kidney failure and even cancer.

Other excess emissions of heavy metals harmful to human health is very large, such as cadmium replacing bone calcium, serious bone softening and bone-breaking. Children's high lead level can cause mental retardation, and developmental delays. How to assess human health, and how to quantify the influence of heavy metals? Is it worth sacrifice our health for economic development? Those issues should be further studied.

5. Conclusion

Energy saving, environmental protection, safety are the trends in the automotive development. Along with an increasing consumption of fuel resources, the oil crisis has become a reality. The use and development of new energy is imperative. China is still the world's factory, if electric vehicles are developed excessively without addressing emissions from its upstream and downstream industry that would cause irreversible harm to environment and human health.

There are some suggestions for reference as follows:

(1)Large-capacity lithium battery industry should be unified managed, and develop strict industry standards, so as not to repeat the mistakes of lead-acid batteries.

We should strengthen emission control from battery production and other upstream production, strengthen regulatory aspects of battery recycling. We should strictly control hazardous substances of electric vehicle batteries, such as cadmium (Cd), mercury (Hg) content, lead (Pb) etc. From the perspective of environmental protection, the world environmental organization had classified these three elements as hazardous substances. We can use the way of environmental taxes to control the production and use of these heavy metals.

(2)In some areas, give priority development of electric vehicles where regional conditions are ripe, but give careful development where conditions are not.

Electric cars mainly use electricity, development should be cautious in thermal power dominated areas. Electric vehicles should give priority development in Xinjiang, Inner Mongolia, Yunnan, where wind or hydro power are locally abundant. Wind or hydro power are clean energy, and electrical energy will be wasted if not be merged into the national grid. The use of electric vehicles can effectively solve this problem. Policies should be developed to encourage the use of clean energy vehicles, such as LNG vehicles.

(3) Do in-depth research to electric car industry, provide a basis for the development of industry policy.

Under China's current energy mix, further study should be done on electric vehicles using such secondary energy. What is the difference between electric vehicles and traditional fuel vehicles, and which stages should be controlled over its life cycle? If electric vehicles were blindly extensive developed with Great Leap Forward thinking in the absence of clear study, environment and human health may be inestimably influenced.

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