Development of an equipment preventing overheated in a car using the solar cell

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Abstract: In this paper we develop an equipment which prevents vehicles from overheating their inside due to exposure to direct sunlight in summer. Overheating of inside vehicle may give rise to accidents, for instances, dying from suffocation, the deformation of its internal equipment and the explosion from the cracks of its internal parts etc..

The equipment is operated under no starting engine. We adjust the overheating of the inside vehicle by operating the equipment. This equipment checks the temperature of the inside vehicle using temperature sensor. If the temperature increases more than reference temperature(a condition which can be given by the driver), the equipment will operate until the temperature of the inside decreases to the given temperature. Its power is obtained from solar cell. So the equipment keeps away overheating accidents as well as provides the drivers with optimized condition. And also it increases the ability of original car battery through solar cell.

Keywords: solar cell, temperature sensor, blower motor, vehicle battery

1. INTRODUCTION

Most cars are exposed to the direct sunlight. If the cars should not be parked at an underground parking lot or under the shade of building side, the closing cars are shortly increased the indoor temperature of car by direct sunlight. Overheat of inside vehicle may give rise to accident that of the dying form suffocation, the deformation of its internal equipment and the explosion from the cracks of its internal parts. Our purpose of development this is to control the temperature of inside of vehicle with using the power that is obtained from the solar cell. Therefore it provides an optimal vehicle condition and prevents an accident.

2. CONFIGURATION AND OPERATIONG PRICIPLE OF DEVELOPMENT EQUIPMENT

From now on, we consider an outline of the equipment. First the equipment periodically senses the indoor temperature of car that has no driver. If temperature is rise to affect the person and car, the development equipment will operate automatically. The operation continues until the indoor temperature falls down under the reference temperature. Setup value of temperature sensor is decided by investigating the actual case and the experimental data. For energy needs of a cooling device operation, we used the solar cell that it was attached to car outside. The control part of development equipment was installed in ventilation device control part with the device for display the indoor/outdoor temperature. The temperature sensor was installed on the ceiling of inside car at the part of ventilation device portion in which external airflow. The solar cell is allocated on the roof of vehicle to receive full sunlight. The produced electric power is charged/discharged through the solar controller. The relay that is used to the blower motor control is appended at the relay box with the relay for a vehicle electric device.

2.1 Mechanical design

We can divide the blower motor and solar cell in the mechanical parts. The solar cell is the device to convert from the sunlight to the electricity energy. We used the solar module which is made from the single crystal silicon called as the HSLTF-53W. The single crystal solar cell is widely used to compare with other solar cell from the industry to the home use. The solar module frame was made for satisfying full electric charging condition and suited durability. The inverse current protection diode was connected to power supply connector, it was designed a standardized goods. As the characteristic of solar cell the operation temperature is moved between -45℃ and +85℃ and the conservation temperature has a same moving. E.V.A film which is organized a solar cell was made in high temperature. It will be a gel situation if the temperature goes up over the 150℃. But solar module does not affect because aluminum frame protects E.V.A film. If the temperature goes up, voltage will fall down to the max 0.5V. On the other hand, the current rises up and the total power does not have a big difference. According to season or hours the irradiation of sunlight is irregular. So we should be used the main solar cell controller for charging battery with fixed electric power. We used the SUNSAVER10 model for the main solar cell controller. The current is stably charged to the maximum 10A. The solar controller has the function to inform that battery needs the charge. The charge is used generally when it is night and we have weak sunlight. Therefore we must fill up the battery during the daytime. The battery manufacture company products a private use solar cell but it is very expensive. The battery which is used at the development device is SMF(Sealed Maintenance Free Calcium) battery. It has 60AH(Ampere Hour) and a low temperature engine starting current of 550A. The electric charge current is 3A. The battery electric charging current is the same as solar module producing the current. So it has no problem to charge. The motor parts are composed with blower motor and blower fan to move indoor air out. The blower motor is adhered in front assistance seat and it has an air circulation function. During the experiment, we separate blower motor in a car but we directly installed development equipment for making the environment similar to real situation. The blower fan was installed on the back seat and it deflated

circulated air in the car. By the step, voltage / current dissipation is shown in a table 1.

Table 1 The consumption voltage/current of blower motor

	1 stage	2 stage	3 stage
Voltage	4V	6V	10V
current	2.1A	3.4A	6.7A

We applied the air circulation system with a kind of blower fan and a method of selection. The rated voltage/current of BP1203812H model is DC 12V and 0.4A and the airflow is 100(CFM). Airflow is the flux of the air which is inhaled per a hour. If pressure ratio is less than 1.03, it may be same with inhalation airflow and deflation airflow. Airflow units are classified ㎥/min, ㎥/Hr, N㎥/min, CFM and ㎥/sec[CMS]. Note that ㎥/min = [CMM], ㎥/Hr = [CMH], ft^3/sec = [CFS], ft^3/min = [CFM] ,ft^3/Hr = [CFH], and 1㎥/min = 3.53ft^3/m.

2.1.2 Circuit Design

The temperature sensing part to measure indoor temperature is composed with a ICL7107 and AD590 temperature sensor. ICL7107 is device which id converted from analog input value to digital input value. And output value is shown by the 7-segment. It is built-in a A/D converter, 7-segment decoder and display driver. It is strong at the noise and addition circuit is unnecessary to display the LED. The AD590 temperature sensor has a function that a wide measurement range from -550℃ to +155 and the supply voltage from 4V to 30V. The error of sensor is ±0.5℃ and sensor was protected by the case. The **n** LCD display is narrow a visual angle and it needs a controller. So we used the 7-segment and it is possible the execution with a simple circuit structure. Both the blower motor and the blower fan should be compared output value of ICL7107 with reference temperature voltage. We designed a circuit which is operated at the output value is higher than a reference temperature. We can change a setup temperature with a variable resistance. The mark of a measurement temperature and setup temperature are classified into a toggle switch. The most device of vehicle indoor is executed at the engine either start or key is inserted at the ignition box. But development equipment is operate automatically at indoor temperature higher than outdoor temperature. Consequently, we searched the relay for blower motor control through the maintenance manual. We checked the cable and did change a structure so that suitable to our equipment. We installed relay for ignition switching together with blower motor relay. Also the blower register is installed. The blower register is used to control the blower motor.

3. THE MAJOR TECHNIQUES

The blower motor is most consumed the power in our development equipment. We expressed the voltage/current dissipation of blower motor at the table.1. And vehicle battery not only limited capacity but also is not charged the battery without engine starting. It is the problem that how much consumed the battery and how will you fill up the battery? According to development background reason of temperature rising is a sun. Therefore we decided to use a solar cell for battery charge. First of all, we experimented on capacity dissipation with blower motor when it ordered the activate to 3 stage. To obtained date from experiment is shown in Fig.1.

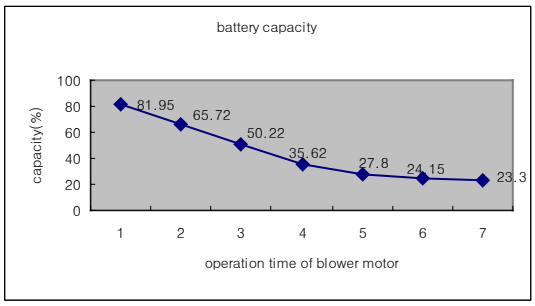


Fig. 1 The battery capacity change of blower motor action.

In the case of solar cell, voltage and current produced a 12V and 3A per hour. The solar cell is connected through solar controller and it is linked with battery and load. The electricity is fill up the battery when the device is not operated.

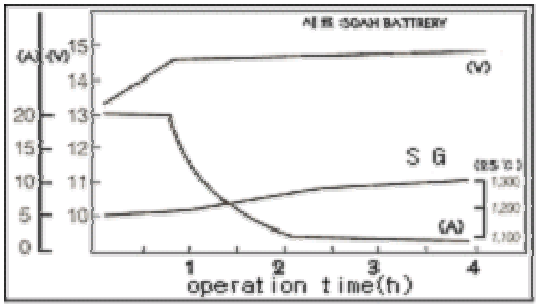


Fig. 2 The battery charge characteristic curve

Fig.2. is a characteristic curve about the battery which is consumed 50% capacity. The method to measure a battery capacity must look into load condition. If load current is static current, it will be done to check the curve which is expressed general characteristic of the battery. The load condition is separated with static current and static voltage. When load is charging/discharging for static current, it is used the general discharge characteristic of the battery. To know the characteristic is difficult when it is a static voltage. Discharge characteristic curve of the battery is a curve which is expressed the relation with terminal voltage and SOC(State of Charge).If we have a discharge characteristic curve, we can assume a SOC which is measured terminal voltage during discharge by static current. For example, pager can classify current of normal state, alarm state and vibration state. The pager is marked message with "Low Battery" when the battery capacity fall down under the reference voltage. This message is set the discharge characteristic curve at the vibration is rung. Battery consumption is biggest at that time. When the current to flow at the load is not a static current. Consideration of SOC is so difficult. The method to measure the SOC is generally various.

1. Open node voltage measurement
2. Specific gravity measurement
3. Accumulation Current Calculation Measurement

1st and 2nd method is the way that SOC can know to measure with voltage or specific gravity of stabilized battery. But it is so difficult because let battery open for 30 minute without load. When we know a battery capacity of initial by AH, we can know the SOC that to calculate which is subtract the current to be measured every sampling time from total capacity. This method is the Current Accumulation Calculation Measurement. This method has the disadvantage that the error is accumulated during the time have passed. Recently, method is used a calculation which combine battery modeling and previous method. The method to measure specific gravity is used an optical fiber to reduce the measurement error. Applying the Accumulation Current Calculation Method and specific gravity measurement method. The consumption battery capacity is given in Table 2

Table 2 The battery consumption capacity of every hour

time	Consumption current(A)	Current Capacity(Ah)	Capacity(%)
1	7.22	32.78	81.95
2	6.49	26.29	65.72
3	6.2	20.09	50.22
4	5.84	14.25	35.62
5	3.13	11.12	27.8
6	1.46	9.66	24.15
7	0.34	9.32	23.3

It can compute operation time to refer the Table 1 and Table 2 The operation time of blower motor is about 4.5 hour and consumption capacity is 64%. The charge power which is produced 12V and 3A by solar cell is a 7.5% affected wit h battery. After 4.5 hour, it will fill up the battery about 33.75% of battery capacity. If operating blower motor by 3 stage concur with charging the battery by solar cell, consumption capacity of battery become about 30.25%. Consequently battery capacity is decreased by 1/2 and operation time is increased double time.

Next, consider the conditions to determine specification of blower fan. Eq.1 is used to calculate the ventilation quantity.

$$Q = H/[0.3(ti - To)] \quad (1)$$

where is

Q : need ventilation quantity(㎥/h)

H : heat incidence(㎉/h)

Ti : room temperature(℃)

To : outside temperature(℃)

According to the PMA (Pusan Meteorological Administration), the maximum quantity of sunlight in summer season is 60.472 kJ/m^2 per minute. Apply to the Eq.(2) to convert the ㎉/h by heat incidence unit.

$$(60.472/4.186)\times 60 = 866.775\ \text{㎉/h} \quad (2)$$

Sunlight which rise the room temperature is transmitted through the glass of vehicle. Multiplying the glass occupies area in Eq.(2).

$$866.775*4.5=3900.4875\ \text{㎉/h} \quad (3)$$

According to an energy conservation rule,

Heat incidence by sunlight > Room heat incidence (4)

We assume that the glass occupies the half area of vehicle frame. Before H substitute a formula to obtain a need ventilation quantity, room temperature and outside temperature are assumed the max value in summer season.(room temperature : 70℃, outside temperature : 35℃)

$$Q=399.4875/0.3(70-35) = 371.475\ /\text{h} \quad (5)$$

The ventilation quantity of blower fan is 169.8㎥/h. A total ventilation quantity is 339.6㎥/h because it installs 2 fans. It is enough to our requirement. And though quantity is smaller than Q that we calculated. It was satisfied. As we changed compact car which is installed development equipment. Also sunlight to come via the glass is absorbed/reflected to meet a different object. We ignored this part even though the loss happened. We regarded a heat incidence to all sunlight. Heat incidence can be smaller than actual calculated value. Before room temperature become 70℃ the blower fan is operated. Hence temperature rise over the 70℃ does not happen and we do not need a big quantity.

4. FEATURES and USAGES

The development equipment is periodically sensed the indoor temperature of car that driver does not ride. It is automatically operated blower motor if a vehicle room temperature is higher than a vehicle outside temperature. The blower fan is deflated high temperature as outside air flow in. As above mention, therefore development equipment guarantee that agreeable taking car which is exposed to the direct sunlight. And child or long distance driver are prevented the death from suffocation. The temperature display unit is adhered so that present room temperature and set up temperature can do confirm. We are fixed setup temperature based on average temperature in summer season. User is possible to change setup temperature. The efficiency of battery capacity using the solar cell can be confirmed Fig.3 and Table 3.

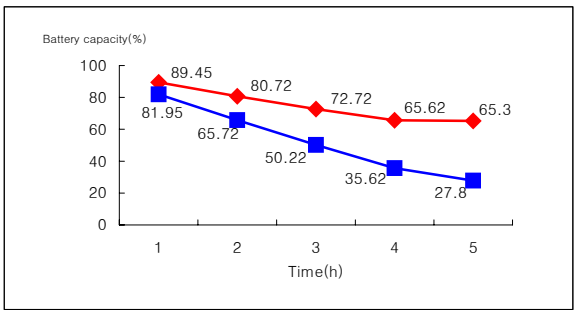
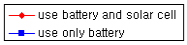


Fig. 3 The battery capacity to use battery or/both solar cell

where is 

The wiring of ignition switch, blower motor and blower fan are all possible the operating after or before engine starting. The ventilation of car is possible without inconvenience which driver directly open/close the window. It take out hot air at an air conditioner activate first of all. The air conditioner effect is enhanced and saved energy. Helpful to safety for driving.

5. CONCLUSION

We made temperature sense device to measure car indoor temperature with ICL7107 and AD590 temperature sensor. We measured intensity of illumination for illumination system. We installed halogen lamp to be satisfied intensity of illumination and used to measure an experiment data. According to solar cell use to know the efficiency, we measured a specific gravity by hydrometer. To compare the value and we compute the battery consumption quantity of blower motor by ACCM. An efficiency test experimented after device installation. We installed the device at the location of the best suited. The development equipment prevents not only a car safety accident beforehand, but also provides the power that is operated every kind of electric device which is used at the vehicle. Finally, it can be used the electricity at the emergency.

REFERENCES

[1] S.O.KASAP, Optoelectronics and Photonics Principle and Pratices, Prentice-Hall, 2001.
[2] W. C. Jung and J. H. Kim, Optoelectronic Engineering, MRCMiraeCOM, 2001.
[3] P. Bhattacharya, Semiconductor Optoelectronic Device, Prentice-Hall, 1997.
[4] Young and Freedman, University Physics with Modern Physics, Addison-Wesley, 2000.
[5] Raymond A. Serway. Modern Physics, Saunders College Publishing, 1989.
[6] Sedra and Smith, Microelectoronic circuits, Oxford University Press, 1998.