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Design and Fabrication of Solar Powered Dust Collector for Industrial Applications

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Abstract:- The object of study is a solar-powered dust collector. It is a more advanced version of portable commercial dust collectors. It operates on the basis of a manual shaking mechanism. A few articles and books have been written about the investigation and research of this type of dust collectors the goal of this project is to explain the efficiency and energy changes of a solar-powered dust collector. Pollution is greatly reduced and the environment is aided by the use of renewable energy such as solar energy.

Keywords:- *Solar Energy, Solar Powered Dust Collector, Renewable Energy and Dust Particle.*

I. INTRODUCTION

The rapid depletion of fossil fuel supplies has necessitated the hunt for alternative energy sources. Solar energy is one of the most long-term promising sources of energy for meeting the ever-increasing human demand for energy. The explanation for this is that the source is virtually limitless, the conversion process is clean, and the technology is well-established. Other common energy sources, such as hydropower and wind power, are converted types of solar energy and are often referred to as indirect solar energies. Since solar energy reaching the earth's surface is highly volatile and sporadic, storing it has become increasingly important. Space heating and cooling, power generation, domestic water heating, and industrial process heating are only a few of the uses for solar energy. In response to this concept, we created a solar-powered dust collector. We used to clean manually back in the day. Previously, we used an electrically powered vacuum cleaner, but this is now only available for residential and industrial use. Diesel-powered dust collectors are used for cleaning larger areas, but they are more expensive and pollute the environment (diesel, petrol etc.). As a result, global warming occurs. We use a solar-powered dust collector to help with this.

II. LITERATURE REVIEW

A baghouse, also known as a baghouse filter or baghouse, is a type of dust collector. The air pollution control unit and dust collector is filter or fabric filter that removes particulate matter or gas released from commercial processes. Capable of controlling air pollutants emissions are usually used by plants for power, steel mills, pharmaceutical manufacturers, food manufacturers, chemical producers and other industrial firms. After the creation of high-temperature materials (for use in filter media) that can withstand temperatures over 350°F (177°C), baghouses became widespread in the late 1970s. Contrary to precipitating electrostatics,

Even when particle size is very small, functioning baghouses typically have a particulate collection efficiency of 99 percent or better, even when process and electrical conditions vary significantly.

III. PROBLEM IDENTIFICATION

Though there are several commercial dust collectors in the industry, there is not a single dust collector which runs on green energy and efficient at the same time. There is a need for developing a renewable energy source which is abundant in nature and also causes zero pollution to the environment.

IV. DESIGN

A simple functional block diagram of the project. Is shown below:

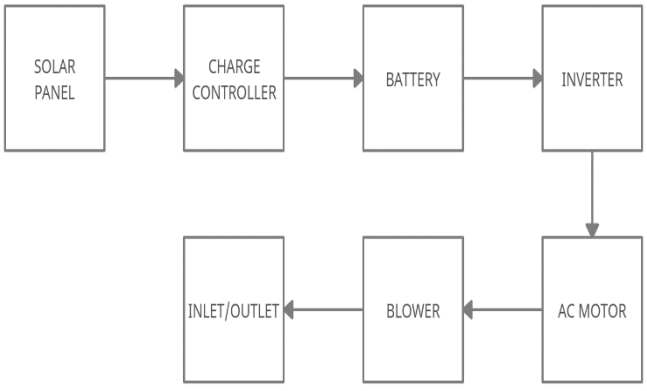

Fig 1: Block diagram of working principle of Solar powered dust collector

V. COMPONENTS OF THE PROJECT:

5.1 DUST COLLECTOR:

The dust collector is a machine used for the collection of dust. There are many dust collectors available in the market and industries. Here, we use a baghouse dust collector with flange mounted AC motor for the purpose.

When operated it produces high suction power, powerful enough to collect the dust and store it in the hopper.

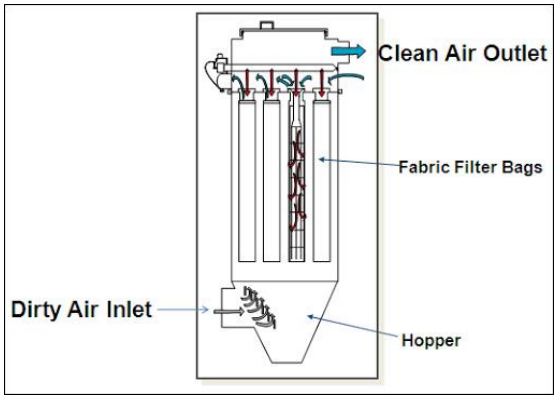

Fig 2: Working diagram of a Baghouse dust collector

5.2 SOLAR PANEL:

The solar panel we use here is of 12V 50W arranged in series of total 24V and 100W. The solar panel is the main component for charging the battery which helps power the dust collector. Solar panel mounting should be done in such a way that it provides maximum efficiency. The solar cell used in the solar panel is polycrystalline. This is because polycrystalline cells are more efficient than monocrystalline cells and have a faster rate of energy conversion.

5.3 BATTERY:

A battery is a device that contains one or more electric cells that store energy that can be converted into electrical power. A chemical reaction generates electrical power in a battery. A battery is made up of two or more cells that are connected in series or parallel. Main and secondary batteries are the two types of batteries. The primary battery is referred to as disposable, whereas the secondary battery is referred to as rechargeable. We use rechargeable batteries for our application (lead acid battery).It consists of 150Ah power and helps in powering the dust collector. We arrange them in series of 24V and 300Ah.

5.4 CHARGE CONTROLLER:

In today's solar panel systems, solar charge controllers are crucial. The charge controller's primary function is to prevent the battery from overcharging. Between the solar plate and the battery is the charge controller. When the battery is fully charged, the charge controller disconnects the battery from the solar. The design is restricted to lead acid batteries because they are currently the most commonly used type in isolated photovoltaic applications due to their high capacity and low cost per capacity when compared to other battery types.

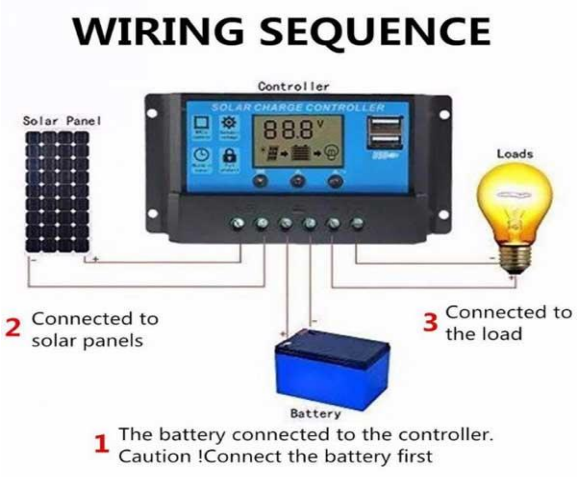

Fig 3: Wiring sequence of the charge controller

5.5 INVERTER:

A power electronic system or circuitry that converts direct current (DC) to alternating current (AC) is known as an inverter (AC). The frequency of the resulting AC is determined by the system used. Here, we employ a single phase (24V) 1550SW inverter to convert the DC source from battery to power the AC motor (220V).

5.6 AC MOTOR:

AC motor runs the blower in the dust collector which is powered by the battery from the solar charge controller. We use single phase AC motor (0.5HP) for our application as it is less expensive and causes less maintenance. It can used for longer applications with minimal wear.

VI. TECHNICAL SPECIFICATION:

6.1 BATTERY:

Weight: 12kg
Cost: 5000 Rs
Voltage: 12V + 12 V
Capacity: 150Ah

6.2 AC MOTOR:

Weight: 10kg
Cost: 2500Rs
Voltage: 220v
Current: 2 amps
Power: 0.5HP
RPM: 2800 RPM

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6.3 SOLAR PANEL:

Size: 55 X 67 X 2.2 cm
Weight: 5kg
Cost: 2500 Rs
Voltage: 12V + 12V
Output: 50W + 50W

6.4 DUST COLLECTOR

Size: 450mm length and 300mm diameter
Weight: 12kg including all components
Cost: 5000Rs
Material: Aluminium and Mild Steel

VII. CALCULATIONS

Solar panel output = 50W + 50W = 100W
Considering the losses output = 85 W
Battery capacity = 150Ah + 150Ah = 300Ah

Time taken to charge the battery:

12*150 + 12*150 = 3600 watt hrs
3600/ 85 = 42.3 hrs (or) 3.5days of sun.

Running time of motor:

AC motor power= 0.5 HP or 375 watts
When fully charge battery capacity = 300Ah
80% efficiency gives= 240 Ah
Current= 375 watts at 220v gives 1.7 amps ~ 2 amps
Inverter conversion loss= 1500 Wh
2400 -1500 = 900 Wh
900 Wh at 24V gives 37.5 Ah
37.5/2 = 18.75 hrs

VIII. WORKING

It involves mounting the dust collector and solar setup on a portable trolley. The solar panel is fitted beside the collector and solar energy is absorbed and stored in a battery. This battery is used to run the dc motor in the dust collector and in turn run the blower. When the dust particles enter through the inlet they are collected by the filter bags and drops down to the hopper. The sanitized air exits through the outlet. This air is free from dust particles.

Efficiency of a Dust collector:

The efficiency of the dust collector can be expressed by the following equation:

$$E = (Q1 - Q2)/Q1 * 100\%$$

Where:
E = Dust collection efficiency in percentage;
Q_1 = Amount of dust entering the collector;
Q_2 = Amount of dust leaving the collector

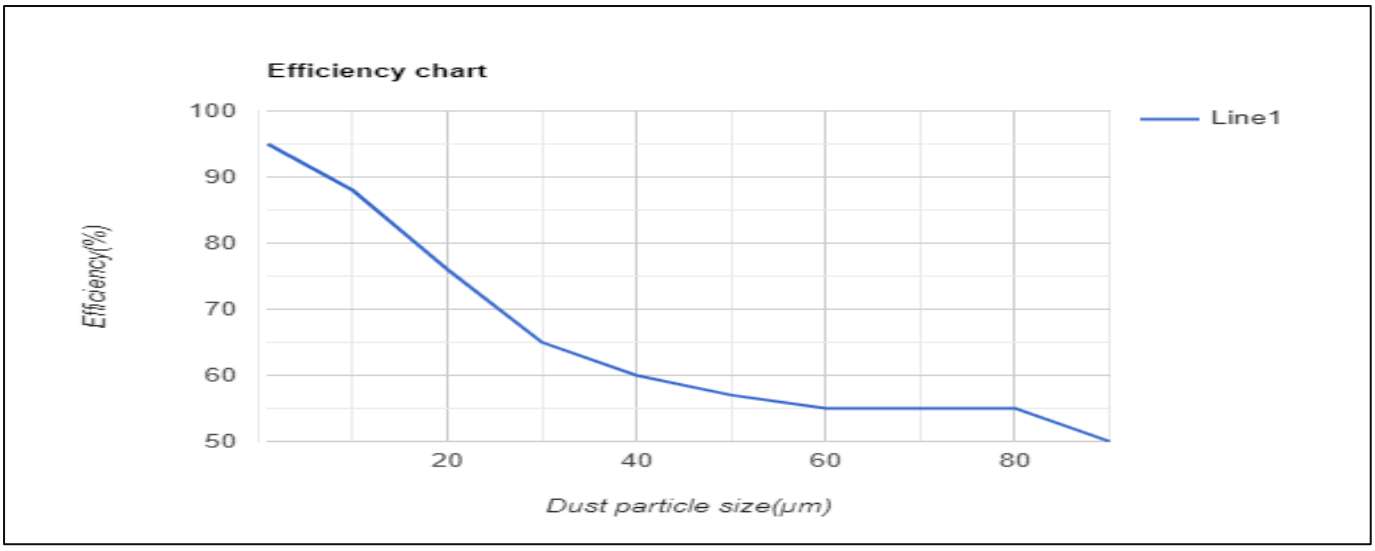

Fig 4: Efficiency chart of the Dust collector

8.1 SHAKER BAGHOUSE:

As the name implies, a shaker baghouse mechanically disposes of collected dust by shaking it out of the bags into a collection hopper at the baghouse's bottom. Filter bags are suspended and tensioned from the top of the filter housing and tied to the tube sheet with the bottom open in a shaker baghouse. Shaker bags do not have any internal cages. The airstream enters from below and is drawn upwards through the bags' interiors, where the dust gathers. The airstream passes through the filter bags, which trap the dusty contaminants. Near the collector's top, clean gas is drained. The airflow through the machine must be regularly shut down, also known as being taken off-line, while mechanical shake-cleaning is used to clean a shaker baghouse, which usually uses woven filter bags. After being released from the bags, the dust cake falls into a hopper at the bottom of the baghouse for removal.

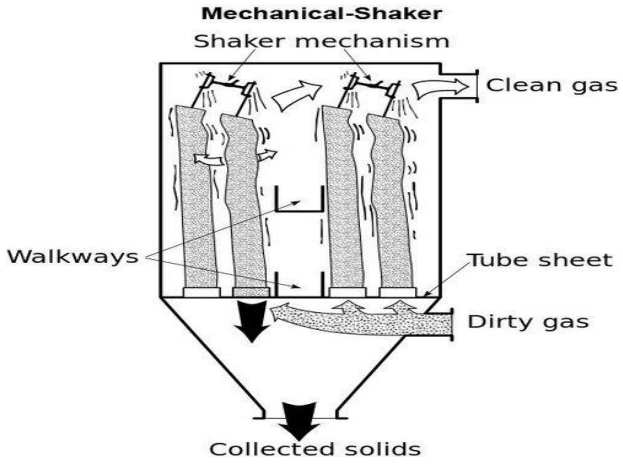

Fig 5: Working diagram of Shaker baghouse

IX. CONCLUSION

- This solar powered dust collector helps in reducing pollution and harness green energy
- It is very easy to move among places and can used anywhere anytime.
- The addition of Solar charge controller helps in easy charging and controlling the model,
- A recent survey shows that many people are shifting towards other renewable energy sources.
- Our project will definitely help promote renewable energy and reduce pollution.

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