Implementations towards Developing a Sustainable Campus and Smart City

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Abstract

Many industries are bringing out innovative changes to tackle the issues related to environment pollution. Foundry industries contribute significantly towards pollution due to the harmful emissions. Major implementations are on to protect our environment. Surprisingly a big university or an institution with a large campus is being considered as a major contributor towards environment pollution at par with a foundry industry. In this regard, an extensive study has been carried out in an institution and useful implementations are carefully planned and suggested in this work. Apart from important guidelines, design and fabrication of four systems have been detailed here towards developing a sustainable campus. One of the largely consumed non-recyclable materials is plastic being used as containers. One of the simple designs suggested in the study brings out the benefits of ecofriendly clay bottles. The proposed design of clay bottles can replace the plastic bottles at affordable price retaining freshness of water for longer period. These are available in varying capacities; with net weight along with the content can be reduced by certain modifications incorporated in design and fabrication process. Another attempt aims to replace plastic body of a pen by newspaper, with the help of a paper pen making machine designed and fabricated. This machine holds a refill between two supporting centers and newspaper is fed and wound on the body of refill at controlled rates by feeders. After ensuring a sufficient gripping surface of the paper is cut and with the help of an adhesive paper end is sealed on the refill. Since pens are used in huge numbers across the campus paper pens can be made available to all at low cost and eliminate the need of plastic body and disposal leading to pollution. The third initiative is developing a napkin and tissue incinerator developed to destroy used tissue papers, napkins and medicated wastes. This wall mounted portable device installed in rest rooms in academic, hostel and other facilities can ensure a safe disposal of napkins and tissue papers with minimum amount of ash produced that can be flushed away. The incinerator has a container with heating coils, covered by glass wool as an insulator develops and retains the required amount of heat for quick burning of the contents. It has two chambers, a pre-heating and burning chamber designed to develop right temperatures to minimize the amount of emissions. The fourth system of interest is locating a smokeless leaf burner installed at the central facility which can burn huge quantities of dry leaves collected in a university campus. The furnace constructed from bricks incorporates two systems, one to dry the leaves and tree discharges and another to burn these at predetermined temperature to ensure that no smoke is produced. Apart from these, carefully designed guidelines have been discussed in the present work towards developing a sustainable campus. Each one of these can be implemented as a project work in the campus by students who are our brand ambassadors, can further extend their contributions towards developing a smart city.

Keywords: Implementations, Smart city, Sustainable Campus

I. INTRODUCTION

A sustainable campus creates a safe and healthy environment in the community and provides a better opportunity for the growth of occupants. Such a campus takes care of the environment by addressing many issues like pollution, wastage disposal, replacing non-recyclable materials and use of non-conventional energy resources etc. This can be made possible by creating awareness and involving each one of the resident inside the campus in the campaign of protecting environment. One way of addressing the related issues is to provide training and allot projects to batches of students, implement the projects and spread the outcomes. These initiatives can begin with creating awareness in students of lower semester and further projects can be allotted to students of higher semesters.

The universities [1] and educational institutions are key places to address the various issues related to environment and sustainability. As the number of universities is growing in size and strength the outgoing students if properly trained will have a sense of responsibility and awareness towards the issues related to environment and in turn will contribute to the society. For the [2] societal development and to build a smart city sharing knowledge, bringing innovations and cultivations inside the campus are very important. Each one of the university [3] can be treated as a smart city as it holds various departments, hostels, canteen and

other facilities that contribute towards pollution of environment. And many activities, events and programmes make the activities more complex and have some serious impact on the environment.

The process of developing a [4] sustainable campus in itself becomes a huge task and needs the contributions in terms of ideas, innovations, investigations and sharing the information. A well designed conservation programme, when implemented in a campus can contribute to around 30 percent [5] of reduction in energy consumption. This is because of replacing conventional energy resources, implementing safe disposal of wastages and creating awareness on optimum utilization of resources.

The role of educational institutions [6] and universities become very important in taking up research in these areas to develop a sustainable campus and in turn a smart city. Many educational institutions [7] and universities are showing keen interest on implementation of policies towards developing a sustainable campus through embedding guidelines and regulations in the curriculum. Also many workshops and activities have been planned with a goal of creating a safe, healthy and competitive study environment for the campus students and faculty.

II. SUSTAINABLE GUIDELINES

The following guidelines can be followed in developing a sustainable campus.

- One of the best methods of addressing pollution is by avoiding the usage of non-recyclable materials to reuse the pollution and unnecessary landfills. Use of water bottles made of clay, Aluminium or any other recyclable material can be helpful. Universities can make policies or make the students take pledge to avoid the use of plastic bottles and dishes inside the campus. Spreading the messages on avoiding plastics. Encouraging and motivating students to replace the same through newsletters and social media groups will really do the needful.
- Encouraging cultivation inside the campus to grow vegetables and to plant more trees will meet the requirements of canteen and also develop a pollution free environment.
- Developing a practice of avoiding lights in during the day time by using reflectors to allow more sunlight in to the buildings.
- Use of bicycles and encouraging people to walk inside the campus can lead to sustainable transportation and helps people to practice healthy life style.
- Avoid use of electrical appliances like heaters and air conditioners by keeping the windows and doors open that can help in saving energy.
- Look for developing portable alternate energy sources like wind mills, solar heaters, solar pumps, and other devices.
- Make the campus paperless by going digital, to replace the notebooks, circulars, and other means of sending messages through papers.
- Finally the best practice would be to use recyclable material and to recycle wherever possible. Create facilities to recycle and reuse materials to develop a sustainable campus.

III. SOME USEFUL PROJECTS

A. *Paper-Pen Producing Machine*

Fig. 1: Paper pen machine

Paper pen producing machine is designed to produce pens having body made of recycled paper. This device makes use of a combination of mechanical and electrical components and is an attempt to eliminate plastics and in turn pollution. The plastic used to make the body of the pen presently cannot be recycled further as a result the disposal of these non-biodegradable plastics lead to various kinds of pollutions.

But, the pens produced using this machine makes use of recycled papers such as newspapers as raw material which is bio-degradable and hence environment friendly. The machine consists of a rigid base on which the other components are mounted. DC motor with 12V and 500mA rating is clamped on the base. A tailstock supports the front end of refill and slots are provided for its easy movement and to constrain its motion. A holder mounted on other end grips the refill and supports rolling of pen cap. This makes use of a mechanism based on the load and fulcrum principle. This part extends to a length of 6cm from the motor shaft as shown. It makes a tight fit with the motor shaft because of the screw that holds it along with the motor shaft. The material used for the holder part is Nylon plastic which makes the part light enough and hard to the required level. An electrical switch closes the electrical circuit to run the motor and disconnects the circuit when released in turn shutting down the motor. A power supply system is employed to step down the voltage of 230 V to 12 V (step down transformer) and converts the pulsating DC into pure DC using filter and rectifier circuits.

B. Portable Tissue Incinerator

Fig. 2: Portable Incinerator

A portable incinerator used inside the campus will be helpful in disposing the tissue papers, napkins and medicated papers by burning and producing a very small amount of ash.

The incinerator works on the simple principle of auto-ignition thereby eliminating the need of fossil fuels or any other external agents for combustion. To sustain the combustion itself, the design has air vents that provide optimum air circulation to completely burn the waste and leave less than 5% ash by weight. The incinerator consists of one heating chamber, rock wool for insulation, two chambers for better insulation thus reducing the temperature of the outer most layers, an automatic heat cut-off mechanism on reaching the desired temperature and an ash tray for disposal of the ash. There's also a proper exhaust valve present for the guided outlet of the fumes generated. The incinerator finds its use in both public and private sectors, such as, hospitals, hostels, malls, theatres, or even in houses.

The main objective of this incinerator is to make a safe and eco-friendly way of disposal of tissues, dry waste, and sanitary napkins. However, this can be extended to a variety of other purposes such as burning sensitive documents, medical cotton containing body fluids and other medical waste.

Typically, medical waste, although bio-degradable, is a breeding ground for undesirable diseases. If not disposed of properly, they gather and propagate pollutants. In order to combat these issues, and maintain user safety at all times the project aims to address both hygiene issues and environmental safety. When power is switched on and the required temperature is set by the operator, the control unit supplies power to the heating chamber, if the required temperature is less than actual temperature inside the chamber. This increases the temperature inside and the incineration process takes place. The thermocouple on the other hand keeps detecting the actual temperature inside the chamber and gives this data back to the control unit. As soon as the temperature goes above the required level, magnetic contactor acts as a relay and cuts off the power supply thus breaking down the heating process and the whole process forms a closed loop control system.

After switching on the power, door can be lifted to insert the tissue into the chamber. When the temperature reaches the auto ignition point of the tissue, it automatically catches fire. The incinerator is kept on for few minutes to ensure that tissue is completely burnt. The ash generated is collected in the ash disposal tray. The benefits of such incinerator are the capability to completely destroy napkins of different grades.

Also, it can successfully burn tissue papers by producing less than 5% ash by weight of the initial weight. The amount of exhaust gases produced is relatively negligible because of the high temperature achieved in burning. The device can also be employed efficiently to burn napkins and medicated waste, although, it needs to be further investigated. This incinerator can be fabricated in its compact form, easy to install and can operated without any supervision.

C. *Dry Waste Burner*

Fig. 3: Dry waste burner.

Disposal of tree fallings, dry leaves and other solid wastages can be in huge quantities in university campus and hence installing a solid waste burner would be an ideal way to get rid of the same. The burner has two major parts, pre heat chamber and combustion chamber. The process involves the combustion of organic substances contained in waste materials. This process of waste treatment systems is known as "thermal treatment" and is employed to reduce the volume of waste requiring final disposal. Such treatment can effectively reduce the volume of waste by around 90%.

The benefits of such burner are, it eliminates all infectious components, reduces landfills, the space requirements are very less and easy to operate. This device has a primary chamber where in temperatures around 600 to 800 ^{0}C can be achieved to preheat / burn the wastages. After the waste is burnt in the primary chamber, the flue gases will rise and due to difference in pressure between the primary and the secondary chamber it will flow towards the secondary chamber via a window between the primary and the secondary chamber A retention time of 2 seconds is necessary for efficient pyrolysis. The Secondary chamber is the most important part of the incinerator. Here due to excess oxygen the harmful gases like CO, NOx, SOx, are oxidized completely. The secondary chamber is maintained at around 1100 Degrees Celsius.

Due to high temperature and excess supply of oxygen the harmful gases are pyrolized in this chamber. The flue gases upon pyrolysis will go down the secondary chamber and find its way through a partition between the secondary chamber and the tertiary chamber.

D. *Clay Bottle*

A human body needs at least 2 liters of water every day for its healthy functioning. The plastic bottles that we use every day are not ideal as it is proven harmful. So as a replacement we can use clay bottles for everyday use to drink and store water.
Such bottles can retain the freshness of water for a longer period and are clean and hygienic. These water bottles made of terracotta clay could be the best way to replace the harmful plastics, metal or the fragile ware that we are currently using.

Fig. 4: Clay Bottle

Storing the water overnight in these clay bottles can provide with health benefits like better digestion, faster metabolism and promises a youthful and glowing skin. Also, the bottle is designed keeping in mind of the comfort of holding it. Although it can be fabricated in different sizes, the clay bottle of 1 litre capacity shown in figure can be comfortably used for use inside the campus. The clay is tested to ensure it is totally clear of toxins like lead and cadmium.

The volume of the cylindrical portion of bottle,

$$V = \pi r^2 h \quad (1)$$

Where, V – Volume of the cylinder,
r – Radius of the cylinder,
h – Height of the cylinder.

The volume of bottom portion is,

$$V = \frac{\pi h}{3} (R^2 + R * r + r^2) \quad (2)$$

Where, V – Volume of the frustum of cone
R – Radius of the lower base,
r – Radius of the upper base,
h – Height of the cone.

1) *Specifications for Cylinder*

- Inner diameter = 85 mm
- Outer diameter = 100 mm
- Wall thickness = 5 mm
- Height = 180 mm
- Volume = 795.21 mm^3

2) *Specifications Bottom Portion*

- Radius of lower base(R) = 37.5 mm
- Radius of upper base(r) = 12 mm
- Wall thickness = 5 mm
- Thickness = 75 mm
- Volume = 159.5 mm^3

By finding the total volume of clay bottle, we found the capacity of the clay bottle to be 954.74 ml.

Some of the important features are, it is made of natural Indian clay which is easily available, and the clay has natural cooling springs which help in self cooling. The clay bottle can retain the freshness of water and is biodegradable. But the clay bottles are fragile and cost more than plastic bottles. Also the man power and time required is more.

IV. CONCLUSION

Implementation of guidelines discussed will definitely help in creating more awareness among our student community; in turn will contribute towards developing a sustainable city. A simple paper pen making machine developed can be installed inside the campus as a pen vending machine that would encourage students and other users to avoid using plastic body pens inside the campus. The choking of sewage pipe lines can be avoided by installing Portable tissue paper incinerator in rest rooms to dispose the sanitary

napkins, tissue papers and other medicated papers. This can be achieved without producing harmful gases by heating at controlled temperatures. The dry waste burner can be effectively installed in the campus to dispose large quantities of dry leaves and other forms of waste. The emissions from this incinerator are well within the acceptable limits of various pollution control standards. Water bottles made of clay can effectively replace plastic bottles and can also retain the freshness of water.

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