WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Effective methodology of combustion and incineration process of used sanitary pads

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CHAPTER 1.

Introduction :

The use of sanitary napkins is the most common method of menstrual hygiene management among women (Wagh et al., 2018). Disposable sanitary pads have the highest consumption levels, especially in urban regions of India (Wagh et al., 2018), and also come with the challenges of their safe disposal. Oral discussions with officials from the administrative body in charge of waste disposal in Bangalore, Bruh at Bengaluru Mahanagara Pawlike (BBMP), revealed that about 70 tonnes per day (TPD) of waste napkins are generated in Bangalore, with North Bangalore alone accounting for 18 TPD. Hygienic handling and source destruction are recommended through various schemes and advocacies spreading awareness of menstrual hygiene (Ministry of Drinking Water and Sanitation, 2015). A few commonly employed methods of disposal are deep burial, open burning, pit disposal, and disposal into public waste management systems. As these sanitary napkins are typically made from non-woven fabrics with plastic barriers which are non-biodegradable, the preferred method of disposal is incineration (Ministry of Drinking Water and Sanitation, 2015). While successful attempts have been made in Western countries at resource and energy recovery from such waste (Arena et al., 2015, 2016), due to high capital and maintenance costs, disposal by incineration is more feasible in developing countries like India. Soiled sanitary napkins have the potential to carry pathogens causing HIV and hepatitis while being a favourable environment for the growth of Tetani. It is, therefore, essential to ensure the destruction of soiled materials with minimal or no human contact. The Central Pollution Control Board (CPCB) of India rules for incineration require that the wastes have a lower calorific value of at least 1450 kcal/kg (6 MJ/kg) and the annual average should not be lower than 1700 kcal/kg(7 MJ/kg) (CPCB, 2016a). Since a large fraction of MSW generated in Indian cities is contaminated with organic wastes, its high moisture content and relatively low calorific value make incineration a poor choice for its disposal (CPCB, 2017). However, dry sanitary napkins have an average calorific
value of 19.33 MJ/kg as measured using a bomb calorimeter (Parr 6100 calorimeter). Therefore, source
hydrocarbons are prima facia evidence of poor mechanics of combustion and should not be tolerated. On the other hand, NOx, SO2, and SO3 are unavoidable if the fuel contains nitrogen and sulphur. The best remedy in this latter case is to remove these species from the fuel. Otherwise, their products of combustion must be removed by absorption, adsorption, or reaction. NOx from the fixation of N, in the air and CO may be minimized by advanced techniques of combustion. One such method is described in some detail. Removal of CO2 can be accomplished by absorption, adsorption, or reaction,but precooling is necessary and the quantity is an order of magnitude greater than that of any of the other pollutants**.**

4. Effects of Combustion Temperature on PCDD/Fs Formation in Laboratory-Scale Fluidized-BedIncineration, Takashi Imagawa, et al., contributes to completing combustion reactions, resulting in reducing the PCDD/Fs concentration.

- Combustion experiments in a laboratory-scale fluidized-bed reactor were performed to elucidate the
- effects of combustion temperature on PCDD/Fs formation during incineration of model wastes with
- poly (vinyl chloride) or sodium chloride as a chlorine source and copper chloride as a catalyst. Each
- temperature of primary and secondary combustion zones in the reactor was set independently to 700,
- 800, and 900 °C using external electric heaters. The PCDD/Fs concentration is reduced as the
- temperature of the secondary combustion zone increases. It is effective to keep the temperature of the
- secondary combustion zone high enough to reduce their release during waste incineration. On the other
- hand, as the temperature of the primary combustion zone rises, the PCDD/Fs concentration also
- increases. The lower temperature of the primary combustion zone results in less PCDD/Fs
- concentration in these experimental conditions. This result is probably related to the devolatilization
- rate of the solid waste in the primary combustion zone. The temperature decrease slows the
- devolatilization rate and promotes the mixing of oxygen and volatile matter from the solid waste. This

dioxide. The outermost layer of the incinerator is made up of Bakelite for easy handling. The disclosed device is scalable in all aspects because the materials preferred for this investigation are easily reachable in the marketplace**.**

A Review on Design and Manufacturing of Portable Sanitary Napkins Disposal Incinerator Ranjit V. Navale1, et al.,

The problem of improper disposal of menstrual waste is a major roadblock block creating a clean India. This waste is problematic for many reasons. Heaps of napkins using lots of disease-causing germs pose a danger. The proposed system uses a safe scientific process of disposal of sanitary napkins to incinerate them to ash, in comparatively low temperatures. Systems bleach the napkins utilizing fire, without letting the procedure be generated, by the smoke-established burner. This measure has to be taken to fix the issues that, the usage of napkins triggers to the health and also to the environment. Also, the proposed system focuses on making the fumes coming out of the chimney less hazardous to the environment by using a wet scrubber for its filtration.

Sanitary Waste Disposer 1 Sharika C, et al.,

The demand for sanitary products is increasing in society, which in turn results in growing mountains of these wastes. To manage these wastes initiatives should be taken to install incinerators across the country to burn sanitary wastes. At the point where the incinerator emissions are being disputed, the mission of devising a machine for the elimination of sanitary waste finds its place. In an attempt to provide affordable and eco- friendly sanitary waste disposer, the system is designed in such a way that it will incinerate sanitary wastes such as napkins and diapers completely with minimal flue gas emission using the process of filtration, utilizing solar energy, electrical power and energy from bio-fuel. The work targets the disposal of both sanitary napkinsand diapers, which make up a large part of sanitary waste.
Sustainable Disposal of Domestic Sanitary Waste, Richard et al.,

The study presented is an example of the assessment of the relative sustainability of either option for disposal of domestic sanitary waste, either via the toilet or via the solid waste route. This required an evaluation of the total (social, economic, environmental, and technical) benefit/cost of implementing and adopting the alternative routes and an assessment of public responsiveness to encouragement to change sanitary waste disposal practices. It illustrates how, even for a straightforward either/or question, the assessment of relative sustainability is complex and the amount of data needed to quantify sustainability indicators is prodigious. The study also provides an appraisal of the effectiveness of public campaigns to reduce waterborne disposal. Important information regarding public attitudes and behaviour about wastewater systems has been acquired and lessons for ways of encouraging behavioural change to more sustainable ways of living have been gleaned.

Reusable sanitary napkins—time to revisitSumita Mehta et al.,
To assess knowledge, attitude and practices (KAP) of women regarding menstrual hygiene and to evaluate the

use of reusable sanitary napkins as an alternative to disposable sanitary napkins.

A community-based cross-sectional study was done in two phases. In the first phase, 50 married women attending Gynecology OPD were asked to use reusable sanitary napkins for 2 months. A pre- and post-usage vaginal swab testing was done to rule out genital infection. This study was extended in the second phase to another 534 women after confirming that reusable sanitary napkins do not cause genital infection and are acceptable. KAP analysis regarding menstrual hygiene was done for all women.
In phase 1 of the study, the microbiological evaluation revealed no pathological organisms on vaginal swab culture after 2 months of usage. KAP analysis of 584 women revealed that only 26% women had awareness about menstruation before attaining menarche; in 51.88%, the primary source of information was their mother;76.54% women in the study used disposable sanitary pads of which 15% were disposing of them

Research gap -

After reviewing research papers, we concluded that to date the sanitary pad disposable incinerator machines available in the market are disposing off the used pads by burning at more than 700 degrees Celsius. During this action, the highly toxic gas floats in the environment and it takes a very long time to completely disposing the used pads. This process is not suitable for domestic purposes. Because of this, the domestic users usually dropped the used pads in municipal solid waste collector beans. Which is further improperly disposed by municipal corporations, and as a result, environmental hygiene is not properly maintained.

Research objective

The main objective of this research is to design a compact sanitary napkin disposal system, which could be used to reduce the problem of disposing of sanitary waste.
Also, reduces the spread of infection due to the unhygienic disposal of sanitary napkins, reduces environmental pollution due to nonbiodegradable sanitary napkins, and reduces clogging of the public drainage system due to the spongy nature of napkins. In this experimental work, we have designed user user-friendly compact machine for disposing off the used pads.

CHAPTER 4.

Results and discussion:

Initial testing Procedure for incineration of soiled napkins was followed as per the manufacturer's operating manual. Using the loading port, a batch of napkins is loaded into the combustion chamber and the power is switched on. When sufficient temperature is attained, the napkins ignite, and combustion proceeds till only inert ash is left behind. In the present work, this operation is identified as a cold start of the system. The emission and temperature data are recorded in 10-second intervals using the setup mentioned in the previous section. As mentioned in Section 2.3 data is recorded from the instant the batch is loaded in the CC till all the all the combustible material is combusted. The collected data is then averaged over the time duration of that particular run and the average emission data of each component is reported as measured and corrected to 11% oxygen It is evident from the data that the performance of both the incinerators falls short in meeting the norms specified by the CPCB. The CO and CO2 values corrected to 11% oxygen in stack gas are also presented in. The CO concentration levels were found to be much higher in the case of Incinerator-1, and combustion efficiency was low. This behaviour is argued to be due to the low chamber temperatures when most volatiles was released, which was insufficient for reactions to proceed to completion. An investigation into the heating rates of the two chambers revealed higher heating rates in Incinerator-2, thus reaching the peak temperature in less time. The heating rate near the walls of Incinerator-1 was experimentally determined to be 39 C/min while that of Incinerator-2 near the heating wall was approximately 90 C/min which is more than double that of Incinerator1. It was observed that to reach a temperature of 400 C Incinerator-1 required 600 s while Incinerator-2 required only 300 s and to reach 600C Incinerator-1 required 930 s and Incinerator-2 required only 450 s. This difference in the heating rates within the combustion chambers is attributed to the positioning of the heating elements in both incinerators. Although there was not much difference in the power ratings of the two incinerators (1.25 kW for Incinerator-1 and 1.3 kW for Incinerator-2), the heating element of Incinerator-2 directly

CHAPTER 5.

Conclusions :

This study has brought to light several shortcomings in two currently available sanitary napkin incinerators commonly used in India that promote source-level handling and disposal. The low heating rates of the combustion chamber in the case of Incinerator-1 caused the high release of CO in the stack gases. In the case of Incinerator-2, the initial forced draught tended to have a quenching effect on the combustion process. In both the incinerators, the grate was unsuitable for handling napkins at a time. From experimental studies, it was evident that by improving the design of the airflow within the chamber and operating with high preheat temperature (>600 C) CO and CO2 emissions could be brought in compliance with the CPCB standards for MSW incineration. In several runs, combustion efficiencies of over 99% for 1- napkin batches have been achieved. Due to the shortcomings of the initial design, as explained in the previous section, a system was tested. Preliminary results showed encouraging results for both one and five napkin batches. This may be attributed to the rapid heating of the napkins to high temperatures and the sufficient gap provided for airflow between the grate and the ashtray. The combustion efficiencies are over 99%, thus conforming to the emission standards for incinerators. The CO emissions are below the limit. The average mass of CO released in the case of incineration of which approximately 25 mg/m3 is emitted from the combustion of the itself. The results of the based system in comparison with the electrically-heated system for both batch sizes are tabulated. It is to be noted, that combustion efficiency of over 99% was achieved for 5-napkin batches, which was not possible for the electric resistance-based incinerators. The alternative of using incineration ensures quick heating and provides a constant high-temperature heat source on the napkins loaded. Further, sufficient area is provided under the grate for the inlet of air through natural draught. However, there remains scope for further optimization of the combustion process concerning the following: (a) air injection and distribution within the chamber. (b) combustion chamber design to handle larger batches.

CHAPTER 6.

Future scope of the work:

In the disposal machine, the controller part was tested and it was found that the machine was working as per operation. The napkin disposer is fabricated and integrated with a disposal machine so that dispensing and disposing can be achieved in a single unit. Through our project, sanitary wastes can be reduced, thus reducing the harmful effects of improper disposal of sanitary napkins. The machine can thus be said to have appropriate technology and if further research is carried out on the study, the quantity of output, time of operation and reduction in pollution by reducing the hazard effect of improper disposal of sanitary waste can be achieved.

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