

# Compact and Energy Efficient Solution for Menstrual Waste Disposal

Tharani B<sup>1</sup>, Jeevitha Mani S<sup>2</sup>, Kayathri R D<sup>3</sup>, Revathi Sangeetha R<sup>4</sup>, Sri Ranjani Devi N<sup>5</sup>

<sup>1</sup>Associate Professor, <sup>2-5</sup> Student, Dept of Electrical and Electronics Engineering  
Sri Shakthi Institute of Engineering and Technology, Coimbatore, Tamil Nadu, India.

**Abstract-** The improper disposal of menstrual waste has become a major concern due to its impact on hygiene, public health, and environmental sustainability [1][3][4]. Conventional disposal methods such as open dumping, flushing, or mixing sanitary waste with regular garbage can lead to pollution, unpleasant odor, and difficulties in waste management [3][5]. To overcome these challenges, this work presents a compact and energy-efficient menstrual waste disposal system designed to provide safe, hygienic, and automated waste handling with minimal human intervention [7][8]. The proposed system is developed using an ESP32 microcontroller that controls the heating, cooling, and monitoring operations of the disposal unit. When menstrual waste is inserted into the chamber and the start button is pressed, a relay-controlled nichrome heating element generates sufficient thermal energy for effective incineration [1][7]. A DHT11 temperature sensor continuously monitors the chamber temperature and transfers the readings to the controller for safe operation. After completion of the burning process, a cooling fan is automatically activated for a predefined duration to reduce the internal temperature of the system. In addition, a 2×16 LCD module displays real-time temperature values and cooling fan status, improving system usability and monitoring capability. The experimental results demonstrate that the proposed system provides reliable operation, efficient waste disposal, and reduced direct human contact with sanitary waste [6][9]. The compact design and automated functionality make the system suitable for deployment in homes, schools, hostels, hospitals, and public sanitation facilities. By integrating automation, thermal processing, and smart monitoring features, the proposed system contributes toward environmentally responsible menstrual waste management and improved sanitation practices [2][5][10].

**Keywords-** Menstrual Waste Disposal, ESP32, Automated Incinerator, Smart Sanitation, Temperature Monitoring, Energy-Efficient System.

## I. INTRODUCTION

Menstrual hygiene management has become an important aspect of public health and environmental sustainability due to the increasing use of sanitary products worldwide [3][4]. Improper disposal of menstrual waste such as sanitary napkins in open areas, drainage systems, or regular garbage bins can create serious environmental and hygienic problems [1][5]. In many households, schools, hostels, and public sanitation facilities, suitable disposal methods are still limited, resulting in unpleasant odor, blockage of drainage systems, and increased risk of contamination for sanitation workers [3][4]. Therefore, the development of a safe, hygienic, and user-friendly menstrual waste disposal system has become essential for improving sanitation practices and environmental protection.

Several conventional disposal techniques are currently used for menstrual waste management; however, many of these methods require manual handling, consume more energy, or fail to ensure proper waste treatment [7][8]. Incineration-based disposal systems have emerged as an effective solution because they can significantly reduce waste volume and minimize direct human contact [1][7]. Nevertheless, existing systems often lack automation, temperature monitoring, and efficient cooling mechanisms, which can affect operational safety and user convenience. To address these limitations, the proposed project introduces a compact and energy-efficient menstrual waste disposal system that combines automated heating, cooling, and monitoring functions within a single integrated platform. The proposed system is designed using an ESP32 microcontroller to control the complete disposal process

automatically. A relay-controlled nichrome heating element is used to incinerate the waste at controlled temperatures, while a DHT11 sensor continuously monitors the internal temperature of the chamber. After completion of the heating process, a cooling fan is activated automatically for safe temperature reduction. In addition, a 2×16 LCD module displays real-time temperature values and cooling fan status to improve user interaction and system monitoring. The proposed system aims to provide a reliable, hygienic, and environmentally responsible solution suitable for homes, educational institutions, hospitals, and public sanitation facilities [6][9][10].

## II. LITERATURE SURVEY

Several researchers have focused on the development of safe and hygienic menstrual waste disposal systems to reduce environmental pollution and improve sanitation practices. Borooah et al. [1] investigated the performance of sanitary napkin incinerators and analyzed emission characteristics such as carbon monoxide and carbon dioxide during the burning process. Their study highlighted the importance of controlled incineration for reducing harmful emissions and improving disposal efficiency. Similarly, Sasidaran et al. [2] examined the physical properties of menstrual hygiene waste and discussed its suitability for onsite disposal technologies, emphasizing the need for effective thermal treatment methods.

Elledge et al. [3] conducted a comprehensive review on menstrual hygiene management and waste disposal practices in developing countries. The study identified the lack of proper disposal infrastructure as a major challenge affecting hygiene and environmental safety. Kaur et al. [4] also discussed the difficulties faced by women in managing menstrual waste and stressed the importance of developing hygienic and user-friendly disposal systems. Harrison and Tyson [5] further highlighted the environmental impact of menstrual waste and the necessity for sustainable waste management solutions that support public health and environmental responsibility.

Research related to automated incineration systems has also gained significant attention in recent years. Subramanian et al. [7] proposed a domestic incinerator designed specifically for rural areas to ensure safe menstrual waste disposal with reduced human contact. Navale et al. [8] reviewed the design and manufacturing aspects of portable sanitary napkin incinerators and emphasized the role of compact and energy-efficient systems in modern sanitation practices. Gawande et al. [9] introduced a combined sanitary napkin dispenser and

incineration model to improve convenience and hygiene in public facilities. In addition, Fathima [10] developed a sanitary napkin vending machine integrated with an incinerator to enhance menstrual hygiene management in educational institutions and public places.

From the reviewed literature, it is observed that existing disposal systems mainly focus on incineration and waste reduction, while limited attention has been given to automated temperature monitoring, cooling mechanisms, and smart operational control. To overcome these limitations, the proposed project integrates an ESP32 microcontroller, temperature sensing, automatic cooling, relay-based control, and LCD monitoring into a compact and energy-efficient menstrual waste disposal system. The proposed approach aims to provide improved operational safety, reduced manual intervention, and environmentally responsible waste management.

## III. GLOBAL OBSERVATION (INTERNATIONAL STATISTICS)

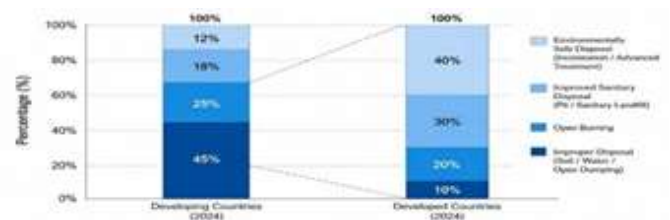


Fig. 1 Percentage Breakdown

Menstrual waste management has become a growing global concern due to the increasing use of disposable sanitary products and the lack of proper disposal facilities in many regions [3][5]. Millions of sanitary napkins and other menstrual hygiene products are discarded every day worldwide, creating significant challenges related to waste handling, environmental pollution, and public sanitation. In several developing countries, inadequate waste management infrastructure and limited awareness regarding menstrual hygiene often result in unsafe disposal practices such as open dumping, burning in uncontrolled conditions, or flushing into drainage systems [3][4]. These practices can lead to blockage of sewage systems, contamination of the environment, and health risks for sanitation workers.

Studies indicate that disposable sanitary products contain non-biodegradable materials such as plastics and synthetic fibers, which may take several years to decompose naturally [5][6]. The increasing consumption of these products has therefore raised concerns regarding landfill accumulation and environmental sustainability. Research conducted in different countries has highlighted the need for improved menstrual waste management policies, awareness programs, and the adoption of hygienic disposal technologies [1][5]. Educational institutions, hospitals, workplaces, and public sanitation facilities are gradually adopting automated disposal systems and incineration-based methods to improve hygiene and reduce environmental impact.

Internationally, there is a growing focus on developing smart and energy-efficient menstrual waste disposal solutions that minimize manual handling and support sustainable sanitation practices [7][8]. Automated incinerators integrated with temperature monitoring and safety mechanisms are increasingly considered effective solutions for reducing waste volume and maintaining hygienic conditions. The advancement of microcontroller-based systems, IoT technologies, and energy-efficient thermal processing has created opportunities for the development of safer and more reliable disposal systems suitable for modern sanitation infrastructure [8][9].

#### IV. INDIAN STATISTICS



Fig. 2 Trends Over Menstrual Waste Disposal Solution

Menstrual hygiene management remains a significant challenge in India due to the increasing use of disposable sanitary products and the lack of proper disposal infrastructure in many regions [3][4]. A large number of women and adolescent girls use sanitary napkins every month, resulting in the generation of considerable menstrual waste across urban and rural areas. Studies have reported that improper disposal methods such as open dumping, burning in open spaces, and disposal along with household waste are still commonly

practiced in several parts of the country [3]. These practices contribute to environmental pollution, drainage blockage, and unhygienic conditions in public spaces.

Research indicates that disposable sanitary napkins contain plastic-based materials and synthetic absorbents that require a long time for decomposition [5][6]. Due to increasing awareness regarding menstrual hygiene, the usage of sanitary products in India has risen significantly over recent years, thereby increasing the volume of menstrual waste generated daily. Educational institutions, hospitals, hostels, railway stations, and public sanitation facilities are facing difficulties in handling this waste safely and hygienically [4][7]. Inadequate segregation and disposal systems further increase the burden on municipal waste management processes.

To address these challenges, several organizations and institutions in India are promoting the use of sanitary napkin incinerators and automated disposal systems for safe waste management [7][8]. Government initiatives and awareness programs related to menstrual hygiene management have also encouraged the adoption of improved sanitation practices in schools and public facilities. The integration of compact, energy-efficient, and automated disposal technologies can significantly improve hygiene standards, reduce environmental impact, and support sustainable waste management practices across the country [8][9][10].

#### V. METHODOLOGY



Fig. 3 Methodology of Menstrual Waste Disposal Solution  
 The proposed menstrual waste disposal system is developed to provide a safe, hygienic, and energy-efficient solution for sanitary waste management. The methodology begins with the design and integration of hardware components including the

ESP32 microcontroller, relay module, nichrome heating element, DHT11 temperature sensor, cooling fan, LCD display, and DC–DC step-down converter. The ESP32 acts as the central control unit that manages the complete operation of the system based on programmed instructions. All components are interconnected to ensure proper control, monitoring, and automatic operation during the disposal process.

The disposal operation starts when the user inserts menstrual waste into the chamber and presses the start button. The ESP32 receives the input signal and activates the relay module, which switches ON the nichrome heating element. The heating element generates thermal energy required for controlled incineration of the waste inside the chamber. During this process, the DHT11 sensor continuously monitors the chamber temperature and sends the readings to the microcontroller. The obtained temperature values and operational status are displayed on the 2×16 LCD module for real-time monitoring.

After completion of the incineration process, the ESP32 automatically switches OFF the heating element and activates the cooling fan through the relay module. The cooling fan operates for a predefined duration to reduce the internal temperature of the chamber and maintain safe operating conditions. Once the cooling cycle is completed, the system shuts down automatically. The remaining ash can then be safely collected and disposed of in an environmentally responsible manner. The proposed methodology ensures automated operation, reduced human intervention, improved hygiene, and energy-efficient menstrual waste disposal.

## VI. BLOCK DIAGRAM

The proposed system is designed for the hygienic and energy-efficient disposal of menstrual waste using an automated incineration process. The block diagram consists of a power supply unit, DC-DC step-down converter, ESP32 microcontroller, LM35 temperature sensor, relay modules, heater, cooling fan, and LCD display. Each component performs a specific function to ensure safe and reliable operation of the system.

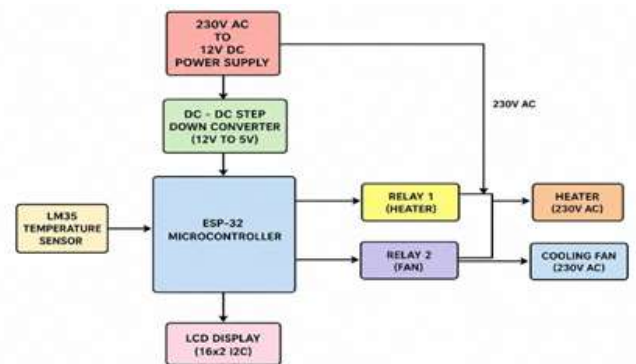


Fig. 4 Block Diagram

The system is powered using a 230V AC to 12V DC power supply, which converts the mains AC voltage into a regulated DC voltage required for the electronic components. A DC-DC step-down converter is used to further reduce the voltage from 12V to 5V for powering the ESP32 microcontroller and display module.

The ESP32 microcontroller acts as the main control unit of the system. It receives temperature data from the LM35 temperature sensor, which continuously monitors the temperature inside the disposal chamber. Based on the programmed conditions, the ESP32 controls the operation of the heating and cooling mechanisms through relay modules.

When the system is activated, Relay 1 switches ON the heater, which generates sufficient heat to incinerate the menstrual waste. The heating process is carried out under controlled temperature conditions to ensure safe and efficient burning. During operation, the temperature readings are continuously monitored by the LM35 sensor and processed by the ESP32.

After completion of the incineration process, the ESP32 deactivates the heater and activates Relay 2, which turns ON the cooling fan. The cooling fan helps in reducing the internal temperature of the chamber for a predefined duration, ensuring safe handling of the system after operation. Once the cooling process is completed, the fan is automatically switched OFF.

A 16×2 LCD display with I2C module is connected to the ESP32 to provide real-time information such as temperature values, heating status, cooling fan status, and system messages. The overall system operates automatically with minimal human intervention and converts menstrual waste into a small quantity

of ash, thereby providing a hygienic, compact, and environmentally friendly waste disposal solution.

**WEIGHTED SENSOR MAPPING FOR DEVIATION MEASUREMENT**

Componet	Function /Role	Input/ Signal	Output/ Action	Purpose
Start Button	Initiates System Operation	User Press(On/Off)	Sends Signal To Microcontroller	Start The Disposal Process
Microcontroller	Controls Entire System	Input From Button & Sensor	Activates Relay, Fan, And Lcd	Central Control And Automation
Temperature Sensor	Monitors Internal Temperature	Heat Level(°C)	Sends Data To Microcontroller	Ensures Safe And Controlled Heating
Relay Module	Switches High Power Devices	Control Signal	Turns Heater On/Off	Controls Heating Element Safely
Nichrome Heater	Burns Menstrual Waste	Electrical Supply	Generates Heat	Incineration Of Waste

**VII. SUPPORTING IMPLEMENTATION**

**HARDWARE IMPLEMENTATION**

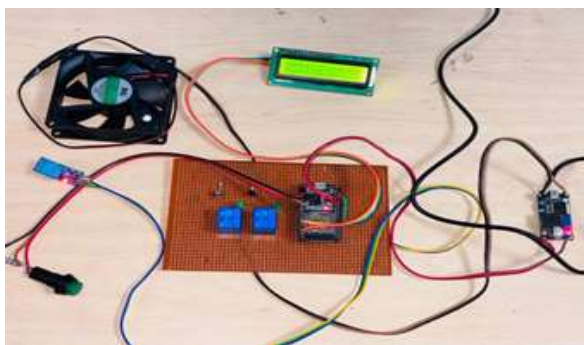


Fig. 5 Hardware Prototype

The hardware setup of the menstrual waste disposal system is designed to be compact, safe, and easy to operate. At its core, a microcontroller coordinates the entire process by controlling the heating and cooling stages. A nichrome wire heating element is installed inside a heat-resistant chamber to incinerate the waste efficiently, and it is activated through a relay module

to handle higher power safely. A push-button is provided for the user to start the process, while a 16x2 LCD display shows real-time information such as temperature and system status. After the burning process, a cooling fan is automatically switched on for a fixed duration to reduce the internal temperature. All components are powered through a stable power supply, with proper insulation and wiring to ensure safe and reliable operation.

**1. Power Supply**

The power supply provides the required electrical energy for the entire system. It delivers a stable 12V output needed for components like the fan, relay, and heater. A consistent power source ensures smooth and uninterrupted operation. It is designed to handle the current requirements of the system efficiently. Proper power supply selection is important for safety and performance. It forms the backbone of the hardware setup. It also helps in protecting the system from voltage fluctuations that could affect performance. A reliable power supply increases the overall lifespan and stability of the device during continuous operation.

**2. ESP32 Microcontroller**

The ESP32 is the central controller of the system, responsible for managing all operations. It receives input signals from the user and sensors, processes the data, and controls the heating and cooling mechanisms accordingly. Its fast processing speed allows smooth and real-time operation of the device. The microcontroller is programmed to automate the entire process, reducing the need for manual intervention. It also ensures proper timing between heating and cooling cycles. Overall, it acts as the brain of the system.

**3. DHT11 Temperature Sensor**

The DHT11 sensor is used to measure the temperature inside the device. It continuously sends temperature data to the microcontroller for monitoring. This helps in maintaining safe operating conditions during the heating process. The sensor ensures that overheating is avoided by triggering the cooling system when needed. It is simple, cost-effective, and easy to interface with the controller. Its role is important for both safety and efficiency.

**4. Nichrome Heater**

The nichrome wire is used as the heating element for burning the waste. It produces heat when electric current passes through it due to its high resistance. This property makes it suitable for

achieving the high temperatures required for incineration. The heater is placed inside a heat-resistant chamber to ensure safe operation. It provides uniform heating for effective waste disposal. Its durability and efficiency make it ideal for this application.

#### 5. 16×2 LCD with I2C Module

The 16×2 LCD display is used to show system information to the user. It displays temperature readings and the current status of the system, such as heating or cooling. The I2C module reduces the number of wires required for connection, making the setup simpler. It improves the readability and user interaction with the device. The display provides real-time feedback, helping users understand the process. It enhances the overall usability of the system.

#### 6. Cooling Fan (12V DC)

The cooling fan is used to reduce the temperature inside the system after the heating process. It helps in bringing the device back to a safe operating condition. The fan is automatically controlled by the microcontroller based on programmed timing. It prevents overheating and protects internal components from damage. The fan operates efficiently using a 12V supply. Its role is essential for safety and proper system functioning.

#### 7. Relay Module

The relay module acts as a switch to control high-power devices in the system. It allows the low-voltage microcontroller to safely operate the heating element. When triggered, it turns the heater on or off based on the program. This ensures electrical isolation between control and power circuits. It improves safety and prevents damage to sensitive components. The relay plays a key role in automation and control.

#### 8. DC to DC Step-Down Converter

The DC–DC converter in the proposed menstrual waste disposal system is used to provide a stable and regulated voltage supply for the electronic components. It converts the higher input DC voltage into a lower required voltage suitable for operating the ESP32 microcontroller, DHT11 sensor, LCD display, and relay module safely and efficiently. The converter helps maintain consistent power delivery even during voltage fluctuations, thereby improving the reliability and performance of the system. In addition, it reduces power loss and heat generation, contributing to the overall energy efficiency and stable operation of the automated disposal unit.

## VIII. SOFTWARE IMPLEMENTATION



Fig.6 Arduino IoT Cloud Platform Used for Program

### Development

The software implementation of the proposed menstrual waste disposal system is carried out using the Arduino IoT Cloud platform. The platform is used for developing, compiling, and uploading the program code to the ESP32 microcontroller. It provides an easy and efficient environment for integrating different hardware components such as sensors, relay modules, LCD display, cooling fan, GSM module, and GPS module within a single control system.



Fig. 7. Experimental Output of the Proposed Menstrual Waste Disposal

The program is designed to continuously monitor temperature data, control the heating and cooling operations, and display real-time system status on the LCD module. The Arduino IoT Cloud platform also supports reliable communication between the ESP32 and connected devices, enabling smooth execution of automated functions. Using this platform simplifies software development, improves system flexibility, and ensures stable operation of the

### System Displaying Temperature and Cooling Fan Status

The experimental output of the proposed menstrual waste disposal system during operation. The 2×16 LCD module displays the real-time temperature inside the disposal chamber along with the operational status of the cooling mechanism. In the displayed output, the chamber temperature is recorded as 45.10°C, indicating that the system continuously monitors the thermal condition during the disposal process. The LCD interface improves user interaction by providing clear and immediate status information.

When the measured temperature exceeds the predefined threshold value, the ESP32 microcontroller automatically activates the cooling fan through the relay module. This condition is indicated on the display by the message “Cooling Fan ON.” The automatic cooling process helps reduce the internal temperature of the chamber and ensures safe operation of the system after incineration. The obtained output confirms the successful implementation of temperature monitoring, automatic control, and real-time status display in the proposed disposal system.

## IX. RESULT AND DISCUSSION

The proposed menstrual waste disposal system was successfully designed and implemented using an ESP32 microcontroller, nichrome heating element, relay module, DHT11 temperature sensor, cooling fan, and LCD display. The experimental results confirmed that the system was able to perform controlled incineration of menstrual waste in a safe and hygienic manner. The nichrome heating element generated sufficient thermal energy for effective waste burning, while the DHT11 sensor continuously monitored the chamber temperature during operation. The LCD module displayed real-time temperature values and operational status, enabling easy observation of the system performance.

The relay module effectively controlled the switching operation of both the heating element and cooling fan based on the programmed conditions. When the chamber temperature exceeded the predefined threshold value, the cooling fan was automatically activated to reduce the internal temperature and maintain safe operating conditions. After the completion of the cooling cycle, the system shut down automatically without requiring manual intervention. The obtained results demonstrated stable system operation, reliable temperature

monitoring, and efficient thermal control throughout the disposal process.

The proposed system offers several advantages such as hygienic waste handling, reduced human contact, compact structure, and energy-efficient operation. The integration of automated control and smart monitoring improves operational safety and user convenience. In addition, the system contributes toward environmentally responsible disposal by reducing improper waste handling practices. The overall performance indicates that the proposed menstrual waste disposal system can serve as a practical solution for homes, schools, hostels, hospitals, and public sanitation facilities.

## X. CONCLUSION

The proposed menstrual waste disposal system provides a safe, hygienic, and automated solution for the effective handling of sanitary waste. The system integrates an ESP32 microcontroller with a nichrome heating element, relay module, temperature sensor, cooling fan, and LCD display to perform controlled incineration and automatic temperature regulation. The experimental results confirmed that the system successfully carried out waste disposal with minimal human intervention while maintaining safe operating conditions through continuous temperature monitoring and automated cooling.

The developed model offers several advantages including improved sanitation, reduced direct contact with waste, compact design, and energy-efficient operation. The real-time monitoring and automatic control features enhance system reliability and user convenience. In addition, the proposed system helps minimize environmental pollution caused by improper disposal methods and supports cleaner waste management practices. Therefore, the implemented solution can serve as an effective and practical approach for menstrual waste disposal in households, educational institutions, hospitals, hostels, and public sanitation facilities.

## REFERENCES

1. Boroah, R., et al., “Investigations into the performance of single chamber sanitary napkin incinerators with emphasis on CO and CO<sub>2</sub> emissions,” Waste Management, 2020.

- [https://doi.org/10.1016/j.wasman.2019.11.032?utm\\_source=chatgpt.com](https://doi.org/10.1016/j.wasman.2019.11.032?utm_source=chatgpt.com)
2. Sasidaran, S., Kachoria, P., Raj, A., Ramalingam, S., Stoner, B.R., Sellgren, K.L., & Grego, S., "Physical properties of menstrual hygiene waste as feedstock for onsite disposal technologies," *Journal of Water, Sanitation and Hygiene for Development*, 2021.  
[https://doi.org/10.2166/washdev.2021.262?utm\\_source=chatgpt.com](https://doi.org/10.2166/washdev.2021.262?utm_source=chatgpt.com)
  3. Van Eijk, A.M., et al., "Menstrual Hygiene Management and Waste Disposal in Low and Middle Income Countries — A Review of the Literature," *International Journal of Environmental Research and Public Health*, 2018.  
[https://doi.org/10.3390/ijerph15112562?utm\\_source=chatgpt.com](https://doi.org/10.3390/ijerph15112562?utm_source=chatgpt.com)
  4. Kaur, R., Kaur, K., & Kaur, R., "Menstrual Hygiene, Management, and Waste Disposal: Practices and Challenges Faced by Girls/Women of Developing Countries," *Journal of Environmental and Public Health*, 2018.  
[https://doi.org/10.1155/2018/1730964?utm\\_source=chatgpt.com](https://doi.org/10.1155/2018/1730964?utm_source=chatgpt.com)
  5. Harrison, M.E., & Tyson, N., "Menstruation: Environmental impact and need for global health equity," *International Journal of Gynecology & Obstetrics*, 2023.  
[https://doi.org/10.1002/ijgo.14311?utm\\_source=chatgpt.com](https://doi.org/10.1002/ijgo.14311?utm_source=chatgpt.com)
  6. Blair, L.A.G., Bajón-Fernández, Y., & Villa, R., "An exploratory study of the impact and potential of menstrual hygiene management waste in the UK," *Cleaner Engineering and Technology*, 2022.  
[https://doi.org/10.1016/j.clet.2022.100423?utm\\_source=chatgpt.com](https://doi.org/10.1016/j.clet.2022.100423?utm_source=chatgpt.com)
  7. Navale, R.V., Mane, M., Alam, P., Bachche, S., & Khetre, S.N., "A review on design and manufacturing of portable sanitary napkins disposal incinerator," *International Journal of Engineering and Advanced Technology (IJEAT)*, 2022.  
[https://www.ijiresm.com?utm\\_source=chatgpt.com](https://www.ijiresm.com?utm_source=chatgpt.com)
  8. Fathima, S., "Sanitary napkin vending machine with incinerator for menstrual hygiene," *International Journal of Science and Technology Research (IJSTR)*, 2021.  
<https://journals.stmjournals.com/joecc/article%3D2025/view%3D213331>
  9. Gawande, M.B., Kokat, L.V., Jakate, N.D., & Kodlinge, A.A., "Combined model of incineration and dispenser for sanitary napkins," *IEEE ICEMPS 2024 – International Conference on E-Mobility, Power Control and Smart Systems*, 2024.  
<https://doi.org/10.1109/ICEMPS60684.2024.10559302>
  10. Mistry, P.A., et al., "Challenges and opportunities for implementing resource recovery from sanitary waste streams: insights from India," *Journal of Material Cycles and Waste Management*, 2025.  
<https://www.researchgate.net/publication/392506311>