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DESIGN AND FABRICATION OF PORTABLE SOLAR-POWERED SEMI-AUTOMATIC PELLET MACHINE

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Abstract: The project at hand represents a groundbreaking endeavor, delving deep into the realms of innovation, sustainability, and agricultural advancement. At its core lies the conception, planning, and realization of a revolutionary portable pellet mill, ingeniously fueled by solar power. This visionary initiative not only aims to redefine biomass processing but also seeks to address the pressing global need for renewable energy solutions while catering to the specific challenges faced in the Indian context.

In a world increasingly cognizant of the finite nature of fossil fuels and the urgent imperative to mitigate climate change, the quest for sustainable alternatives has never been more crucial. Against this backdrop, the fusion of solar energy with pellet mill technology presents a beacon of hope, offering a tangible pathway towards a greener, more ecologically balanced future.

Central to the project's mission is the transformation of biomass processing, a cornerstone of agricultural productivity, and resource utilization. By harnessing the abundant energy of the sun, the portable pellet mill not only promises to streamline pellet production but also significantly reduce its environmental footprint. This synergy of renewable energy and innovative machinery heralds a paradigm shift in the way we approach not only biomass processing but also agricultural sustainability as a whole.

The significance of this endeavor is particularly pronounced in the context of India's agricultural landscape, where challenges such as the gap between demand and supply of compound feeds for livestock loom large. With approximately 57% of this gap remaining unmet, the vulnerability of dairy farmers to disruptions in trade becomes glaringly apparent. The project thus assumes a pivotal role in addressing this critical issue, offering a locally adaptable solution that empowers farmers to take control of their feed production, mitigating the risk of price fluctuations and ensuring the affordability of essential cattle pellets.

Moreover, the accessibility of the technology is a key factor in its potential impact. Traditional feed pelleting machines, while effective, often come with prohibitive costs that place them beyond the reach of individual farmers. Recognizing this barrier, the project endeavors to democratize access to pellet production technology, making it feasible for even small-scale farmers to adopt and benefit from its advantages. In doing so, it not only promotes economic empowerment at the grassroots level but also fosters a culture of self-sufficiency and resilience within agricultural communities.

Beyond its immediate practical implications, the project holds the promise of broader socio-economic and environmental benefits. By reducing dependence on fossil fuels and minimizing carbon emissions, the integration of solar power into pellet production aligns with global efforts to combat climate change and mitigate environmental degradation. Furthermore, the utilization of locally available biomass resources for feed production enhances resource efficiency and promotes circular economy principles, thereby fostering sustainable agricultural practices and contributing to food security objectives.

In summary, the endeavor to develop a portable pellet mill powered by solar energy represents a pioneering step towards a more sustainable, resilient, and inclusive agricultural future. By marrying cutting-edge technology with a commitment to environmental stewardship and social equity, the project not only addresses pressing challenges but also unlocks new opportunities for innovation, empowerment, and progress. As we embark on this transformative journey, the vision of a world where sustainable energy powers sustainable agriculture stands within reach, awaiting only the dedication and ingenuity of those willing to seize it.

Index Terms - Component, formatting, style, styling, insert.

I. INTRODUCTION

Biomass pellets, derived from various organic materials, offer cost-effective and efficient energy solutions. Their dense and uniform structure enables easy handling and automatic feeding, making them ideal for various applications including household heating and boiler fuel. Pellets, typically cylindrical in shape and ranging from 6-25 mm in diameter, can be tailored to specific requirements due to the versatility of pelletization machinery. While not economically viable for electricity generation due to low energy density, pellet machines can process a wide range of materials including wood, agricultural residues, and even animal feed ingredients like corn and soybean meal. Our project aims to develop a semi-automatic pellet making machine powered by solar energy for mixing and pelletizing biomass, catering especially to rural areas where electricity may be scarce. By incorporating an inbuilt shredder and mixer, this machine offers a sustainable solution for producing fodder without heavy reliance on electricity.

1. COMPONENT DESCRIPTION

1.1 FRAME

The mild steel frame of the solar-powered portable semi-automatic pellet machine serves as a crucial structural element with multifunctional capabilities. The frame strategically houses and secures the shredder, mixer, and pellet containers, ensuring their stability during operation.

The sturdy construction of the mild steel frame not only withstands the dynamic forces generated by the integrated mechanisms but also enhances the overall durability and longevity of the machine. This thoughtful design ensures that the frame acts as a reliable foundation, holding and supporting critical components, thereby contributing to the efficiency and effectiveness of the entire pellet production process.

1.2 SHREDDER

The shredder container of the solar-powered portable semi-automatic pellet machine is constructed from mild steel, a material chosen for its durability, strength, and suitability for the demanding task of shredding raw materials. The robust nature of mild steel ensures that the container can withstand the mechanical forces and stresses associated with the shredding process. Its excellent tensile strength allows the container to endure the impact and forces exerted by the shredding mechanism, ensuring long-term structural integrity. The corrosion resistant properties of mild steel, when appropriately coated or treated, protect the container from environmental elements, ensuring longevity and sustained performance.

1.3 SHREDDER PIPE

The shredding pipe of the machine is constructed from galvanized iron, a material chosen for its corrosion resistance, durability, and strength. The galvanization process involves coating the iron with a layer of zinc, providing effective protection against rust and corrosion, which is crucial for components in direct contact with raw materials during the shredding process. The shredding pipe serves as the housing for the rotor blades, and its galvanized iron ensures longevity and sustained performance even in diverse environmental conditions. The strength of galvanized iron allows the shredding pipe to withstand the mechanical forces and impacts associated with the shredding of raw materials.

1.4 BLADE ASSEMBLY

The blade assembly inside the shredding pipe of the solar-powered semi-automatic pellet machine is made from mild steel, selected for its robustness, machinability, and durability. Crafted with precision, these

mild steel blades efficiently shred various raw materials, benefiting from the material's excellent tensile strength. The blades' durability is enhanced by mild steel's resistance to mechanical stresses and impacts during the shredding process. Mild steel's versatility allows for intricate designs and surface treatments, contributing to the longevity and reliability of the blade assembly. This material choice ensures effective and long-lasting performance in breaking down diverse materials into smaller, uniform pieces for the pellet production process.

1.5 MIXER CONTAINER

The mixer container of the solar-powered semi-automatic pellet machine is constructed from stainless steel for superior corrosion resistance, hygienic properties, and structural strength. This material ensures prolonged durability, even in demanding environments, by resisting corrosion and maintaining integrity. Stainless steel's strength allows the container to withstand the mechanical forces during the mixing process. Its smooth and non-reactive surface facilitates easy cleaning, making it ideal for applications where hygiene is crucial. The use of stainless steel enhances the overall durability, cleanliness, and versatility of the mixer container, contributing to the efficiency of the pellet production process.

1.6 KNEADING ARM

The kneading arm, responsible for mixing contents within the stainless-steel mixer container of the solar-powered semi-automatic pellet machine, is crafted from stainless steel. This material ensures durability, corrosion resistance, and hygiene, enduring the mechanical stresses of the mixing process. The stainless-steel construction also contributes to cleanliness, making it suitable for applications with stringent hygiene standards, such as the production of animal feed or biomass pellets. The use of stainless steel for the kneading arm underscores a commitment to efficiency and durability in the mixing component of the pellet production process.

1.7 PELLET FORMING CONTAINER

The pellet forming container in the solar-powered semi-automatic pellet machine, housing a roller assembly and an extrusion plate, is crafted from alloy steel. This material choice ensures exceptional strength, wear resistance, and durability, vital for withstanding the mechanical forces during the pelletization process. The roller assembly and extrusion plate, key components for pellet formation, benefit from the toughness and hardness of alloy steel, ensuring prolonged performance and reliable pellet production. This material selection is particularly suited for applications demanding wear resistance, contributing to the efficient and robust creation of high-quality pellets in the forming phase of the overall process.

1.8 ROLLER ASSEMBLY

The mild steel roller assembly in the solar-powered semi-automatic pellet machine serves essential functions in the pelletization process. It provides the mechanical force needed to compress and shape raw materials into cohesive pellets, ensuring durability and longevity. Mild steel's ductility allows for the fabrication of precise rollers, contributing to efficient pellet formation. The assembly facilitates uniform material extrusion, ensuring consistent pellet size and quality. Overall, the mild steel roller assembly plays a pivotal role, enabling the machine to produce high-quality pellets efficiently.

1.9 EXTRUSION PLATE

The extrusion plate in the solar-powered semi-automatic pellet machine is made from mild steel, chosen for its durability and versatility. This component is integral to the pelletization process, providing a sturdy surface against which compressed raw materials shape into uniform pellets. Mild steel's strength ensures the extrusion plate withstands mechanical forces, ensuring long-term durability. Its malleability allows for precise fabrication, contributing to the efficiency of the pelletization process. In summary, the mild steel extrusion plate supports the reliable and consistent production of high-quality pellets in the machine.

1.10 MISCELLANEOUS COMPONENTS

The solar-powered semi-automatic pellet machine incorporates various miscellaneous components essential to its functionality. A 60-watt DC motor and a 1 HP motor drive critical mechanisms, providing the necessary power for the shredding, mixing, and pellet forming processes. The solar panel harnesses renewable energy, converting sunlight into electricity to power the machine. A battery storage system stores excess energy, ensuring continuous operation even in low light conditions. A temperature sensor monitors and regulates the pellet-making chamber, optimizing conditions for efficient pellet formation. Additionally, castor wheels enhance the machine's portability, allowing easy movement and positioning in different locations. Together, these miscellaneous components contribute to the overall efficiency, sustainability, and user-friendliness of the solar-powered pellet machine.

2. WORKING

2.1 WORKING PRINCIPLE

The solar-powered semi-automatic pellet machine features separate chambers mounted on the same frame, integrating a shredder with a blade assembly, a mixer with a kneading arm, and a pellet chamber equipped with a roller assembly and extrusion plate. Solar panels harness energy to power the entire system, enabling the shredding, mixing, and pelletizing of biomass materials. This compact and efficient design allows for easy access and maintenance of individual components while reducing reliance on traditional energy sources and producing biomass pellets for various applications.

2.2 WORKING

The solar-powered semi-automatic pellet machine integrates a shredder, mixer, and pellet chamber into separate chambers mounted on the same frame. This innovative design utilizes solar energy to drive its operations, making it environmentally friendly and sustainable. In the shredder chamber, biomass materials are broken down into smaller pieces by a blade assembly. These shredded materials then move to the mixer chamber, where a kneading arm thoroughly mixes them with additives or binding agents, ensuring a homogeneous mixture. Finally, in the pellet chamber, a roller assembly compresses the mixture into dense pellets, which are shaped by an extrusion plate. This streamlined process minimizes manual intervention while producing high-quality biomass pellets for various applications, such as heating, cooking, or animal bedding.

2.3 WORKING PROCEDURE

- Sunlight Collection:** Solar panels harness sunlight and convert it into electrical energy to power the machine.
- Shredding:** Biomass materials are fed into the shredder chamber, where a blade assembly breaks them down into smaller pieces.
- Mixing:** The shredded biomass moves to the mixer chamber, where a kneading arm thoroughly mixes it with additives or binding agents, ensuring a homogeneous mixture.
- Pelletization:** The mixed biomass is transferred to the pellet chamber, where a roller assembly compresses it into dense pellets. An extrusion plate shapes the pellets to the desired size and density.
- Temperature Monitoring:** Throughout the process, a temperature sensor continuously monitors the biomass material's temperature, triggering alerts or shutdowns if temperatures exceed safe levels.

6. Final Product: The streamlined process minimizes manual intervention while producing high-quality biomass pellets suitable for various applications, such as heating, cooking, or animal bedding.

7. Safety and Efficiency: Integration of the temperature sensor ensures operational safety and efficiency by preventing overheating and enhancing equipment longevity.

4 CALCULATIONS AND DESIGN

4.1 CALCULATIONS

- NUMBER OF CUTS IN THE SHEDDER PROVIDE FOR RAW MATERIALS :**

$$\text{RPM} \times 2 \times \text{No. of blades} = 3000 \times 2 \times 3 = 1800 \text{ RPM}$$

- MASS OF THE FRAME:**

$$\text{Mass of the frame} = \text{Density of Mild steel} \times \text{Volume}$$

$$(\text{Volume} = \text{Volume of the square pipe} + \text{volume of flat bar} + \text{Volume of base sheet metal}) - (\text{Volume of the hollow volume}) + (\text{Volume of the flat bar}) + (\text{Volume of the sheet metal}) - (\text{Volume of the cut section})$$

$$V = 7.2 \times 0.02 \times 0.02 - (7.2 \times 0.016 \times 0.016) + 2.28 \times 0.03 \times 0.0005 + 1 \times 0.4 \times 0.002 - 0.3 \times 0.3 \times 0.002$$

$$V = 0.0028 \text{ m}^3 - 0.0018 \text{ m}^3 + 0.00034 \text{ m}^3 + 0.0008 \text{ m}^3 - 0.00018 \text{ m}^3$$

$$V = 0.00196 \text{ m}^3$$

$$m = \rho \times v$$

$$m = 7850 \times 0.00196 \text{ m} = 15.3 \text{ kg}$$

- VOLUME OF SHREDDING CONTAINER :**

$$V = L \times B \times H$$

$$= 44 \times 30 \times 30 = 39,600 \text{ cm}^3$$

- MASS OF THE SHREDDER CONTAINER:**

$$m = \rho \times v$$

$$m = \rho \times (L \times B \times t \text{ of sheet metal}) = 7850 \times (0.57 \times 0.002)$$

$$m = 7850 \times 0.00114 \text{ m} = 8.9 \text{ kg}$$

- VOLUME OF MIXER CONTAINER:**

$$V_{mc} = \pi \times R^2 \times H$$

$$= 3.14 \times (21.6)^2 \times 20 = 29,299 \text{ cm}^3$$

- MASS OF SHREDDER BLADE ASSEMBLY:**

$$m = \rho \times v$$

$$V = (\text{Volume of Shaft} + \text{Volume of Blade}) = (\pi \times r^2 \times h + L \times B \times t)$$

$$V = (3.14 \times (0.01)^2 \times 0.25 + 0.1 \times 0.002 \times 0.002)$$

$$V = 0.000082 \text{ m}^3$$

$$m = 7850 \times 0.000082 \text{ m} = 0.6 \text{ kg}$$

- **MASS OF SHREDDER PIPE:**

$$m = \rho \times v$$

$$m = \text{Density of galvanized iron} \times \text{Volume of pipe metal} V = (\pi \times r^2 \times h - \pi \times r^2 \times h)$$

$$V = \pi \times ((0.12)^2 \times 0.4 - (0.11)^2 \times 0.4)$$

$$V = 3.14 \times (0.005 - 0.0045)$$

$$V = 0.00068 \text{ m}^3$$

$$m = \rho \times v$$

$$m = 7000 \times 0.00068 \text{ m} = 4.7 \text{ kg}$$

- **MASS OF ROLLER ARM**

$$m = \rho \times v$$

$$m = \text{Density of Mild steel} \times \text{Volume of rod} \text{Volume} = \text{Area} \times \text{length of the rod}$$

$$= \pi r^2 \times 0.58$$

$$= 3.14(0.01)^2 \times 0.58$$

$$= 0.00018 \text{ m}^3$$

$$m = 7850 \times 0.00018$$

$$m = 1.41 \text{ kg}$$

- **MASS OF ROLLERS**

$$m = \rho \times v$$

$$\text{Volume} = \text{Area of rollers} - \text{area of the holes}$$

$$= (\pi \times r^2 \times h - \pi \times r^2 \times h)$$

$$= 3.14((0.04)^2 \times 0.08 - (0.01)^2 \times 0.08)$$

$$= 3.14(0.000128 - 0.000008)$$

$$= 0.00037 \text{ m}^3$$

$$m = 7850 \times 0.00037 = 2.9 \text{ kg}$$

- **MASS OF EXTRUSION PLATE**

$$m = \rho \times v$$

$$\text{Volume} = \text{volume of disc} - \text{volume of the holes}$$

$$= \pi r^2 \times t - (N \times \pi r^2 \times t)$$

$$= 3.14((0.125)^2 \times 0.005) - (72 \times (0.005)^2 \times 0.005)$$

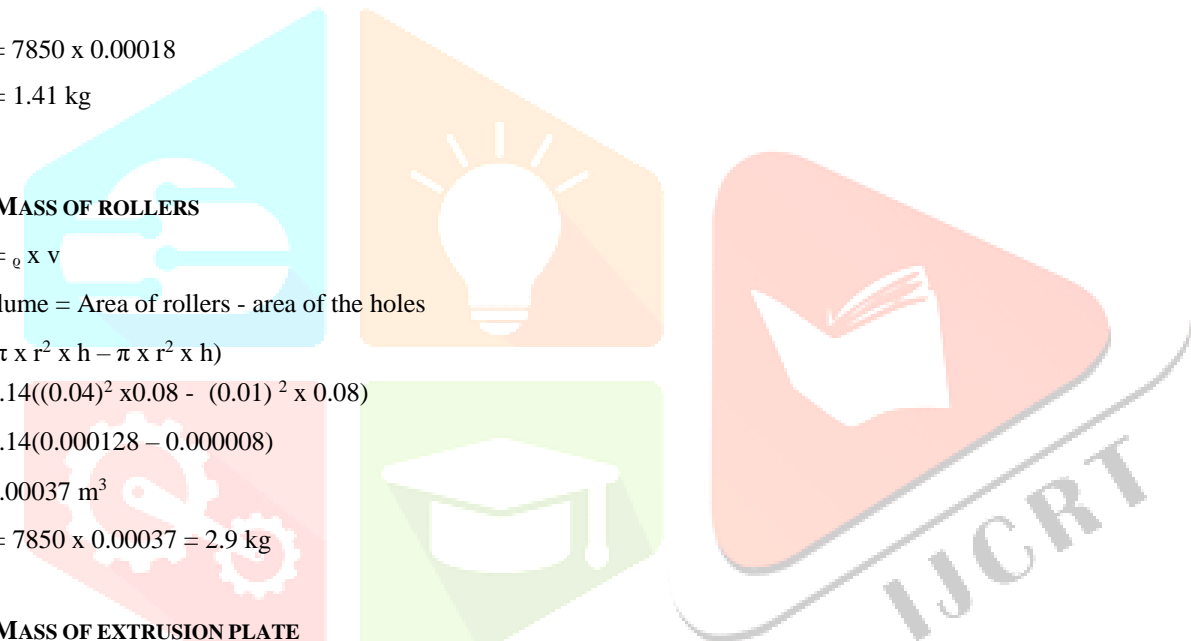
$$= 3.14 (0.000078 - 0.000009)$$

$$= 3.14 (0.000069)$$

$$v = 0.000216 \text{ m}^3$$

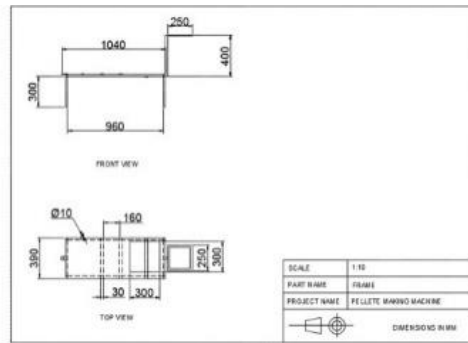
$$m = 7850 \times 0.000216$$

$$m = 1.69 \text{ kg}$$

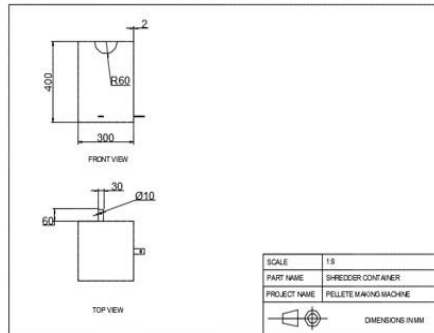
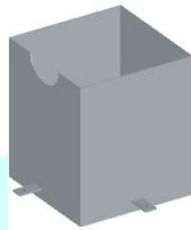


4.2 DESIGN OF MACHINE

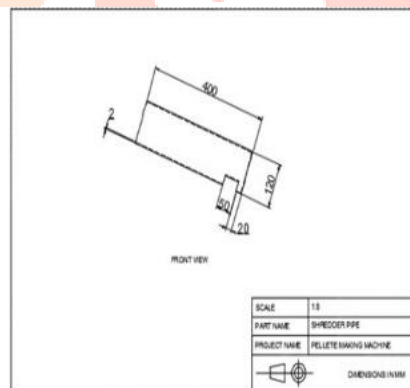
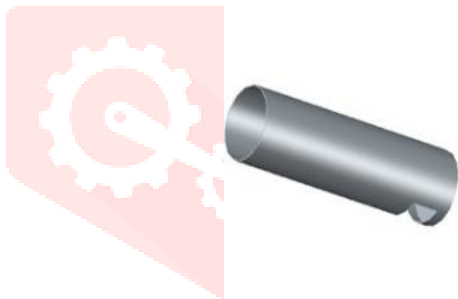
1. Frame



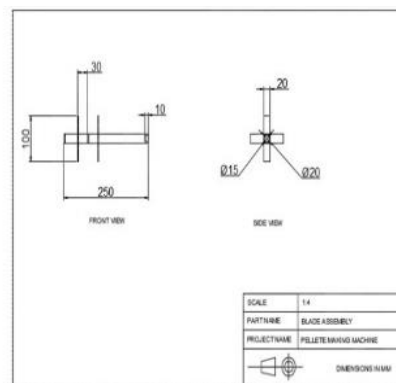
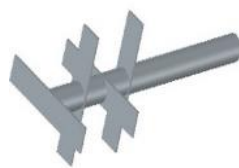
2. Shredder



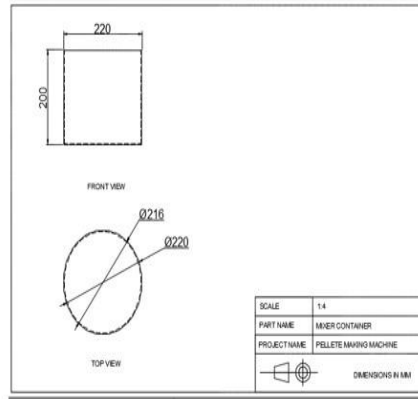
3. Shredder pipe



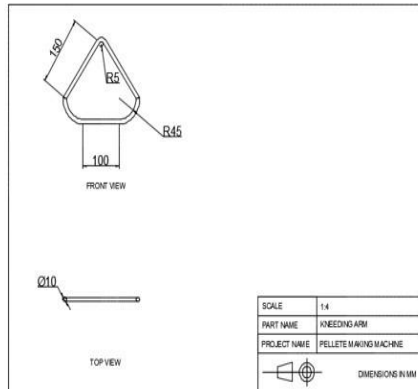
3. Blade Assembly



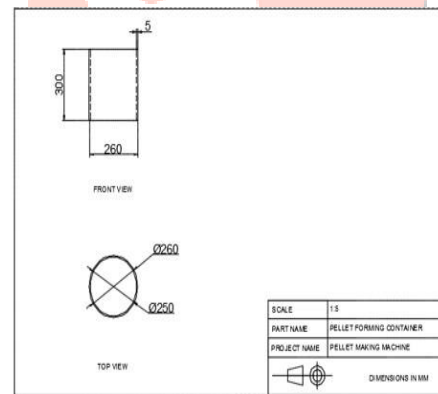
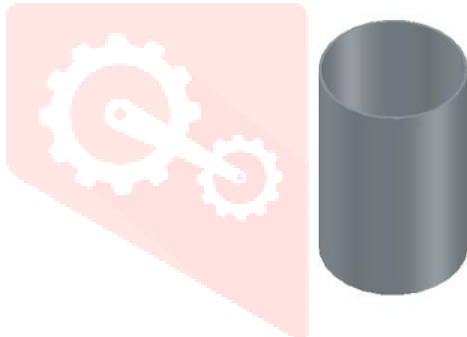
4. Mixer container



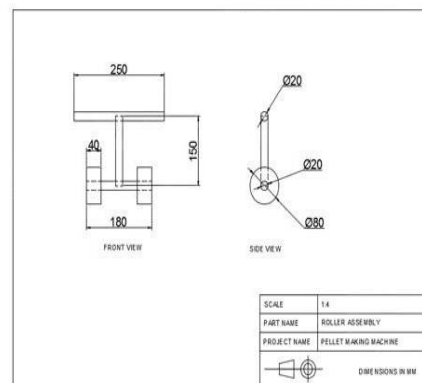
5. kneading arm



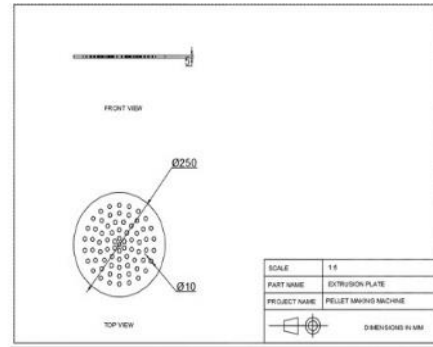
6. Pellet making container



7. Roller Assembly



8. Extrusion plate



5. ASSEMBLY AND FABRICATION PROCESS

- Marking out -The first stage of this fabrication is the marking out of the required dimensions of the sheet metal and the angle iron together with the square iron bars.
- Cutting process - The second stage after the required dimensions is marked out the cutting out of the required length from the main material will take place on cutter machine, lathe machine.
- Welding Process- After the first two processes is carried out, the materials are joined together by means of the joining process called “welding”. This involves the welding of the various parts of the frame together using the electric arc welding process.
- Coupling Process -This comprises the coupling of the various parts of the machine which include the induction motor, aluminum container, roller crusher, the shaft etc. Following are the different views of solar operated biomass pelletizing machine.



Fig 5.1



Fig 5.2

6. CONCLUSION

In conclusion, the development of the solar-powered portable semi-automatic pellet machine with an integrated shredder and mixer assembly represents a significant stride toward sustainable and accessible pellet production, particularly in off-grid areas facing power challenges. By harnessing solar energy through high-efficiency panels and incorporating a robust battery storage system, the machine overcomes power cut issues prevalent in rural communities. The integration of shredding and mixing functions within a compact, portable frame enhances efficiency and usability. This innovation not only streamlines the pellet production process but also promotes environmental sustainability with its solar-powered operation. The incorporation of user-friendly features, safety mechanisms, and temperature monitoring ensures a seamless and secure operation. Ultimately, this project aligns with the broader goal of providing rural communities with an affordable, scalable, and eco-friendly solution for pellet production, addressing both energy and agricultural needs in a holistic and manner.

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