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Design and Fabrication of Coir Pith Prequetting Machine

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Abstract: Small scale industries play a major role in the economic development of India. To enhance its growth and to effectively utilize the renewable energy, waste products to be reused one such product is coir pith. Coir Pith is the spongy, peat like residue from the processing of coconut husk and it is pressed to required thickness in order to make it as pith briquettes. Coir is mainly used in exporting and in agricultural field, as it is good absorbent of the water. It maintains the moisture content of the pith to enhance the quality of the product. Simulation of the pneumatic circuits for the operation of forward and return movement of the piston rod with flow, pressure and direction control is given with the help of Automation Studio.

Key words:

INTRODUCTION

Small scale industries create innovative ideas to accompany the agricultural field to enhance its growth. The intention of the proposed paper is to develop a product that satisfies the society by its usage, less consumption of energy, development of the small scale industries and Agriculture. Coir pith is one such product mainly used in agriculture, exporting and in processing industries. Coir is made from the fibre found between the husk and the outer shell of coconuts. It is a relatively new growing medium that is becoming popular throughout the world in growing mixes and as a substrate for hydroponics [9]. The demand of coir and coir products is slowly decreasing and that other profitable markets have to be found for this commodity. The best way to bring the existing coir industry to a higher level is the development of new coir products with higher added value. One possible technology that could fulfil this goal is the use of coir fibre in exporting and in agricultural areas [1].

From Table 1, it is shown that coir has high lignin content which prompt to fighting against the bacterial and fungal activities. So that it can be effectively utilized in the agricultural field as a well suited potting agent.

Coir Pith briquetting is done with the help of pneumatic piston rod. Pneumatic source is effectively utilized in the briquetting technology, different type of pressing are Piston and Ram and Screw briquetting.

Table 1: Properties of coir with other natural fibres

Properties	Coir pith	Jute	Cotton
Density g/cm3	125	146	151
Tensile strength Mpa	220	400-800	400
E-Modulus Gpa	6	10-30	12
Specific density	5	7-21	8
Elongation at failure %	15-25	18	3-10
Relative price compared to Coir	100%	40%	600-900%

At present two main high pressure technologies: Ram or piston press and screw extrusion machines are used for briquetting. The briquettes produced by a piston press are completely solid, screw press briquettes on the other hand have a concentric hole which gives better combustion characteristics due to a larger specific area. The screw press briquettes are also homogeneous and do not disintegrate easily. The pollution problem is become so acute, that the State Government of Tamil Nadu has banned the burning of loose Coir in southern areas. It is very likely that other States in India will soon follow this policy. The users are advised to use coir either as briquetted material or in fluidised bed boilers with proper pollution control measures. On the basis of compaction, the briquetting technologies can be divided into:

- High pressure compaction
- Medium pressure compaction with a heating device
- Low pressure compaction with a binder.

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Fig. 1: Cellulose helical structure of coir fibre

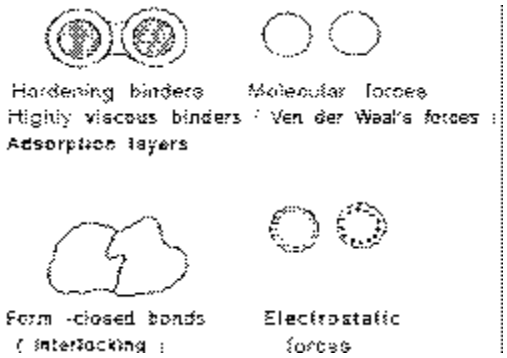


Fig. 2: Binding mechanisms

In all these compaction techniques, solid particles are the starting materials. The individual particles are still identifiable to some extent in the final product. Briquetting and extrusion both represent compaction i.e., the pressing together of particles in a confined volume. If fine materials which deform under high pressure are pressed, no binders are required. The strength of such compacts is caused by van der Waals' forces, valence forces, or interlocking. Natural components of the material may be activated by the prevailing high pressure forces to become binders. Some of the materials need binders even under high pressure conditions.

The recent successes in briquetting technology and the growing number of entrepreneurs in the briquetting sector, are evidence that biomass briquetting will emerge as a promising option for the new entrepreneurs and other users of biomass.

WORKING METHODOLOGY

Drying of fibre: Initially the fibre of the coco and jute are dried so it will be easy to remove the powder from the fibre. Drying is done by means of sunlight instead of electrical energy by effectively using it

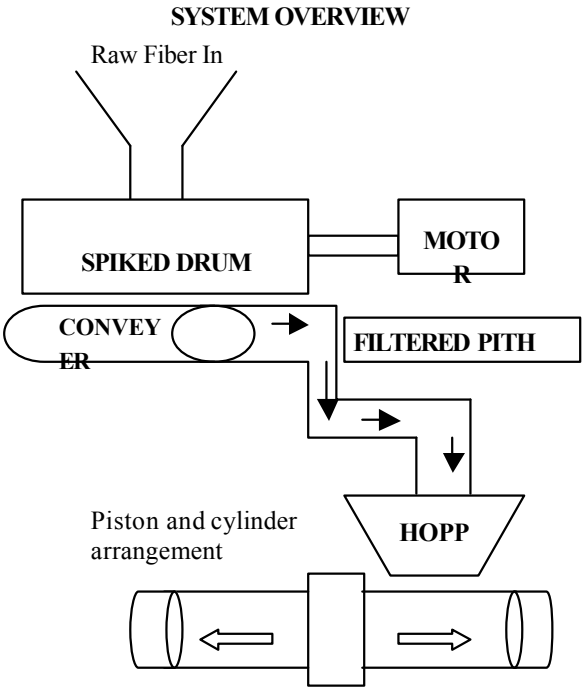


Fig. 3: Block diagram

without wasting the electricity. Coco peat is a natural fibre made out of coconut husks. The extraction of the coconut fibre from husks gives the by-product called coco peat. This coco peat dried in the natural sun, are processed to produce different items. This makes an excellent growing medium for hydroponics or container plant growing. Clean coir has natural rooting hormones and anti-fungal properties. Most of all coco peat is 100% organic natural and root friendly product. An organic potting medium made from natural fibres, this all natural material is not only ideal for hydroponics and mixed media cultivation, but is an excellent soil conditioner as well. This material loosens clay soils and is highly porous to aid in strong root development. It has a soft fibrous texture that does not crust when dry.

Table 2: Chemical properties

Material	Moisture (%)	pH	EC (dS/m)	N	P	K	Cl
Coir peat	13	5.1	0.80	0.5	0.3	0.4	0.07
Sphagnum peat	9	3.3	0.85	0.9	0.5	0.1	0.05
Sedge peat	83	4.9	0.35	0.9	0.5	0.1	0.05

Separation of pith: After drying the fibres are separated according to the quality, so that low quality fibres are used for the purpose of making the preserver sponge. High quality fibres are used for toys making and commercial products. Coir dust is the spongy, peat like residue from the processing of coconut husks (meso carp) for coir fibre. Also known as coco peat, it consists of short fibres (<2cm) around 2%-13% of the total and cork like particles ranging in size from granules to fine dust.

Powdering of the fibre: Separated fibre is taken and dropped into the revolving drum studded with metal spikes that comb the fibres out. Automatic process starts by grinding the fibre to required consistency, filtering and pressing. Grinding mechanism consist of nested bowl with spikes attached to single phase induction motor so that motor rotates the bowl and the powered pith fall in to the filter.

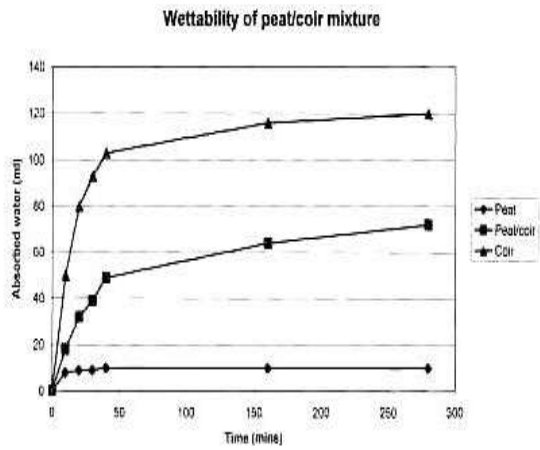
Filtration: Filtering of the sand dust and waste material is done in the filtering process and the powder is transferred to the hopper.

Compaction: The pith in the hub is pressed using the double rod cylinder in which both the strokes of the cylinder is utilized for the pressing of the pith. Efficiently return stroke of the rod is utilized and the production is also increased by this design of the cylinder.

pH and EC (Electrical conductivity) were measured on a Squeeze extract. N is Nitrogen, P is phosphorous, K is potassium and Cl is Chlorine. Coir dust is less acidic than sedge or sphagnum peat and smaller amounts of lime are needed to achieve a pH suitable for growing plants. Tomato seedlings grew larger and faster than in coir or peat with an acceptable salt content. The nitrogen and phosphorus content of unamended coir as with peat and most other organic media is too low to contribute greatly to plant nutrient needs. These and other nutrients must be added as part of a balanced fertilizer program to obtain maximum plant growth.

WETTABILITY

One of the most important attributes of coir dust is its ease of wetting. Unlike peat becoming increasingly difficult to rewet as it dries down (said to be hydrophobic), coir dust remains relatively hydrophilic (water attracting) even when it is air dry. This property impacts on water and fertiliser use efficiency and on plant quality. The coir pith is functional where overhead irrigation is used (sprinklers, misters and drippers), the presence of coir dust in a mix ensures quick and efficient rewetting.



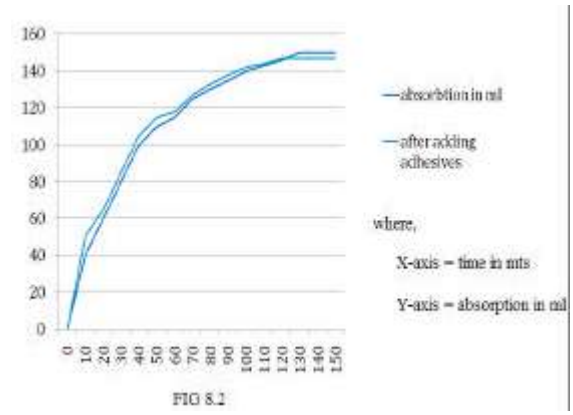
Graph 1: Wettability graph

ABSORPTION CAPABILITY

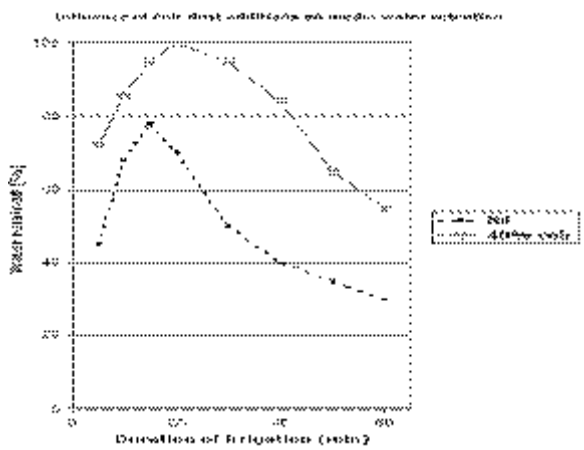
As the coco peat absorbs the water, it increases it size after absorbing the water to its two third of the original size. The pores of the pith expand such that bulk density of the briquettes is also increases. Before absorbing the water the pith powder are compacted to a particular size. Water is poured on the pith sponge during exporting of the agricultural products it retains the water for more time because of the density of the pores increases so pith absorbs more water when compared to the sedge pith and sphagnum pith. As the water holding capacity of the coco pith is nearly 58-69% it is useful growing the interior decoration plants as well as in the office reception.

CAPILLARITY

Coir dust has better capillary wetting properties (capillarity) than peat and most other common potting mix ingredients. Capillarity is the property that enables water to be drawn from a saucer or a capillary bed



Graph 2: Absorption test
Inference from the graph
Absorption capability ( ) =111.18 ml
Absorption capability ( ) =113.125 ml
% increase of WHC =2%
%decrease of air filled porosity =0.5%



Graph 3: Capillarity graph

towards the top of the pot. These are the same forces that allow a small spill of red wine to spread on a white table cloth. Capillarity is not only an important property for mixes used with some form of sub irrigation such as capillary mat or ebb and flow. Capillarity is also needed to redistribute moisture already absorbed by a mix. In this way, it influences the maximum rate water from an overhead irrigation absorbed as it drains through a mix; the water retention efficiency.

Capillary wetting indirectly affects the availability to plants of water and nutrients held by a potting mixture with poor capillarity. Under the influence of gravity, most water collects in the base of the pot where it fills the pore spaces and reduces the availability of air for roots. Thus on the other extreme, these same mixes tend to become too dry at the surface for roots to grow. Consequently, the volume of mix which can be explored by plant roots is reduced. This is having an impact on the availability of moisture and of fertiliser nutrients to the plant. Coir dust and other materials with strong capillarity provide more uniform moisture conditions for roots. They are able to increase aeration in the base of the mix and reduce drying of the surface by lifting moisture higher in the pot. This increases the volume of the mix that is suitable for root development improving access to moisture and fertiliser. This redistribution of moisture is perhaps one reason why plants can be grown in pure coir when they could not be grown in a medium with similar air filled porosity.

The viability of a seed that has started imbibing water is greatly reduced, if the seed dries. It is important such that the surface of a seedling mix is not allowed to dry during the critical first few days after sowing. Peat based mixes are sown in inclined, so that they are prone to dry at the surface very quickly after an irrigation. To counter this, it is normal practice to frequently mist the seed tray or to cover the surface of the mix to reduce evaporation. Management of the surface moisture in a seedling mix based on coir is much easier because the material has the capacity to draw (wick) moisture from deeper in the mix to replace evaporative losses.

SIMULATION RESULTS WITH AUTOMATION STUDIO SOFTWARE

AUTOMATION STUDIO is a completely integrated software package that allows users to design, simulate and animate circuits consisting of various automation technologies. AUTOMATION STUDIO is the ideal CAD and simulation tool for teachers, students and engineers [8].

The editor window in AS shows the piston movement by controlling the inlet flow of compressed air into the cylinder. The controlling action is made with the help of electrical controlled solenoid valve. The working is checked by running the designed circuit using the available tools the AS.

Coir in potting medium: If the soil is fertile and contain components like micro and macronutrients, many gardening problems can be nullified. Much attention must be paid to keeping it in good condition. The ideal vegetable garden soil is deep, friable, well drained and has high organic matter content. Proper soil preparation provides the basis for good seed germination and subsequent growth of garden crops. Careful use of various soil amendments can improve the physical and biological condition of soil and provide the best possible starting ground for your crops.

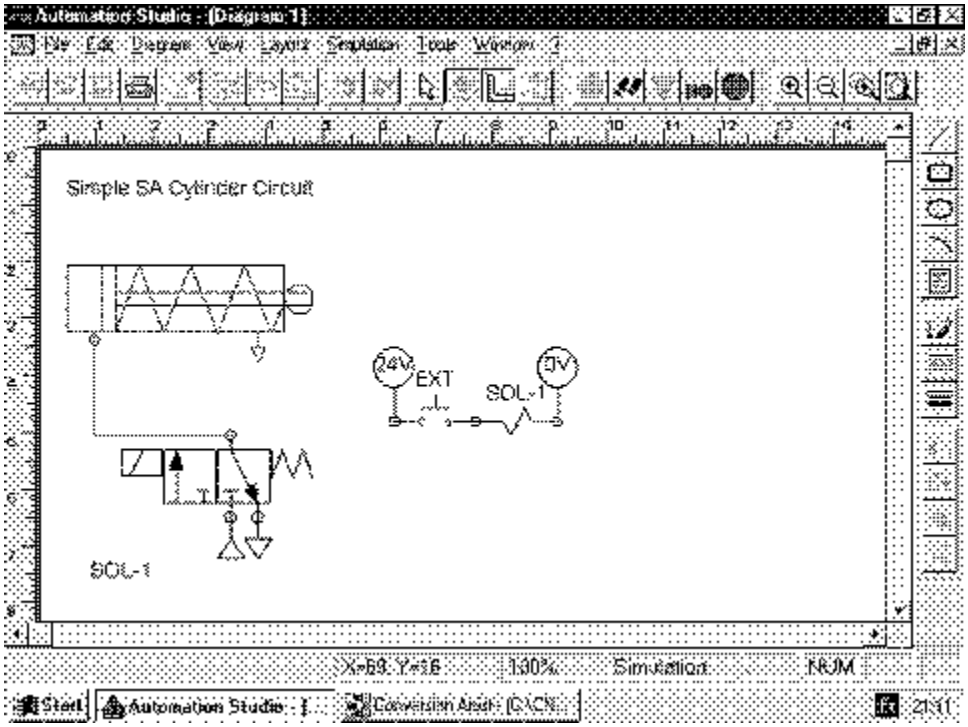


Fig. 4: Editor window of automation studio

Coir pith not only revitalizes your plants, it induces uniformity in growth by enhancing water retention and microbial activity [7]. Coir pith contains high quality of nutrients that keep the soil healthy in a natural way. It acts as a top dressing that helps maintain moisture and reconditions the soil. Coir pith enhances the nutrient carrying capacity of plants. Sustainable agriculture practices such as this creates a healthy perfect loop from table to earth. Pure and natural, this organic biodegradable matter is an economical and natural alternate for rock wool slabs, peat moss and perlite. This natural spongy coir industry by-product is a perfect organic growing medium for fruits such as strawberry, vegetables such as pepper, cucumber, tomatoes and flowers such as gerbera, gladiola, lily, anthurium and rose.

Coir Fibre Coco Peat Disks are a shredded form of coco, as opposed to the coffee ground consistency of competitive products, which results in a much higher air to water ratio, extremely important for healthy root development. As a result, promote stronger root systems with better nutrient absorption resulting in excellent growth and plant formation. These are entirely organic and manufactured from renewable resources. Washed and pH balanced so you can begin fertilization immediately. The fibrous material settles faster after planting, absorbs water easily at all times and has optimal drainage characteristics so the medium always stays extremely airy. Its structure holds up throughout cultivation, with minimal settling.

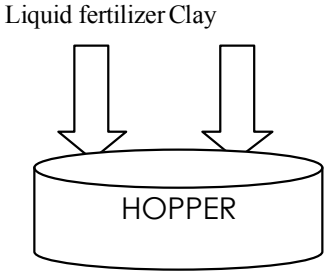


Fig. 5: Adhessive addition

ADDITION OF ADHESIVES

From hopper it is been transmitted to the mould to get the required shape and the powder with adhesives shown in Fig. 5 are pressed using pneumatic press. Fibre Peat Disk expands to over five times its compressed size, to approximately 237.5 cubic inches, enough to fill four (6) six inch pots. Fibre dust strongly absorbs liquids and gases.

This property is due in part to the honeycomb like structure of the mesocarp tissue which gives it a high surface area per unit volume. Fibre dust is also hydrophilic (attracts water) which means that moisture spreads readily over these surfaces. The extensive film

Table 4: Physical data

Material	Dry weight	% WHC (A)	(B)	% AFP
Coir dust	90	52	69	15

Table 5: Chemical data

Material	Moisture %	pH	EC dS/m	N	P	K	Cl
Coir dust	13	5.1	0.80	0.5	0.3	0.4	0.07

Table 6: Dry density calculations (Before compressing)

S. No	Properties	Quantity
1.	Dry weight	0.140 kg
2.	Dry mass	0.01427Kg
3.	Height of the pith in dry condition	0.155m
4.	Dry density	7.502 kg/m^3

Table 7: Density after compression (After compression)

S. No	Properties	Quantity
1.	Dry weight	0.140 kg
2.	Dry mass	0.01427Kg
3.	Height of the pith after compression	0.07m
4.	Compressed density	16.61 kg/m^3

Calculation of the bulk density

Table 8: Bulk density calculation

S. No	Properties	Quantity
1.	Wet weight	0.980 kg
2.	Wet mass	0.0998 kg
3.	Height after absorption of water	0.145 m
4.	Amount of water	100 ml
5.	Bulk density	56.08 kg/m^3

of water that is produced gives moist coir the capacity to absorb air and other gases (odors).

ANALYSIS AND TESTING RESULTS

Testing of coir briquettes for its properties: The Table 4 shows the following characteristics which for the water holding capacity of the coir.

Chemical characteristics which resembles the soil characteristics in the coir gives the hydroponic plants a required growth shown in the Table 5

Density calculation

Formulas

Density: Mass/Volume

Where volume is pr^2h

h-height of the pith

r-radius of the pith briquettes

Testing for the potting of plants

Fig. 6: Coir pith after compression

Fig. 7: Testing for the growing of plants

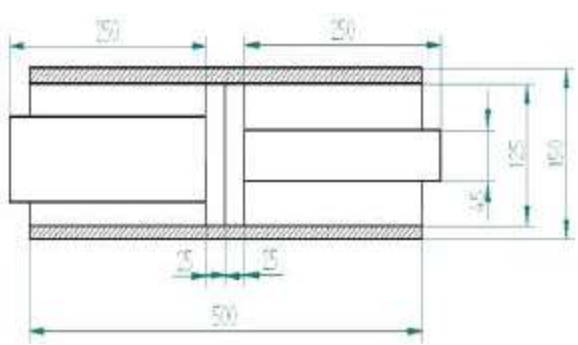


Fig. 8: Cylinder specification

The density of the pith is increased twice from its original density after compression, so that pores will be completely [11] filled as the water is poured on it expands to its two times from its compressed height.

Cylinder calculations: Cylinder Specifications are given in the Fig. 8.

Area of the piston	$-p*d^2/4$
Where,	d = 0.125 m
	= 0.0122 m^2
Velocity of the extend stroke	$-A_p*L$
Where,	L = 0.250 m
	= $3.05*10^{-3}$ m/s

CONCLUSION

Coir pith is a useful product to produce better yield in the field of agriculture and in home nurseries. This is a new technique proposed for maintaining the growth of plants in the potting medium. The technology proposed in this paper helps to develop the product with less consumption of electricity and labors. The fertile growth of plants during the summer season, in dry lands and also at the time of deficiency of minerals in the soil can be avoided using coir pith product.

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