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Semi-Automated Packaging Machine for Skim Coat

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Abstract: The study was conducted due to the need of rising construction companies today. Keiti Coatings Inc. aims to expand their business to supply retail stores in different places with a steady supply of skim coat. However, this requires an increase in their manufacturing capacity. Currently, the company filling 20kg bags of skim coat manually, which lack the speed and quality that a machine is capable of. The group has answered this call by fabricating a machine that can cater to the needs of the said company. Through a combined study of mechanical, electrical, and programming research, the group was able to produce a machine that can fill 20kg bags of skim coat and further improved it through careful experimentation and testing. The ideal settings for the program proved to have increased the machine's efficiency. This enabled the machine to have a high rate of accuracy while maintaining the speed and capacity which the company requires. By using high quality local parts, the group was also able to minimize cost and provide a competitive price to rising companies. The machine was a product of the close collaboration between the company and the group, which allowed the machine to embody the solution of their problem. Additionally, the group was also able to discover numerous of possible improvements above that was already implemented that can further improve the capabilities of the machine. Nonetheless, the machine at its current state is able to meet all objectives of its design, proving itself to be an efficient, cost-saving, and reliable asset that can serve as the main stepping stone for growing companies.

Key Words: skim coat, automation, packaging machine

1. INTRODUCTION

In developing countries such as the Philippines, numerous buildings are being built every day. However, the needs of buildings today are far from that of a structure made before. Surfaces must not only be sturdy but smooth and cost efficient. Although the use of cement can achieve this, it has its limitations as well. It does not provide a smooth texture for the surfaces, and has a thick surface application. Furthermore, putty and paint are still applied to cracks along the surfaces as well as the final touches to make the surface smooth.

As an answer to the growing demand of construction, alternative products such as skim coat

was formulated to provide for the need of having a finishing touch that is similar to using cement, putty and paint combined, thus also minimizing the costs. Skim coat is a powder-based alternative for finishing that can be applied very thinly unto the interior and exterior of the ceilings or walls of concrete surfaces. It is able to provide up to a millimeter thickness needed to bring that smooth thickness desired that ordinary finishing cement could not do. Furthermore, it may already come in different colors; thus, saving expenses for painting and labor. Skim coat may be left unpainted and still look neat especially when applied to places that do not require that much color designs such as parking lots and warehouses. It is able to provide the needs and demands of construction establishments and much more. This product is already included in standard procedures when building structures in other countries like Hong Kong and Singapore, and the Philippines is slowly getting there.

Keiti Coatings Inc. is a company that attends to this growing demand by producing their own brand of skim coat, Painter's Choice, for the construction of different establishments. Companies such as the Ayala Land and Real Estate Corporation and other private companies are some of its product users. It is currently seeking opportunities to expand to retailers such as Wilcon Builders and Do It Yourself (DIY). Each 20 kg bag of skim coat can cover a surface area of around 20 square meters and is sold at Php 400. The production of skim coat follows a certain process that includes preparing the mixture through a giant mixer, filling the bags with the processed skim coat, weighing and sealing them manually. Workers fill the sack with skim coat and add or remove excess to achieve the right weight. They hold the opening of the sack in place, and seal it with a hand held sewing machine. With their system for packaging that mainly relies on manual physical labor, the company seeks for better solutions to increase their production to meet the growing demand.

A semi-automated packaging machine would serve to be practical for the skim coat's mass production. It can provide a greater productivity by reducing labor costs, increasing the production output, and maximizing the consistency/accuracy. Also, there would be a more standard quantity of output despite the possibilities of workers being absent from work. Finally, a faster production rate can satisfy the growing demand for the product.

2. PROBLEM STATEMENT

The manual packaging of 20 kg skim coat by hand requires extensive physical labor. This process makes the whole procedure inconsistent, costly, and inefficient In order to increase production, a company such as Keiti Coatings Inc. would need a semi-automated filling, weighing and sealing machine for the packaging of their skim coat at a particular weight (20kg). Similar machines such as those used for sand, concrete or cement are not able to do the job efficiently because of the difference in the consistency and texture of the skim coat.

For the machine to be considered efficient, it must at least double the production rate of the manual process and obviously minimize error and wastage.

It should be noted though that this study focuses mainly on the packaging process of skim coat only – filling the sack, eighing and sealing the sack. Any defects on the skim coat or the sack is outside the scope of this study.

3. METHODOLOGY

Research and Design

Researches are to be done as the machine design is made. Previous packaging machine designs are taken into consideration as basis for the study. The final output is a machine specifically designed based on the needs of the company. The common problems and other improvements are always considered in the designing process to optimize the use of any material or knowledge that has been gained.

Surveys and Interview of Company

The existing companies now are mostly experienced and knowledgeable in this line of system/production, so it is preferable to get their perspective and know how to address the problems of packaging more efficiently. Knowing the standard practice and processes of the different companies allowed us to investigate their usual problems and desired or proposed solutions.

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Research on Materials

Through researching on the costs of each material and their proper usage, alternatives were also found for improving quality or lowering costs. Comparing all the possible materials that can be used and taking into consideration the quality, costs and availability, every possibility is explored and nothing is overlooked.

Fabrication and Testing

The testing of the sensors and other mechanical related parts are done to achieve the set goals. The costs for each fabrication should also be within the budget allotted. Further testing of each sack after the whole process is done to have a final inspection, which means that there is still another weighing scale (outside the packaging process) to check for the consistency of the machine output.

4. DESIGN

A. Skim Coat Packaging Machine Design Overview

The main consideration of designing the machine is to speed up the process of filling a 20 kilogram bag of skim coat. It is divided into three main parts as shown in figure 1: the filler, weigher and stitcher. A main control system is installed to operate the filling process while the stitcher operates on a separate control.

Fig 1

The skim coat is temporarily stored in the hopper mounted at the opening of the stand. A worker situated beneath the filler assembly just right in front of the weigher holds the bag to be filled. A push button for automatic filling located at the control panel starts the filling process. When the 20 kilogram weight is achieved, the filling automatically stops. The worker then folds the bag and brings it to the conveyor. The folded bag opening is fed into the stitcher and the worker steps on a foot pedal to begin the stitching process.

B. The Filler

Fig 2

The main components of the filler as shown in figure 2. The hopper storage was designed to store approximately 5 bags of skim coat at a time. It has a detachable nozzle for easy maintenance and modification. A 100-watt geared AC motor powers the agitator arms to allow the stagnant skim coat to fall into the middle.

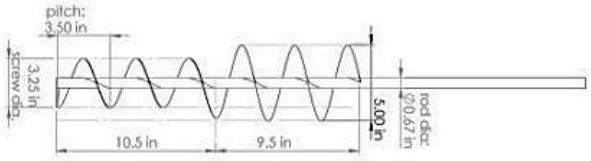

Figure 3

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Table 1. Screw Design Considerations

RPM at 100%	RPM at 80%	RPM at 60%	RPM at 40%	Auger #	Diameter	Pitch	Shaft Dia.	Cu. In. Per Rev	Cu. Cm Per Rev
623.98	779.97	1040	1559.9	#36	2-1/4"	2-1/2"	5/8"	**9.17**	**150.25**
497.52	621.9	829.2	1243.8	#40	2-1/2"	2-1/2"	5/8"	**11.50**	**188.44**
355.37	444.21	592.28	888.43	#44	2-3/4"	3-1/2"	5/8"	**16.10**	**263.81**
241.86	302.32	403.1	604.65	#48	3"	3-1/2"	5/8"	**23.65**	**387.62**
221.37	276.71	368.95	553.42	#50	3-1/8"	3-1/2"	5/8"	**25.84**	**423.50**
204.71	255.88	341.18	511.77	#52	3-1/4"	3-1/2"	5/8"	**27.95**	**457.97**

*Auger size number represent 1/16" diameter
(No. 16=16/16=1 inch auger diameter)

Skim coat density:	1.28	kg/L
Use: Density:	1280	kg/cu. M
Target weight:	20	kg/bag
Time to finish:	10	sec

The screw dimensions were computed together with a 1-hp DC motor, gear reduced to have a final rotational speed of 360 rpm. Figure 3 & Table 1 shows the considerations in designing the screw, such as the skim coat density and the target finishing time. An efficiency of 80, 60, and 40 percent were also computed to determine what rotating speed would meet the target time. In this case, the screw dimensions can meet the target assuming it has an efficiency of as low as 60 percent.

The filler is then controlled by a motor controller designed and programmed to start, stop, speed up and slow down as signaled by the weigher. An optical sensor is also installed to regulate the speed of the motor regardless of the load.

C. The Weigher

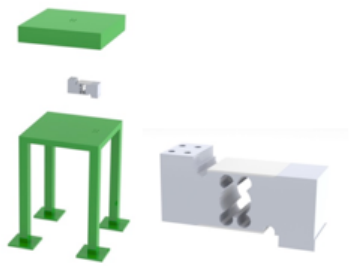

Fig 4

The weigher is designed as shown in figure 4 to signal at what target weight the filler should stop. It consists of a stand and a load cell enclosed by a metal plate to serve as a weighing scale. The load cell is calibrated with the use of known weights by taking their analog equivalent value and inputted into the program.

D. The Stitcher

Fig 5

A hand-held stitcher is mounted into a roller conveyor using modular angle bars and has a fixed height to maintain a straight stitch. It is modified to be actuated by a foot pedal. A slide is located at the end of the conveyor to easily take out the bag from the machine where it is finally picked up.

E. The Control Box

Fig 6

The control box contains all the necessary controls for the filling of the bag and encloses all the circuit boards. It has an LCD to display the weight of the bag and the current process of the machine. It contains the auto filling, manual override, stop/reset, and tare button. The power switch is located at the side and an emergency stop in front as a safety feature.

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5. Experimental Results

The experiments are divided into three main parts: Filling, Stitching, and Overall process.

A. Filling

To determine the most effective setting/s in the program that can balance speed and accuracy of the filling process. The variable in the various setups is the speed of the load cell.
Parameters:
Setup 1 - Maximum Speed until 20kg
Setup 2 - Maximum Speed until 18kg
Setup 3 - Maximum Speed until 18kg and then slow down
Setup 4 - Maximum Speed until 17.8kg and then slow down
Setup 5 - Maximum Speed until 17.5kg and then slow down

Table 2.

Determining Ideal the Speed and Accuracy Settings			
	Trials	Passing Rate	Standard Deviation (kg)
Setup 1	30	0%	1.05
Setup 2	30	25%	0.73
Setup 3	30	35%	0.36
Setup 4	30	75%	0.18
Setup 5	30	100%	0.17

B. Stitching

To determine the time required for the stitching process to produce quality seals.

Table 3.

Stitching		
Trials	Average Time (s)	SD (s)
30	17.6	1.64

C. Overall Process

To determine the time consumed by performing the whole process: from filling to weighing to stitching.

Table 4.

Overall Process				
Trials	Average Time (s)	Target Time (s)	Passing Rate	SD (s)
100	38.9	60	100%	6.24

6. CONCLUSION

The Semi-automated Skim Coat Packaging Machine is capable of consistently filling 20-kilogram bags of skim coat with the rate of 1 bag per minute by incorporating a screw type agitator at the end of a funnel shaped hopper to control the flow of skim coat that flows/drops into the sack that is on top of a weigher measuring the weight of the sack with skim coat in real time. Currently, Keiti Coatings Inc. can only pack 1 bag per 7 minutes with 2 workers. Now with the automatized filling to weighing processes, their rate of production is increased and they also have the option of reducing the number of workers to 1. A roller conveyor helps transport the filled sack into a stitcher that would seal the sack.

Various tests and experiments were conducted to ensure the machine's competencies. All of the said tests were performed per process so that the investigation is thorough.

7. REFERENCES

Brody, A. L., & Marsh, K. S. (1997). The Wiley Encyclopedia of Packaging Technology Second Edition. New York: John Wiley & Sons, Inc.

Chenery, P. J. (1958). Fillers for dry products. In Stouffer, Modern Packaging. New York: Breskin.

Holloway, M. D., Nwaoha, C., & Onyewuenyi, O. A. (2012). Process Plant Equipment: Operation, Control, and Reliability. Hoboken, New Jersey, United States of America: John Wiley & Sons.

Karwowski, W., & Salvendy, G. (2011). Advances in Human Factors, Ergonomics and Saftey in Manufacturing and Service Industries. Boca Raton: CRC Press.

Organisation Internationale de Métrologie Légale. (2000). Erratum: International Recommendation (OIML R 60). Troyes, France: Grande Imprimerie de Troyes.

PackTech. (n.d.). Elevating Screw or Auger Feeders. Retrieved on April 13, 2012 from Unscramblers: http://www.unscramblers.co.uk/screwfeeders.htm

Weighing & Bagging Machines. (n.d.). Retrieved on April 13, 2012 from http://www.indosawagri.com/Weighing%20&%20Bagging.html