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A REAL-TIME FABRICATED MODEL OF A MULTISTAGE SAND SEPARATOR AND FILTER MACHINE AND ITS DOMESTIC APPLICATIONS

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Abstract
In day-to-day life scenario, sand is crucial for construction purposes. However, acquiring the right quantity of sand, filtered to various sizes for specific construction processes like column/beam construction, plastering, flooring, etc., can be challenging. Conventional sand separation methods are time and labor-intensive, increasing both separation time and costs. The conventional method is slow, reducing production rates, making it unsuitable for large-scale production. To address this, we have designed a multi-stage sand separator and filter. Our machine is capable of separating sand into three different sizes using three filters and compartments. It features a single slider crank mechanism and a DC motor. A spur gear, mounted on the DC motor, drives the separator. The motion from this gear is transmitted to another spur gear attached to the separator, causing it to vibrate and move the filtered sand to the next filter. The drive from the cam and camshaft mechanism is transferred to the secondary filter through a belt drive. In this separator, sand is separated, and the remaining material is directed to the third filter. The machine also removes big stones, coal, wood, etc., ensuring that only sand is separated into the three compartments.
Keywords: Multi-stage, efficiency, separator, gear, filter

I. Introduction

The describes that in construction sites or industries, the process of separating sand can be extremely time-consuming. By using the multi-stage sand separator and filter, this time can be saved, allowing construction projects to be completed within the specified time period. that sand is a vital construction material, necessitating different sizes for various structural components. The screening process is essential for ensuring quality construction, but traditional methods are time-consuming and labor-intensive [1]. This research introduces an automated sand screening method, revolutionizing traditional practices. The detailed study in this research paper includes experiments and software analysis, leading to significant improvements. The machine features three different qualities of sand filters, utilizing a slider crank mechanism. Experimental results, compared with ANSYS software, demonstrate the machine's superiority over manual methods, reducing labor costs and time while increasing efficiency by up to 35%. The DC motor is securely fixed at the bottom of the frame stand, receiving power from a 230-volt main supply. When the power is supplied, the machine activates and the motor begins running at a speed exceeding 60 rpm. Speed reduction is achieved through a section spur gear. found that this reduced speed is then transferred to the the author gear, with a disk mounted on the second spur gear shaft. A connecting rod is attached eccentrically to the disk at one end and to the frame at the other [2,3,4]. This setup converts rotary motion into the reciprocating motion required for the primary size filter, used to filter small-sized sand particles. Similarly, the medium size filter separates the sand from the primary size filter, while the large size filter handles the remaining sand from the medium size filter. This sequential filtration process ensures that sand is effectively separated into different sizes, optimizing the efficiency of the multi-stage sand separator and filter. By utilizing this mechanism, the machine is able to efficiently filter sand of various sizes, reducing the need for manual labor in material handling departments across industries [5,6,7]. Additionally, the use of spur gears and other components helps to maintain

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a steady and controlled filtration process, enhancing overall performance and reliability. The Multistage Sand Separator and Filter in this project significantly reduces the workload for students during foundry workshops, saving time and energy while ensuring the production of fine, impurity-free sand. While the current size may be larger than necessary, the machine can be modified to suit different usage locations[8,9,10,11]. However, one notable limitation is the lack of an automatic stop feature upon sand filtration completion, with notifications sent to the user's phone instead. Future improvements should focus on enhancing this aspect for greater user convenience and efficiency.

2. Principal Components of Multistage Sand Separator and Filter

(1) Sand filter
(2) L-angle frame
(3) Spur Gear Mechanism
(4) Shaft
(5) Bearing with bearing cap
(6) D.C Motor
(7) 12 volt Power supply unit

(1). Sand Filtration System:

Our project utilizes four sand filters, ranging from large to small holes, all connected to a single motor via a gearbox arrangement. This setup efficiently separates sand of different sizes simultaneously.

(2). L-Angle Frame:

Constructed from mild steel, the frame takes on an "L" shape, earning it the name "L-angle frame."

(3). Spur Gear Mechanism:

Spur gears are engineered to transmit motion and power between parallel shafts, representing a cost-effective solution in power transmission.

(4). Drive Shaft Function:

A drive shaft, also known simply as a shaft, is a mechanical component used to transmit torque and rotation. It is commonly employed to connect various components of a drive train that cannot be directly linked due to distance or the need for relative movement between them.

Torque Transmission:

(5). Drive shafts serve as torque carriers and are thus subjected to torsion and shear stress, which is the difference between the input torque and the load[12,13,14,15]. They must be robust enough to withstand this stress while keeping additional weight to a minimum to avoid increasing their inertia excessively.

6).Bearing Installation with Bearing Cap:

(Bearings are carefully pressed into the shafts to ensure a smooth fit, as hammering may lead to cracks in the bearing. The bearing is typically made of steel, while the bearing cap is constructed from mild steel.

2. 1. Problem Identification

A. Labor required for the filtration process.
B. Manual removal of waste materials.
C. Time required for filtration and separation.

The project addresses these issues by implementing an fabricated model of multistage sand separator and filter machine, reducing the need for manual labor, improving efficiency, and speeding up the filtration process.

3. Objective of the Present Study

Develop an efficient multistage sand separator and filter machine , separation and filtration system for construction applications, capable of filtering sand into three distinct sizes for various construction processes. Increase production rates and reduce labor costs by implementing a multi-stage sand separator that improves the speed and efficiency of sand separation compared to conventional methods. Design a user-friendly sand separation machine that not only separates sand efficiently but also removes unwanted materials such as stones, coal, and wood, ensuring high-quality filtered sand for construction purposes.

4. Experimental work

Aluminum materials and components for our project are sourced from their respective markets, including mild steel L-angles, sheet metals, bearings, a DC motor, a cast iron gear wheel, and mild steel shafts. The L-angle is cut into the required number of pieces according to the dimensions and welded together, with weld metal applied over the joints to form the base of the multi-stage sand separator and filter. Sand filters are attached to the multi-stage sand separator and filter using appropriate methods. The DC motor is affixed to the shaft of the multi-stage sand separator and filter using bolts and nuts. A spur gear is mounted on the output shaft of the DC motor, which is then coupled with two separate spur gear mechanisms from fig 1. The output shaft is connected to the cam and camshaft mechanism for the sand filter arrangement.

Our design aims to replace conventional sand filters with an automated sand filter and pneumatic waste separator machine Design and Calculations from table1. This transition is intended to significantly reduce time consumption, human effort, labor costs, and reliance on manual labor. Additionally, our machine has proven easy to operate and control during fieldwork, ensuring efficiency and effectiveness in real-world applications.

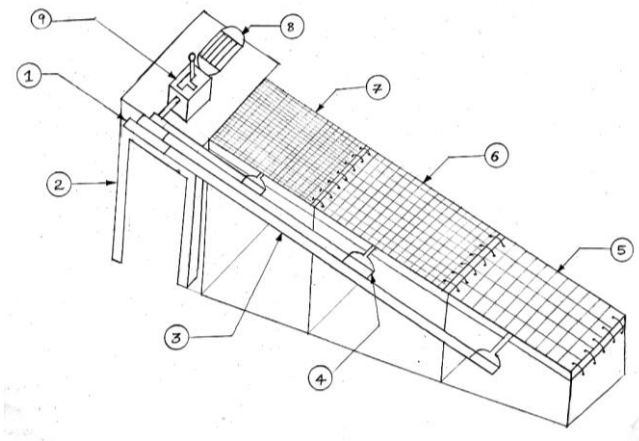

Fig 1.: Fabricated Model of Multistage Sand Separator And Filter
1.Stepped Pulley,2.Frame,3.Cam and cam Shaft,4.Cam plate,5.Large size net,6.Medium size net
7.Small size net,8.DC Motor,9. Spur Gear

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Table 1: Design Parameters Selection and Design and Calculations

Components	Material	Specification
L-Angle	Mild steel C 40	25 x 25 x 3 mm
Ball Bearing	HSS	SKF 6202
Sand filter	M.S	12 inch * 14 Inch
Spur Gear	Cast iron	1" and 4"
D.C motor	Aluminium	12 volt 90 watts 60 rpm
Shaft	M.S	15mm Dia
Frame	M.S	32" x 12" x 12"

5. Design calculation multistage sand separator and filter

5.1. Multistage Sand Separator and Filter At Stationary Condition:

Area of L-angle=66 mm², Total area, 4 x 66 = 264 mm², Total Load=40 Kg (Approx.), Stress due to load, Load/Area = (40 x 9.81) / (264) = 1.486 N/mm² (Calculated), Yield stress for material (C40): 323.73 N/mm² (Obtained) (Reference: PSG Design Data. book Page. No. 6). Finally Calculated stress less than obtained stress, since design is safe .

5.2. Multistage Sand Separator and Filter at moving condition:

The CG of multistage sand separator and filter lies inside the quadrilateral is formed by joining the wheel position point. Since the design is safe from table 2.

Table 2. List of Materials

Components	Material	Quantity
L-Angle Frame stand	Mild steel C 40	1
Ball Bearing	HSS	8
Sand Filter	M.S	3
Spur gear	Cast iron	2
D.C Motor	Aluminium	1
Shaft	M.S	2
Cam and cam Shaft	M.S	3
Bearing Cap	M.S	8
12 volt Power supply unit	-	1

5.3. Design of Ball Bearing

Bearing No: 6202: Outer Diameter of Bearing (D)=35 mm, Thickness of Bearing (B)=12 mm, Inner Diameter of the Bearing (d)=15 mm, r_1=Corner radii on shaft and housing, r_1=1(From PSG design data book),Maximum Speed = 14,000 rpm (From PSG design data book), Mean Diameter (dm)=(D + d) / 2,=(35 + 15) / 2, dm=25 mm[19,20]

5.4. Wahl Stress Factor

$$Ks = \frac{4C - 1}{4C - 4} + \frac{0.65}{C}$$

$$= \frac{(4 \times 2.3) - 1}{(4 \times 2.3) - 4} + \frac{0.65}{2.3}$$

$$Ks = 1.85$$

6. Discussion

From in our project's inception, several challenges have been encountered. The initial hurdle was selecting a suitable motor, with a DC motor initially chosen but proving insufficient to shake the filter[16,17,18]. After consulting experts, a power window motor was recommended and adopted.

Another issue arose concerning the funnel. While the design originally included the funnel integrated with the frame to ensure sand collection in the container, time and financial constraints prevented the installation of the funnel onto the machine frame.

7. Conclusion

To further improve efficiency, a solar panel can be added to increase the efficiency of the multi-stage sand separator and filter. This innovative technology not only streamlines the construction process but also ensures that the right size of sand is used for each specific application, thereby enhancing the overall quality and durability of the construction project. By selecting appropriate materials, efficiency can be further enhanced. This improvement is particularly beneficial in the material handling departments of all industries, as the addition of rotary drum filtration reduces the need for manpower.

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