HYDRAULIC OPERATED VERTICAL MATERIAL HANDLING SYSTEM

1D. MADHAN, 2K. ELANGO, 3D. ELAVARASAN, 4M. GOBINATH
1Assistant Professor, 2UGStudents
Department of Mechanical Engineering, K.S.R COLLEGE OF ENGINEERING,
TIRUCHENGODE-637215,
Tamil Nadu, India.

Email: 1gopi.dme24@gmail.com, 2killerking556@gmail.com

Abstract-
The main purpose of this paper is to develop an Attachment which will enable the lateral movement of the manufacturing Dies by mounting it on the forks of any Hydraulic Stacker or Fork Lift. The Attachment manufactured is unique because it can be attached or mounted on any hydraulic stacker in the One Ton range. The attachment is a combination of two separate bed of rollers, a lead screw, a gear mechanism and a moving frame which enables the hydraulic stacker to easily load or unload Dies up to the range of one ton, in and out of Machine Presses and Storage Racks which reduces material handling time and cost, manual effort and increases safety. The developed attachment in this work can also be easily detached and kept aside when not in use, so that the stacker can be used for regular purposes in the logistics department.

Keywords-Attachment, material handling systems, hydraulic stacker.

I. INTRODUCTION

The main processes on the shop floor of any industry include production and manufacturing of various components and the Material Handling is done by various Cranes and Hydraulic Stackers. The material handling system is responsible for safe and speedy movement of products from Storage Rack to Machine Press and Machine Press to Storage Rack. Also the movement of manufactured components to the storage facility. Thus the material handling processes are of utmost importance on a shop floor. Various equipment like Cranes, Conveyors, and Hydraulic Stackers (Fork Lifts) etc. are used. Each of these has a set number of degrees of freedom. To increase the functionality of a these equipment we either need to combine them or make modifications

EXISTING INDUSTRIAL SCENARIO

The material handling companies [A1 & A4] provided a unique solution to providing Portable Conveyors. These could be placed anywhere and lateral movement could be achieved but for a fixed height. This problem was solved by [A3] which provided a height adjustment but this feature was not as flexible or easily adjustable like that provided by a forklift and was time consuming.

Forklift manufacturers like renowned company [A7], added a tilt feature to the products so that the material handled would slide off, but method is not only inaccurate but unsafe for heavy loads as minimum control can be established. Forklift manufacturer [A2] came up with a unique solution of providing Bulldozer like jaws to the forklift thus allowing it to grab whatever it had to ferry but this lead to creation of a complex system of hydraulic cylinders leading to increased initial and maintenance cost. Pune based company like [A6], tried to develop a solution by providing lateral movement to the hydraulic stacker. But this lead to the loss of the vertical movement of the stacker as the modification rendered the stacker to become a portable conveyor belt. And most important of all, none of these modifications are such that they cannot be easily detached allowing the user to use the original machine for regular purposes thus rendering the machine permanently as a Special Purpose Machine (SPM). Hence in order to overcome the above stated disadvantages and limitations research in this field is required. This paper focuses on a simplified solution to increase the functionality/versatility of the Hydraulic Stacker. Any stacker or fork lift has a movement only about the Vertical Axis. Thus the materials have to be loaded or unloaded onto the forks either by cranes or manually by workers thus leading to increased material handling time, manual effort and cost of material handling as there is no lateral movement. Hence in this work a sincere effort is made to reduce material handling time, manual effort, safety and cost of material handling by developing an attachment.

PROBLEM DEFINITION

The main objective of this work is to design and develop an attachment for hydraulic stacker to ease the loading and unloading of the products by providing a mechanism that will reduce the effort and the time required for the process. Moreover it only requires one worker for the process, thus saving time and not interrupting other processes on the shop floor. Also this arrangement should be such that it can be detached anytime and also be attached to variety of stackers in the same capacity range. The manufactured mount should have minimum maintenance and running cost thus not becoming an added expense for the company.
II. LITERATURE SURVEY

[1]. E.J. Skilling, C. Munro, et al, (2016) were done a Human factors in material handling, Human Factors in the Chemical and Process Industries.


[4]. Bipan Zou, Xianhao Xu, Yeming (Yale) Gong, René De Koster, has done a modeling parallel movement of lifts and vehicles in tier-captive vehicle based warehousing systems.

III. EXPERIMENTAL SETUP

Generally the Material Handling is done by various Cranes and Hydraulic Stackers. The material handling system is responsible for safe and speedy movement of Dies. The Dies were loaded or unloaded on the stacker manually by three to four workers as they weigh above 300 kilograms. Also the crates full of the components are carried by the stacker from the storage rack to the transport vehicles in the logistics department. The fig.1 shows the existing hydraulic stacker used for the loading and unloading process of Dies on the shop floor. As we can see the stacker only provides vertical movement and there is no provision for lateral movement. Thus the Dies loaded or unloaded have to be pushed over the forks of the stacker which requires more manual effort and handling time.

IV. DEVELOPED ATTACHMENT FOR HYDRAULIC STACKER

The attachment developed shown in figure fits easily and firmly onto the forks of the stacker. The developed attachment moves up and down along with the forks of the stacker not interfering in any way with its regular operation.

The main components of the developed attachment for the Hydraulic Stacker shown in fig. 3 are as follows:
1. Roller Beds
2. Lead Screw and Square Nut
3. Bevel Gears
4. Mandrel
5. Pushing Frame
6. Steel Cables and Hooks
Fig. 3 Solid Model of Assembly
**Roller beds**

These are the most vital components of the Attachment. The Roller beds take the whole weight of the Dies, and are the reason the lateral movement of the Die becomes safe and speedy. The Roller beds are constructed by placing Rollers (MS tube rollers with bearings) along the length of two Channel Sections in sets of six on each bed of rollers at equal intervals. The weight of the Die is uniformly distributed among all the rollers in contact with the Die. They are designed for a Uniformly Distributed Load of 1000 kg.

**Lead screw and square nut**

Unlike most applications the lead screw in this attachment does not have to carry any weight, but is simply used to move the pushing frame attached to the top surface of the square nut. Like the lead screw in a lathe machine, the rotational degree of freedom of the nut is curbed, thus allowing it to only translate along the length of the lead screw. The lead screw is of fixed-fixed type. The design is done for the load of frame (Dead Weight), the bending and crushing stresses on it developed due to reaction force equal to frictional force. The two frictional forces Eq. (1) & (2) are; Sliding Friction,

\[ F_l = \mu N \]

**Bevel gears and Mandrel arrangement**

The Bevel gear pair used in the attachment has both the gears of equal sizes i.e. the gear ratio is 1. There is no speed reduction as the only purpose served by the gears is to transfer the rotary motion of the mandrel to the Lead screw which is assembled perpendicular to it. The design of bevel gears was carried out by considering the Beam and Wear strength Criterion. The Mandrel is used for holding one of the Bevel gears and has the handle attached to one end. The mandrel is supported in the rear section of the attachment, perpendicular to the Lead Screw. The Mandrel is rotated using the handle and it transfers this rotary motion to the Lead screw using the Bevel gear arrangement.

**Pushing frame**

The Pushing frame is a structure made to push the Die when it is needed to be unloaded from the Stacker into the Storage Rack or Machine Press. It transfers the translational motion of the Nut to the Die.

**Steel cables and hooks**

These are attached to the mandrel and are guided by the Pushing frame mounted on the Nut. They are used to pull the Die onto the rollers from the Storage rack or Machine Press. The hooks enable us to attach the cables to the Die so that the cables are firmly attached to the Die when the pulling force is applied.

**V. RESULT AND DISCUSSIONS**

The previous process of material handling consisted of the 3 to 4 workers manually loading the Die onto the Forks of the Hydraulic Stacker. This lead to damage to the Die due to improper handling, also risking the safety of the workers. Engaging 3 to 4 workers lead to disruption of other processes on the shop floor, leading to time loss, leading finally to loss of efficiency. Now as only one worker is sufficient other processes are unaffected. The manual effort required for material handling is more than 10 times the effort required for Material handling when the Attachment is used as seen in the Graphs shown in figure. The time required for material handling without the attachment is much more, so is the manual effort. All this leads to increased Cost of Material Handling.
VI. CONCLUSION

By the use of Developed attachment the efficiency has increased on the shop floor by reducing the material handling time to half and manual effort required is ten times less. And now only one worker can load or unload the Dies in the range 300 to 800 kg thus not disrupting the other processes. There is increase in safety as the dies are smoothly handled and there is no damage to the Dies either. The use of developed attachment has led to reduction in the material handling cost by 50% which was our main objective. The Attachment manufactured is unique because it can be attached or mounted on any hydraulic stalkers in the One Ton range.

REFERENCES


Note:
1. Margin – Left, Right, Top and bottom1” (Normal)
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3. Abstract – Times new roman - 9 (Bold)
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