Investigation of Bonding Brake Liners and Castings in Automated Manufacturing System

Asvath R[1], Suresh M[2], Aravind N[3]
[1&3]*Student, Department of Mechanical Engineering,*
Sri Krishna College of Engineering and Technology, Coimbatore, India
[2]*Associate Professor, Department of Mechanical Engineering,*
Sri Krishna College of Engineering and Technology, Coimbatore, India

Abstract

Brake lining bonding consists of different methods in the manufacturing sector. The purpose of this research is to select the best process of manufacturing involved in method of bonding brake liners with improved level of automation. The level of automation is implemented in order to achieve more efficient and robust production systems. The operation and process presented in this paper contains three major stages where the chosen level of automation is correspondence to the manufacturing optimization techniques. The comparison data analysis was performed between the traditional method and the automated method of manufacturing. The final system improved the method of bonding brake liners with less time delay with increased production output and aided in improvement of the manufacturing lead time.

Keywords: *manufacturing, automation, bonding adhesive, brake castings, liners.*

I. INTRODUCTION

Adhesive bonding in brake liners and castings are manufactured with variety of methods. About 5 decades ago, the manufacturing method involved in bonding brake liners were initially done by mechanical fastening, soldering or by welding. After world war II, a series of novel adhesives were developed and methods used to apply was far too simple. This traditional method of applying adhesive involves surplus amount of time for presetting. During the process the uniformity of bonding glue is not applied throughout the surface of the castings and liners in most of the pieces. Due to manual handling, the application of pressure is considerably not maintained throughout the complete set of operation. For this reason, the precision of the bonding process is increased with increase in production capacity in addition to the automated machine. With this the wastage of the adhesive glue is completely eliminated to a considerable extent. The automated machine with only three stages include lynching followed by drying. Measurements were taken at the end of the process for uniformity in comparison with the regular method of manufacturing.

II. RELATED WORKS

M. Mitsuishi et al studied the evolving requirements of global sustainability and the value-creation taken place along the tradition production process priorities [8]. V.

Sriraman et al given under emphasis on assembly design and examined the current approach to it in the manufacturing engineering technology [2]. A. J. Curley et al., improved solutions are justified by comparing with the original theoretical solutions, and experimental and numerical results[3]. S. Anderson examined the mechanisms driving adhesion, categories of adhesives, techniques for bond formation and evaluation, and major industrial applications [4]. R. D. Adams et al enumerates the components, processes, performance, and comparative economics of several types of automatic assembly systems, also highlighting the importance for well designed products[5]. Bralla, J. et al emphasized the optimization in the manufacturing process with certain network statergies involved[6]. Petrie. E the steady state properties and the life of the adhesives were studied [7]. S.Ebnesajjad studied the economic , environmental safety concerns in manufacturing with the use of adhesives and sealants[8].

III. MANUFACTURING SYSTEM

A. Initial Process Before Applying Glue Adhesive

During chromatising the metal surface dissolves to a small extent causing a pH increase at the surface-liquid interface. To prevent the formation of large quantities of sludge and high cost of sludge disposal, the spent chromatising bath is regenerated and purified. In this process the chromatised castings are visually inspected for every 200 numbers and in the case of abnormalities, the castings are again dipped in the solution. This chromatising chemical process on the surface of the aluminum brake casting would make change in color to lite brown. After the chromatising process, the lynching operation is performed on the aluminum brake castings. This operation completely performed with rubbing of the casting surface with emery belt powered by motor. This would make the surface of the casting from smooth to rough surface. The rough surface is generally preferred for the perfect bonding of the glue adhesive on the casting surface.

Part no.	Roller Description	Roller diameter (inches)	Bearing diameter (inches)	Bearing number 6000 series metric
A11	Glue dipper roller shaft	ϕ 4.00	ϕ 5.90	6020
A12	Intermediate roller shaft	ϕ 3.10	ϕ 4.90	6016
B11	Foam roller shaft	ϕ 1.85	ϕ 3.15	6010
C11	Conveyor roller shaft (motor powered)	ϕ 5.30	ϕ 8.26	6028
C12	Conveyor roller shaft (storage area)	ϕ 5.30	ϕ 8.26	6028

B. Automated Machine description

The main drive to the conveyor is provided by 2 HP motor with a reduction gearbox with a ratio of 100:4. The conveyor belt is provided with slots to hold the castings and liners forsteady manufacturing.In addition to that, a slot variable is provided in order to position the different width of the castings. The base is made up of 3 inch thickness machined slab to carry the whole setup. Apart from that stand up pillars are welded to bottom of the base to accommodate effective running of conveyor belt throughout the cyclic operation. Three rollers are chosen by manipulation of rolling radius, in which the motor power is supplied to first steel roller and third foam roller with the same reduction ratio as that of conveyor. The speed of the first and second roller is comparatively 20% faster than the foam roller, so that the dispersion of the glue is imbibed on the foam uniformly. The Foam roller radius is 7 inches and the radius is varied according to the requirement with the provided adjustment screw. Third foam roller rotates about 10 rotations per minute, more or less it covers the width of 50 castings and liners approximately. The blow dry air chamber is extended up to 3 feet in length to accommodate the castings for 5 minutes in total. At the end of the machine, trays are fixed to collect the finished castings and lined up for bonding and curing process.

Network flow chart for the flow of the operations involved in the automated machine is shown in fig.4. It depicts the actual production channel of typical manufacturing company. The selected manufacturing system is a multichannel process involving three stages of cyclic operation. Although it is a continuous process, there are no manual feed operations and therefore production is accumulated to feed the castings and liners until the

I. The dimension of the roller components used in the automated machine

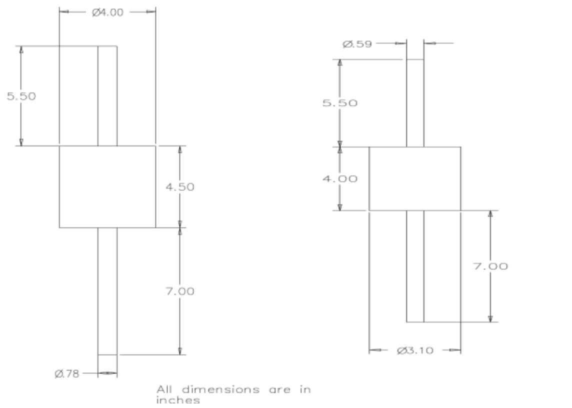

Fig1.Part-A11&A12

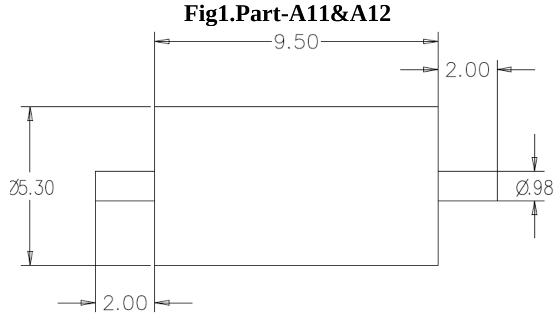

Fig 2. Part C11

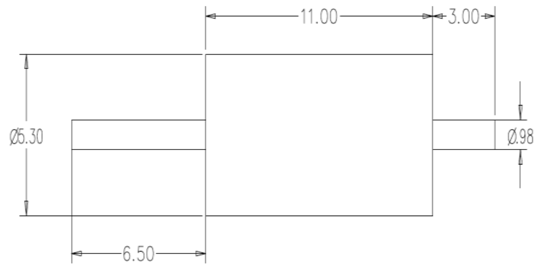

Fig 3. Part C12

glue is applied on the machines depending upon the urgency of the orders and availability. In case of frequently changing size of brake casting sets, the production is not all affected for small quantity orders. Also the production time analysis were carried out to estimate the advantages of this automated machine.

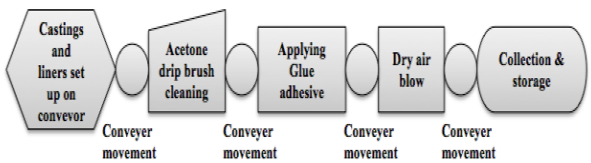

Fig4. Simplified Production Process of the Automated Machine.

IV. PRODUCTION STAGES WITH DESCRIPTION

A. Acetone Drip Brush Cleaning

Once the initial procedures are set right, the conveyor belt moves at fixed constant speed by a reduction gearbox at the end of the motor output. The acetone is applied to the casting and liner surface through the drip brush setup. The acetone flows down to the brush at a constant application. This would make the process completion, as the casting moves forward by rubbing against the drip brush. During this instinct the acetone cleans the surface and makes it perfect for the glue adhesive to stick on.

B. Glue Adhesive Feed Through Rollers

In this intermediate stage, the glue is initially stirred for proper of coagulation of the glue bonding. The first steel roller half immersed in the glue bath carries the glue adhesive while it rolls shown in fig5, the next roller carries it gently without rubbing the surfaces of each steel rollers. The final foam roller receives the adhesive from second roller. This foam roller position can be adjusted according to the height of different castings. This third roller shown in fig6,applies the glue on to the inner surface of liner and bonding area of the casting with the application of pressure to ensure uniform spread of the glue adhesive. The pressure is about 1-2 inch depending on the grade of foam used. In order to apply the adhesive with certain thickness the pressure is adjusted by positioning the foam roller in corresponding slot. The output speed from the motor is reduced to the third roller and rotation is nearly 10 times per minute.

C. Dry Air Blow

After the glue adhesive is applied on to surface, the time taken for the casting to drying up takes a lot. The purpose of this stage is to reduce the time blow heat drying, which makes 45% faster than traditional method of drying up. The castings after glue application moves into the blow drying chamber, the dry blow is delivered by the blower for continuously. The length of the chamber is provided in such a way, so that castings are accommodated in the blow dry air process for nearly 5 minutes. The grouped castings and liner grouped in the conveyor belt fixture is removed manually at the end of final stage.

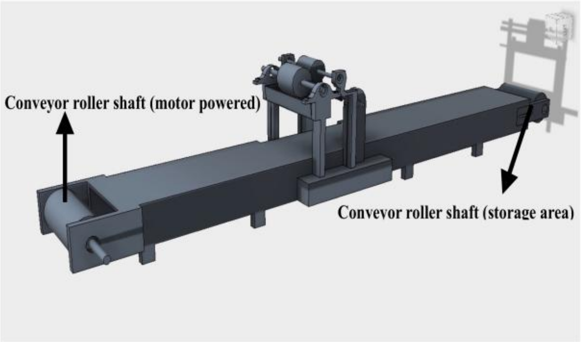

Fig 5. Isometric View of the Automated Machine with Motor Roller Description.

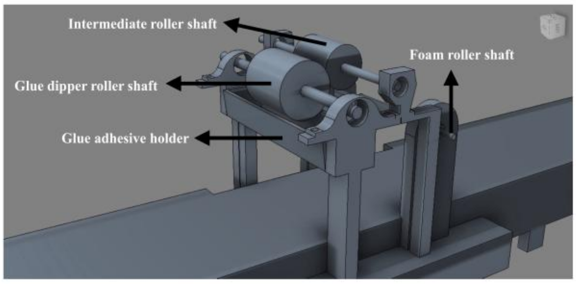

Fig 6.The Intermediate Stage Roller Operation Parts are Described.

V. RESULTS AND DISCUSSION

The manufacturing system was developed incorporation to the traditional method of manufacturing with comparing the production capacity and time taken. From the results, it is clearly understood that the production capacity is increased about 60-65% than the latter. In addition to that the wastage of the adhesives and the cleaner solvent that is used in this manufacturing system has completely reduced the wastage with optimized performance. The automated machine operation has completely reduced the operation time, accuracy of the gluing on the bonding surface and also increased the production output by introducing a blow dry air combination at the end of the cycle to provide rapid dry up. The daily usage of the acetone and glue adhesive for bonding has reduced almost 30%. This has significantly increased the design sustainability, ubiquitous manufacturing with the automated machine operation.

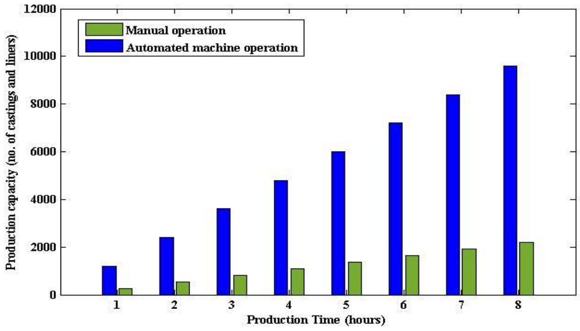

Fig 7.Comparison Between Automated Machine and Manual Operation.

From the fig 7, it clearly shows that in automated machine operation the production capacity is increased at enormous rate. Comparing with the manual operation, it is done up to 275 numbers as in the case of automated operation the number of castings and liners finished is about 1200 at the first hour and an average of 1200 numbers per hour. The chart plot shows the production capacity for 8 hours, in total the automated machine manufactures about 9600 number of castings and liners whereas manual operation in total is only 2200 number of castings.

The usage of the glue adhesives and acetone are shown in fig 8,in comparison with the production time. The glue adhesives used in both manual and automatic operation are steeps gradually till 600 milliliter and the usage is optimized in scale after that. Almost 30% of the wastage in glue adhesives is reduced. Also the usage of acetone is mixed up for liners and for cleaning application is reduced to about 15-20% in the case of automated machine operation. Hence the material cost is reduced and uniformity with precision is increased considerably.

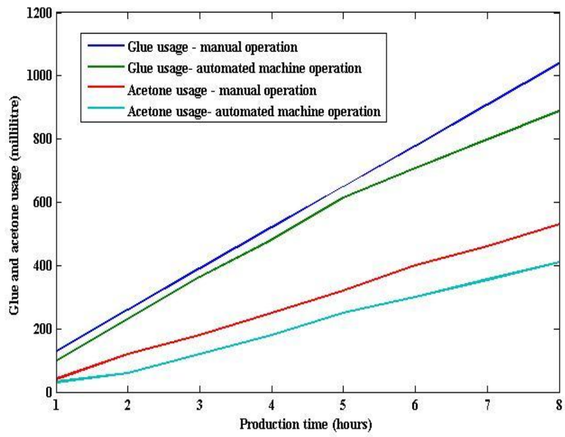

Fig 8.Usage of Glue Adhesives and Acetone in Production Process.

VI. CONCLUSION AND FUTURE SCOPES

The automated machine operation has increased the homogeneity of the manufacturing process in all the aspects. Further, in order to work with complex and intricate problems arising in the manufacturing due to insufficient precision and manufacturing time. The automation is implemented to improve the production rate in shorter time.

ACKNOWLEDGMENT

I gratefully acknowledge Grips N’ Brakes Automation, Coimbatore for technical support and providing the research facilities. I would also like to thank to Mr. S. Sanjeevraj, Managing Director (Grips N’ Brakes Automation, Coimbatore) for his help and dedication toward my research work and related research, also for their support and excellent co-operation.

REFERENCES

[1] M. Mitsuishi, K. Ueda, F. Kimura, “Manufacturing Systems and Technologies for the New Frontier”, CIRP Conference on Manufacturing Systems, pp. 325-327, 2008.

[2] V. Sriramanet. Al,”Assembly modeling for product design and analysis”, Journal of Engineering Technology, 2001.

[3] A. J. Curley et. Al., “Predicting the Service life of adhesively-bonded joints”, International Journal of Fracture, 103, pp. 41-69, 2000.

[4] S. Anderson, “Adhesives in Automotive Interiors – Versatile and Economical Bond Solutions”, Product Development, pp. 72-75, 2003.

[5] R. D. Adams and J. Comyn, “Joining Using Adhesives”, Assembly Automation, pp. 109-117, 2000.

[6] Bralla, J., & Press, I. “Handbook of Manufacturing Processes”, Industrial Press, pp. 282-283, 2007.

[7] Petrie, E.“Handbook of Adhesives and Sealants”.McGraw-Hill Education, pp. 522-524, 2007.

[8] 8.S.Ebnesajjad, “Adhesive technology Handbook”. William Andrew Inc. Publishers, pp.192-195, 2008.

[9] Neha B. Thakareet. Al,”A Review on Design and Analysis of Adhesive Bonded Joint by Finite Element Analysis”,International Journal of Mechanical Engineering, 2015.