

Process Realization with Model Based Automation Approach towards Rubber Plant to Manufacture Vehicle Tires

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Abstract—Rubber tire is a vital term relate to an enhancer of human lifestyles' immense motion in modern superfast hectic technological era with its diverse usage at every domestic field. Automation incorporated with mechanical wheels paves a new path to achieve success towards several impossible missions. Now-a-days, development of civilization becomes enrich with modern technology and based on wings of wheel. Implementation of semi-automatic or manual techniques replacing with fully automation approach of machineries will be enhanced the product quality and quantity of concerned industry. This informative paper designates an enhanced survey on procedure of manufacturing green tires in a local reputed rubber industry for industry institute collaborative activity facets along with existing machinery details.

Keywords— automation; boiler; green tires; rubber industry.

I. INTRODUCTION

Tire manufacturing [1] industry is one of the most crucial industries in modern engineering era. Riding the wings of changes with modification and upgradation technical skills from mid eighteenth century to now-a-days, this industry becomes a part and parcel of every human life to enhance the immerse progress of lifestyle. In every part of human lifestyle, not only in engineering field, also in technological domain, educational perspectives, and health consciousness and so on, rubber industry creates bondage to civilize human beings. This industry relies on semi-automation technology for raising economic viability and mass production with supreme quality. To ascertain the production of rubber industry, comprehensive daintily tuned processes with sophisticated instruments are highly requisite, depending upon excellence and cost diminution. Entire process realization with enthusiastic influence on manufacturing vehicle tires is the scholastic approach of this proposed paper. Mainly the purposes of an industry now-a-days affirm the superlative product quality, enhancement the rate of productivity, diminishing of production time and cost.

II. A PREVIEW ON LOCAL BASED TIRE INDUSTRY ORIENTED INTERACTIONS

Enhancement engendered between industry-institute collaborative projects activities; several interactions have been done with employees of 'S & H Manufacturing And Trading Pvt. Ltd.' The Company [ISO 9001:2008 certified] established on 1999, manufactures ten different types of bicycle, ranger and rickshaw tires. The details of production are represented in table.1 [2]

TABLE I. SEVERAL TYPES OF TIRES AND THEIR SIZES

Tire Types	Tire Production Types	Sizes of Tires (Inch)
Bicycle Tires	Kavach Bicycle Tire	10
	PRF RoadStar Tire	11
	Bicycle Tires	13
	Bicycle Tire	15
	Tubeless Bicycle Tires	20
Ranger Tires	Nylon Rickshaw Tires	21
	Ranger Bicycle Rubber Tires	22
	Ranger Tires	25
Rickshaw Tires	Rickshaw Tire	17
	Auto Rickshaw Tires	19

Emphasis on behalf of the idealistic motto of supreme quality of tires with cost-effectiveness, this company has different small sections for suitable batch procedures. The boiler section is merged with water treatment procedures to maintain the large scale of pure steam distribution in entire industry. Various automatic and manual mode operated machines (Kneader Mill, Calender Mills, Bias-cutter machine, TBM and Tire curing machines) are incorporated here to sustain the productivity of the industry.

III. MODEL BASED PROCESS REALIZATION TOWARDS TIRE MANUFACTURE

Manufacturing of bicycle rubber tires are not an easy task, these have several subsequent batch procedures used to feasible the production with supreme quality and quantity. For manufacturing rubber tires initially raw materials (the rubber stocks, carbon stocks, silica, sulphur, oil, different chemical ingredients like polybutadiene, zinc-oxide etc.) are placed in suitable ratio of quantity at the kneader mill for well-mixing purpose. [3] The mixture of raw materials is passed through the calendar mill to produce the rubber sheets with 8-12mm thickness that are transferred at supply mill for checking and purifying the dust particles. The rolling sheets are reserved at the bias cutter for nylon coating in between of two sheets and cut the rubber sheet into three consequent parts arranging in rubber beam rolls. The spooling machines are used to check the shapes and quality of rolled rubber sheets. The green tire is shaped at customer requirements by pasting thick copper wires aside of the green tire by tire building machine. After those successive steps, the green tires are transferred at tire curing section for several designing aspects as per customer requirements. The green tires become ready to dispatch at market after color lining, tire wrapping and packaging. The steam and correspondence compressed air are supplied in several sections and machine operation from boiler section and air compressor room respectively. The entire process flow for producing green tire is depicted in the fig.1 [4]

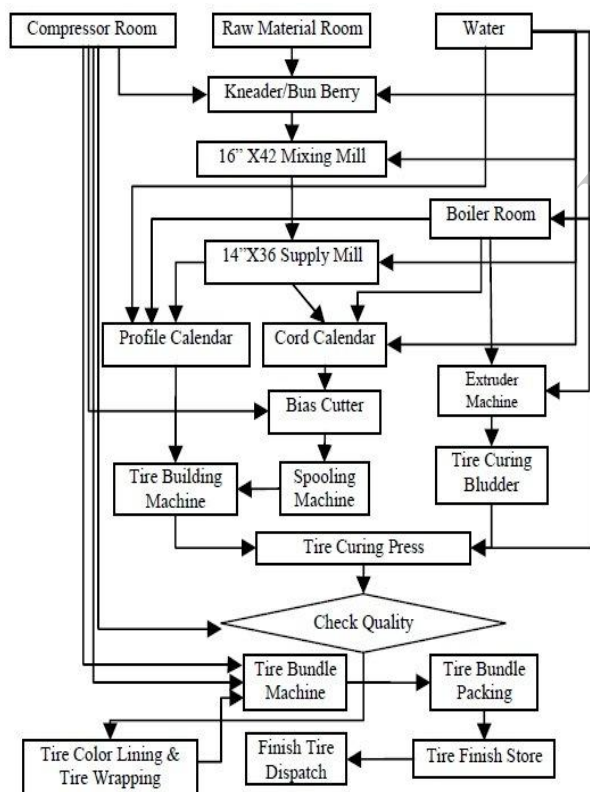


Fig. 1. Process Flowchart for manufacturing green tire

IV. AUTOMATED MACHINERY ACTIVITY-AN OVERVIEW

As per plentiful visit at concerned industry, the mechanisms of different machineries were created a realization of gross

productivity and quality improvement of products. Several sections and machineries of this industry are discussed briefly:

A. Boiler Section

Boiler [5, 6], the heart of an industry, is a closed aluminium insulated vessel that produces steam by evaporating water or other fluid. Boiler (fig.2) size depends upon the total volume of steam requires in industrial intend. In a standard boiler, the water temperature belongs to 100 degree centigrade with pressure of 6 bars and output power upto 300 KW. In concerned industry, the horizontal boiler with 2.5 tons capacity serially connected with furnace at one side and other is a chimney. Furnace is one of the most important parts for generating heat from fuels, logs and so on. Ground water is supplied at boiler by submersible pumps completing the water treatment process. In water treatment process the iron and other compounds of water are reduced with controlling the pH of water using sodium chlorides. The purified water is stored in a receiver tank with suitable water level indicator that indicates the present water level. Furnace, used for heat purposes using woods, oils and coals, is kept in serial direction of the boiler. Generated heat is supplied to the boiler for purpose of converting the water into steam under pressurized condition. At the far side of boiler, an ID fan is used to suck steam from furnace through boiler in 1440rpm rotational speed. Due to super-heated steam engendered under pressurized condition, the boiler is insulated with aluminium sheet to maintain constant temperature of the steam. The carbon and dust particles mixed with steam are filtered in chimney by precipitating the carbon particles and evaporating the dust particles in the air. These filtration techniques are essential for manufacturing high quality of tires. The pure dust free steam is supplied in different sections of all over the industry by insulating pipelines.



Fig. 2. Boiler Section with water level gauge

B. Air Compressor

Air Compressor [7], depicted in fig.3. is another important machine used for industrial purpose that converts power generated by electric, diesel or gasoline engine into kinetic energy by compressing air and released in quick bursts from a chamber. Mainly three types of air compressors are used: Reciprocating, Rotary Screw, Rotary Centrifugal compressor. Among them Reciprocating and Rotary Screw air compressors are positive displacement compressors and commonly use in industrial purposes. In this industry, seven rotary screw air

compressors are used to generate the pressure range 200-400 psig each. Due to adiabatic heating generated by movable rotor blade to compress air internally, air compressors are required cooling procedures using oil, air or water injected into bearing. The compressed air is collected by the air receiver and supplied to several sections of the plant.



Fig. 3. Air Compressor with air receiver

C. Kneader Mill

Mixing or blending, a batch or continuous process in industrial aspects to determine mixing procedures by various raw materials related to industry product requirements. Batch mixers are used for small productive quantity purposes and continuous mixers are used for multiple procedures applied for high production rates. Kneaders, high intensity mixers applied for cohesive solid systems are generally two types: Bunbury mixers and Double arm kneaders. [8] The double arm kneader contains of two heavy blades kept on parallel horizontal shafts with a saddle shaped bottom. Blade types are depends on desirable quality of mixing materials and the blades are mounted in a manner that their paths are overlapping or tangential. Another, bunbury or heavy-duty two arm mixer is consists of eight chambers with a rotors in each part turn in several speeds depending upon material characteristics and top feeding facilitated. The materials are trimmed between the rotors and the walls and the saddle between them is attached to a discharge door. In this industry, the rubber stocks, carbon stocks, silica, sulphur, oil, different chemical ingredients like polybutadiene, zinc-oxide etc. are mixed in a definite ratio with requires as maintaining qualitative productivity. In temperature maintenance perspectives alloy steel is coated in mixing chamber and the fig.4 is represented the image of Kneader mill.



Fig. 4. Kneader Mill

D. Calender Mill

Calender mills (fig.5) are operated by multiple pressurized counter-rotated rollers to squeeze the materials and to design rubber sheets with equal thickness as per desired production. The material mixtures out from the kneader are loaded with talc on the calendar machine making smooth rubber sheets of thickness 8-12mm and 2metres width. The rubber sheets are fed back once to the roller for thickness accuracy.

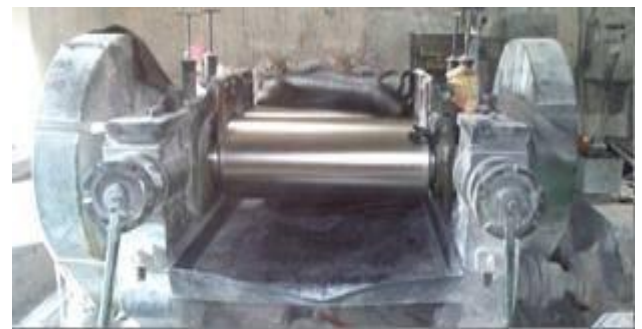


Fig. 5. Calender Mill

E. Bias Cutter

Bias cutter [9] is mechanized with servo motor powered conveyer technique with cutting width accuracy of bias $\pm 1.0\text{mm}$ and $\pm 0.5\text{mm}$ tolerance respectively. Gear controlled cutting mover can be set up one or two way as design perspectives. Fabric cords and nylon, coated with rubber sheet and cut it into 3 similar parts to reel them in coil form are shown in fig.6.



Fig. 6. Bias Cutter



Fig. 8. Tire Curing Machine

F. TBM and Tire Curing Machine

Tire building machine [10], manual or fully automated in nature, assembles all necessary components in a green tire. In rotating drum, two copper wires are kept in one side of green tire coil in a distance allocation and merged with other green tire coil by releasing the pressure. The beads of the tire are joined to form like rubber belt and makes different shapes and sizes of tires as vehicle requires. Curing is the procedure to give the tire its final shape as customer requirements applied to the pressure in respective 6-7 minutes time duration. The temperature applied for this procedure is nearly 300degree Fahrenheit and the pressure is around 350psi and hydraulic in nature.



Fig. 7. Tire Building Machine

CONCLUSION

Frequent interactions and plentiful visit in concerned rubber industry enriches the industry institute collaborative project work deeds. Automated system model design for different manual sections of rubber industry will be entertained further to increase the activities of industry institute collaborative work. This piece of work is essential to gather brief knowledge about the procedure and machineries of rubber industry, not only for industry entrepreneurs also institute employees to enrich project activities relate to industry basis.

REFERENCES

- [1] Sadhan K. De, Jim R. White, Rubber Technologist's Handbook [ISBN: 1-85957-262-6], vol.1, pp.358-365, 2001.
- [2] Our products: S & H Manufacturing And Trading Pvt. Ltd., 2012-13: <http://www.prftires.com/products.html>
- [3] Anil K. Bhowmick, "Rubber Products Manufacturing Technology", [ISBN: 0-8247-9112-6], Marcel Dekker, Inc., 1994.
- [4] Rajdeep Chowdhury, Biswarup Neogi, Zinkar Das, Prasenjit Chatterjee, Sourajit Ghosh, "Advancement and Up Gradation Aspects En Route for Enhancement of Rubber Plant Industry Performance by Introducing Scholastic Support through the Proposed CDGN Model", Proceedings of 2014 1st International Conference on Non-Conventional Energy (ICONCE 2014) IEEE [Print ISBN: 978-1-4799-3339-6], Jan 16-17, Kalyani, pp.413-417, 2014.
- [5] Boiler Operation Maintenance & Safety Study Guide, American Trainco Inc, pp.1, 2006
- [6] Brad Buecker, Basics of Boiler and HRSG Design,[ISBN: 1-59370-186-1], Penn Well Corporation, 2002.
- [7] Thomas Klenck, "How it Works: Air Compressor". Popular Mechanics. May1, 1997, 12am. :<http://www.popularmechanics.com/home/improvement/energy-efficient/1275131>
- [8] Mixer, Encyclopedia Of Chemical Engineering Equipment,; <http://encyclopedia.che.engin.umich.edu/Pages/MaterialsHandling/Mixers/Mixers.html>
- [9] Bias Cutter Machine, Shyr Chiuann Machinery Industry Co.,Ltd: <http://www.tire-tire-machine.com/bias-cutting-machine/cutter.html>
- [10] How A Tire Is Made, Maxxis International, 2014: <http://www.maxxis.com/sponsorship/automotive/how-a-tire-is-made>