Research on Automation of Production Line for Standard Lamp LED Module

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Abstract: LED module is the luminous part of lighting fittings. There are many kinds of lighting fittings. According to different places where used, it is divided into roadway lighting fittings, landscape lighting fittings, commercial lighting fittings, and the others. The design of standardized LED modules is a consensus in the industry to improve production efficiency and reduce production costs. The problems that result in are how to improve the production efficiency of standard lamp LED modules, improve production quality, reduce production costs and reduce production waste. This paper draws a certain conclusion by studying the automatic production line of standard lamp LED modules and optimizing the original manual production line. It provides research foundation for the optimization of production lines in the industry.

1. Introduction for the manual assembly production line

At present, most LED enterprises in China adopt the traditional discrete manufacturing mode, in the LED device packaging process, from solid crystal, welding wire, point glue, bake to braid and package the main equipment in the whole process is independent, the information of production materials such as raw materials, semi-finished products and finished products is dependent on manual identification. Inaccurate and delay problems result in the entire LED packaging process of production inefficiency. In addition, LED packaging manufacturing processes technology is complex, multi-varieties batch production, multi-variety of tooling the enterprise's technology, planning and control ability requirements are very high. Assembly process of manual production line for the standard assembly LED module and time node are as follows. The LED module needs lighting tests for many times during the assembly process, but it is obvious there is certain damage to the worker's eyes exposed in the Blu-ray of the LED light source without the protection of the lens. Therefore, for the safety of production, the company will give each worker protective glasses. However, workers sometimes will not wear the glasses for convenience.

There are a lot of screwing screws by hand and brushing glue in the production line, which is in order to make products achieve IP65 level, waterproof and dust proof capacity when it is used outdoors, however, there is instability for the quality because of rough manual operation, and the protection level test belongs to destructive test, what’s more, it is impossible to do a full inspection, generally random inspection, so it may make some products that the protection level is unqualified access to market, resulting in after-sales claims. Due to the massive steps in the manual production line, the production efficiency is relatively low. If the delivery time is to be guaranteed, it may take a long time for the customer to order the product in advance, which will challenge the sales competitiveness of company.

Table 1. Assembly process of manual production line for the standard assembly LED module and time node

No	***Procedure of assembly***	***Standard time***	***Persons of allocation***	***Time of allocation***	***unit***
1	Combination of pre-processing line and waterproof junction	10	1	10	
2	Threading for radiator and screwing the junction	8	1	8	
3	Brush coating for the LED module	10	1	10	
4	Fastening to the LED module	17	2	8.5	
5	Welding for the LED module	16	2	8	
6	Packaging, disassembly and installation for the lens	10	1	10	
7	Installation for the seal ring and frame	7	1	7	
8	Placing for the locking screw of lens	6	1	6	
9	Fastening to the screw of lens	9	1	9	
10	Fastening to the waterproof connecting nuts	14	2	7	
11	Lighting test	10	1	10	
	Total:	***117***	***14***	***93.5***	
			Bottleneck process	***10***	***second***
	Module capacity		Line balancing rate	83.57	%
			Standard capacity	360	pcs/H
			Persons of assembly line	14	
	Usage quantity of heat conduction silicon grease		Generalist	1	
			Other staffs	0.5	
			Total persons	15.5	

2. Proposing for the automatic production line

Automated production line is mainly aimed at LED packaging workshop production planning, logistics distribution, equipment control, personnel management, quality control. The management and control requirements of elements are established based on big data analysis method. LED packaging production process of big data acquisition, storage, analysis, decision-making. Integrated
production process intelligent analysis helps build a decision-making platform to achieve high product accuracy, zero defect and short cycle production.

2.1 Design the station of the automated production line according to the original site and station:

1.There are on-line operator (total is 5 operators): four persons are responsible for the assembling each components and parts, one person is responsible for the line patrol and feeding material;

2.The equipment drives the carrier through the upper and lower circulating streamlines to realize the vehicle cycle between the stations;

3.The equipment adopts manual feeding material, which is radiator and power cord; The equipment adopts the automatic feeding system with tray, which is sealing ring; The equipment

adopts the vibrating tray, which is the cover; The equipment adopts the clip for feeding material, which is: lens , module cover, lens assembly of A/B product;

4.The sealing ring of the new product needs to be manually inserted into the lens offline, and the lens assembly is manually fed into the clip;

5.The finished product is automatically put into the storage rack by the 6-axis robot. After the product is stored for 15 minutes on the storage rack, the operator takes away the finished product on the storage rack;

6.All the carriers of the whole line are equipped with RFID, which can be bound to the information of each product. A few days ago, all the defective products are discharged at the same bad station it the end;

7. The cycle time of equipment ≤ 15S, (supplied materials for each component must meet CPK ≥ 1.33);

8.Overall size of the equipment: L × W × H = 22500mm × 4000mm × 2200mm.

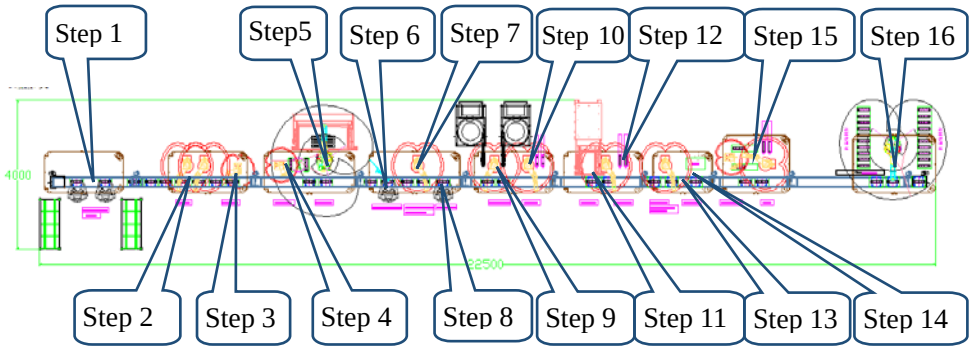

Figure1. Design sketch of station arrangement

Step 1:Installing the power cord by hand , pre-screwing the waterproof junction, radiator feeding material; Step 2:Tightening the waterproof junction (double station); Step 3:Automatically painting heat conduction silicone grease; Step 4:LED module is fed with tin automatically; Step 5:LED module assembly; Step 6:Tightening the grounded wire by hand; Step 7:Tightening the screws of LED module; Step 8:Manually bonding wire(3 wires);Step 9:Cover assembly; Step 10:Lens assembly; Step 11:Sealing ring assembly; Step 12:Module cover assembly; Step 13:Tightening screw of module cover; Step 14:Lighting and power test; Step 15:Feeding material, brush coating and pressuring for new sealing ring; Step 16: take away the qualified and unqualified products.

It is as follows for every station arrangement and time of production:

1. Installing the power cord by hand, pre-screwing the waterproof junction, radiator feeding standalone: there are 2 manpower for this station, manual operation time is less than 13S, the time of carrier displacement is 2S, total is 15S. The 2 kinds of waterproof junction of new products need to be tightened by operator for this station, the rest products need to be pre-tightened;

2. Waterproof junction fastening, automatically painting heat conduction silicone grease station: waterproof joint fastening station moves in and out with double carrier at the same time, the junction fastening time of single station is 25s, carrier displacement is 5S, that total is 30s (manual pre-screw station should be twisted as much as possible); The coating time of thermal conductive silicone grease is 12S, and the running time of carrier is 2S,that total is 14s;

3. LED module is fed with tin automatically, feeding assembly standalone: the time of automatically feeding tin for 1 point is 4 S, 3 points is 12 S, product rotation is 1s, that the total is

13S. moving module to position of feeding tin is 7S, product rotation is 1s, handling and assembling to radiator is 5s, that total is 13s;

4. Tightening screw of LED module , bonding wire standalone: manual fastening ground wire and 2 screws, which need 12S, the time of automatically fastening the remaining 4 screws is12s, the time of manual welding 3 wires is 12s, time o f carrier displacement is 2s, that the total is 14s;

5. Cover, lens assembly standalone: the time of installing 2 covers is 8s, time of positioning and displacement is 2s, time of lens assembly is 2s, the running time of carrier is 2s, that total is 14s;

6. Sealing ring, module cover assembly standalone: time of sealing ring assembly is 6S, time of module cover assembly is 5S, the running time of carrier is 2s, that the total is 13s;

7. Screw fastening of cover, lighting power test standalone: two drills fasten two screws at the same time in a single station the time is 3s, 8 screws are 12S, rotation angle of drill is 1s, carrier displacement is 2s, a total of 15s. The time of lighting and power test should be less than 10s;

8. The lens assembly feeding of new product, automatically coating sealant, lens pressing standalone: the product is moved to the coating station, the time is 1S, the time of automatically coating is 11S, the time that the product is rotated to the assembly station is 1S, and time that the lens assembly is moved from the clip to the carrier for coating is 5S, The time of handling and pressing by robot is 6S, the glue is the dual carrier, part of the action can be overlapped, a total of 14S.The time of manually installing the sealing ring into the lens is less than 11S;

9. Taking away the finished product standalone: the time of carrying the product is 10S by robot with 6-axis

3. Situation of Index improvement after implementing automatic production line

The original production line is replaced by the automatic production line of 9 modules, which improves the overall production efficiency. The specific statistics are as follows:

After statistics, the original production line of standard lamp LED module: personnel is 12, production capacity is 120 / hour. After upgrading to automatic production line, LED module automatic line: personnel are 4, production capacity is 240/hour. The production efficiency has been greatly improved and the labor has been greatly reduced.

Table 2. Statistics of automatic production line

Name of module	***content of process***	***umber of staffs***	***Number of robots***	***power***	***remark***
module 1	Installing the power cord by hand, pre-screwing the waterproof junction, radiator feeding standalone	2	0	0.75kw	
module 2	Waterproof junction fastening, automatically painting heat conduction silicone grease station	0	1	1.15kw	robot with 4-axis
module 3	LED module is fed with tin automatically, feeding assembly standalone	0	2	10.5kw	robot with 4-axis robot with 6-axis
module 4	Tightening screw of LED module manually or automatically, bonding wire standalone	1	1	2.6kw	robot with 4-axis
module 5	cover, lens assembly standalone	0	2	5.25kw	robot with 4-axis

module 6	sealing ring, module cover assembly standalone	0	1	3.85kw	robot with 4-axis
module 7	screw fastening of cover, lighting power test standalone	0	1	8.2kw	robot with 4-axis
module 8	The lens assembly feeding of new product, automatically coating sealant, lens pressing standalone, taking away the finished product standalone	0	1	3.55kw	robot with 4-axis
module 9	Taking away the finished product standalone	1	1	2.6kw	robot with 4-axis
	total :			38.45kw	

4. Conclusion

This paper has performed an application of standard lamp LED module and figured out the effect of standard lamp LED modules on saving time and personnel. Besides, this paper posed evaluation for the level of production capacity improved. Standard lamp LED module is characterized with high degree of automation, saving manpower and effectively improve the production efficiency, the rate of defective products dropped substantially. The modules help to build automotive assemble lines, which will lay the foundation for unmanned plant in the future.

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