Electropneumatic Systems Modification Analysis for Automatic Weighing with Cosmetics Industry Study Case

Abdul Syukur Alfauzi[1], Dicky Mileno[2], Farika Tono Putri[3], Wahyu Isti Nugroho[4], Timotius Anggit Kristiawan[5], Ampala Khoryanton[6], Yusuf Dewantoro Herlambang[7]

Mechanical Engineering Department, Politeknik Negeri Semarang
Sarjana Terapan Teknik Mesin Produksi dan Perawatan
Semarang, Indonesia
farika.tonoputri@polines.ac.id

Abstract. PT ABC is company located in Semarang, Indonesia which engaged in cosmetics and castor oil production. One of main product of the company is face powder. According to observation there was a problem occur in the face powder production department. These problems are the results of inconsistent product weighing. The cause of the problem is the powder mass quality control process, where this process is a process of weighing the powder which is carried out conventionally by the operator, so the processing time for weighing the powder is not consistent and can cause a rejected product. This research aims to solve the problems that exist in the company. The solution to solving the problem given is to design a powder weighing process motor driven with an electro-pneumatic system. The results of this design are able to reduce the cycle time of weighing 40 gram powder by 1.07 seconds or 10.57% and reduce not good products by 1.16% for 40 gram powder products.

Keywords: electropneumatic; cycle time; automatic weighting.

1. INTRODUCTION

Cosmetics and skin care products demand is growing and increasing. Due to internet exposure, local beauty brand products are on the rise recently [1]. In the future, Indonesia is predicted to be one of five biggest cosmetics market in the world [2]. PT. ABC, one of Indonesia's government holding company operating in pharmacy field produces loose powder local brand with light and soft formula and suitable for sensitive skin. The loose powder produced in PT ABC cosmetic production department. Cosmetic product department consist of two process, i.e. production section and packaging section. Loose powder mass quality control process is one of the process carried out in production section of PT ABC cosmetics department. Loose powder mass quality control conducted in purpose to determine whether the mass of the loose powder that has been filled using a filling machine falls within quality standards. The loose powder quality control process carried out conventionally by weighing the powder using a digital scale with manpower. The weighing method used can give rise to the potential for Not Good (NG) products and requires quite a long time. The problem-solving solution provided is to design a tool for driving the powder weighing process with an electro-pneumatic system to reduce the potential for not good powder mass and reduce cycle time during the powder mass quality control process.

M. U. H. Al Rasyid and M. R. Mufid (eds.), *Proceedings of the International Conference on Applied Science and Technology on Engineering Science 2023 (iCAST-ES 2023)*, Advances in Engineering Research 230,
https://doi.org/10.2991/978-94-6463-364-1_96

Electropneumatic system has been widely developed and used both in the field of education [3-4] and industries [5-8]. Previous study designed the electro-pneumatic system for hot stamping machine used in automobile industries [4]. The study found that system delay time can be obtained using on-delay timer valve which installed in the design. Another study [5] developed an electro-pneumatic system with pneumatic motors which suitable for pump drivers, conveyor drivers and others. This present study developed an electro-pneumatic system with relay, solenoid valve and photoelectric sensor in purpose to improved and reduced cycle time the loose powder quality control process in PT ABC cosmetics department.

2. METHODOLOGY

The research methodology in this study consists of: (i) problem identification, (ii) engineering design, (iii) fabrication of an electropneumatic-based automatic weighing system, (iv) testing cycle time and quality of weighing products.

Problem identification conducted through an observation in PT ABC via student industrial internship activity and interview carried out during the internship. The interview involved quality control operator, production engineering staff, quality control engineering staff and engineering manager in PT ABC cosmetics department. Loose powder weighing result in quality control process which not constant affects the high weighing time process and product quality. There was urgent need to develop a quality control system in orderto reduce loose powder spilled potential which caused a NG product and reducing cycle time for loose powder weighing process.

The engineering design process in this study carrid out using Shigley method. Then the next step is fabrication of an electropneumatic-based automatic weighing system continued with electro-pneumatic system test.

3. RESULT AND DISCUSSION

3.1 Engineering Design

Engineering design process result can be seen in Figure 1. Design drawing conducted using computer aided design (CAD) software.

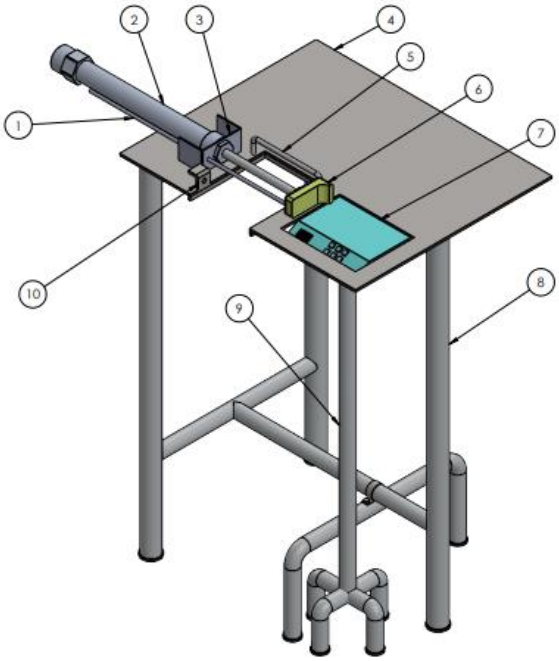

Fig 1. Automatic scale system using electropneumatic.

Figure 1 illustrated the automatic weighting station in PT ABC, where notation explanation as follows:

1. Cylinder stabilizer
2. Air cylinder
3. Cylinder base
4. Base plate
5. Stopper
6. Nylon
7. Scales
8. Main frame
9. Scale stand
10. Housing Sensor

After the design obtained, then electro-pneumatic circuit system simulated using Fluidsim software as shown in Figure 2. This simulation was carried out to determine the efficient movement of the pneumatic cylinder and determine the number of electro-pneumatic components that will be needed.

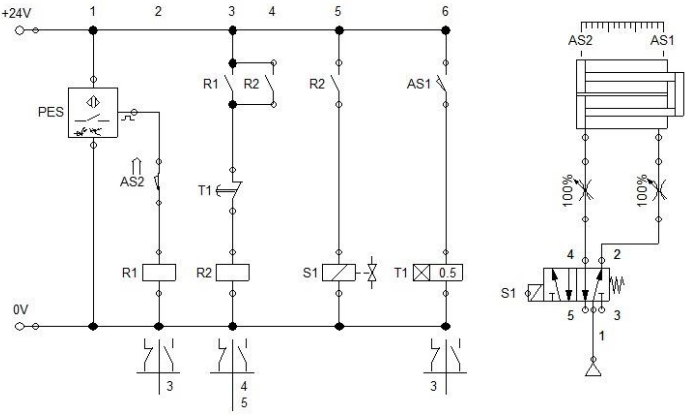

Fig 2. Electo-pneumatic circuit simulation using Fluidsim.

Figure 3 shows the electrical circuit of electro-pneumatic system which defined hardware lists used in this research.

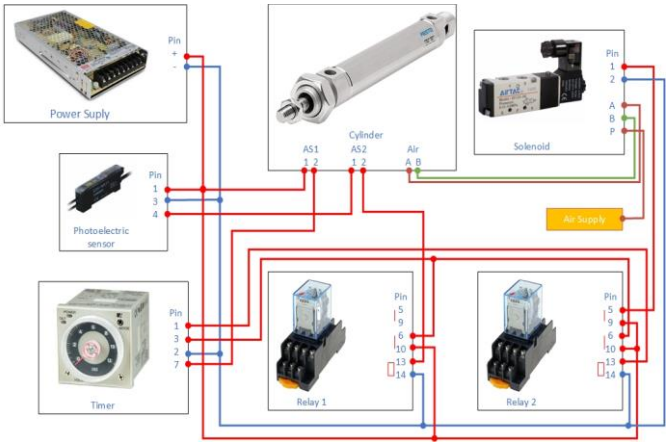

Fig 3. Electro-pneumatic circuit diagram which illustrated the component used in the research.

Based on the electro-pneumatic electrical circuit (Figure 3), it can be explained that the electrical system works from a power supply type 24V-20A RECO, to a photoelectric sensor type E3X-NA11, then the current goes to the automatic switch cylinder (A2), relay 1 is active, relay 2 is connected current, activating the TPC 5/2 type solenoid valve and the CDM2B25-200 type cylinder to move forward. The cylinder moves forward activating the cylinder automatic switch (A1), the H3CR-A8 Delay Timer is active to delay the cylinder for 2 seconds. Then the automatic switch (A2) loses current, deactivates relay 1 and the solenoid valve type TPC 5/2, cylinder type CDM2B25-200 moves backwards. The electrical circuit is continuously active when the E3X-NA11 type photoelectric sensor detects objects/powder.

3.2 Fabrication of An Electro-Pneumatic Based Automatic Weighing System

Fabrication process started with components machining and the assembly. The machining stage is carried out to make components such as scale base plates, base plates, cylinder stabilizers, frames, main frames, and stoppers from raw materials using bench grinding machines, hand grinders, drilling machines, files, and tig welding machines

The assembly process divided into two stages, i.e. frame assembly and electrical assembly. Figure 4 (a) and (b) show the frame and compoennet assembly process. Pneumatic component assembly shown in Figure 4 (a) meawhile frame assembly shown in Figure 4 (b).

(a)

(b)

Fig 4. Components assembly: (a) Pneumatic component assembly and (b) Frame asembly.

Figure 5 shows electrical assembly of electro-pneumatic based weighing station. The electrical assembly connects the power supply components, timer delay, relay, photoelectric sensor and solenoid valve.

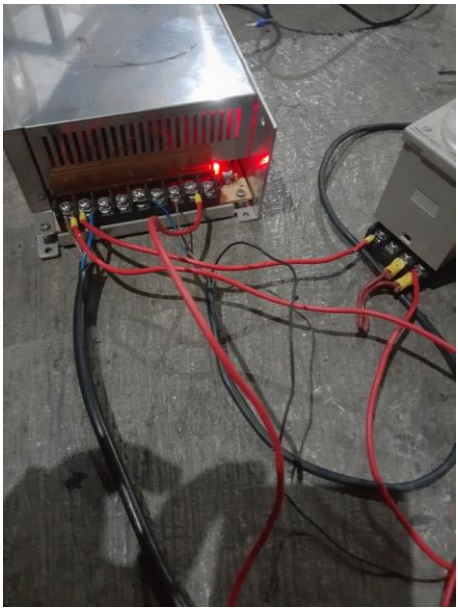

Fig 5. Electrical assembly process

3.3 Testing The Loose Powder Automatic Weighing Electro-Pneumatic System based

Electro-pneumatic based loose powder weighing system test consist of three experiments, i.e. cycle time testing, product quality testing and work pressure testing.

The cycle time testing stage was carried out to obtain a comparison value of the time before and after using the loose powder weighing process pusher. Cycle Time data collection was carried out for 25 days with 2500 trials. The cycle time test aims to determine the weighing process time using a loose powder weighing process pusher with an electro-pneumatic system. Cycle time testing is carried out by observing, calculating and recording the time required for the weighing process using a stopwatch measuring instrument. The product tested was a 40 gram powder product. The expected result from cycle time testing is a reduction in the cycle time of the loose powder weighing process. The cycle time test aims to determine the process time for weighing the mass of 40 gram powder using the design of a driving tool for the powder weighing process using an electro-pneumatic system by observing, calculating and recording the time required for the process of weighing 40 gram powder. Figure 6 shows the cycle time testing result before improvement using electro-pneumatic system and after electro-pneumatic system applied.

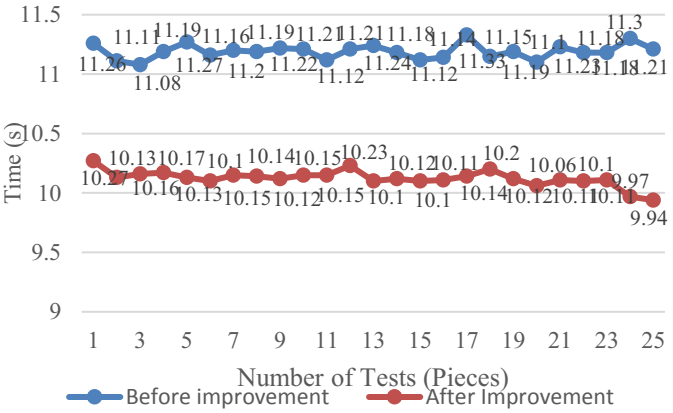

Fig 6. Cycle time testing result before improvement using electro-pneumatic system and after electro-pneumatic system on loose powder weighing process

This decrease in cycle time was due to the process carried out by the operator, namely weighing the powder and experiencing a decrease in the cycle time after using the powder weighing process pusher. The decrease in cycle time before and after improvement is shown in Figure 7.

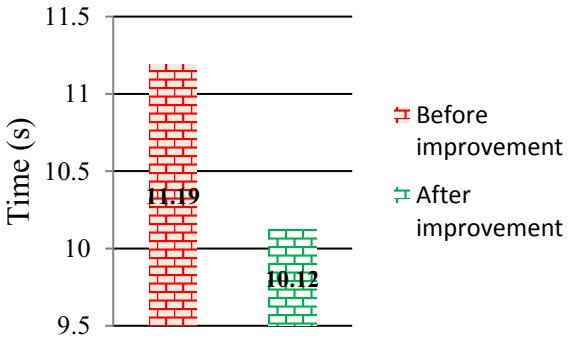

Fig 7. Cycle time reduction.

It was obtained that the cycle time for weighing 40 grams of powder before and after improvement was reduced by 10.57%. This shows that the propeller for the powder weighing process is capable of having an impact on the 40 gram powder weighing process.

Quality testing is carried out to determine the quality of the powder product after the weighing process is carried out using a electro-pneumatic system based loose powder weighing process. The quality testing process is carried out by carrying out visual observations of loose powder products and weighing the product mass of 2,500 pieces

of product weighed using a tool that drives the powder weighing process to find out if the product is NG or if the powder spills during the transfer process to the digital scale. The results of product quality testing in the weighing process using a powder weighing process driver are expected to reduce the number of NG products. Figure 8 shows the NG products difference before improvement and after improvement.

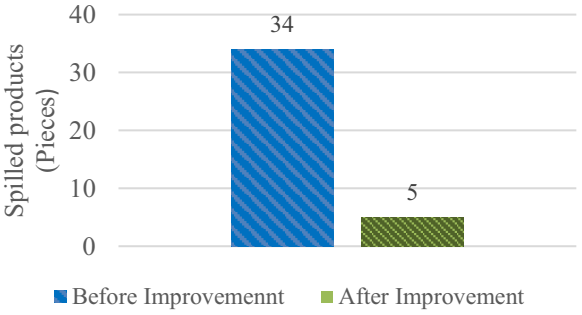

Fig 8. Weighing loose powder quality.

Determination of working pressure is carried out by comparing the amount of NG powder product spilled at variable pressures of 2 bar, 3 bar and 4 bar. Figure 9 shows the result of working pressure experiments.

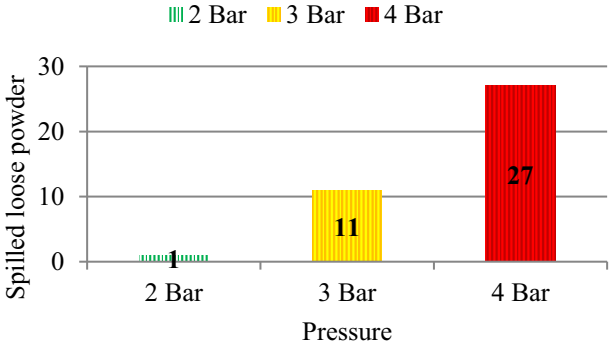

Fig 9. Comparison graph of working pressure variables

Based on Figure 9, the 2 bar pressure variable shows that the amount of spilled loose powder product is less, so the working pressure used in the electro-penumatic based loose powder weighing process used the 2 bar pressure variable.

4. CONCLUSION

The results of the design of the powder weighing process propulsion tool with an electro-pneumatic system are able to reduce the cycle time of the 40 gram Marcks powder weighing process by 1.7 seconds or 10.57% with an average powder weighing process before improvement of 11.19 seconds. and after improvement of 10.12 seconds. Able to reduce the potential for not good powder to spill on 40 gram powder products during the powder weighing process. The decrease in the percentage of 40 gram not good powder spilled powder products from 1.36% to 0.2% or a decrease of 1.16%.

REFERENCES

1 M. Ferdinand and W.S. Ciptono,: "Indonesia's cosmetics industry attractiveness, competitiveness and critical success factor analysis," Journal of Theoritical and Applied Management, vol. 15, no. 2, (2022).

2 Allied Market Research,: "Indonesia skin care products market," In: www.marketreserach.com, (2019).

3 J.P. Rojas Suarez, J.A. Pabon Leon and M.S. Orjuela Abril,: " Development of an electro-pneumatic system for the practical training of pneumatic processes in the university environtment," Journal of Physics: Conference Series, Vol. 2073, No. 012016, pp. 1-7, 2021 [1st STEAM Education Congress, 2021](2021).

4 M. Sukarjo, U. Khasanah, S.T. Rahmat and Khaerudin,:"Augmented reality media design for electro-pneumatic practical learning for vocational high school students," Journal of Education Technology, Vol. 7, No. 1, (2023).

5 B.I. Oladapo, V.A. Balogun, A.O.M. Adeoye, I.E. Olubunmi, S.O.Afolabi,: " Experimental analysis of electro-pneumatic optimization of hot stamping machine control systems with on-delay timer," Journal of Applied Research and Technology, Vol. 15, No. 4, (2017).

6 I.C.Dutu, T. Axinte, L. Calancea, C. Fratila, M. Diaconu and R. Cojocaru,: "Research regarding electro-pneumatic systems with penumatic motor," Magazine of Hydraulics, penumatics, Tribology, Ecology, Sensorics, Mechatronics, No. 3, (2021).

7 Pippie Arbiyanti,: "Development pf stamping machine module to imporve practical competency," International Journal of Applied ciences and Smart technologies, Vol. 1, No. 2, pp. 113-120, (2019).

8 N. Sapre and S.M. Kumar,: "Industrial automation with electro-pneumatic system using PLC and wireless/LAN environtment-a remote experiment," International Journal of Current Engineering and Scientific Research, Vol. 2, No. 10, pp. 71-75, (2015).