International Journal of Multidisciplinary Studies and Innovative Technologies

e-ISSN: 2602-4888
dergipark.org.tr/en/pub/ijmsit
Research Article

2022, 6 (2), 177-180
DOI: 10.36287/ijmsit.6.2.177
Received: Oct. 1, 2022; Accepted: Nov. 10, 2022

Compression Featured Lock Design Compatible for Outdoor Conditions

Mustafa CAN[1*], Engin GÜNEŞ[2] and Anıl AKDOĞAN [3]

[1*] *Mesan Kilit A.S, Silivri, Istanbul, Turkey (Mustafa.Can@essentra.com) (ORCID: 0000-0001-5899-3250)*
[2]*Mesan Kilit A.S, Silivri, Istanbul, Turkey (EnginGunes@essentra.com) (ORCID: 0000-0002-0070-2630)*
[3]*Department/of Mechanical Eng., Yildiz Technical University, Istanbul, Turkey (nomak@yildiz.edu.tr) (ORCID: 0000-0003-0318-8873)*

Abstract – The aim of our paper is to present the development proses of a locking mechanism that may act as each a hinge and a lock, compresses the gaskets between the panel and the door at least 6 mm, helps to supply controlled air outlet and will increase the protection level. Thanks to the compression feature of the product, the novel designed mechanism could be tightened the cabinet by the cabinet gaskets. It provides IP65 sealing standard requirements. Thus, it can be used in outdoor environments in safe. Since this mechanism be developed more, it can be used in ventilation, generator, and plenty of different sectors. It has a high potential to lead to new applications and R&D studies in numerous technology fields.

Keywords – Cabinet, *Latch, Hinge, IP65, Mechanism, Protection level, Compression*

I. INTRODUCTION

In industry, various industrial locking systems are used in outdoor and indoor environments, in application areas such as cabinets, generators and panels. The industrial lock systems are designed and developed to meet the requirements of application areas and working conditions. The requirements for indoor locks are lower than the requirements for outdoor applications. One of the outdoor lock requirements is to provide leak proofing due to the weather and ambient conditions. We designed and developed a novel product in accordance with IP65 sealing protection level. This level of protection offers the assurance of the products will withstand winds, harsh environments, changing weather conditions and more. IP rated as "dust tight" and protected against water projected from a nozzle [1]. IP protection classes are defined in the international standard EN 60529 standard [2]. Another goal of this study is to develop a product that might have both functions hinge and latch, compresses the gaskets at least 6 mm between the panel and the door which helps to supply controlled air outlet and provides IP65 requirements, as well. In general, the most important aspect of the HVAC (Heating, Ventilation, and Air Conditioning) refers to the special structures used for transferring air among indoor and outside areas, alongside heating, and cooling each residential and industrial buildings interlocking solution is ensuring that the cabinet is properly sealed. The locks, hinges, profiles, and cut-outs must be designed in such a way that the entire door is completely sealed. Another important consideration for a properly sealed unit is whether the internal air pressure is positive or negative. This is because negative air pressure pulls the door in, while positive air pressure pushes it out. This affects the interlocks and sealing profiles in a wide variety of shapes. The air pressure in the interior also influences the behavior of a door when it is opened. Therefore, an HVAC shutter must be opened in two stages. The first stage should only open the door far enough to depressurize the unit, making it perfectly safe to fully open the door in the second stage [3].

II. PRODUCT DESIGN AND ANALYSIS

As a part of our research in the part design study, existing industrial locks from the HVAC sector were examined and their missing and useful aspects identified. As a result of the research, other industrial locks in the sector offer the IP65 sealing level and the compression property of about 5 mm in generally. In addition to these features provided by the existing products, the research has been taken to the next level by adding push-to-open functionality and a secure combination locking system to the redesigned industrial lock. When determining the material according to ISO 846 standard, 30% glass fiber reinforced nylon 6 (PA6GFR30) was selected as the material [4]. The conceptual design shown in Figure 1 was obtained by selecting 1.5 mm material thickness, 6 mm compression function and IP65 sealing level according to related standards' requirements. It works by push opening which means the product's 180° rotating opening function can work at any direction and secure combination of the locking system. Since electrical and mechanical push-button locks have gained popularity over the past 15 years, these locks are particularly advantageous where many people require access. The major advantage of course is the ability to change the lock combination instantly without incurring the cost of changing the lock and reissuing the keys [7].

Fig. 1. Concept design of the lock

At the designe stage we used the SolidWorks - 2021, one of the well-known 3D conceptual design programs. At the design stage, the encrypted cylindrical part is placed inside the part called push-open. The key is designed after this password. When the key cylinder enters the hub, all passwords match and the key cylinder can rotate easily. The locking and unlocking functions are achieved by turning the key cylinder 90 degrees reversible. After the unlocking function, by pressing the cylinder on the handle, the handle can be separated from the lock body thanks to the push-to-open function. The operator lifts the latch arm, which is separated from the latch body, and the cover's pressure on the seals is removed. Therefore, thanks to the compression feature; it provides a controlled air outlet avoiding accidents that may occur due to the air pressure difference when the door is opened. In our study, the compression function of 6 mm is provided using the rack and pinion gear mechanism. The lever of our lock is designed to act as a pinion and the rack part is designed to supply compression. The handle rotates angularly about a pin axis in the lock body, which allows the latch part of the lock to move up and down 6 mm. The 6 mm upward movement applies pressure to the lid, compressing the seals and preventing air leakage. This meets the requirements of the DIN EN 1886 ventilation for buildings standard [5]. For the concept design, virtual simulations were applied with the analyzing package of SolidWorks program. Some statical analyses were applied to the design part and simulated. For the designing and analysis purpose the Solidworks software is used. Besides, the study reveals the maximum value of the stress and displacement of such parts[8].

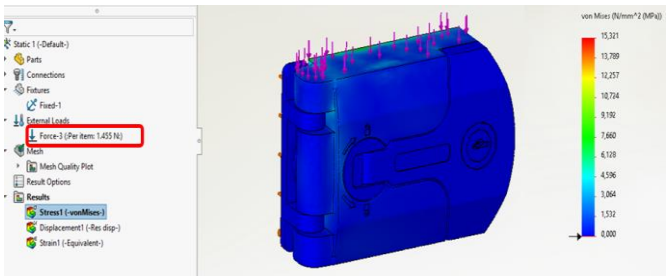

Fig. 2. Analysing results at 1455 N Force (Stress)

Figure 2 shows the analysing results of stress (von-Mises in N/mm^2) values scale of the product when the applied force is 1455 N per item in a specified direction.

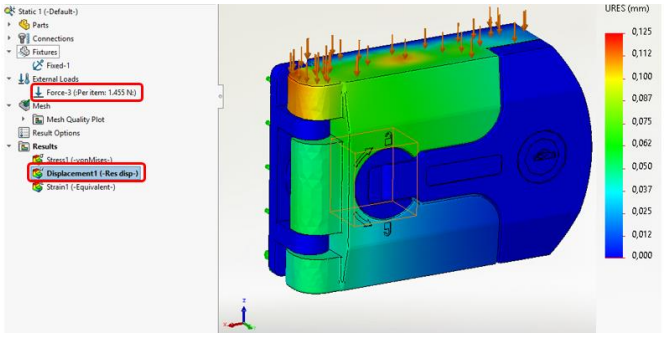

Fig. 3. Analysing results at 1455 N Force (Displacement)

Figure 3 shows the analysing results of displacement (mm) values scale of the product when the applied force is 1455 N per item in a specified direction.

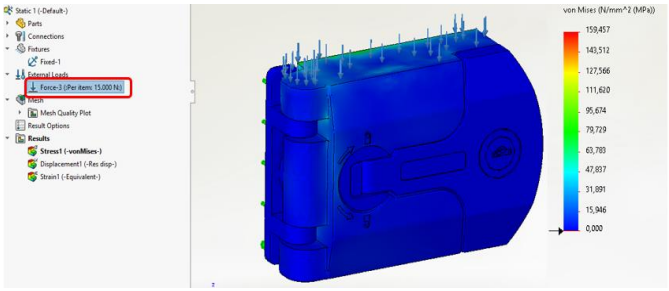

Fig. 4. Analysing result for 15000N (Von Mises N/mm^2)

The analysis was repeated with increasing force to see at what force plastic deformation of the product would occur. If we apply a force of 15000 N, as shown in Figure 4, the material be expected to start to yield.

III. PROTOTYPING AND TESTING

After the virtual simulations were completed, the prototype shown in Figure 5 was fabricated using 3D printing Fused Deposition Modelling (FDM) technology. This process can be used to create prototypes that can be used with multi-material and multi-color plastics, food, or living cells [6]. Details regarding the 3D printing machine used are given below.

Fig. 5. 3D Printed Prototype Lock

Build Volume: 203 Width X 203 Length X 152 mm Height
Layer Height Settings: 100,200,300 Microns
Workstation Compatibly: Windows 10/8.1/8/7
Network Connectivity: Ethernet TCP/IP 10 /100 base T
Machine Size: 635 (w) X 660 (l) X 940 (h) mm
Machine Weight: 94 kg
Software: CatalystEX

The prototype was subjected to an actual test by applying a maximum compressive force of 14550 N for 4.1 seconds at the standardized laboratory conditions as shown in Figure 6. The compression feature of the product by the novel designed mechanism could help tightened the cabinet by the cabinet gaskets.

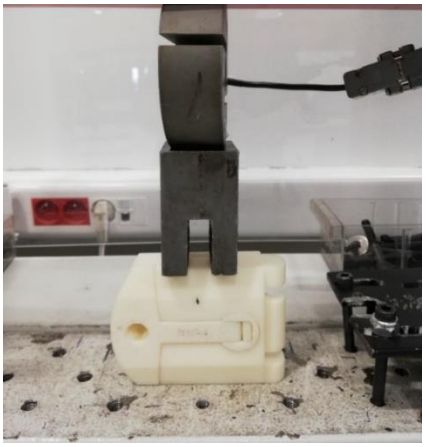

Fig. 6. Compression testing process

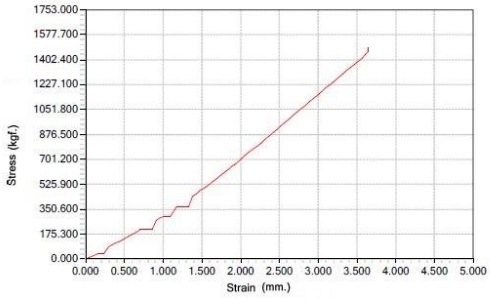

Fig. 7. Stress / Strain graph from the testing machine software

Figure 7 shows the stress/strain graphic created by the tensile testing machine software program. It can be seen 3.6 mm strain value against 14550 N force when the force is applied during 4.1 s.

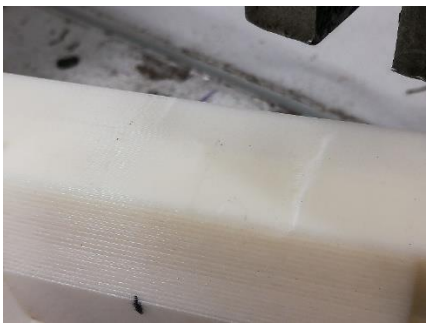

Fig. 8. Product deformation after testing

Figure 8 shows the deformation of the product because of the conducted compression test. Even if it damages to the product, it is evaluated just a visual but not a functional problem. In other words, it is not expected to cause a problem on the functionality of the product.

IV. RESULTS

This study was conducted to make a better lock than the existing design in many ways. The use of the push-open method and the combination closure system used in the product makes the design unique. In addition to these features, the IP65 sealing level and the current compression amount have been increased from 5 mm to 6 mm. As a result of this research, a novel product which acts as both a hinge and a lock, was developed to be used in the HVAC industry. According to the analyse results the new design can meet the environmental and climatic conditions which are the basic requirements of the HVAC industry and can meet the DIN EN 1886 standard. As a result of the conducted studies, the novel design registration was confirmed for the product with the registration number 2020/09992.

V. DISCUSSION

If we compare the existing previous studies with the novel designed product, although both products can function as a hinge and as a lock, the current product's unlock function can be opened with a simple Allen key. It means the security level is weak. By the new design, it is made more secure by using different password combinations. Since the current product does not have 6 mm compression function, the pressure cannot apply to the joints sufficiently. With the novel product, all gaskets are pressurized equally and air flows in and out under control. The previous design was not suitable with IP65 sealing level. By the new one IP65 sealing level requirements are achieved.

IV. CONCLUSION

With this study we conducted we met the needs of the HVAC industry requirements in locking industry. Innovations we have added to our product and the concluded results are achieved. Instead of 5 mm compression level in previous design, it is increased to 6 mm. The level of IP65 sealing requirements and the requirements of the EN 60529 standard are achieved. Thanks to our push-open function, a controlled air outlet has been achieved. The goal is to continue to develop products by adapting it to the changing needs of the industry and bringing it to market at the next level.

ACKNOWLEDGMENT

This study is a part of a R&D project of Mesan Locks Inc., Turkey, titled "Developing a mechanism that has both functions hinge and latch, helps supply controlled air outlet" (Klima santralleri için hem kilit hem menteşe görevi gören, güvenli hava aktarımı sağlayan fonksiyonel mekanizma geliştirmesi) and Project Number MP20002.

REFERENCES

[1] The Enclosure company website. [Online]. Available: https://www.enclosurecompany.com/ip-ratings-explained.php.
[2] IEC EN 60529, "Degrees of Protection Provided by Enclosures (IP Codes)," ed. 2.1 (Geneva: International Electrotechnical Commission, 2001).
[3] The Industrilas website. [Online]. Available: https://industrilas.com/en-us/industries/hvac
[4] Plastics-Evaluation of the action of microorganisms, ISO 846 Std.1997.
[5] Ventilation for Buildings-Air Handling Units -Mechanical Performance DIN EN 1886 Std.2009
[6] A. Muller, & S. Karevska, "How will 3D printing make your company the strongest link in the value chain?", EY's Global 3D printing Report 2016, 2016. [Online]. Available: https://www.ey.com/Publication/vwLUAssets/ey-global-3D-printing-

report-2016-fullreport/$FILE/ey-global-3D-printing-report-2016-full-report.pdf. [Accessed 2019].
[7] Tony W. York,Don MacAlister "Hospital and Healthcare Securiity," Physical Security Safeguards,Ch:18,pp.437-457, 2015
[8] Arpit Arora,Arpit Pathak,Akshat Juneja,Pankaj Shakkarwal,Rajender Kumar "materialstoday:proceedings",Design & analysis of progressive die using solidworks, vol:51, Part1,pp:956-960,2022