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THE ASSESSMENT OF REFLECTOR MATERIAL DURABILITY FOR CONCENTRATED SOLAR POWER BASED ON ENVIRONMENT EXPOSURE AND ACCELERATED AGING TEST

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The reflector durability is essential to maintain suitable photo-to-thermal conversion in concentrated solar power plants. The present study evaluates the impact of environmental exposure and accelerated aging of the reflector material. The study is conducted to assess the reflector material's durability to withstand environmental exposure and accelerated aging test. The evaluation is conducted using four different reflector materials commonly used in concentrated solar power: stainless steel and silvered-glass mirror (solid-state reflector), aluminum and silvered-polymer film (sheet-based reflector). The environmental exposure and accelerated aging test are conducted for 1,080 hours according to the standard reference of ISO 8565:2011 and ASTM B117–11. The mass loss after exposure is used as a reference to determine the corrosion rate for each reflector. Further observation is conducted by using microscope light to observe the effect of exposure on the surface of the reflector. Each reflector indicates a different corrosion rate which implies different weather resistance for each reflector type. The highest corrosion rate is found on aluminum film, with a value of 295.8 g/m²·year. The accelerated aging test through neutral salt spray demonstrates that a metallic reflector has a higher corrosion rate compared to a silvered-glass mirror which uses silicon dioxide as the top coating. Microscope observation demonstrates that suitable protection from soiling elements for the silvered-glass mirror is mainly caused by the presence of silicon dioxide on the top surface of this reflector. The assessment suggests that a suitable coating can be developed to be used for reflector protection. Furthermore, the corrosion mechanism is observed clearly, which can be referred to the synthesis of new reflective material that withstands environment and salt exposure

***Keywords:** accelerated aging, concentrated solar power, reflector material, salt spray, soiling*

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1. Introduction

Climate change is a global topic that needs to be solved immediately and comprehensively among all world residents [1]. Climate change directly impacts global warming, mainly caused by high carbon emissions into the atmosphere. Carbon emission is a byproduct of the common procession of the industrial, power and transportation sector, which is mainly driven by hydrocarbon fuel. On the other hand, high hydrocarbon fuel consumption leads to a significant decrement in fossil fuel reserve across the globe and potentially bring a global energy crisis [2]. Efforts have been made to solve the problem by improving the existing energy system [3] or modifying the existing system and occupied with intelligent sensors for energy management [4], which successfully slows down the fossil-fuel crisis risk. Further effort is also considered by utilizing renewable energy sources and shifting the energy balance on the demand side by introducing energy substitution from alternative sources such as biomass.

Renewable energy sources are done mainly by harvesting solar and wind energy, which is abundantly available across the earth. As a good example, wind turbine technology is proven highly feasible in a specific region with sufficient wind potential and producing cost-effective electricity [5]. Solar energy utilization can be done by using photothermal and/or photoelectric conversion [6]. The intermittent nature of solar and wind energy can be tackled by equipping the plant with an energy storage system [7]. There is various model of the energy storage system, such as direct storage method by storing electrical and thermal energy or indirect method like hydrogen storage and heat for pyrolysis process [8]. Despite the type of storage model, the storage system provides a better renewable energy plant, promoting affordable clean energy and reliable power sources.

Solar energy utilization through photoelectric conversion uses photovoltaic, while photothermal conversion operates as concentrated solar power [9]. Specifically, concentrated solar power can be applied to broader applications since it produces thermal energy, which can be taken for several applications that require heat in the process, such as desalination, industrial heat process and power generation. Nevertheless, the technical barrier to developing concentrated solar power remains high and requires extensive research to effectively solve the related problem to maximize the plant operational capacity throughout the year. The nature interruption mainly causes the technical barrier during photothermal conversion since the plant is located in an open environment and potentially disrupted by the weather.

Concentrated solar power works by reflecting the incoming solar radiation with the help of a concentrator to a smaller surface area which is defined as the receiver. The reflection process is done by attaching reflective material on the concentrator surface called a reflector. The amount of photo-to-thermal conversion depends entirely on the amount of reflected light from the reflector to the receiver. The reflector is attached to the concentrator surface, which can be formed as a parabolic trough, parabolic dish, flat reflector for tower system and Fresnel reflector. Several related problems with the nature phenomenon are the adjustment of concentrator position in order to follow the sun position, which can be solved by using a tracking system. The tracking system can maintain the concentrator position at the optimum spot to track the movement of sun position and ensure the photo-to-thermal conversion effectively throughout the day. The generated thermal power from the receiver can be stored in the thermal energy storage unit [10], which can be transported using heat transfer fluid through a convective heat transfer system [11] and pumping system [12]. Another critical technical barrier for the concentrated solar power plant is related to the environmental effect on the reflector degradation, which reduces the photo to thermal conversion.

The solar thermal power plant concentrator is located in an open environment, making direct contact between the reflector and the surrounding area. The time shifting from day to night promotes a significant temperature difference and repeatedly occurs during the plant operation. Another factor related to the environment is the weather, rain and dry season, which repeatedly occur throughout the year and lead to a higher surface degradation on the reflector surface. Furthermore, the atmosphere and site area of the solar thermal plant can be a high sand exposure (i.e., desert area), high pollutant particles (urban and industrial regions), high humidity environment (for the tropical area) and salt particles (for the coastal area) causing a different effect on the surface degradation of the reflector material [13].

The soiling effect from the environment varies between sites and depends on the reflector type. Thus, the assessment for reflector material is essential to observe the durability of the reflector candidate to withstand according to the nature of the site location. Different soiling effects provide essential information to understand and determine the ideal candidate of the reflector for solar thermal plants that can withstand the site environment. Therefore, research in the assessment of reflector material for environmental exposure is fundamentally essential to conduct in the first place before establishing the solar thermal plant, particularly for the tropical and coastal area which has high solar radiation and can be taken as the ideal area for installing concentrated solar power plant for clean thermal energy production.

2. Literature review and problem statement

The reflectance index and reflection accuracy from the reflector on the concentrated solar power concentrator are critical indicators to ensure the quality of photo-to-thermal conversion. The reflectance index is related to the reflective surface's ability to reflect the incoming radiation with minimum losses (transmittance and absorptance), where the accuracy determines the specularity of the concentrator [14]. The accuracy works with the solar tracking system to maintain the effective reflection process during the daytime and the sun's movement, both in azimuth and latitude direction [15]. To obtain high effectiveness of photo-to-thermal conversion, the terrestrial of solar spectrum is ideally between 200–4000 nm. As discussed in detail here [16], any reflection losses due to environmental exposure (soiling effect) and diffracted reflection resulting from diffuse reflectance reduce the overall performance of concentrated solar power.

Environmental exposure leads to surface degradation due to soiling matter and temperature gradient. For instance, a reflector–absorber made of ZrO_x/ZrC-ZrN/Zr implies the impact of microstructure and mechanical deformation on the solar thermal response after electrochemical and nanoindentation characterization [17]. It reduces the reflectance index of the reflector and promotes diffracted radiation from the incoming radiation [18]. The main challenge for reflector-absorber is the required time for assessing the ability of the reflector/absorber material to the environmental exposure, which takes time. It is mainly caused by the diffusion process of soiling matter and the impact of environmental exposure, which generally varies from site to site. The diffusion process is also relatively slow, which makes the characterization of reflector material conducted both as actual environmental exposure and accelerated aging test [19].

The assessment through the combination of actual environment exposure and the accelerated aging test is expected to provide more reliable data for characterizing the reflector material. The accelerated aging test through neutral salt spray is generally conducted since it shows a relevant result for the common metallic surface and can be used as a suitable option for the site selection of concentrated solar power plant in coastal areas [20]. Further consideration is taken for the environmental exposure test, which depends on the local climate, which varies from one specific area. For example, the article [21] discusses the assessment of solar reflectors for a concentrated solar power plant in Morocco, indicating a high soiling loss from the reflector. It is specifically addressed as the impact of sand erosion on the reflector surface, which is also worsened by the arid climate. As a result, the soiling rate is obtained up to 35 % after one week of exposure. Another study [22] also reports in detail the impact of sand erosion on the solar reflector material. The study also proposes a better method for testing the solar reflector by considering the wind speed and relative humidity to understand the corrosion and erosion model for the selected reflective material.

There are numerous alternatives for reflective materials in a solar concentrator. However, the primary consideration for choosing the reflector material is related to the durability to withstand environmental exposure and the formability of the reflector to the concentrator shape, particularly for paraboloid reflectors [23]. The study [24] discusses in detail the effect of surface slope error and optical performance of the reflector for concentrated solar power systems. The flat concentrator tends to have a lower error reflection than the paraboloid reflector. However, the paraboloid reflector (particularly for the parabolic dish) is relatively better in solar concentrator ratio compared to flat reflectors such as heliostat in solar tower systems [25]. When the cost comes into consideration during the developing process, stainless steel reflector has an advantage, as discussed here [26]. The stainless-steel mirror is also known to have a better mechanical property to withstand mechanical degradation from environmental exposure. The common reflector material is a silvered glass mirror with a higher reflectance index and suitable durability, including the possibility of using various coatings as extra protection and minimizing the transmittance index [27]. However, both reflectors are considered solid-state reflectors, which are hard to attach to the paraboloid concentrator's surface.

The paraboloid concentrator requires a relatively thin reflector (sheet-based reflector) since it has better formability than a solid-state reflector. The sheet-based reflector can be adjusted precisely according to the concentrator shape without special treatment as commonly required for solid-state reflectors [28]. The review in the article [29] demonstrates the potential of using a sheet-based reflector since it is also considered has a better accuracy of the reflected radiation and low weight, which reduces the load of the motor driver for the solar tracking system. The specular reflectance of silvered-polymer and aluminum film reflectors is considerably high, up to 80 %. Thus, both reflectors can be used as suitable reflector materials for concentrated solar power concentrators. Furthermore, the aluminum film reflector is relatively low cost with a suitable reflectance index and can be easily fitted to the concentrator shape made of poly(methyl 2-methyl propanoate), polyvinyl chloride and even metal base concentrator [30]. However, the durability of silvered-polymer and aluminum film reflectors is generally low and becomes the major drawback on the actual application. Each type of reflector has advantages and disadvantages, which make it is essential to conduct a study for the durability of those reflector materials and assess its ability to withstand to the environment exposure and accelerated aging test. It helps to further analyze and decide which material more suitable under specific environment conditions.

3. The aim and objectives of the study

The study aims to assess the durability of the chosen reflector candidate through actual environmental exposure and accelerated aging by using a neutral salt spray test. The proper assessment is expected to evaluate the reflector's ability to withstand the environmental conditions for the actual implementation of concentrated solar power. It is also essential to develop a suitable coating, such as an anti-soiling coat by using the finding from this study.

To achieve this aim, the objectives are set:

– to evaluate the corrosion rate of the solid state and sheet-based reflector through environmental exposure and salt spray test;

– to understand the degradation mechanism after environment exposure and salt spray test through microscopic observation.

4. Materials and methods of research

The study indicates two relevant reflectors, which are defined as solid-state reflectors (stainless steel and silvered-glass mirror) and sheet-based reflector (silvered-polymer and aluminum film reflectors). Both types can potentially be applied as reflector material for the solar concentrator. In order to understand the actual durability of the reflector candidates, it is essential to take an assessment by using a specific condition that combines actual environment exposure and accelerates aging test through a neutral salt spray.

The study's primary goals are to assess the reflector material's durability to withstand environmental exposure and compare it with the accelerated aging test through a neutral salt spray. Four different reflectors were prepared and divided into two major categories: solid-state and sheet-based reflectors (Table 1). The reflectors were chosen by considering their potential to be installed on the concentrator for concentrator solar power.

Table 1

Sample reflector

Category	Type	Reflectance
Solid state reflector	Stainless steel 201	0.62+2
	Silvered-glass mirror	0.95+1
Sheet-based reflector	Aluminum film	0.86+4
	Silvered-polymer film	0.92+3

Two different aging tests were done for the reflectors using actual environment exposure and neutral salt spray for 1,080 hours (45 days). For the actual environmental exposure, the samples were placed in an open environment at the top of a building (38 meters after sea level) located in Jakarta, Indonesia (with detail coordinates of altitude – 6.339083 and longitude 106.833168). The standard reference for the environment test is close to ISO 8565:2011 by considering the typical weather for a tropical area with high relative humidity and air pollutant in an urban area. The aperture area of the specimen is 150 mm (length) and 100 mm (width). The mass of the sample was measured every 72 hours (3 days) by using high accuracy weight scale (0.001 g). The mass loss for each reflector during the environment exposure was taken to determine the corrosion rate according to the mass loss method.

The second assessment was taken using an accelerated aging test through standardized salt spray apparatus according to the ASTM B117–11. The test used sodium chloride ($NaCl$, purities 99.8 %) with a weight ratio of 5:95 by mass water. The temperature of the salt spray chamber was set at 50+2 °C. The specimens were placed in the chamber with an inclination angle of 22° relative to the atomizer tower. The size of the sample is similar to the environment test (150 mm (length) and 100 mm (width)). The exposure time was set for 1,080 hours. The final mass of the reflector after salt spray exposure was then measured to obtain the mass index of corrosion rate after the accelerated aging test. For further inspection, all samples were observed using a light microscope to detect the corrosion mechanism on the reflector surface after exposure to the environment and salt spray.

5. Results of assessment for corrosion rate of reflector material

5. 1. Results the corrosion rate of the solid state and sheet-based reflector after environment exposure and salt spray test

Fig. 1 presents the corrosion rate based on mass index of corrosion rate for each reflector type after environment exposure and salt spray test. It shows that each reflector has a different corrosion rate. The solid-state reflector consists of a silvered-glass mirror and stainless steel has a lower corrosion rate after environment exposure for 1,080 hours. Stainless steel has a higher corrosion rate, with an average value of 94.3 g/m^2.year, compared to silvered glass mirrors, with a corrosion rate of 9.8 g/m^2.year. In contrast, sheet-based reflectors demonstrate a higher corrosion rate than a solid-state reflector. The aluminum film shows the highest corrosion rate by a value of 276.3 g/m^2.year, while the silvered-polymer film has relatively lower corrosion by a value of 230.8 g/m^2.year.

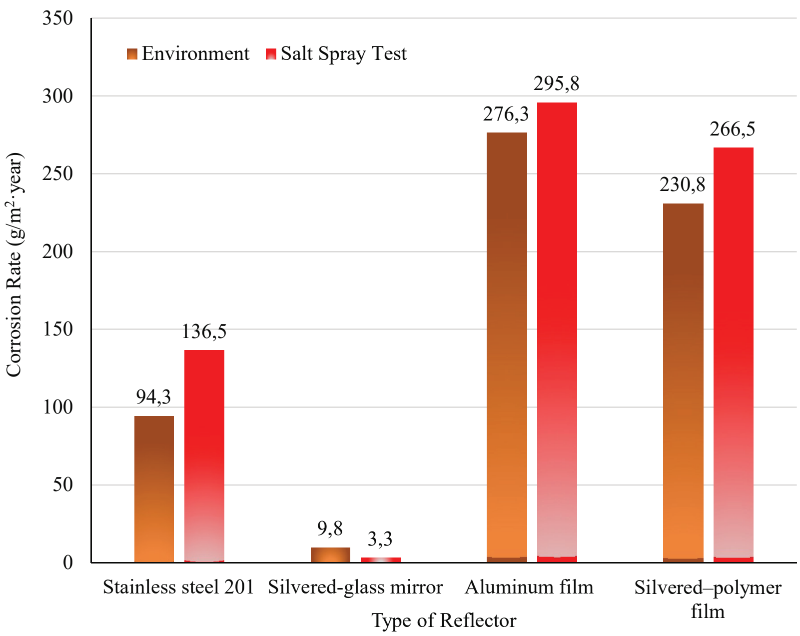


Fig. 1. Corrosion rate for reflector material under environment exposure and neutral salt spray test

The accelerated aging test through neutral salt spray provides a clear comparison of the corrosion rate of each reflector. The exposure time for accelerated aging and environment test are the same; thus, the differences solely depend on the reflector's ability to withstand different environmental conditions. As observed, the corrosion rate for solid-state and sheet-based reflectors denotes a higher value after the accelerated aging test. Again, the aluminum film has the highest corrosion rate after salt spray exposure, with a final corrosion rate of 295.8 g/m^2.year, followed by silvered-polymer film and stainless steel, with corrosion rates of 266.5 and 136.5 g/m^2.year, respectively. Interestingly, the corrosion rate for silvered glass mirrors indicates a lower value after the salt spray test compared to environmental exposure. The final corrosion rate after salt spray exposure for the silvered glass is only 3.3 g/m^2.year.

5. 2. Results of surface observation after environment exposure and salt spray test through to understand the corrosion mechanism

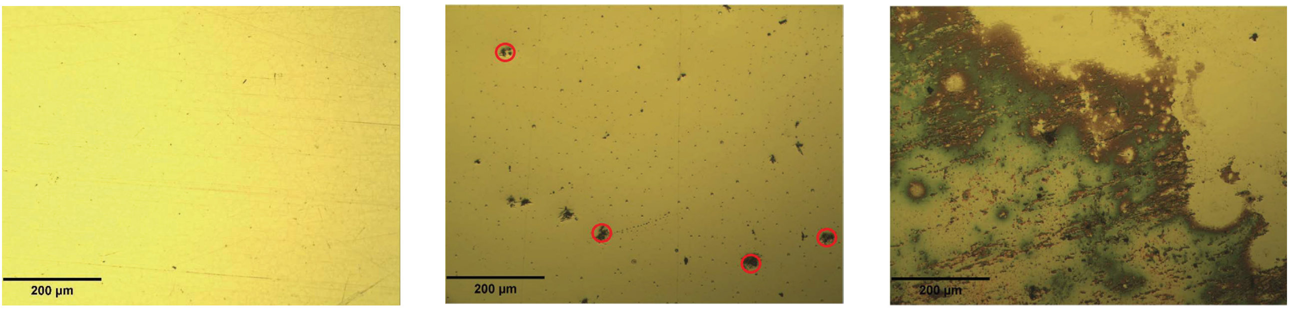
Further observation is done using microscope light to visualize the sample's surface after environmental exposure and neutral salt spray. Fig. 2 presents the comparison of the stainless-steel reflector before and after exposure. As can be seen, there is significant surface degradation after the environmental exposure and accelerated aging test. The effect of environmental exposure is observed as the formation of pitting corrosion (the red circle) on the surface of the stainless-steel reflector. Oppositely, the actual corrosion of stainless-steel reflectors is demonstrated after salt spray exposure. Rust corrosion is formed and can be observed noticeably from the stainless-steel surface after the salt spray test. The salt exposure accelerated the oxidation process and promotes a significant mass loss which increases the corrosion rate of the sample.

Fig. 3 presents the surface observation from a reflector silvered-glass mirror. There is no significant change before and after exposure to the actual environment and the neutral salt spray test. However, it can be spotted that several pitting corrosions (the red circled) occur on the surface of a silvered glass mirror. In addition, micro-pitting corrosion occurred for the sample after the actual environment test. Furthermore, it also observed that a defect (the green squared box in Fig. 3, *a*) appeared after accelerated aging, which can be caused by an atomized salt particle during exposure within the chamber.

Significant surface degradation is observed clearly for the sheet-based reflector after environment and salt spray exposure. As seen in Fig. 4, the surface characteristic of the aluminum film before exposure shows numerous pitting formations, which naturally occur for this type of reflector. As a result, environment exposure and accelerated aging test through a salt spray chamber accelerate the pitting formation and reduce the reflector's mass, thus increasing the corrosion rate of the aluminum film reflector. Extreme corrosion as rust is shown for the sample after environment and salt spray exposure (the red rectangular line). It makes sufficient particle losses of the aluminum reflector, which detached from the base material and led to significant mass losses. Moreover, the thin film leads to an extra defect which can be seen as a scratch (the blue rectangular line, Fig. 4, *b*) caused by soil particles and accelerates the molecular diffusion from air and pollutant to form rust.

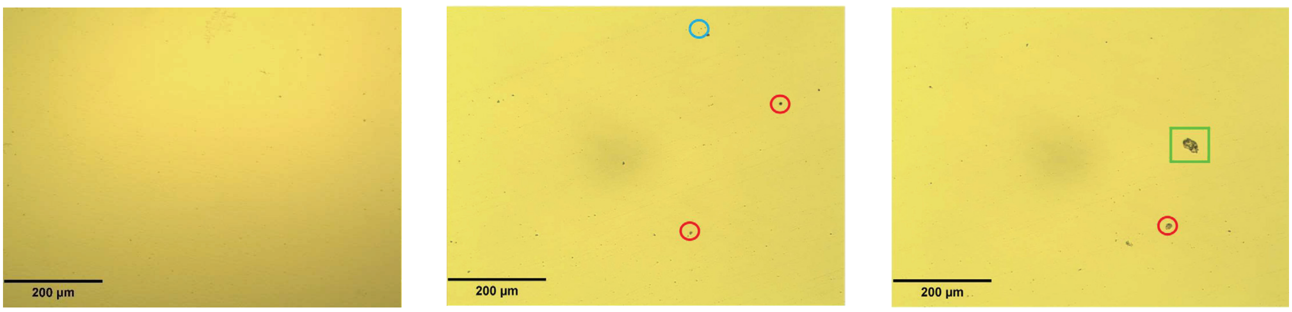
Though the silvered-polymer film is considered as a sheet-based reflector, it shows a different surface degradation compared to aluminum film. It is clear that the corrosion mechanism varies from one type of reflector to another. It can be observed for the surface observation of silvered polymer film before the exposure test, which clearly shows an almost perfect surface without pitting formation (Fig. 5, *a*). As a result, the environmental exposure leads to a different surface degradation which can be indicated as deposit formation (the green circled) and micro pitting formation (the blue circled). However, the same sample is also experiencing rust formation after environment exposure (the red rectangular line). The accelerated aging test through salt spray promotes pitting corrosions (the red circled) and scratches (the blue rectangular line), which can be promoted by atomized salt particles within the chamber during the exposure period.

The surface observation for all samples demonstrates significant transformation for the degradation caused by environment and salt spray exposure. Thus, the corrosion mechanism for each reflector varies and is caused by the nature of the reflector type and environment condition for the actual exposure and accelerated aging test. The indication can then be referred for further consideration to assess the potential reflector type to meet the site location criteria for concentrated solar power.



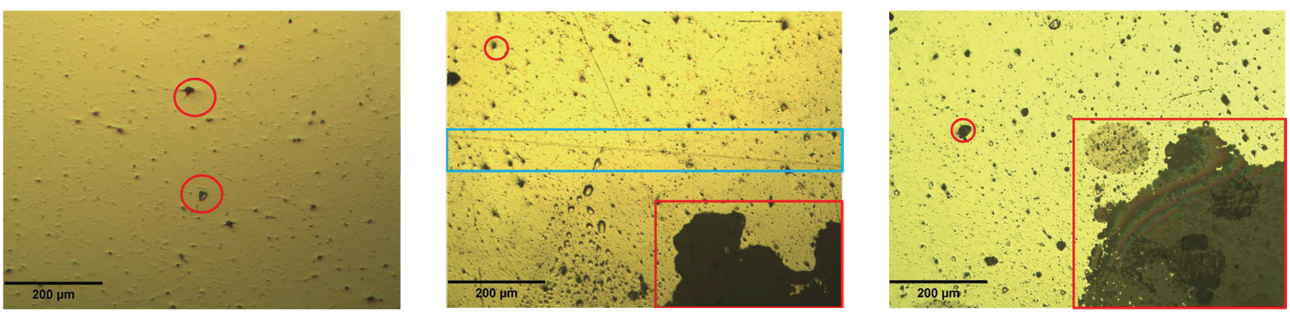
a *b* *c*

Fig. 2. Microscopic observation for stainless steel reflector:
a – before exposure; *b* – after environment exposure; *c* – after neutral salt spray



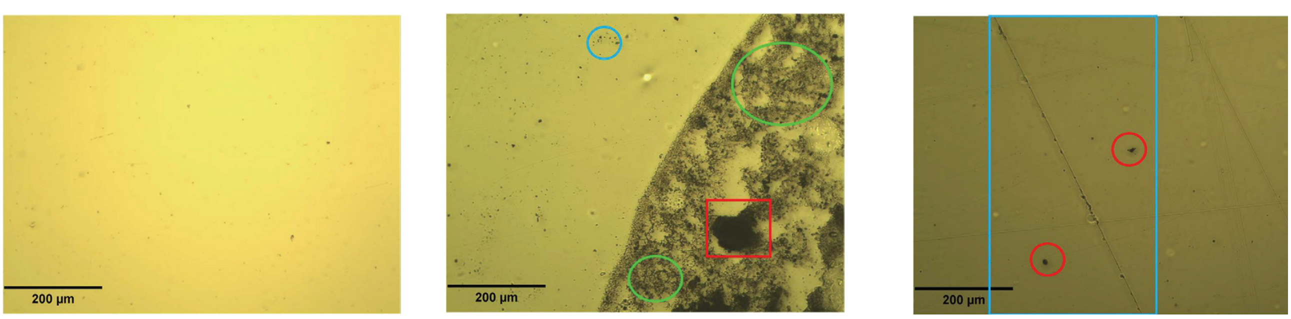
a *b* *c*

Fig. 3. Microscopic observation for silvered glass mirror:
a – before exposure; *b* – after environment exposure; *c* – after neutral salt spray



a *b* *c*

Fig. 4. Microscopic observation for aluminum film reflector:
a – before exposure; *b* – after environment exposure; *c* – after neutral salt spray



a *b* *c*

Fig. 5. Microscopic observation for silvered polymer mirror:
a – before exposure; *b* – after environment exposure; *c* – after neutral salt spray

6. Discussion of the results of assessment for corrosion rate of reflector material

Locating the solar concentrator in an open environment causes soiling losses due to weather conditions, humidity, solar radiation and daily/seasonal temperature gradient. It makes the reflector material experience aging, which reduces its ability to meet the targeted function as a reflective surface to collect incoming solar beams. The typical method for determining the aging effect of the reflector is the corrosion rate since most reflective surface employs metal-based compound. It can be observed in Fig. 1, which indicates that the all-reflector experiences corrosion. The corrosion rate for solid-state reflectors shows a lower value than sheet-based reflectors after the environment and neutral salt spray exposure. It proves that the nature of stainless steel and silvered-glass mirror has better environmental durability and withstand the soiling effect. Therefore, the corrosion rate for both reflectors is lower than sheet-based reflectors. Notably, the silvered-glass mirror has the lowest corrosion rate compared to the other reflectors after the environment and neutral salt spray, indicating that this type of reflector has better corrosion resistance to maintain its onsite performance.

The neutral salt spray test shows the highest corrosion rate to environmental exposure. It is the main reason this method is employed for the reflector assessment since it provides a better comparison to understand the durability of reflector material. The salt concentration during the salt spray test promotes a reasonable estimation of the reflector material under extreme conditions, particularly for a site close to the coastal area. Aluminum and silvered polymer reflectors have the highest corrosion rate than stainless steel and silvered-glass mirrors. Those reflectors use thin film, making it easier to degrade as the impact of high erosion rate during the exposure time. Though both samples indicate substantial increment in the corrosion rate, the highest increment is obtained by stainless steel, which increases by 44.7 % compared to environmental exposure. It shows that the stainless steel is relatively weak to withstand a high-salinity environment, which makes it inadequate for installation in coastal areas.

The microscope light observation provides essential information to understand the corrosion mechanism for each reflector under different environmental exposure. Fig. 2 presents a distinct factor affecting the corrosion rate of stainless steel after an accelerated aging test through the neutral salt spray. The main corrosion for stainless steel is formed as rust corrosion (Fig. 2, *c*) which drives a higher mass loss after the salt spray test. The escaping electron from the metal host forms a free ion and reacts with oxygen. On the contrary, environmental exposure is a slower process that does not facilitate further oxidation. It only causes several defects, mainly formed as pitting corrosion caused by high ash content on the surface of stainless steel and the other soiling particulate that promotes a localized diffusion process.

Perhaps, the ideal result is only shown by a silvered-glass mirror with minimum corrosion defect both for the environment and neutral salt spray test (Fig. 3). The top coat for the glass is used silicon dioxide (SiO_2) that optimally protects the reflective surface, which mainly made of silvered layer compound. Since the silicon dioxide layers effectively protect the reflective surface, it makes the sample able to withstand erosion from soiling particulate (during environment exposure) and salt exposure during the salt spray test. As seen in Fig. 3, *c*, the only corrosion form is pitting corrosion with an unsubstantial defect after the accelerated aging test. Thus, it corresponds to a lower corrosion rate for the silvered-glass mirror.

Microscope observation for aluminum film indicates extreme corrosion after the environment and neutral salt spray exposure (Fig. 4). The initial condition of the reflector (Fig. 4, *a*) shows pitting, which spread around the reflector surface that provides a pathway for soil element and pollutant to diffuse with the metallic structure. As a result, significant mass loss occurs caused by a higher corrosion rate. Furthermore, Fig. 4, *b* implies scratches on the surface (the blue rectangular line) as the effect of erosion from soil elements (dust, sand, ash, or other pollutants) wiped out by the wind. The thin film of the aluminum reflector makes the reflector quickly degrade with the soiling particulate. Fig. 4, *c* shows the impact of the accelerated aging test, which promotes higher corrosion on the reflector surface. It can be observed that the pitting corrosion becomes wider and spreads out evenly on the entire surface. The rust corrosion is also concentrated on several locations of the reflective surface as the effect of electron diffusion from aluminum film, similar to stainless steel.

Silvered-polymer reflectors demonstrate better surface resistance as a sheet-based reflector. The corrosion rate for the reflector is relatively lower than the aluminum film, with a corrosion rate of 230.8 g/m^2·year and 266.5 mm/year, compared to aluminum film with a higher corrosion rate of 276.3 g/m^2.year and 295.8 g/m^2·year. Microscopic observation for the reflector shows a localized deposit on the surface after environmental exposure for 1,080 hours (the green circled in Fig. 5, *b*). The soiling element caused it to stick on the reflector surface. Contrary to that, surface observation after the accelerated aging test indicates scratch (the blue rectangular line, Fig. 5, *c*) and pitting corrosion. According to the result, the silvered-polymer film demonstrates a higher corrosion resistance to salt exposure, making it better than aluminum film and stainless steel.

The assessment proves that the effect of environmental exposure and accelerated aging test through neutral salt spray degrades the surface of the reflector material. The environment exposure assessment combines the effect of weather and day shifting, which affect different corrosion mechanisms for each reflector type. A different result is shown after the accelerated aging test with a standardized salt spray test for each reflector, which implies different corrosion mechanisms that vary based on reflector characteristics. The finding in this study is useful to be used as a suitable reference for developing a special coating that protects the reflector based on the corrosion characteristic and environmental condition.

Nevertheless, there are still limitations from the study. Therefore, further study still needed by focusing on the detail of corrosion mechanism for the reflective material, including more in detail observation through scanning electron microscope (SEM), chemical analysis for the composition of reflector material. It also can be correlated better by addressing the effect of corrosion for the reflective index. Thus, the result can be used specifically for developing anti-soiling coating and material development for reflector in concentrated solar power.

7. Conclusions

1. The solid-state reflectors indicate a lower corrosion rate compared to a sheet-based reflector which demonstrates a higher corrosion resistance where the highest corrosion rate is 136.5 g/m^2.year for stainless steel (solid-state reflector) and 295.8 mm/year for aluminum film reflector (sheet-based reflector).

2. Accelerated aging through salt spray promotes a higher corrosion rate for the metallic reflector (stainless steel, aluminum film and silvered-polymer film), which promotes rust corrosion where the silvered-glass mirror indicates better corrosion resistance as the presence of silicon dioxide which protects the silvered-reflective surface.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

Data will be made available on reasonable request.

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