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Physics Learning in Secondary Schools by Sea Water Purification Devices Using Solar Panels: Systematic Literature Review

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Abstract: There are several ways to purify sea water to make it suitable for use, one of which is:is through a purification process by utilizing solar energy. Apart from being cheap, this energy is also renewable and highly available abundant in tropical areas. Solar energy is an important component for Human survival because human life activities are very dependent on energy availability. This research examines solar panel-based sea water purification devices as a physics learning medium in secondary schools. Using the Systematic Literature Review (SLR) method, this research analyzes various studies on the development of sea water purification equipment that utilizes solar panels. This study highlights relevant physical material such as thermodynamics and renewable energy, which is used as a basis for developing sea water purification devices using solar panels. In addition, this research identifies variations in the tools and materials used in the desalination process, as well as the application of these tools in the context of physics learning.

Keywords: Physics Learning; Sea water purifier; Secondary school; Solar Panels

Introduction

In the era of competitive globalization, high-quality human resources are the main key to a nation's progress. The ability to compete with other nations is very dependent on the quality of human resources possessed. Education is the main determining factor in shaping the quality of human resources. The better the quality of a nation's education, the better the quality of its human resources (Ewar et al., 2023).

Education plays a crucial role in supporting the success of nation development. Education cannot be separated from the learning process, especially in scientific fields such as physics. Physics studies natural phenomena through a series of scientific processes, starting from observation, formulating problems and hypotheses, conducting experiments, to drawing conclusions and discovering theories and concepts (Fatmawati et al., 2022).

In essence, product-oriented learning aims to increase student competence in various aspects of scientific performance. Some of these aspects include the ability to plan and design, use equipment (especially if the product produced is innovative), carry out projects, observe and record data, interpret results, and be responsible for the entire process and final results (Ernidawati et al., 2021). In an educational context, selecting appropriate learning strategies, including the use of appropriate media, can increase student understanding and create a more interesting and enjoyable learning atmosphere (Ghifari et al., 2023).

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Increasingly serious global environmental problems have had a negative impact on the lives of coastal communities. They are increasingly having difficulty getting clean drinking water because wells are polluted by sea water intrusion and flooding. However, Indonesia has great potential in developing solar energy because of its abundant resources. Solar energy can be an alternative solution to overcome the problem of limited clean water and other energy needs in coastal areas (Arif et al., 2020).

Considering that water is a basic human need and a natural resource contained in the earth, its management and utilization in Indonesia is regulated in the 1945 Constitution Article 33 Paragraph (3). This article emphasizes that the earth, water and natural resources contained therein are controlled by the state and must be used for the greatest prosperity of the people. Therefore, the state has the responsibility to ensure the availability and access to clean water for all communities, especially for those who live in coastal areas which are vulnerable to environmental problems (Ernidawati et al., 2022).

Global water demand continues to increase along with population growth and industrial development. However, the availability of clean water sources is decreasing due to environmental pollution and climate change. This condition is exacerbated by the scarcity of clean water in arid or dry areas and coastal areas. Therefore, there needs to be serious efforts from the government and society to preserve water sources, develop water treatment technology, and look for alternative water sources such as solar energy to overcome the problem of lack of clean water (Khlaifat et al., 2024).

Water is an essential element for all living things on earth. However, the need for fresh water continues to increase along with population growth and industrial development. Even though the sea is the largest water source, sea water cannot be used directly because of its high salt content. Desalination is a solution to convert seawater into fresh water, but this process requires large amounts of energy, usually coming from fossil fuels. Therefore, it is important to look for renewable energy alternatives that are more environmentally friendly for the desalination process, such as solar energy which is abundant in Indonesia (El-Naggar et al., 2016).

One renewable energy that can be used as an alternative energy source is the use of solar power (solar cells). Solar panels are a renewable electrical energy generator that has become widely used in recent years. Solar panels are an electricity generator that utilizes solar energy as its main energy source. Solar energy sources are one of the most feasible or economically reasonable alternative energy sources and is one of the techno-economic solutions for electricity for rural areas (Sukma et al., 2020)

Based on this presentation, the researcher wants to explain how to use sea water purification equipment using solar panels in physics learning. The study begins by explaining what materials have developed for sea water purification devices using solar panels. Here are the questions for this article; what high school physics material can be developed using a sea water purifier?; what variations are used in sea water purifying devices?; how is the sea water purification device implemented?; what are the specifications of a sea water purifying device that uses solar panels?; and how to implement a sea water purification device using solar panels.

Method

The method used in this research is Systematic Literature Review (SLR). With a survey-based quantitative descriptive approach. The survey was conducted on secondary data, namely the results of research into the development of sea water purification equipment using solar panels. Research stages include data collection, data analysis, and drawing conclusions. The data collected is in the form of primary research that has been published in national and international journal articles, data is collected from electronic databases registered with Google Scholar, Publish or Perish, Science Direct, and Tandfonline. Next, all articles found were extracted. Only articles that were relevant and met the inclusion criteria were included in the analysis stage.

Inclusion criteria to obtain data that is in accordance with the research objectives. The following inclusion criteria were used: Evaluating studies in the field of physics; The study analyzed seawater purification devices primarily using solar panels; Research targets from secondary school to tertiary education level (PT); The study must include the approach or method used in the research. Primary studies that did not meet the inclusion criteria in the study selection process were excluded from this systematic review study process. The research instrument is an observation sheet relating to inclusion and exclusion criteria based on year of publication, level of study, number of samples, research location, journal indexer and material used.

The protocol that the author uses is the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyzes) protocol. The primary study selection process is carried out through four stages which refer to PRISMA, namely; identification, screening, eligibility, and included. The population in this study is all research on sea water purifying devices published in indexed journals. Based on searches using social media, a sample of 66 articles was found. What will be analyzed in this research are the design, development and implementation stages of the tool.

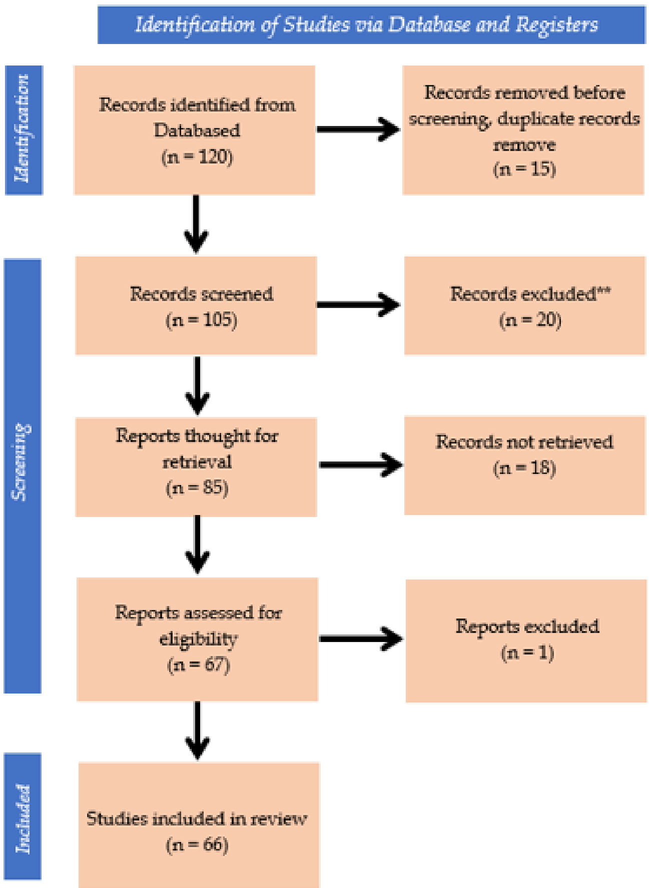

Figure 1. Stages that refer to PRISMA

Result and Discussion

What secondary school physics material can be developed using a sea water purifier?

The results of this research reveal positive results in the development of sea water purification equipment. Researchers found several physical materials that were used as the basis for developing sea water purification equipment.

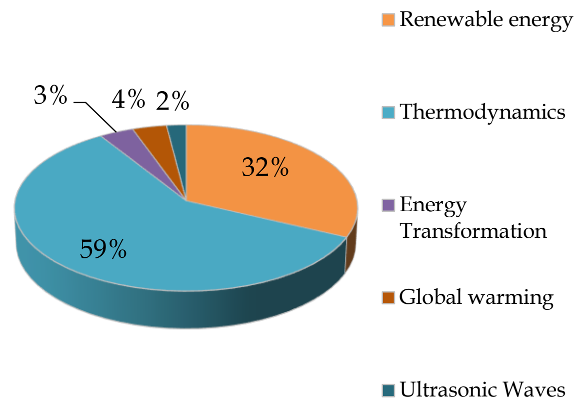

Figure 2. Physics material graph

The research results revealed that the majority (59%) of thermodynamics material was the basic supporting knowledge in developing sea water purification equipment. In renewable energy materials, the percentage obtained is (32%), which is the basis for developing sea water purification equipment. Next, energy transformation materials (3%), global warming (4%) and ultrasonic waves (2%), still contribute to sea water purification tools. The following is a summary of data regarding physical materials developed in sea water purifying devices that researchers have collected based on authors who have conducted research, related objects in the form of physical materials and the author's country of origin.

Table 1. Middle School Physics material articles that can be developed using sea water purifying equipment

Author (Year)	Object	Country of origin
(Suneesh et al., 2017)	Renewable energy	India
(Samuel et al., 2016)	Renewable energy	India, Egypt
(Khechekhouche et al., 2019)	Renewable energy	Algeria, Egypt
(El-Sebaii et al., 2015)	Renewable energy	Egypt
(Ali et al., 2015)	Renewable energy	Tunisia
(Asrori & Yudiyanto, 2019)	Renewable energy	Indonesia
(Arif et al., 2020)	Renewable energy	Indonesia
(Dewantara et al., 2018)	Renewable energy	Indonesia
(Kale et al., 2017)	Renewable energy	India
(Napoli & Rioux, 2018)	Renewable energy	Arab Saudi
(Gaib et al., 2023)	Renewable energy	Indonesia
(Tanusekar & Sutanhaji, 2014)	Renewable energy	Indonesia
(Abdulloh, 2015)	Renewable energy	Indonesia
(Missimer et al., 2016)	Renewable energy	Singapura
(Krisdiarto et al., 2020)	Renewable energy	Indonesia

Author (Year)	Object	Country of origin
(Hong et al., 2016)	Renewable energy	Korea
(Nababan et al., 2019)	Renewable energy	Indonesia
(Panchal et al., 2022)	Thermodynamics	India, Qatar
(Omara et al., 2014)	Thermodynamics	Egypt
(Malaeb et al., 2014)	Thermodynamics	Saudi Arabia, Lebanon
(Yuvaperiyasamy et al., 2023)	Thermodynamics	India, Saudi Arabia
(Rajaseenivasan et al., 2014)	Thermodynamics	India
(Larik et al., 2019)	Thermodynamics	Pakistan
(Appadurai & Velmurugan, 2015)	Thermodynamics	India
(Hoque et al., 2019)	Thermodynamics	Bangladesh
(El-Naggar et al., 2016)	Thermodynamics	Egypt
(Mahian et al., 2017)	Thermodynamics	Iran, Thailand, Saudi Arabia
(Sahota & Tiwari, 2016)	Thermodynamics	India
(Jani & Modi, 2018)	Thermodynamics	India
(Wazwaz & Khan, 2020)	Thermodynamics	Oman
(Tuteja, 2017)	Thermodynamics	India
(Noori et al., 2022)	Thermodynamics	Indonesia
(Januardi et al., 2016)	Thermodynamics	Indonesia
(Ambarita, 2018)	Thermodynamics	Indonesia
(Pratama & Rahmadianto, 2021)	Thermodynamics	Indonesia
(Munir et al., 2023)	Thermodynamics	Indonesia
(Zulkarnain et al., 2018)	Thermodynamics	Indonesia
(Natawisastra et al., 2022)	Thermodynamics	Indonesia
(Rahmalina et al., 2022)	Thermodynamics	Indonesia
(Said & Iswadi, 2016)	Thermodynamics	Indonesia
(Suyitno et al., 2018)	Thermodynamics	Indonesia
(Siregar et al., 2021)	Thermodynamics	Indonesia
(Yazidi, 2021)	Thermodynamics	Indonesia
(Nababan & Ambarita, 2015)	Thermodynamics	Indonesia
(Khlaifat et al., 2024)	Themodynamics	Mesir
(Mir & Bicer, 2021)	Themodynamics	Qatar
(Pandey et al., 2017)	Thermodynamics	India
(Sugiman et al., 2021)	Energy Transformation	Indonesia
(Niroomand & Amidpour, 2013)	Energy Transformation	Iran
(Ernidawati et al., 2022)	Global warming	Indonesia
(Ernidawati et al., 2021)	Global warming	Indonesia
(Fetyan et al., 2020)	Ultrasonic Waves	Mesir

What are the variations used in sea water purifying devices?

In making seawater purification equipment, various tools and materials are used depending on the desalination method used. In general, variations in the manufacture of seawater purification equipment are caused by factors that influence the selection of manufacturing methods and materials. Geographical and climatic conditions determine other interrelated criteria, including solar intensity and sea water quality. Therefore, the type of technology used in seawater purification devices may be more suitable in certain context. The availability and cost of energy such as electrical energy are also interconnected. In addition, areas with expensive or less stable and less developed energy will tend to use renewable energy such as solar or wind.

The scale of production and the approximate production capacity required influence whether large-scale or small-scale desalination technology is more suitable. Existing infrastructure and available technology play an important role in the same framework as local availability of materials and components. All of the above factors allow for variations that allow technologies to be selected for specific locations and everyday conditions, ensuring effective and efficient solutions. Below, the researcher describes the variations in tools and materials used in making sea water purifying equipment by compiling a table based on the author who conducted the research, the variations in tools and materials and the country of origin.

Table 2. Articles on Variations in Tools & Materials Used in Sea Water Purifying Equipment

Author (year)	Tools and materials	Country of origin
(Larik et al., 2019)	Reflector, Thermocouple, Condenser, Solar still	Pakistan
(Suneesh et al., 2017)	Glass	India
(Panchal et al., 2022)	Solar still, Parabolic collector	India, Qatar
(Omara et al., 2014)	Solar still, Reflector	Egypt
(Malaeb et al., 2014)	Drum, Photovoltaic, Aluminum mill finish	Saudi Arabia, Lebanon
(Rajaseenivasan et al., 2014)	Thermocouple	India
(Appadurai & Velmurugan, 2015)	Solar stills are made of Galvanized Iron	India
(Kale et al., 2017)	Solar still	India
(Hoque et al., 2019)	Solar still, Light steel sheet	Bangladesh
(El-Naggar et al., 2016)	Glass cover, Condensate film, Distillate Channel	Egypt
(Mahian et al., 2017)	Solar collector, Centrifugal pump	Iran, Thailand, Saudi Arabia
(Jani & Modi, 2018)	Dual tilt solar still	India
(Wazwaz & Khan, 2020)	Glass, Reflector	Oman
(Siregar et al., 2021)	Glass, Aluminum composite	Indonesia
(Yazidi, 2021)	Stone, charcoal, sand	Indonesia
(Tanusekar & Sutanhaji, 2014)	Water jet pump series, water pump	Indonesia
(Ihekweme et al., 2021)	Clay	Nigeria
(Lengaye et al., 2019)	Electric balance (KM No-2401), Normative sieve (ISO 3310-1), THERM-EURO furnace, Drying binder	Central African Republic
(Niroomand & Amidpour, 2013)	Solar chimney, Collector, Urbin	Iran
(Sugiman et al., 2021)	Solar panels, DC-AC inverter and battery	Indonesia
(Krisdiarto et al., 2020)	Glass	Indonesia
(Bosscher et al., 2019)	POU filters	USA
(Nababan et al., 2019)	Photovoltaic, Evaporator	Indonesia
(Raiguel et al., 2023)	Nanofiltration system	Belgia
(Hong et al., 2016)	RO Membrane, Generator	Korea
(Mir & Bicer, 2021)	Electrodialysis (ED) Cells & Reverse Osmosis, RO	Qatar
(Nababan & Ambarita, 2015)	Evaporator, Heating Element, Condenser, APK Pipe, Thermocontrol Panel and Thermocouple	Indonesia
(Pandey et al., 2017)	Reactor	India
(Fetyan et al., 2020)	Ultrasonic generator, membrane filtration	Egypt
(Wijayanto & Sutanto, 2011)	DC Source, Avometer	Indonesia
(Bahalwan et al., 2022)	Sand and Gravel	Indonesia
(Setiabudi & Khudhori, 2015)	Collector	Indonesia
(Ernidawati et al., 2022)	Iron, cement, bricks, sand, coral, boards, pipes, wire and nails	Indonesia
(Januardi et al., 2016)	CDI cells	Indonesia
(Asrori & Yudiyanto, 2019)	Fresnel lens	Indonesia
(Arif et al., 2020)	Solar PV	Indonesia
(Dewantara et al., 2018)	Solar Still, Acrylic	Indonesia
(Ambarita, 2018)	Solar Collector	Indonesia
(Pratama & Rahmadianto, 2021)	Coconut shell charcoal	Indonesia
(Munir et al., 2023)	Concentrated Solar Power (CSP)	Indonesia
(Zulkarnain et al., 2018)	Clear glass, concave mirror	Indonesia
(Natawisastra et al., 2022)	Glass, board, mild steel	Indonesia
(Ernidawati et al., 2021)	Glass	Indonesia
(Rahmalina et al., 2022)	Solar collectors	Indonesia
(Said & Iswadi, 2016)	Transparent glass fiber	Indonesia
(Suyitno et al., 2018)	Pyramid construction	Indonesia

How is the sea water purifier used?

When making a seawater purifying device, it is important to know the purpose of making this tool and who it will be used for. The results of several studies show that there is still very little application of sea water purifying equipment for education, so researchers realize that sea water purifying equipment for education still needs to be developed. Details regarding the application of sea water purification equipment can be found in the Figure 1.

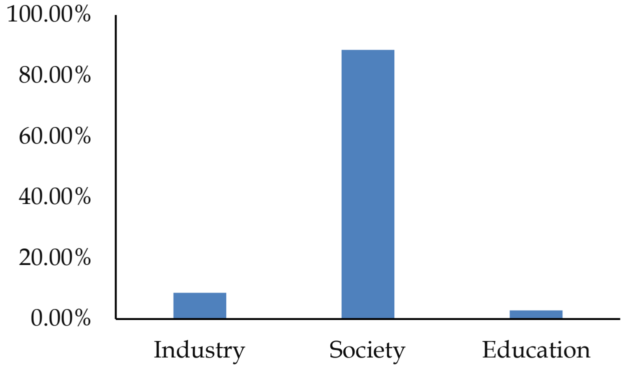

Figure 1. Graph of Application of Sea Water Purification Equipment

Figure 1 shows the percentage of application of sea water purification equipment. Research reveals that the majority (88.57%) of sea water purification equipment is applied to the community. The next application is for industry (8.57%), and the least application is for education (2.86%). Apart from the pictures, in the researcher's efforts to describe the applications of this sea water purifying device, the researcher has compiled a table based on the author who conducted the research, its application and the country of origin.

Table 3. Articles that Apply Sea Water Purification Equipment

Author (Year)	Application	Country of origin
(Larik et al., 2019)	For industry	Pakistan
(Samuel et al., 2016)	For industry	India, Egypt
(Panchal et al., 2022)	For industry	India, Qatar
(Omara et al., 2014)	For society	Egypt
(Hoque et al., 2019)	For society	Bangladesh
(Wazwaz & Khan, 2020)	For society	Oman
(Siregar et al., 2021)	For society	Indonesia
(Yazidi, 2021)	For society	Indonesia
(Abdulloh, 2015)	For society	Indonesia
(Tanusekar & Sutanhaji, 2014)	For society	Indonesia
(Napoli & Rioux, 2018)	For society	Saudi Arabia
(Sugiman et al., 2021)	For society	Indonesia
(Hong et al., 2016)	For society	Korea
Mir dan Bicer (2021)	For society	Qatar
(Fetyan et al., 2020)	For society	Egypt
(Wijayanto & Sutanto, 2011)	For society	Indonesia
(Setiabudi & Khudhori, 2015)	For society	Indonesia
(Ernidawati et al., 2022)	For society	Indonesia
(Januardi et al., 2016)	For society	Indonesia
(Asrori & Yudiyanto, 2019)	For society	Indonesia
(Arif et al., 2020)	For society	Indonesia
(Dewantara et al., 2018)	For society	Indonesia
(Ambarita, 2018)	For society	Indonesia
(Pratama & Rahmadianto, 2021)	For society	Indonesia
(Munir et al., 2023)	For society	Indonesia
(Zulkarnain et al., 2018)	For society	Indonesia
(Natawisastra et al., 2022)	For society	Indonesia
(Ernidawati et al., 2021)	For education	Indonesia
(Rahmalina et al., 2022)	For society	Indonesia
(Said & Iswadi, 2016)	For society	Indonesia
(Suyitno et al., 2018)	For society	Indonesia

What are the specifications of a sea water purifying device that uses solar panels?

There are around 15.15% who use solar panels to purify sea water, meaning that there are still few who use solar panels to purify sea water. Solar panels are devices used to convert energy from sunlight into electricity. This technology is an important part of renewable energy solutions because it utilizes clean, abundant and non-polluting energy sources.

How to implement a sea water purification device using solar panels

For the application of sea water purifying devices using solar panels, there are only 4 articles for the public, as in Table 5. Thus, it can be said that there are no sea water purifying devices using solar panels for use in the educational sector.

Table 4. Article Specifications for Sea Water Purification Equipment Using Solar Panels

Author (Year)	Specification	Country of origin
(Malaeb et al., 2014)	One Photovoltaic (PV) Panel	Saudi Arabia, Lebanon
(Appadurai & Velmurugan, 2015)	solar still (Galvanized Iron Material) with a thickness of 2 mm, dimensions of 1 m, and a depth of 0.12 m	India
(Kale et al., 2017)	The solar still is made of glass with a thickness of 4 mm	India
(Hoque et al., 2019)	The solar still has an effective area of 0.214 m2 with basin dimensions of 650 mm×330 mm	Bangladesh
(Sugiman et al., 2021)	400watt Solar Panel and inverter from DC current (250 Watt)	Indonesia
(Nababan et al., 2019)	Photovoltaics	Indonesia
(Arif et al., 2020)	7 Photovoltaics	Indonesia
(Ambarita, 2018)	solar collector with a total area of 3 m2	Indonesia
(Natawisastra et al., 2022)	solar water distiller, water heater, and mounting frame	Indonesia

Table 5. Articles that apply sea water purification equipment using solar panels

Author (Year)	Application	Country of origin
(Sugiman et al., 2021)	For society	Indonesia
(Arif et al., 2020)	For society	Indonesia
(Ambarita, 2018)	For society	Indonesia
(Natawisastra et al., 2022)	For society	Indonesia

Conclusion

This research concludes that it is necessary to develop sea water purification equipment using solar panels in the education sector. Apart from overcoming the scarcity of clean water, it is also used as a medium in secondary school physics learning to help improve science process and critical thinking skills. By integrating this tool into the school curriculum, it is hoped that students can learn about relevant physics concepts in a practical and interesting way.

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Author Contributions

The main author's contribution of ideas was Ernidawati, then collaborated with Zulia Ulfa, Nur Adh Dhuha, Rayatul Akbar, Mitri Irianti, Zuhdi Ma'ruf, Sri Wilda Albeta, Naila Fauza, Eva Astuti Mulyani, Diah Anugerah Dipuja, Meilan Demolawa, Dina Syaflita, and Defni Satria, in searching sources and drafting articles.

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Conflicts of Interest

The authors declare no conflict of interest.

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