HYBRID SOLAR STILL WITH ADDITION OF CHARCOAL AND OIL PALM FIBER ASH FOR SEAWATER DESALINATION

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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STUDENT’S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Penyulingan suria merupakan proses penyejat di mana tenaga suria digunakan untuk menghasilkan air tawar dari air garam atau air payau tetapi mengalami kecekapan haba yang rendah dan hasil air tawar yang rendah. Oleh itu, penyulingan suria menggunakan biomas sebagai simpanan tenaga haba merupakan alternatif yang menarik untuk diterokai kerana ia adalah teknik mudah untuk penyahgaraman, penggunaan tenaga yang rendah dan mesra alam. Objektif penyelidikan ini adalah untuk mengkaji kesan penyulingan suria meliputi sudut kecondongan, kedalaman air dan biomas (arang dan abu serat kelapa sawit (OPFA)) dalam penyulingan suria. Penyulingan suria direka bentuk dan dibina. Biomas, arang dan OPFA, digunakan sebagai penyimpanan haba. Kesan kedalaman air laut (1cm hingga 4 cm), sudut kecondongan penutup (10° hingga 40°) dan nisbah biomas kepada air laut (1:50, 1: 100 dan 1: 500) disiasat. Eksperimen dijalankan siang hari yang cerah selama tujuh jam dari 10.00 pagi hingga 5.00 petang. Kualiti air untuk air laut selepas eksperimen dan air yang disejat dianalisis untuk menentukan pH, kekonduksian, jumlah larut pepejal (TDS), permintaan oksigen kimia (COD) dan kekeruhan. Biomas sebelum dan selepas eksperimen dicirikan menggunakan Brunauer Emmet Teller (BET), X-Ray Detector (XRD) dan Pengimbasan Mikroskop Elektromagnetik (SEM). OPFA mempunyai kandungan karbon dan logam oksida yang tinggi termasuk SiO_2, K_2O dan CaO. Sementara itu, arang mempunyai kandungan karbon dan saiz liang yang tinggi. Permukaan arang dan OPFA stabil selepas diuji dalam air laut. Tanpa aplikasi biomas, didapati bahawa sudut kecenderungan 30º menghasilkan pengeluaran air yang sejat yang tertinggi (6.68 wt%). Kedalaman air laut pada 1cm mempunyai suhu tertinggi (51 °C) dan menghasilkan 6.14 wt% air sejat. Kehadiran arang dan OPFA meningkatkan prestasi penyulingan suria. Telah didapati bahawa hasil paling tinggi air penyejatan telah dicapai apabila nisbah biomas kepada air laut berada pada 1:100. Penambahan arang menghasilkan lebih banyak air sejat berbanding OPFA. Sebanyak 17% penghasilan air sejat dan suhu air laut sebanyak 60 °C telah dicapai apabila arang digunakan dalam penyulingan suria. Sementara itu, 11.6 wt% hasil air sejat dan 53 °C suhu air laut telah dicapai apabila OPFA digunakan. Pengurangan 60% dan 58.5% COD juga diperolehi apabila arang dan OPFA digunakan masing-masing. pH, kekonduksian, COD dan kekeruhan air sejat yang dihasilkan dari penyulingan suria mematuhi piawaian kualiti air minum. Sebagai kesimpulan, aplikasi arang dan OPFA dapat meningkatkan suhu air, menghasilkan lebih banyak air sejat dan mengurangkan kekotoran dalam air tercemar.

ABSTRACT

Solar still is an evaporator where solar energy is used to produce fresh water from saline or brackish water but suffer low thermal efficiency and low yield. Therefore, a solar still with biomass application as alternative solar thermal energy storage is attractive to explore because it is a simple technique for desalination, cheap, low energy consumption and environmentally friendly. The objective of this research is to study the effect of solar still cover inclination angle, water depth and biomass (charcoal and oil palm fiber ash (OPFA)) application in solar still for seawater desalination. The solar still was designed and fabricated. The biomass, charcoal and OPFA, was used as thermal storage. The effect of depth of seawater (1cm to 4 cm,) the cover inclination angle (10° to 40°) and biomass to seawater mass ratio (1:50, 1:100 and 1:500) were investigated. The experiment was carried out under sunny daylight for seven hours from 10.00 a.m. to 5.00 p.m. The water quality of spend seawater and evaporated water was analyzed by determining the pH, conductivity, total dissolve solid (TDS), Chemical Oxygen Demand (COD) and turbidity. The fresh and spent biomass were characterized by using Brunauer Emmet Teller (BET), X-Ray Detector (XRD) and Scanning Electromagnetic Microscope (SEM). The OPFA has high carbon and metal oxides content including SiO_2, K_2O, CaO and other traceable oxides. Meanwhile, the charcoal has high content of carbon and large pore sizes. The surface of charcoal and OPFA was stable after testified in the seawater. Without biomass application, it is found that 30º cover inclination angle contributed to the highest yield of evaporated water production (6.68 wt%). The depth of seawater at 1cm has the highest temperature (51 °C) and yielded 6.14 wt% of evaporated water. The present of charcoal and OPFA in solar still significantly enhanced the performance of solar still. It is found that highest yield of evaporated water was achieved when the biomass to seawater mass ratio was at 1:100. Addition of charcoal produces more fresh water than OPFA. A 17% of evaporated water yield and seawater temperature of 60 °C were achieved when charcoal was used in hybrid solar still. Meanwhile, 11.6 wt % of evaporated water yield and 53 °C of seawater temperature was achieved when OPFA was used. A 60 % and 58.5% reduction of COD was also obtained when charcoal and OPFA was used respectively. The pH, conductivity, COD and turbidity of the evaporated water that produced from solar still complied with drinking water quality standard. In conclusion, charcoal and OPFA application are able to increase the water temperature, produce more evaporated water and reduce the impurities in polluted water.

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