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Enhancement in Enviroeconomic Parameters of Active Solar Desalination System Using Nanoparticles

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Abstract - *In this study we have try to establish a relation between environ-economic and exergo-economic type analytical study of solar distillation system (D.S.U.S.) that coupled with N identical type of parabolic collector of concentrating type (N-C.P.C.) which is further coupled with helical coiled heat exchanger in which we use* Al_2O_3 *nanoparticles. In this analysis we observed a typical atmospheric situation of New Delhi with a fed by a tool in MATLAB. The Indian Metrological Department in Maharashtra, Pune India, collected the data needed as the study's input. On the basis of energy production over the changing seasons of winter as well as summer, the overall average utility of yearend energy output is calculated. This is followed by an assessment of the monetary (financial), enviroeconomic, and exergoeconomic aspects of the current system used in the survey of research and compared with forgoing arrangement of system. Additionally, based on yearly basis of once in a year with taking life time of arrangement 15 and 20 years. It after proper study we found that 8.5 percent more yield, the yearly exergy 7.31 percent higher, reduction of develops energy on behalf of* CO_2*. per ton is 3.9 percent and 2.85 percent decrease for corresponding years, productivity of the system is higher by amount 5.17 percent and exergo-economic domain 4 percent higher proportionately. Now we conclude that the current system configuration is substantially superior.*
Keywords: *Economic,* CO_2 *mitigation, Carbon credit earned, Environ-economic, nanoparticles*

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I. Introduction

1.1 History of distillation system by solar power is not a new one. It is an old as our industrial revolution in 1589 AD Della Porta use the term solar stills in their research for solar distillation system in 16th century. Lawrence and Tiwari [1] discovered an empirical framework for the inner factors of heat transfer from natural flow to an exchanger for heat in a solar distillery unit. Popiel and Wojtkowiak[2] learned about the thermo-physical characteristics of the fundamental fluid. Several relationships were examined by Pak and Cho [3] for various attributes. G. N. Tiwari's [4]. Research demonstrates that the solar still's basic architecture. Hwang et al. investigated the heat transmission coefficient of Al2O3 Nano-fluids. The base fluid's heat transfer coefficients can also be enhanced thus according Barden [6]. The base fluid of nano-particles of size varies from 1 to 100 nanometer size are as ethylene glycol water various thermal oils. Tiwari and Tiwari [7] highlighted very well multiple features of solar distillers that eliminate distillation challenges such as battery packs, filters, the membranes, and other equipment that have a high initial cost but lack a readily apparent source of energy. Ho et al. [8] investigated the effect of unpredictability in viscosity and heat conductivity on nano-fluids for convection that occurs naturally in a square vessel. Nano-fluid was used by Otanicar and Golden [9] to evaluate both the ecological and economic implications of solar collectors, and they discovered that it neutralises 74 kg over the course of 15 years. Patel et al. [10] discovered that Nano-fluids had thermal conductivity. Entropy generation for Nano-fluids was theoretically explored by Singh et al. [11]. Elzen et al. [12] examined carbon price, abatement expenses, and emission reductions. This paper by Khanafer and Vafai [13] demonstrated the thermo-physical properties of nanofluids. Khullar and Tyagi [14] examined and found reduced emissions of 103 kg/household/year for a solar energy system that heated for Nano-fluids. Based on the price of flat plate collectors (FPC) which employ tin oxide, copper oxide, oxide of titanium, and aluminium oxide). Nano-fluids, Faizel et al. [15] conducted an analysis. It has been noted that copper oxide's performance parameter (CuO) Nano-type fluids have a low specific heat and great thermal conductivity, making them significantly more effective at higher densities. Liu et al. [16] analysed the economic analysis of the evacuated tube's integrated solar distiller unit. The only bent solar distiller unit that contained a vacuum has been examined by Kabeel et al. [17] as a water-based Nano-fluid. Elango et al. [18] used several Nano-fluids to assess the heat generated, A single slope solar distiller's exergy and production. Omara et al. [19] examined the performance of a fluted filament type and a simple solar distiller unit employing Nano-fluids. Tiwari and co. [20] The water needs for the photovoltaic thermal flat plate collector are satisfied by a water-based nanofluid after being evaluated experimentally on an active solar distiller for exergo-economic and environmental reasons. The annual environmental and economic cost is estimated to be $6.29 US dollars. A saline water-filled active solar distiller's yearly economic performance was examined by Sharon and Reddy (21). By employing Nano-fluids to examine Sahota et al. [22, 24] arrived at the conclusion that aluminium oxide-based Nano-fluids outperformed others in the performance of a passive double slope solar distiller unit. Singh et al.'s[23] investigation into the energy matrix and existence cycle conversion efficiency produced unit expenditures of 0.144 & 0.137, respectively, in addition to exergo-economic features for traditional single and double slope distiller systems. [28]. Solvent's impact on solar distiller units was examined, and it was discovered to be effective. According to an analysis by Chen et al. [29], brackish water's constancy, optical, and thermal characteristics may be influenced by nanofluid, and it was also observed experimentally that poor luminous stability was maintained extremely well using nanofluid in solar distiller units. Mahian et al. [30] reported that the heat exchanger was of little significance at temperatures below 30 °C and that the total quantity of water was twofold the amount as it would have been otherwise. In a broad sense, we may argue that introducing nanoparticles to water promotes the transfer of warmth. transmission results in better vaporization at low temperatures. Therefore, it is crucial to assess the value of cost-effectiveness viability in the design, construction, cost of product lifecycle, total [36] Shanker et al. examined the functionality of the C.I. Anup et al. used FEA to assess the refrigerator compartment in order to maximise thermal efficiency when employing an engine powered by biodiesel fuel [37]. [38] Kumar and Singh attempt to optimise the closed-pack heat exchanger's thermal behaviour. The presentation in the field of sustainable energy by Zhang et al[39] focuses on the use of green and clean technologies. Dhivagar et al. [40] examined the energy, efficiency, and economics of a big crude smart thermal storage single slope solar still. Samsher and Dharamveer [41] evaluated the energy matrix and environmental economics of passive as well as active solar stills. Arora et al. [42] investigated the integration of carbon nanotubes via an N-PVT-CPC double slope solar distillery. [43] Dharamveer et al. conducted an analytical research on Nth comparable photoelectric thermo (PVT) compounded parabolic concentrated solar (CPC) active double gradient solar distiller employing CuO Nano-particles. [44] Dharamveer and companions evaluated the efficiency N-identical PVT-CPC collectors with active single gradient solar distillation and a spirally coiled heat exchanger. [45] Experimental and Comparative Evaluation of One Phase Microchannel Heat Flow, Kumar and Singh Making Utilisation of CFD Subrit and Singh completed a thermal research with waste cotton oil liquid and coal. When diesel engine fuel is pyrolyzed, this liquid oil gets created.

II. Methods and Materials

In both system we use aluminum oxide (Al_2O_3) nano-particles and done various calculation for result and then compare the same with previously exist system of solar distiller units.

2.1 **Description of System**

Figure 1 depicts a schematic representation of an N-identical type photovoltaic thermal compound parabolic concentrating system. Aluminum oxide (Al2O3) nano-fluid is used in a double slope configuration in a collector helical heat exchanger An active type solar distiller (N-PVT-CPC-HE). This contained a focusing parabolic collector and a photovoltaic (PV) module. Its four components are an inverter that powers it, a module, a rack, and a battery for solar power. Only 25 percent area of concentrating type parabolic collector (CPC) is used to electricity and remaining 75 percent is used to heat the nanofluid. The nanoscale fluid is then utilized to raise the temperature of the water collected in the basin. There are 'n' different types of catchers that concentrate (CPC) are used to raise the temperature of water but in our study we take only four number of concentrating type collector (CPC). These all four collector are joined by proper arrangement of piping system so that the circulation of nano fluid is maintained during the operation. After these parts a basin of dimension (2.0mX1.0mX0.2m) in meter, is also attached with heat exchanger helically coil type made by a high grade of copper material. To prevent radiation energy loss, the basin's outside surface is painted black. Finally, the top of the basin is covered by glass, which is employed to capture solar radiation for basin water evaporation. A foot valve is installed in the basin to control the level of liquid in the basin and achieve optimum performance throughout its operation. We are currently focusing on the suggested system's operation method. When the sun's energy falls on the surface of a focusing type parabolic collector (CPC) on PV module generation of direct electric current (DC).

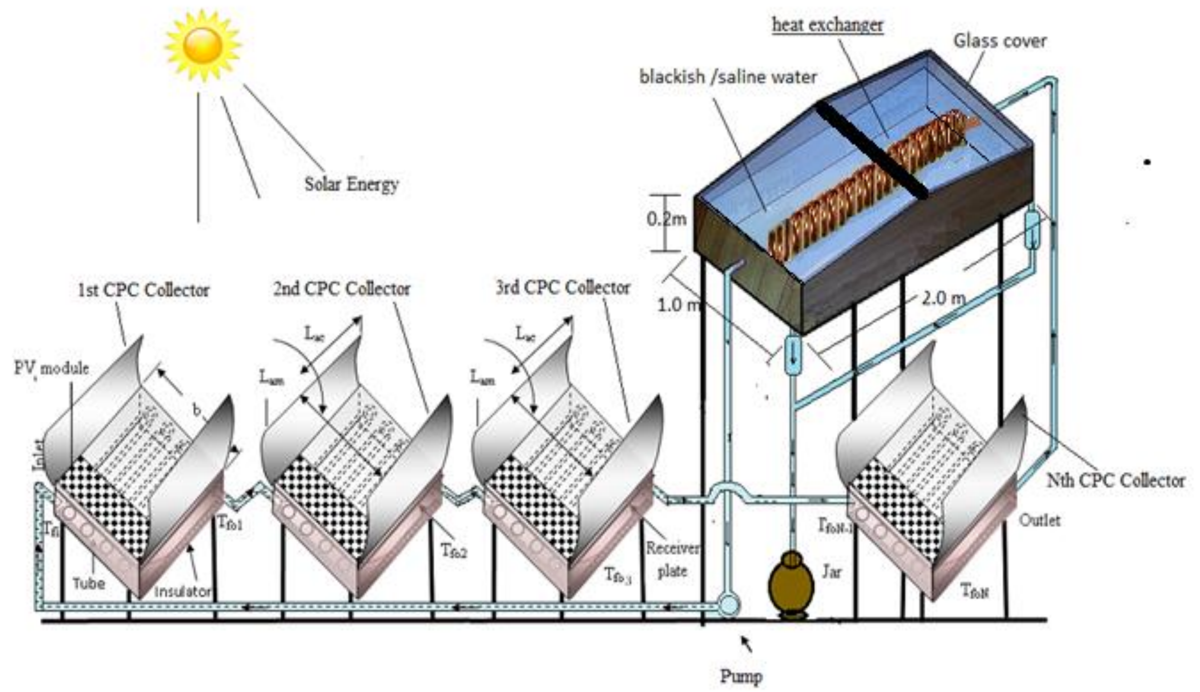

Fig. 1 dual slope type continued active solar 25% (N-PVT-CPC-DS-HE)

2.2 **Thermal modeling**

The following assumptions must be made in order to generate the characteristic equation:

2.2.1 Energy governing calculations for multiple elements of the distiller unit of active twice as high slope [43]

a. East face

$$\alpha_g I_{SE} A_{gE} + h_{1wE'}(T_{w'} - T_{giE'})\frac{A_b}{2} - h_{EW'}(T_{giE'} - T_{giW'})A_{gE} = U_{cgaE}(T_{giE'} - T_a)A_{gE'} \quad (1)$$

b. West face

$$\alpha_g I_{SW} A_{gW} + h_{1wW'}(T_{w'} - T_{giW'})\frac{A_b}{2} + h_{EW'}(T_{giE'} - T_{giW'})A_{gW} = U_{cgaW}(T_{giW'} - T_a)A_{gW'} \quad (2)$$

c. Water equation

$$m_f C_f \frac{dT_w}{d_t} = \alpha_w(I_{SE} + I_{SW})\frac{A_b}{2} + 2h_{bw}(T_b - T_w)\frac{A_b}{2} - h_{1wE}(T_w - T_{giE})\frac{A_b}{2} - h_{1wW}(T_w - T_{giW})\frac{A_b}{2} + Q_{uN} \quad (3)$$

d. The energy balance for the solar distiller unit's heat exchanger covered in basin water (BF/NF) may be stated as:

$$T_{woN`} = \left[\left[\frac{(AF`_R(\alpha\tau))1(1-K_p^{N`})}{m_f C_f(1-K`_p)}\left(\frac{1}{(1-e^z K_m^N)}\right)\right] I`_b + \left[\frac{(AF_R(UL)1)(1-K_p^N)}{m_f C_f(1-K_p)}\left(\frac{1}{(1-e^z K_m^N)}\right)\right] T_a + T_{HE}\left(\frac{(1-e^z)K_m^N}{(1-e^z K_m^N)}\right)\right] \quad (4)$$

The constant 0.933 represents the conversion constant for solar radiation of exergy, per hour water generation of the system that's suggested, which can be calculated using the equation below.

$$M_w = \frac{q_{ew}}{L_v}3600 = \frac{h_{ew}(T_w - T_g)}{L_v}3600 \quad (5)$$

Where [47] denotes the potential heat of the vaporisation process

$L_\nu = 3.162510^6 + [1 - (7.61610^{-4}T_\nu)]$ for $T_\nu > 70$ °C

$L_\nu = 2.493510^6[1 - (9.477910^{-4}T_v) + 1.313210^{-7}(T_v^2) - 4.797410^{-3}(T_v^3)]$

For $T_\nu < 70$ °C

2.2 Environmental and fiscal evaluation of the N-PVT-CPC collector, which uses a dual incline solar distillate with an annular coil exchanger for heat and aluminium oxide (Al2O3) nanoparticles- The following are mathematical depiction of cost to the environment such as carbon credit acquired and carbon di-oxide (CO2) mitigated per year:

2.2.1 Emission of carbon-di-oxide(CO_2)

The intensity of energy generation is equivalent to 0.98 kg of CO2/kWh of average carbon dioxide emissions.

2.2.2 CO_2 emission per year = $\frac{\text{Embodied energy} * 0.98}{\text{life time}}$ (6)

For Indian conditions

CO_2 emission per year = $\frac{\text{Embodied energy}*1.58}{\text{life time}}$ (7)

2.2.3 Mitigation of Carbon di-oxide(CO_2)

The reduction of greenhouse gases may be estimated per Kilowatt-hour and stated via a mathematical formula.

total CO_2 mitigation per year = (E_{out}X n) X 1.580 (8)

Equation is used to determine the total CO2 mitigation.

Whole life-cycle CO2 reduction

= (E_{out}*n)*1.58/1000 (9)

2.2.4 Earning of Carbon credit Earning carbon credits equals net life-time mitigation times Where D' reflects a shift from five to twenty dollars per tonnes of carbon dioxide avoidance.

2.3 Environmental and economic assessment of the N-PVT-CPC collector based on a dual slope solar distillate with an annular coil heat exchanger and aluminium oxide (Al_2O_3) nanocrystals - Many academics and writers carried out study on Exergo-economic analysis non-availability of energy per unit cost with the primary goal of avoiding exergy injury.The Exergo-economic parameter (Rex) is calculated using the formula that is given. Tiwari and co. [ref-20]

$$\boldsymbol{R_{ex}} = \frac{\boldsymbol{L_{ex,annm}}}{\boldsymbol{TAC}} \quad (10)$$

III. Result and Discussion

3.1 An Economic-environmental analysis Using Al2O3 Nano-fluid particle, the The innovative type N-PVT-CPC collecting dual-slope solar distillate is integrated into an annular coil form heat exchanger – The CO_2 mitigation per tonnes and carbon credit gain (in US dollars) based on the energy of the needed system is projected to be 3.970, 2.850, and 1.820 percent 4.2 factor less than the prior system.The CO2 cleanup based on the proposed system's energy of 40.850, 57.460, and 90.670 tonnes, and the carbon borrowing earned (in US dollar bills) based on the system's energy requirements of 204.260, 287.300, and 453.360 tonnes, respectively, have all been studied for tthe system's life times of 15, 20, and 3years.

3.2 Exergo-economic evaluations of a dual slope solar distiller with an active type N-PVT-CPC collector and a helical coil type exchangers utilising Al2O3 nanoparticles - Many academics and writers attempt to demonstrate the need to minimise energy loss using exergo-economic analysis of energy loss per unit rate.

Table number 12a

Exergo-economic studies of a connected helical coil heat exchanger and an active twin slope solar distiller with an N-PVT-CPC collector aluminum Oxide (Al_2O_3)Nano-fluid particles for a time period of 15 years

RO I	0.010	0.03	0.050
Annual Exergy	378.650	378.650	378.650
Rex in kWh/₹	6.080	5.010	4.220
USD ($)	73.310	73.310	73.310
Rex in kWh/₹	0.080	0.070	0.060
Mw	3666.39	3666.39	3666.39
Sell price (₹)	5.00	5.00	5.00
Annual productivity (np)	401.54	330.88	278.91
Present value	152.13	113.37	84.96

Table number 12b

Exergo-economic analytical study employing with dual gradient solar distiller of the active type and an N-PVT-FPC collector in combination with a helical coiled exchangers copper oxide (C_uO) Nano-fluid particles for a life time of 15 years

ROI	0.010	0.030	0.050
Annual Exergy	352.85	352.85	352.85
Rex in kWh/₹	5.85	4.82	4.06
USD ($)	73.31	73.31	73.31
Rex in kWh/₹	0.08	0.07	0.05
Mw	3378.40	3378.40	3378.40

Sell price (₹)	5.00	5.00	5.00
Annual productivity (np)	381.80	314.61	265.19
Present value	147.43	109.86	82.33

3.2.1 The exergo-economic Analysis using the exergo-economic characteristic (Rex) kWh/ over a period of 15 years at interest rates of 1, 3, and 5% yields values for the A-SYSTEM of 0.0820, 0.0680, and 0.0570 and the B-SYSTEM of 0.07890, 0.06500, and 0.05480, respectively.
3.2.2 The exergo-economic analysis according to the exergo-economic parameter (Rex) kWh/₹ for 20 Years with an interest rate of 1, 3, and 5 percent are 0.1060, 0.0830, and 0.0670 for the A-SYSTEM and 0.1020, 0.0800, and 0.0650 for the B-SYSTEM, respectively.
3.2.3 A-SYSTEM: 0.1490, 0.1060, and 0.0800; B-SYSTEM: 0.1430, 0.1020, and 0.0770; similarly, the exergo-economic analysis based on exergo-economic variable (Rex) kWh/ for time period of thirty years at rates of interest 1, 3, and 5% is 0.1490, 0.1060, and 0.0800. According to the findings of our study, the A-SYSTEM is more prosperous than the B-SYSTEM. As a result, the A-SYSTEM is better than the B-SYSTEM.

IV. Concluding Remarks and Future Scope

4.1 **The Summing Up**
We can summaries the our research in following manner based on yearly analysis of suggested system on the basis of exergy, energy and yield of system loaded with CuO nano-fluid particles

- A-SYSTEM is more Environ-economic compared to B-SYSTEM on the basis of yearly analysis with assuming life time of system.
- The acquisition of credits for carbon dioxide in the energy sector Dollar ($) for B-SYSTEM is much more environ-economic than A-SYSTEM.
- A parameter Exergo-economic parameter (R_{ex}) kWh/₹ is used to elaborate the Exergo-economic study of present study for a life time of 15 years with a interest rate taking sequence are as 1 percent, 3percent and 5 percent.
- Now we come at analysis productivity of A-SYSTEM and B-SYSTEM. Productivity of A-SYSTEM is higher than B-SYSTEM.

Thus on the basis of above conclusion we can say that N-PVT type Concentrating CPC collector in double slope type solar distiller unit that are integrated with a heat exchanger with helical coiled by using aluminum Oxide nano-fluid particles. WE have shown the various annual performance characteristics on the tenets of monetary, environ-economic and exergo-economic.

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