ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 7, July 2016

Performance Enhancement in Steam Condenser for Water Desalination of Solar Thermal Energy using Randomized Genetic Optimization (RGA)

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ABSTRACT

The simulation is important to study the behavior of the steam power plant system by means of a model and surface condensers are considered in this research. It has been found that the energy creation from the PTC of sizes 4.5 m × 3.0 m with an aperture area of 21.6 m2 was 19.4 kW, It has been calculated that the distilled water production volume of the solar energy connecting system per day is 55.6 l, arrogant solar irradiance to be 0.95 kW m-2 and the efficiency of solar energy harnessing system as 45% constantly ,the mathematical model are first presented in our research, followed by a discussion of simulation of a steam power plant and cooling water input temperature was assumed to be 30 °C. The minimum length required for a SS 304 tube of Ø 0.95 mm was 0.1724 m for the traditional condenser and 1.9275 m for the surface condenser. Further, efficiency is enhanced due to density separation of wet vapor by changing the flow direction near the wet sump and proposed efficiency for randomized genetic optimization(RGA) technique at d = [0.13 ,0.257 ,0.381]can be used to overcome the problem for energy consumption for surface condenser and optimized solution, in which enhance volume flow rate , mass flow rate , and its overall all system efficiency , minimizing are also evaluated to be less as compare to surface condenser which is simulated in MATLAB 2014Ra version .

Keywords- *Heat exchanger; Randomized genetic optimizer; Steam condenser; objective function.; Surface condensation; Water desalination, fitness function; cost reduction etc.*

NOMENCLATURE

AHsurface area of humidifier (m2).
Cp brine heat capacity (J/kg°C).
Cpwheat capacity of liquid water (J/kg°C).
Cpa heat capacity of air (J/kg°C).
Ti temperature at point i(°C).
UT overall coefficient of heat transfer at tower (J/s.m2.°C).
Ucond overall coefficient of heat transfer at condenser (J/s.m2.°C).
m =mass flow rate of the water drain from the heater

m_{in} =the mass flow rate of the water entering the heater.

HDH humidification–dehumidification

RES Renewable energy resources

PTC Parabolic trough solar energy concentrator

1. INTRODUCTION

Modeling is one of the most crucial elements in the analysis of thermal systems. Practical processes and systems are generally very complicatedand must be simplified through idealization and approximations to make a problem solvable.

1.1. Curve fitting

Curve fitting is an important and valuable technique that is usedextensively to represent the characteristics and behavior of thermalsystems. It is a means by which tabular or graphical information canbe readily assimilated into a component model or a systemsimulation.

1.2. Regenerative Cycle

In this cycle, the feed water heater is preheated by means of steam taken from some sections of the turbine, before it enters the boilers from the condenser. This process of draining steam from the turbine at certain points during its expansion and using this steam for heating the feed water supplied to the boiler, is known as ”bleeding”.

1.3. Power Plant System Verification

Simulation programs can be verified with existing data to justify the model. In this work, an input data for the system is the steam entering into the high pressure turbine of mass flow rate ms = 0.083 kg/s, temperature, T = 5500C and pressure, p = 150 bar,in recent years due to the possibility of low-temperature energy use (geothermal, solar, waste energy), its simplicity, its low installation and operation costs. Moreoverhumidification–dehumidification(HDH) desalination systems work at atmospheric pressure; hence they do not need additional large mechanical energy. These kinds of systems do not require sophisticated high-technologies so that they can be easily implemented in developing countries. Therefore, their design, construction and operation are easy. The system is modular; so that the capacity can be increased system additional solar collectors and additional HDH cycles [3].

2. DESCRIPTION OF PHYSICAL MODEL

The physical model of water-shedding of the treated condenser surface, which is composed of 10 micrometer posts and a lubricant coating. The capillary action of the regions between the posts holds the lubricant to the surface.[3] Water droplets as large as 10 µm condensing on this type of surface are 10,000 times more mobile than those condensing on hydrophobic patterned surfaces without the lubricant treatment.

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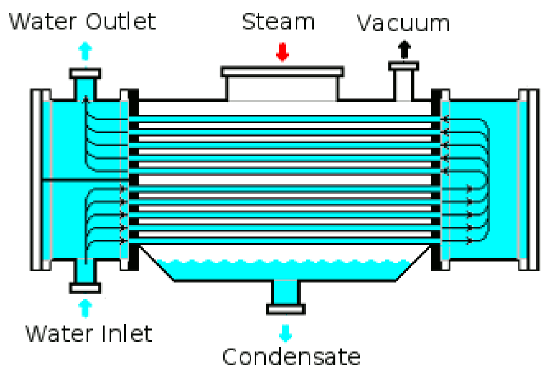

This droplet motion assists in droplet removal from the surface, so that new droplets can condense. The identification and evaluation of the renewable energy resources (RES) in an area, is the primary step to be performed when designing a RES-driven desalination system. Such systems should be characterized by robustness, simplicity of operation, low maintenance, compact size, easy transportation to site, and simple pre-treatment and intake system [6].

3. MATHEMATICAL MODELING

A tower humidifier, a condenser and a solar collector. Air is saturated at point (5), its enthalpy is expressed as:

H =Cp Ti+(CpwTi +□Hvap)Wi . ………………..(1)

Where a Cp and w Cp are the heat capacities respectively of air and water. vap ^H is the heat of vaporization of water.

The absolute humidity of saturated air, Wi is computed by the following expression:

$Wi=PiM_w/(P-Pi)Ma$……………………………….(2)

The vapor pressure of water 0 i P , is calculated as a function of temperature with following equation [4]:

$Pi=Po\ e^{A+B/Ti+ClnTi+DTi}$ …………………………………………….(4)

Where T is in Kelvin and P0=7,384kPa for water, A=67,35, B=-7218,15K, C=-7,9939, D=0,00052333 K-1.

Air is not saturated at point 6. thus at this point a humidity factor f is considered. So that enthalpy at that point is given by the product fH6

3.1. The main assumptions used in the mathematical model are:

1. Counter current flows of air and water;
2. Steady state conditions;
3. Pumping and blowing powers are negligible compared to the energy input of the heater.

Where TavgT is the average temperature in the tower, ULT is the overall heat transfer coefficient of tower and AT is the external area of tower.

3.2. Objective Function using Genetic optimization

The objective functioncouldbe formulatedby a combinationof desalinated water mass flow rate and desalinated water cost:

CCost = Σ(TCI) ,………………………………….(3)

$\dot{m}$ des =nΣ (Di+ di) ……………………………….(4)

i=1

and solar field, were considered the decision variables.

Although the decision variables might vary in the optimization procedure, each was normally required to be within a reasonable range. The upper and lower bands ofthese parameters were selected based on the previous studies.

Each solution is treated as an individual which contains a position (X) and velocity (V) matrices of T X Ndimensions. The position matrix X contains the on/off status of thermal units. So this matrix can be treated as a potential solution. The individuals in initial population are created based on weighted priority list of the units. For each hour the units are committed in the order of priority list until the spinning reserve requirements is not matching and the solutions generated in previous concept, needs to be repaired for constraint violation. [8] Minimum up/down constraint violations for each solution are repaired in this step. The loads for each hour are distributed among the thermal units and renewable energy sources in limit differencecalculation.

4. SIMULATION RESULTS

In Simulation results implementing using MATLAB 2014Ra toolmathematical software application, for five different tube diameters, and the results are given in below figure [4.1-4.6].

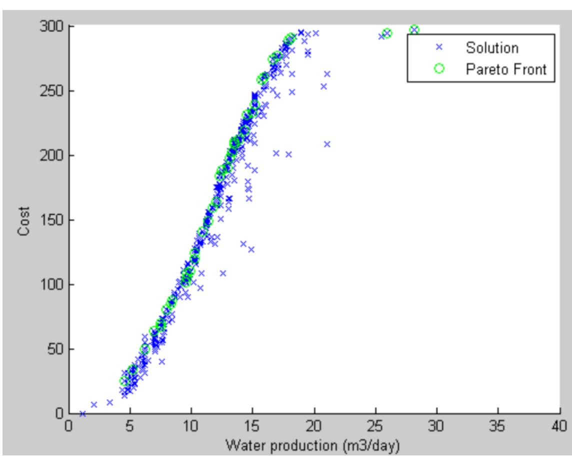

Figure 4.1: Sensitivity analysis and its solution on solar collector acceptance angle and cost reduction

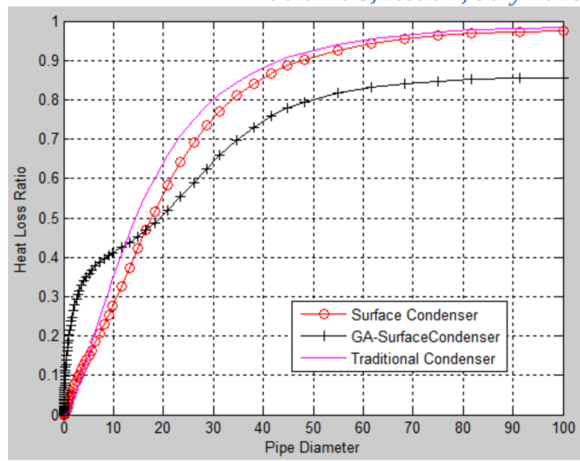

Figure 4.2 :Simulation for Heat loss ratio in different pipe diameter for our proposed GA surface condenser

In the Figure 4.2, the required pipe length is always shorter for same crossover value the surface condenser compared to the traditional One and cost is always higher in Figure 4.1 for the GA-surface condenser as compare to traditional one. It can be clearly seen that in Figure 4.3, in the surface condensing condenser, when the tube diameter is 15.9 mm there is a maximum cost with different iteration as same population size, and then it decreases interference for higher energy factors

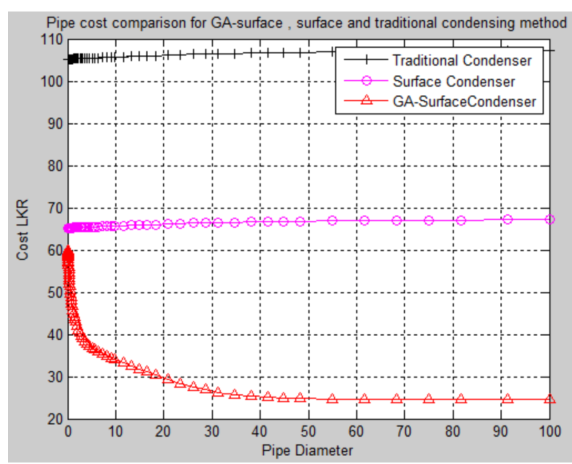

Figure 4.3: Solution for GA-surface, surface traditional condensing and its method.

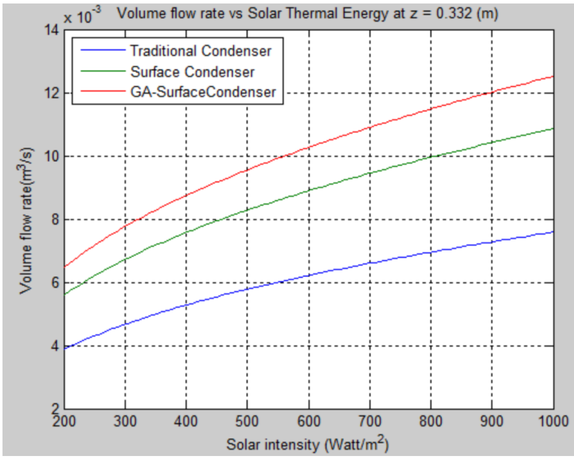

Figure 4.4 : comparison of volume flow rate and solar thermal energy at z=0.332 (m)

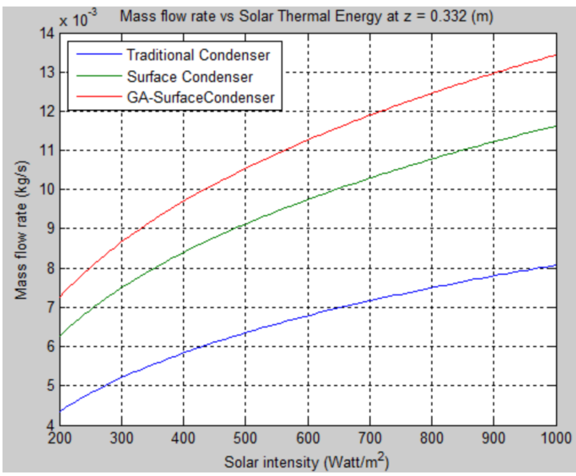

Figure 4.5: Mass flow rate(kg/s) and solar intensity with different number of iterations.

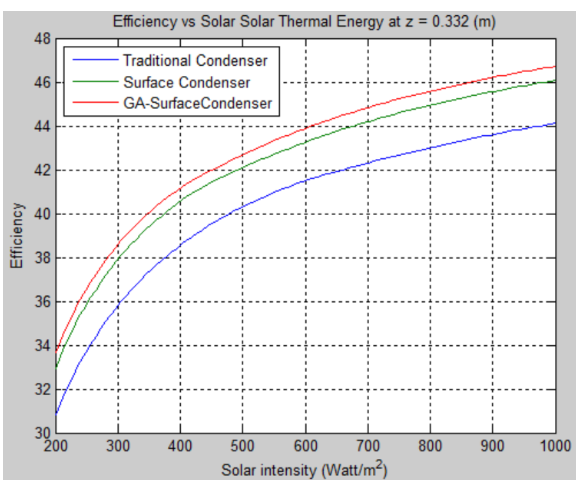

Figure 4.6: Total efficiency for solar thermal energy with same dimension as with mass flow.

Below mention table give numerical success rate for solar intensity for existing and proposed technique analysis.

	EFFICIENCY		
Solar Intensity	**GA-Surface Condenser (Proposed)**	**Surface Condenser (base)ref[5]**	**Traditional Condenser Ref[7]**
200	7.1	6.1	4.3
300	8.7	7.5	5.1
400	9.8	8.5	6.9
500	10.5	9.1	6.2
600	11.1	9.9	6.9
700	12.01	10.20	7.12
800	12.4	10.9	7.6
900	13.00	11.10	7.92
1000	13.50	11.72	8.01

5. CONCLUSION

The methodintroduces multi populations unlike trivial genetic optimization operators such as crossover, mutation, elitism is appliedto the higher potential solutions for next population. Quick convergence is further ensured by careful adjustment of inertia factors, accelerating constants for GA. The mutation operator is applied as a GA operator with a very low probability, since updating the binary positions of each particle's dimension is analogous to mutation and performance efficiency of material usage and cost of two types of cross-flow steam condensers that can be used for water desalinationin conjunction with a parabolic trough solar energy concentrator type plant (PTC) is being improved using genetic optimization. The efficiency of GA-surface condenser is enhanced due to the formation of a condensed water layer on the surface of the tube and it approximately as compare to existing technique as 3% more at 1000 solar intensity(watt/m^2), thermal barrier,pressure and density separation of wet vapor by changing the flow direction near the wet sump The basic thermal system model is integrated with environment friendly renewable energy sources forreducing mass flow rate. In Future work, will focus on the inclusionof wind and solar forecasting error as with firefly optimization with thermal unit assurance strategy and different length.

References

[1]A. J. Wood and B. F. Wollenberg Power Generation, Operation, and Control New York: Wiley, 1996.

[2] T. Senjyu, K. Shimabukuro, K. Uezato, and T. Funabashi, "A fasttechnique for unit commitment problem by extended priority list," IEEE Trans. Power Syst., vol. 18, no. 2, pp. 882-888, May 2003.

[3] A. Dayem, M. Fatouh, -Experimental and numerical investigation ofhumidification/dehumidification solar water desalination systems,‖Desal, vol.247, pp.594-609, 2009.

[4] Sushant Anand, Adam T. Paxson, Rajeev Dhiman, J. David Smith and Kripa K. Varanasi, "Enhanced Condensation on Lubricant-Impregnated Nanotextured Surfaces," ACS Nano, Article ASAP, DOI: 10.1021/nn303867y, October 2, 2012.

[5] P. D. C. Kumara * 1, S. K. K. Suraweera2, H. H. E. Jayaweera3, A.M. Muzathik* 4 and T. R. Ariyaratne" Efficient Type of Steam Condenser for Water Desalination of Solar Thermal Energy in Remote Arid Areas and Islands" International Journal of Energy Engineering Mar. 2016, Vol. 6 Iss. 1, PP. 13-18.

[6] E. Tzen, R. Morris, Renewable Energy sources for desalination, Solar Energy,2003 Vol. 75, No. 5, pp. 375-379.

[7] R. Deng, L. Xie, H. Lin, J. Liu and W. Han, "Integration of thermal energy and seawater desalination", *Energy*, Vol. 35(11), pp. 4368–4374, Nov. 2010.

[8] S. A. Kazarlis, A. G. Bakirtzis, and V. Petridis, "A geneticalgorithm solution to the unit commitment problem," IEEE Trans. Power Syst., vol. 11, no. 1, pp. 83-92, Feb. 1996.