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Abstract. Solar chimney power plant is a sustainable source of power production. The key parameter to increase the system power output is to increase its size but the plant cannot operate during night hours. This study deals with simulation work to validate results of pilot plant at Manzanares and include the effects of waste heat from a gas turbine power plant in the system. The effects show continuous night operation, a 38.8 percent increase in power at 1000 W/m^2 global solar irradiation at daytime and 1.14 percent increase in overall efficiency.

1. Introduction

Solar chimney power plant runs truly on renewable energy source that is the sun. Many parts of the world that have flat land properties and receive massive amount of solar radiation, can be utilized for such system. It can work under diffuse solar radiation and is durable and require less maintenance. The system has three main components a) collector b) chimney and c) turbine. The collector absorbs heat energy from solar radiations, the air inside the collector moves due to buoyancy effects and finally reaches the center of the chimney with a certain velocity. The turbine located there rotates by extracting the kinetic energy of the air. Finally this kinetic energy is converted to electric power. One of the drawback of this system is that it cannot operate during night hours. Although previous researches have shown by using means to make it work at night. In this study, a simulation is carried out that not only shows night operation of the plant but also power output enhancement and efficiency. The simulation includes the effects of exhaust gases from a nearby gas turbine power plant on the system that originally operates only on solar energy.

A detailed numerical analysis was carried out by Roozbeh [1], showing with increasing solar radiation values, the power increases. Simulation with energy storage layer for different solar radiations was carried out by Tingzhen [2], which resulted that heat loss from the storage medium increases with increase in solar radiations. According to Bernardes [3], the power output can be increased by increasing chimney height, collector area and transmittance. Another study by Jiakuan [4], show that power output of power generating system increases with global solar radiation intensity, collector area and chimney height. It also concluded that the larger the chimney height, the greater would be the driving force in air. The use of water storage system in collector was presented by Kreetz [5], his study indicated a continuous day and night operation of the solar chimney power plant.

The main purpose of this research is to model the system so that it will work at night and also enhance the power output. The results of Manzanares pilot plant were validated by simulating a mathematical model. Later, the effects of exhaust gases were incorporated with the mathematical model. This simulation uses ANSYS Fluent to calculate the heat transfer effects of exhaust gases on the system.