Having an HTF storage system is a key factor for the fuel saving process; it ensures working on a full saving capacity for the whole year achieving a maximum saving of fuel. If the system is absorbing maximum solar heat from the sun (496 W/m) during the whole year, the fuel saving will reach 5 ton/day. The combined cycle works on a nominal fuel flow rate of 310 ton/day, therefore the total amount of fuel saved would reach 1.65%.

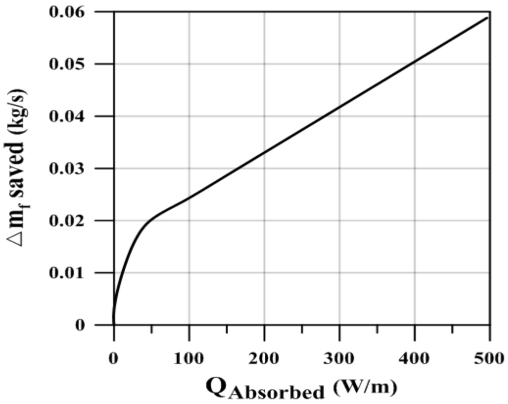

Fig.9. Mass flow rate of fuel saved vs. QAbsorbed

The amount of money that could be saved, knowing that the price of the ton of fuel is assumed to be 242.2 $ (4000 LE) [17], is compared in Table III for two situations: with and without considering the HTF storage system. In case of using the HTF storage system, and according to Fig. 8, it can be seen that all months except December can satisfy their needs of heat energy. Consequently, the saving in December is 29,500 $, while in the rest of the months the maximum value of 37,000 $ is reached, and the annual saving is 436,000 $.

Table III. – Monthly and annual money savings with and without the HTF storage system.

Month	*With storage ($)*	*Without storage ($)*
January	37,000	12,096
February	37,000	13,617
March	37,000	13,931
April	37,000	14,859
May	37,000	14,890
June	37,000	15,015
July	37,000	14,906
August	37,000	14,607
September	37,000	14,104
October	37,000	13,601
November	37,000	12,501
December	29,500	11,498
ANNUAL	*436,000*	*165,625*

Without the HTF storage system, the money savings depend on the number of hours in which the sun can provide energy more than 496 W/m only. It is found that the number of hours differ from month to month, being the minimum in January, with 8.65 hours, and the maximum in June, with 10.19 hours. The anual money saving in this case is 165,625 $, that represents 38 % of the money saved during the year by controlling the HTF.

5. Conclusion

This study investigates the integration of renewable energy into an existing combined cycle with the objective of reducing the fuel consumption. Maintaining constant the total power output of the combined cycle, the model modulates the fuel, steam and HTF mass flow rates, and calculates the fuel savings compared to the standalone combined cycle under two situations: with and without a HTF storage system. The results show that controlling the mass flow rate of HTF through the solar field can save 436,000 $, that is 264 % more than that without controlling it (165,625 $). The fuel savings represent about 1.65 % of the consumption of the combined cycle, and they would be increased if the constraint of the pinch point in the HRSG could be overcomed.

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