

**Title of the thesis:** Design and performance of a solar dryer for processing of coffee beans in Colombia

**Ph.D. student:** Eduardo Duque Dussán.

**Reviewer:** Hector Andres Tinoco Navarro M.Sc. Ph.D.

**General comments:**

The main objective of the PhD thesis is related with the design of a hybrid solar coffee drying unit for house-farm coffee growers in Colombia. In the design process are considered computational tools to understand the relation between the drying phenomena in coffee beans and their governing equations. The assessment of a hybrid solar dryer which mixes solar and mechanical drying principles was designed and built. This considers the uses of a traditional solar tunnel-type dryer as a base featuring a biomass burner which uses coffee trunks left from the yearly crop renovation as biofuel. A heat exchanger heats the drying air for ensuring a moisture removal as well as a photovoltaic system is included to obtain a fully self-sufficient drying unit. The developed dryer was tested under three different configurations for testing in the field. This PhD thesis contains valuable information related to improve the efficiency of traditional dryers used for Colombian coffee growers.

**Comments:**

**Abstract.** The verbal time of the last paragraph should be in past and not in future. i.e. “the three of them will have the same capacity”, “The assembly will be done”

**Chapter 3.**

- How do you define the criteria and parameters for Table 1?
- Sun radiation is considered directly on the coffee beans, It means that the drying process is air opened or how are the assumptions?
- Could give some information in the literature that your results are applicable for a real case? It means you can mention results from other works (comparing the data) if these exists. Since you mention some similarity in the results with the works.
- In Figure 2c. What explanation you can describe for the differences in the internal temperatures in the bean (since these achieve the steady temperatures at the same time), for the incremental isothermal temperatures.

**Chapter 4.**

- What is the relationship between the results obtained in chapter 2 and the results described in chapter 1? Moistures are a good example of a comparable variable. My question is addressed because the methodology shown in chapter 1 is very interesting and it could be used for optimizing the design of type of dryers. How the results of the chapter 2 could be used for improving the models of chapter 1, is only for additional discussion in the thesis defense.

## Chapter 5.

- Regarding the results, what are the advantages or disadvantages of the new varieties developed by Cenicafé with traditional ones in relation with a drying process? I would like a clarification since is mentioned “it will hold the heat during a more extended period”. This aspect is really interesting in the researching since Coffee varieties could be used for optimizing the traditional coffee drying processes.

## Chapter 6.

- Considering the design of dryer, and the hybridization process, I would like to inquire about their potential application. It appears that the results are very promising for real applications. Please discuss the pros and cons considering implementation costs, energy consumption, and efficiency in terms of selecting a technology that can be comparable or competitive regarding other technologies available in the market. This is for discussion on the thesis defense.

## Minor Comments

- Some figures are not in the quality required. You can review the figure format.
- The quality of the equations included in the text also present quality format issues. i.e. Names of the variables does not present the same format when the variables are mentioned inside the text

## General remarks

I am delighted to inform that the work submitted meets the requirements set for a Ph.D. thesis. Considering the exceptional quality and rigor of this thesis, I would like to recommend that it can be presented at the upcoming defense. Also, I will like congratulate Eduardo Duque-Dussan for the dedication and the obtained results since most of the results were published in journals with impact factor. In the case of a successful defense, I agree that Ing. Eduardo Duque Dussán, MBA. will achieve Ph.D. title.



**Hector Andres Tinoco Navarro, M.Sc., Ph.D.**

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