Modeling, Characterization and Analysis of the dynamic behavior of heat transfers through polyethylene and glass walls of Greenhouses

- N. Bibi-Triki[a],
- S. Bendimerad[a],
- A. Chermiti[a],
- T Mahdjoub[a],
- B. Draoui[b],
- A. Abène[c]
- [a] Unité de Recherche des Matériaux et Energies Renouvelables (U.R.M.E.R) Université Abou-Bekr Belkaid, B.P. 119, Tlemcen, Algérie
- [b] Laboratoire énergétique en zones arides - Université de Béchar, Algérie
- [c] Laboratoire I3ER de l'université de Valencienne, France

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Abstract

The conventional agricultural tunnel greenhouse is highly widespread in Mediterranean countries, despite the shortcomings it presents, specifically the overheating during the day and the intense cooling at night. This can sometimes lead to an internal thermal inversion. The chapel-shaped glass greenhouse is relatively more efficient, but its evolution remains slow because of its investment cost and amortization. The objectives of the agricultural greenhouse are to create a microclimate that is favorable to the requirements and growth of plants from the surrounding climatic conditions and produce cheap off-season fruits, vegetables and flowers which must be highly available all along the year. The agricultural greenhouse is defined by its structural and functional architecture as well as by the optical, thermal and mechanical qualities of its wall and the accompanying technical support.
The greenhouse is supposed to be a confined environment where there is an exchange of several components. The main intervening factors are: light, temperature and relative humidity.
When protected, the culture heats up more than when in free air because of the wall that acts as a barrier to harmful influences of the wind and the surrounding climatic variations as well as to the reduction in internal air convection.
This thermal evolution state depends on the air-tightness degree of the cover and its physical characteristics. It has to be transparent to solar rays, and must as well absorb and reflect infrared rays emitted by the soil. This leads to trapped solar rays, called the "greenhouse effect". In this article, we propose the dynamic modeling of the greenhouse system, the characterization and analysis of the thermal behavior of the wall for both experimental greenhouses, where the first one is made of polyethylene (tunnel greenhouse) and the second of glass (chapel-shaped greenhouse), throughout experimentation and simulation which finally lead to identifying the evolution in the thermal loss coefficient (K) through the wall.

Keywords

Greenhouse; Microclimate; Thermal; Materials; Modeling; Micrometeorology; Agro-system management; Solar energy; Energy saving