

## Dryer control with the management of the solar energy coupled with gas or electricity energy

The purpose of the thesis is to propose a management of the mixed energy supply with solar and fossil or electric energy for hybrid food dryers. The applications are for dryers with a capacity under 2 tons of fresh products per cycle and for technologies used in developing countries. Gas and electricity energies being expensive and not renewable, their uses have to be minimized. The thesis should propose solutions for the control of electricity and gas supply coupled with the renewable solar energy. Its design and maintenance must be adapted to the technology of the solar dryers.

The actually gas and electricity dryers were designed to work on constant temperature to insure a good quality of the dry products, without coupling solar energy. When solar energy is used, it is at the beginning of drying then the drying is relieved by other energies, but there is no solar dryer which alternates 2 or several energy modes during all the drying duration. The coupling of such multi – energy modes is not insured because of the instrumentation missing, of the acceptable cost of the not renewable energy and the lack of a theoretical approach of transfers. The management of both energy supplies during drying duration is very delicate because of the irregularity of the sun power. Using solar dryer is a real problem in moist climatic zones where the solar energy availability is irregular and the air is too moist. A good management during the drying time of the use of all these forms of energy coupled between them, will allow to optimize the energy cost and to insure a good final quality of the product.

Up to now, when the drying is controlled, it is only with the level of the air temperature. A multi criteria approach is envisaged, by taking into account the product quality criteria, the two drying phases, the product temperature, the energy, the needs of the users, the feasibility, the maintenance and the criteria characterizing the local success of the renewability of a dryer.

To take into account constraints of the environment, product locally dried in Vietnam will be chosen. The drying kinetics of the product will be experimentally obtained under constant and under variable air conditions. The drying model will allow to known better the parameters which control the entry of the process.

The control parameters can be the drying air conditions (in the dryer or outside) or the product state represented by its surface temperature. After the understanding of the energy exchange in the system and the control development, the control technologies will be adapted to some dryer technologies actually used in Vietnam, by considering dryers who exist on the field. The used technologies have to be in accordance to the local possibilities of maintenance.

This control will be first experimented on a dryer in the laboratory considering radiative drying (like solar energy) and hot air drying (obtained by gas or electricity energy use).

The interest is to propose a both financially and technologically adapted dryer to the current users, who provides products with good qualities for both the local consumption and export, and with a better control of the renewable energy uses.

