INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES
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FLORIDA COOPERATIVE EXTENSION SERVICE

PACKINGHOUSE NEWSLETTER

W. Wardowski, Editor
CREC
700 Experiment Station Road
Lake Alfred, FL 33850
Phone (813) 956-1151

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DRYER FUNDAMENTALS

This article is the second in a 4-part series detailing considerations in packingline dryers. The principal discussion point in this article is the energy source selection.

PART B: ENERGY SOURCES

First, it should be stated that water evaporation in drying occurs at a rate proportional to vapor pressure deficit or humidity ratio difference. Evaporation rates are further influenced by the mass transfer coefficient which relates to factors such as air velocity where increased air velocity decreases the drying time. To increase the vapor pressure deficit, dryer air is typically heated above ambient conditions. This can be accomplished with an energy source at the dryer (e.g. gas or electrical heaters) or from a remote source normally a boiler. Not only must the energy source be selected, it must be used efficiently. For a given fossil fuel, maximum heat is liberated when ample air is supplied to completely burn the fuel. In the case of natural gas, the chemical equation is:

$$CH_4 + 2O_2 + 7.5\ N_2 \longrightarrow CO_2 + 2\ H_2O + 7.5\ N_2 + \text{heat liberated}$$

Note that nitrogen does not react but is carried through the process as air (about 80% nitrogen). When more fuel is supplied than is required for complete combustion, the reaction is termed "rich." In that case, both hydrogen and carbon monoxide may be present in the flue gasses. These materials are combustibles and further heat could have been liberated. Excess air is typically introduced to achieve adequate air-fuel mixing. Oxygen in the above equation is normally supplied by atmospheric air which is approximately 20% oxygen by volume. Any excess air acts as a dilutant and reduces thermodynamic efficiency. However, this reduction may be required to achieve workable temperatures for the structural material and air handling components of the system. Flue gases should be checked periodically to insure that complete combustion, and a resultant high efficiency, is achieved.

Fuel availability is a major consideration in the initial selection of a fuel source. In some areas of Florida, natural gas is not available. If new dryers are being considered, other operations requiring process heat should be considered. If degreening rooms and color-add tanks have unit heaters, a central boiler facility may be eliminated by switching the dryers to unit heaters also.

A direct combustion process (overall efficiency of about 92%) offers an efficiency advantage over heat exchangers which operate at 80% efficiency. However, this advantage is partially offset by the moisture from combustion. Typically, Florida's electrical costs will be 2.5 to 3 times those for fossil fuel sources. Initial capital outlay should be considered as well as the current lending rate and expected inflation rate for the cost of energy. The energy content for various fuel sources are listed below:

Energy Source	Unit Energy Value
Electricity	3,400 Btu/kW-h
No. 2 fuel oil	140,000 Btu/gal
No. 6 fuel oil	155,000 Btu/gal
Natural gas	1,000 Btu/ft^3
Propane	2,500 Btu/ft^3
Coal	14,000 Btu/lb

Note that 1 million Btu = 0.293 Megawatt-hour (electricity) = 0.97 Thousand Cubic feet (natural gas) = 0.17 Barrel (oil) = 70 lb (coal).

Recently, there has been interest in coal-oil mixtures (COM) where finely pulverized coal is mixed with oil to facilitate combustion in an oil-fired boiler and take advantage of the low price of coal.

Safety Considerations

In a dryer installation, fuel, mechanical, and temperature safety factors should be considered. All drives should be properly guarded. Proper venting of gases is essential when combustion is directly associated with the dryer. Safety controls (high gas pressure, low gas pressure, no flame) are normally provided in the burner control package. Another safety feature is to incorporate a pressure or wind sail sensor to interlock the main blower and fuel supply. Hot surfaces associated with the burner or steam lines should be insulated and properly marked. Standard color coding should be used for gas, steam, and protective guards. Proper safety decals should be placed to alert packinghouse personnel with regard to dryer startup and operation. Installation should be in accordance with Federal OSHA and state safety standards in addition to the building codes for your locale.

ASSOCIATED TECHNOLOGIES

Dehumidification

A unique dryer now being used in Washington state for apples is a refrigeration-type dehumidification unit. Air (2,500 or 5,000 cfm, 1.2 m^3/s or 2.4 m^3/s) from the packinghouse (normally above the hot water rinse section) is dehumidified (evaporator coil) and reheated (condenser coil). Waste heat from the compressor is also recouped by passing the air over that unit located between the evaporating and condensing coils. Such units are advantageous where low electricity costs are encountered.

Chemical desiccants are also a potential source to dehumidify air. Solid and liquid sorbents remove moisture by either physical adsorption or chemical absorption. Such materials eventually reach a saturated state and must be regenerated. Conventional fuel sources, biomass, or solar heated air can accomplish this regeneration.

An advantage in dehumidification is derived from a satisfactory drying potential developed at lower temperatures than those required for conventional heated-air dryers. Insulation requirements and potential thermal damage to the product are reduced at the more moderate temperatures.

Cogeneration

Cogeneration is the process of producing electricity and thermal energy from a single combustion process. In cold storage situations, the electricity would be utilized for cold room storages while the thermal energy would be coupled to dryers or heated water tanks.

Solar

To date, solar installation in the U.S. industrial sector has been very limited. Lack of economic viability and substantial maintenance costs were negative features associated with the U.S. Dept. of Energy Solar Industrial Process Heat installations. However, this first phase of projects should be viewed as experimental as opposed to the DOE concept of currently available technology. All of the projects were directed toward high temperature applications requiring concentrating collectors.

Packinghouse applications which require less than 60^{o}C would only require flat-plate technology. Two demonstration projects in Florida citrus packinghouses (Lake Garfield Coop and Winter Haven CGA) indicate a strong potential for solar as a baseload energy source. Such units need to be suplemented with conventional energy sources. In most cases, a packinghouse would be able to utilize all solar energy collected, negating any need for an energy storage system.

Bill Miller
CREC, Lake Alfred

POSTHARVEST WORKSHOP

The Florida State Horticultural Society will hold its 99th annual meeting October 26-28, 1986, at the Doral Hotel in Miami Beach, Fla.

A workshop entitled "Trends and Needs in Florida Postharvest Horticulture" is planned for the Handling and Processing Section of the Society. The workshop will involve open discussion between Government, University and Industry research and development scientists and engineers.

The program is tentatively scheduled for Monday afternoon of the meeting. Members of the Society will receive further information as part of the preliminary program to be mailed out later this month. Others may contact:

David J. Hall
V. P. Handling & Processing Section
c/o Agri-Chem, Inc.
P. O. Box 17477
Orlando, Florida 32860
305/295-6256

OR

For Membership Information:

Florida State Horticultural Society
800 Lake Jessie Drive
Winter Haven, Florida 33881

Dave Hall
Agri-Chem, Inc., Orlando

AVAILABLE PUBLICATIONS

Available from Dr. W. Wardowski, CREC, 700 Experiment Station Road, Lake Alfred, FL 33850

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W. Wardowski, Editor
Professor
Extension Horticulturist