AGRI-FACTS
Practical Information for Alberta's Agriculture Industry

Agdex 736-9

Solar Grain Drying

"Everything," said Goethe, *"has been thought of before. The difficulty is to think of it again."*

Direct solar energy has been applied to grain drying for years. The sun and wind dry crops in the field, stack or windrow. Artificial drying has supplemented this process to increase the harvest rate during inclement weather or to minimize field losses. This article investigates solar grain drying as one alternative.

Availability of solar energy

Radiant energy from the sun reaching the earth's surface is known as shortwave radiation, solar radiation, solar energy or insolation. The total radiation may be 'direct', from the sun; 'diffuse', scattered by the atmosphere; or 'reflected', from adjacent surfaces.

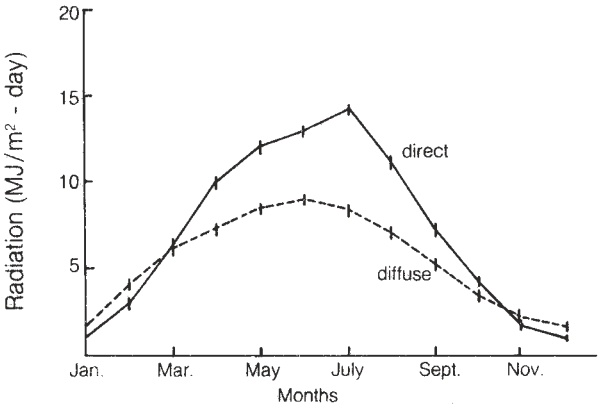

Figure 1. *Average monthly values of solar radiation on a horizontal surface at Edmonton.*

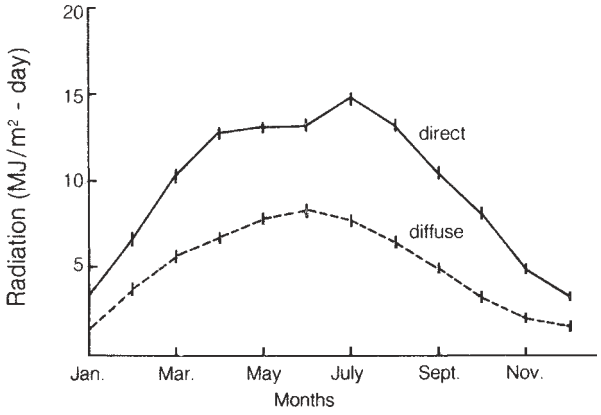

Figure 2. *Average monthly values of solar radiation on a 30° south-facing slope at Edmonton.*

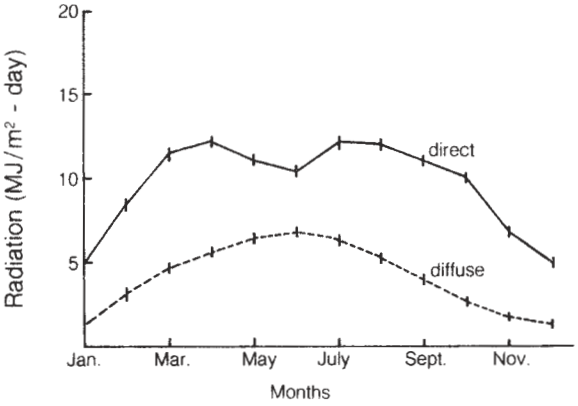

Figure 3. *Average monthly values of solar radiation on a 60° south-facing slope at Edmonton.*

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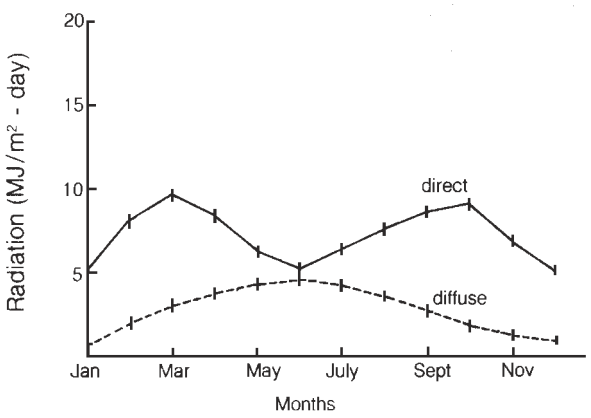

Figure 4. *Average monthly values of solar radiation on a 90° south-facing slope at Edmonton.*

Figures 1 to 4 show the availability of direct and diffuse solar radiation at Edmonton for the year. Surface orientations are horizontal, 30°, 60° and 90° south-facing.

Figures 1 and 2 illustrate that in the fall more radiation falls on the tilted collectors, while in the summer the horizontal collectors have the advantage. For July, the horizontal and 30° tilt collectors collect similar amounts of direct radiation. In August the 30° tilt is best. In September the 30° and 60° tilts are similar. In October the 60° tilt is best. In November the 60° and 90° tilts are similar.

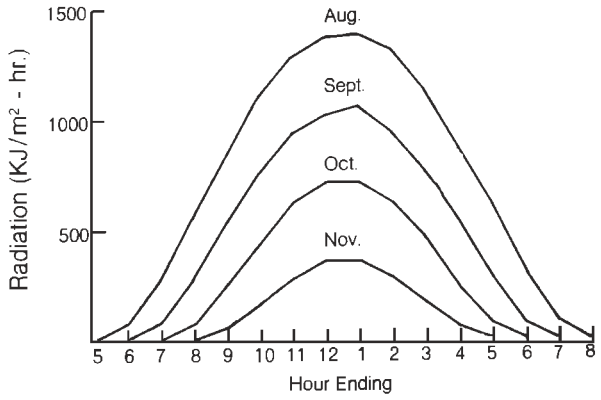

Figure 5. *Average monthly solar radiation on a horizontal surface at Edmonton.*

Figure 5 shows daily solar energy during different months of the year. Grain drying months of August to November at illustrated.

Solar Collectors

The units of energy are the average total number of megajoules per square metre per day for each month (MJ/m² - day). A horizontal solar collector in September has about 7 MJ/m² - day available to it. From this information, a 30 per cent efficient collector will need an area of 12,000 m² to equal the capacity of a 1,000,000 BTU/h (300 kW) hot air dryer. This would be a very large collector covering about three acres.

As the cost of a large solar collector required for high-temperature, high-speed drying is prohibitive, this article considers low-temperature, low-speed solar drying. The collectors described here have a flat plate configuration using air as the heat exchange medium. Covered collectors are much more efficient than uncovered ones.

A covered solar collector consists of a radiant-energy-transmitting material and an energy-absorbing material. Figure 6 shows both covered and uncovered flat plate collectors. The transmitting material for a covered plate collector may be glass, fibreglass or clear polyethylene. The absorbing section may be metal, wood, paper or plastic. The closer the absorbing material is to dull black, the greater is its efficiency in absorbing solar radiation.

A covered solar collector using air (see Figure 6) operates as follows:

a) Most of the solar radiation passes through the transparent cover;
b) Solar radiation is absorbed on the black surface or absorbing plate which subsequently heats up;
c) Air flowing over the absorbing plate is then heated;
d) The heated air flowing out of the collector is used for grain drying.

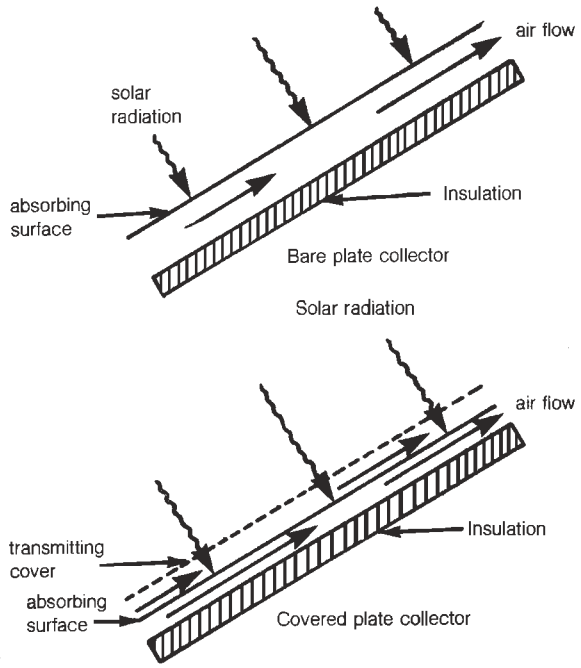

Figure 6. *Flat plate air type solar collectors.*

Collector Configurations

Figure 7 shows an air collector mounted on a grain bin. The walls of the bin are painted black.This system is suited to a low air flow drying system (1-2 cfm/bu), because of the small collector area. Drying time will be in excess of 2 to 3 weeks. Only part of the bin is covered to take advantage of the direct and not the diffuse radiation. The efficiency of this type collector is low when exposed to only diffuse radiation or not direct sunlight.

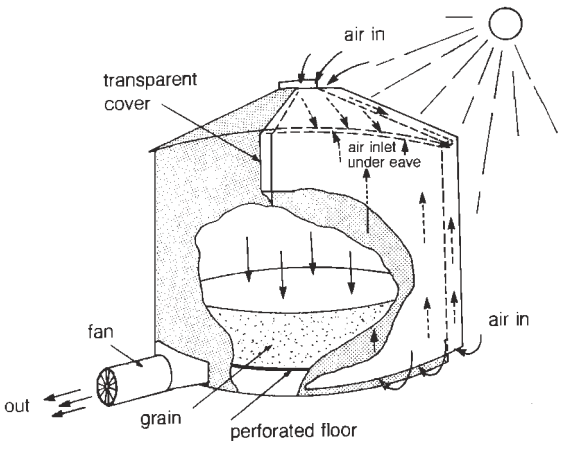

Figure 7. *Air collector mounted on the bin wall.*

The collectors described have been simple flat plate collectors with a black absorber and a clear cover. Figures 8 and 9 indicate two alternatives that increase collection by increasing the absorbing area.

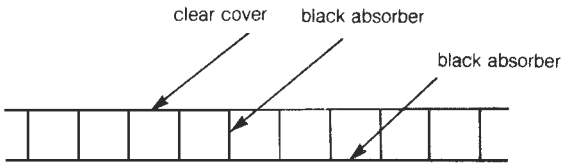

Figure 8. *Cross-section of flat plate collector where the absorbing area has been tripled.*

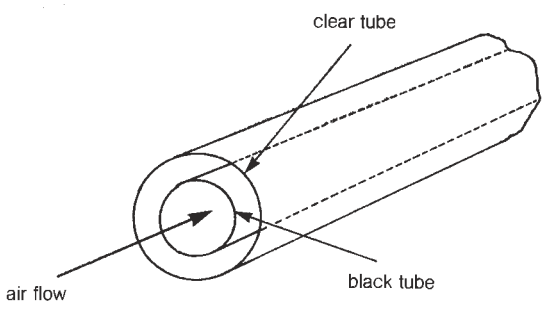

Figure 9. *Long tube configuration of a flat plate collector.*

The Alberta Agriculture Experimental Collector

An experimental solar collector was constructed by Alberta Agriculture to assess the practicality of solar grain drying in Alberta. The following is a brief summary of the results.

A collector of the type illustrated in Figure 8 was constructed using heat sealed 10 mil black and 10 mil clear polyethylene. Collector size was 10 m x 25 m. Air was blown by a 7 kW fan motor through the collector and into a grain drying bin at 5000 cfm. The drying time for the 500 bushels of barley in the bin was 14 daylight hours over a period of four days. Figure 11 shows a comparison of drying with ambient air and drying with air heated by the solar collector.

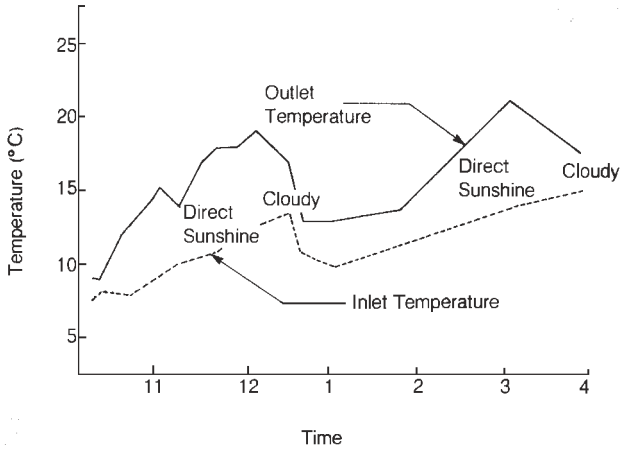

Figure 10. *Temperature rise for 250 m^2 polyethylene-covered flat plate air collector at Edmonton for a typical October day.*

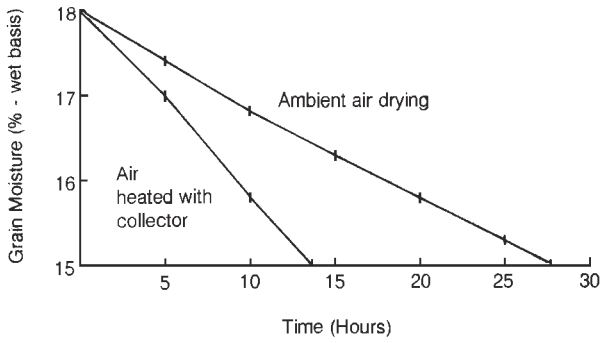

Figure 11. *Drying time to dry 500 bushels of barley from 18% to 15% moisture content. Grain temperature 7°C, ambient temperature 10°C, ambient relative humidity 50%, air heated to 18°C by the collector. The depth of grain dried is 1.2 m.*

Experience in the Edmonton area indicates that solar grain drying alone is not a dependable grain drying alternative. Solar collection relies on direct sunshine which is not always available when drying is required.

Collector cost is a major obstacle to solar drying. Considering reliability and cost, both hot air and ambient air grain drying are more appropriate than solar grain drying in Alberta.

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