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Energy Efficiency of Peanut Drying Systems



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Energy Efficiency of Peanut Drying Systems

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1 Purpose and scope

1.1 The purpose of this Standard is to:

1.1.1 Establish uniformity and consistency in terms used to describe and evaluate the energy efficiency of peanut trailer drying systems.

1.1.2 Define a test procedure for measuring the air delivered to individual ports where trailers are attached. A resistance plate is fastened to each port to simulate a resistance to airflow equivalent to a trailer filled with peanuts to a depth of 1.3 m (4.25 ft).

1.1.3 Provide a method for interpretation and presentation of test results such that the energy efficiency of different designs can be compared.

1.1.4 Provide test data which can be used to improve the energy efficiency of peanut dryers.

1.2 The scope of this Standard includes:

1.2.1 All peanut dryers where trailers (or wagons) are filled with harvested peanuts in the field and the peanuts are dried in the trailer. The Standard is applicable only to those systems where the drying air is exhausted after a single pass through the peanuts.

1.2.2 Direct-fired burners, indirect-fired burners, or heat exchangers using a fluid heated by a remote energy source. The Standard is written for dryers with petroleum fuel burners. Specific instructions for dryers with heat exchangers are included where needed for clarification.

1.2.3 A procedure for measuring the efficiency of heat and total energy delivery to the ports where trailers are connected for drying.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies unless noted. For undated references, the latest approved edition of the referenced document (including any amendments) applies.

NFPA 58, Liquefied Petroleum Gas Code

NFPA 70, National Electrical Code

ASAE D271, Psychrometric Data

3 Terminology

3.1 test: All events and data comprising the simulated drying of one or more trailers of peanuts for a 4 hour period.

3.2 test fan: The subject fan being tested.

3.3 main plenum: The structure that delivers air from the fan to the various ports where trailers are connected.

3.3.1 port: Opening in the main plenum where a trailer is connected.

3.3.2 flexible duct: Structure used to connect the port and the trailer.

3.4 dryer: The test fan and main plenum connected together as a single unit.

3.5 trailer: Vehicle used to transport harvested peanuts to the dryer. It can be any conveyance, trailer, wagon, or truck, with a drying floor and plenum that delivers air under the entire horizontal cross section of the load. Air passes up through the depth of peanuts and is exhausted out the top.

3.5.1 trailer plenum: Compartment beneath the drying floor that distributes air under the entire cross section of the trailer.

3.5.2 drying floor area: Cross-sectional area of the trailer perpendicular to the airflow.

3.5.3 trailer volume: Drying floor area multiplied by the peanut depth, defined as the average depth of peanuts in a fully loaded trailer.

3.6 direct-fired burner: Burner mounted downstream from the test fan which heats the airstream delivered into the main plenum.

3.7 heat exchanger: Device mounted downstream from the test fan that exchanges heat from a fluid to raise the temperature of the air delivered into the plenum. This term is used to refer to air-to-air exchangers, where the drying air flows around a combustion chamber which is vented outside the dryer, and to liquid-to-air exchangers, where liquid is heated by a remote source and circulated to an exchanger in the airstream.

3.8 collar: Device developed to give a standard method for measuring static pressure at a port. The flexible duct fastens to the upstream side of the collar.

3.9 resistance plate: Structure used to simulate the airflow resistance provided by a trailer of peanuts. The resistance plate fastens to the downstream side of the collar.

4 Site conditions

4.1 The dryer shall be tested under a structure that protects all parts of the fan and main plenum from direct solar radiation. The dryer shall be supported on a foundation that maintains at least 10 cm (4 in.) between the bottom of the plenum and the ground surface. There shall be no obstructions within 3 m (10 ft) of the fan inlet.

4.2 Fuel supplies and electrical connections, up to the point of connection to the dryer, shall comply with the following applicable Standards of the National Fire Protection Association: NFPA 54, National Fuel Gas Code; NFPA 58, Liquefied Petroleum Gas Code; and NFPA 70, National Electrical Code.



5 Test equipment

5.1 Petroleum fuel. Only fuel with known composition shall be used. Heat content data for liquid or gaseous fuel shall be obtained from the supplier. Total fuel consumption, TFC, will be measured by one of the following three methods:

5.1.1 Consumption of gaseous fuel shall be measured with a totalizing positive displacement flow meter rated for a maximum flow that is at least 10% greater than the maximum rated fuel consumption of the burner. The meter shall be temperature compensated, have an accuracy of $\pm 0.5\%$, and be calibrated to operate at the line pressure recommended by the burner manufacturer.

5.1.2 Consumption of liquid fuel shall be measured with a totalizing flow meter rated for a maximum flow that is at least 10% greater than the maximum rated fuel consumption of the burner. The meter shall have an accuracy of $\pm 0.5\%$.

5.1.3 Consumption of liquid, or LPG, fuel may be measured with a portable fuel tank, sized to contain at least twice the fuel consumed in a 4 hour test, mounted on a weighing device with an indicator having a resolution equal to $\pm 1\%$ of the total fuel consumed.

5.2 Flow of liquid in a liquid-to-air heat exchanger shall be measured with a totalizing meter with an accuracy of $\pm 1\%$. This meter shall be mounted at the outlet of the heat exchanger. Correction for temperature shall be applied based on calibration data supplied by the flow meter manufacturer.

5.3 Electrical energy consumption shall be measured in kW·h with an accuracy of $\pm 1\%$.

5.4 Temperature. All dry bulb temperatures shall be measured with transducers accurate to $\pm 0.5\text{ }^{\circ}\text{C}$ ($\pm 1\text{ }^{\circ}\text{F}$), a range of at least 0 to 100 $^{\circ}\text{C}$ (32 to 212 $^{\circ}\text{F}$), and time constant of 5 seconds or less.

5.4.1 Ambient temperature, T_a , shall be measured 1 m (3 ft) above the ground at any convenient location within a 2 m (6 ft) radius of the fan inlet. The sensor shall be protected from direct radiation.

5.4.2 Plenum temperature, T , shall be measured at the plane of the first port downstream from the point where heat energy is introduced. It is recommended that this measurement be the average of a minimum of five locations in this plane. Sufficient mixing should occur in all types of dryers upstream of the measurement location to ensure the correct average temperature. Special effort may be necessary on direct-fired dryers to achieve sufficient mixing.

5.4.3 Temperature of fluid entering, T_e , and exiting, T_x , a heat exchanger shall be measured in thermowells mounted within 10 cm (4 in.) of the heat exchanger header pipe.

5.5 Humidity. Ambient humidity may be measured with a sensor with accuracy of $\pm 2\%$ relative humidity, or may be determined by measuring wet bulb temperature. The wet bulb temperature shall be measured with an accuracy of $\pm 0.25\text{ }^{\circ}\text{C}$ ($\pm 0.5\text{ }^{\circ}\text{F}$) in an air velocity greater than 180 m/min (600 ft/min).

5.6 Collar. It is preferred that the collar cross-sectional area equal the cross-sectional area of the trailer plenum opening. It is acceptable to use a collar where the maximum cross-sectional dimension (denoted as length) is 5% less than the trailer plenum, or the minimum cross-sectional dimension (denoted as width) is 10% less than the trailer plenum. If either the length or width dimension is less than the trailer plenum opening, the other dimension must equal the trailer plenum opening.

5.7 Static pressure. A piezometer ring for measuring static pressure shall be installed around the collar as shown in Figure 1.