Vacuum dry heating

Identification

Key words
vacuum drying, heat, absorbed water, microwave vacuum dehydration

Latest version
2012/04/27

Completed by
FRIP

How does it work?

Primary objective
Fast and effective drying of products
The use of vacuum combined with heat can be an effective method for drying. Lower moisture content can be achieved when using a combination of vacuum and heat compared to heat alone (particularly with products that are porous or have a very high surface area). The use of vacuum drying has shown further improvement in quality of food products. It reduces thermal stress and sustains better colour and texture of dried products compared to those that were air-dried [1, 13].

A vacuum drying system consists of the vacuum chamber and source of the heat. Both oil-sealed and oil-free (dry) mechanical vacuum pumps can be used. A condensate trap (typically cooled to very low temperatures) is also used to pump and trap the liquid(s) to be removed. Base pressures of less than 0.1 Torr (1,333 x 10-4 bar) are often required, depending on the liquid to be removed and the temperatures which we want to achieve. Care should be taken to protect oil-sealed pumps from the liquid and operating the pumps properly to minimize the impact of the liquid vapours being ingested into the pump (often with the use of a gas ballast and/or gas purge) [1, 13].

The vacuum drying process often involves multiple steps of applying heat and vacuum. Reducing the pressure (applying vacuum) at the surface of a liquid (such as water) will allow the liquid to evaporate without elevating the temperature. The evaporation of the liquid will continue until the product is dried or until enough heat is removed (through evaporation) that the remaining liquid freezes. At this point the drying process continues as sublimation which is much slower compared to evaporation. In general, this is not desirable. The purpose of heat is to maximize drying while preventing freezing of the liquid. There are several methods of applying heat to the product being dried. Some products have temperature limitations which may impact the methods that may be employed. These methods include:

- Preheating the product using a variety of methods prior to placing into the vacuum chamber.
- Preheating the product in a specially designed vacuum chamber that is configured to provide convection heating.
- Heating the walls of the vacuum chamber. Heat from the chamber walls is normally not a very efficient method of heating a product under vacuum. Radiation is the primary method of heat transfer.
- Heating the shelves inside the vacuum chamber. This technique can apply heat directly to the product by contact to the shelf.
- Flowing hot gas, such as nitrogen, into the chamber. This can be done using a variety of techniques.
- Using infrared heating sources - vacuum infrared drying. This non-contact method can be an effective method of transferring heat to a product under vacuum [1].
- Using microwave heating sources. This technology is advantageous for bulk products with poor thermal conductivity. The microwave vacuum technology is used for high-end drying applications of thermal sensitive products like fruits and vegetables in order to achieve higher product qualities and shorter drying times [2]. Microwave drying is more convenience in compared to conventional drying methods and it offers many kinds of advantages [2, 3, 8].

This technology is suitable for a wide spectrum of food e.g. strawberries, cranberries, banana, carrot, honey, mushrooms etc. [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12].

It can prevent oxidation of sensitive products that cannot be dried in the presence of air. It can also recover the solvent that is removed from the product.
Important process parameters
Pressure, time, temperature, electrical power

Important product parameters
dielectric properties (for microwave heating), water contents, size and number of pores (texture), thermophysical properties

What can it be used for?

Products
Solid and liquid food

Operations
Stabilization, drying

Solutions for shortcomings
This technology is more efficient and faster with better quality of the final product.

What can it NOT be used for?

Products
food with high content of fat

Operations
Stabilization, drying

Other limitations
Microwave drying - The penetration of microwaves is limited (problem with large diameter products) [13].
A high temperature can not be used for temperature sensitive products.

Risks or hazards

Implementation

Maturity
This technology is used in industry.

Modularity
This technology can be included in production line (batch system).

Consumer aspects
Some consumers are convinced about harmfulness of microwave heating.

Legal aspects

Environmental aspects
Smaller energy consumption
Facilities that might be interesting for you

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Further Information

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<th>Institutes</th>
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<td>Wageningen UR - FBR, University College Dublin, Indian Agricultural Research Institute, Washington State University</td>
<td>Püschner, Weiss-Gallenkamp, LACO Technologies</td>
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References

[1] LacoTechnologies, Vacuum drying. Technologies application note, Note#05-07