

Pilot plant for the next step in low energy drying of food and other high value products

Publieke samenvatting / Public summary

Spray drying is used in the food industry to transform food and dairy products into powders to preserve taste, smell and all nutritional aspects. It also guarantees product quality for a longer period of time and facilitates easy transport of products. Spray drying is, however, an energy intensive technology which consumes 15% of the overall energy consumption within the Dutch industry. The ENGENDER project was aiming to realize a breakthrough in drying of food ingredient materials using a new compact energy-efficient drying technology, the Radial Multizone Dryer (RMD). The RMD combines high-G force and multizone operation to intensify spray drying and offers a cost and energy efficient spraydrying solution. Compared to standard spray drying technologies, the RMD enables lower footprint of equipment at equal drying capacity and related reduction of Capex and Opex. The equipment size is reduced by at least one order of magnitude. The dryer can significantly reduce the air consumption and exhaust air flow, but also reduces water use in the cleaning process (CIP) as there is less equipment surface to clean.

In the Engender project the RMD technology was further developed at pilot-scale for design rules for industrial demonstration. The expected energy savings were estimated up to 20-30% compared to conventional spray drying and to be confirmed for a selected set of model systems, that is, test materials.

The project has been building on results from

Projectinformatie / Project information

Projectnummer / Project number
TKITOETKI2019_Engender

Subsidiebedrag / Grant amount
€ 430.400,00

Algemene informatie / General information

Penvoerder / Secretariat
ISPT

Publicaties en materialen / Publications and attachments

- 09.12.2024

TKI19 Engender publieke eindrapportage

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previous projects that developed the RMD concept and in which an RMD apparatus was designed and tested at the lab scale and at the pilot plant scale for the specific needs of Friesland Campina, which focused on milk spray drying and gradual scale-up. Efficient drying is to be achieved by combining radial multizone and high-G force operation. The radial multizone operation allows to feed hot air in the radially central zone of the chamber where the droplets are injected and to feed air of lower temperature in the periphery where the particles are recovered. High-G force operation is achieved by making use of vortex chamber technology. The mild temperature air is injected through a number of vortex chamber inlets to generate a rotational motion and to control the axial motion of air in the drying chamber. Droplets injected in the chamber undergo a fast initial drying upon contact with the hot air and are under the action of the high-G force rapidly discharged to the mild temperature periphery for final drying and recovery.

In the ENGENDER project, the existing pilot plant unit was used to carry out spray drying experiments. The experiments were aimed at confirming the flexibility of the RMD technology and at optimizing the operating parameters and details of the design together with industrial partners Avebe, Corbion and Givaudan. Long-time testing by University of Louvain was planned for this project. The test program did allow us to gain insights during shorter test runs in the window of operating conditions and in the stability of operation. Start-up and shut-down procedures were optimized and fouling conditions further investigated leading to modifications in inlet conditions. The test run length could also be extended to hours instead of minutes.

Powder/air separation and emptying the RMD requires further optimization.

Modifications were also introduced to finetune the countercurrent flows to create a more ideal vortex. This was done with help of computational fluid dynamics (CFD) simulations by University of Twente to optimize the temperature zones in the drying chamber. Modifications are still ongoing to come to

longtime experimental runs and further finetuning.

The energy efficiency was investigated and based on experiments and simulations led to the conclusion of an improved energy efficiency of at least 20 % compared to conventional spray drying.

The operating principle is more energy efficient. The savings estimate is realistic, although scaling up risks will have to be accounted for.

In this context, we see two major challenges. The complexity of the current design makes scale-up and stable operation difficult. This has different reasons; the main one being the number of different airflows.

Recommendation is to use the available knowledge to create a simpler design. Product quality remains a concern. In particular, the exposure of dry product to hot air poses a risk here. This entails very high requirements for separation. This ties in with the design question on the first point and places high demands on the droplet size distribution (when sprayed) and the particle size distribution of the resulting product.

Technology is available to control this. It will have to be an integral part in a new, improved and simplified equipment design. Involvement of an industrial equipment supplier/manufacturer is therefore a pre-condition for any new design.

The conclusion is as a next step towards commercialization of the technology that scaling-up and building a new simplified design based on learnings from the Engender project will be necessary.

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.

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