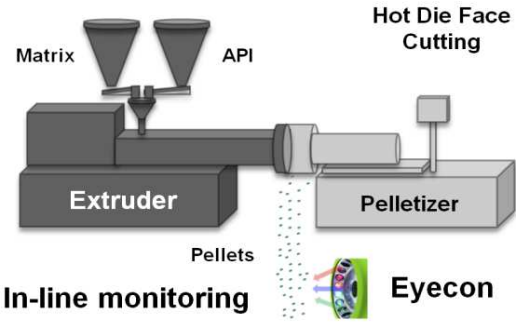
Implementation of a Novel Particle Size Measurement Tool to Monitor Pellets Produced by HME and Die Face Pelletizing

Daniel Treffer[1], Patrick Wahl[2], Theresa Hörmann[2], Daniel Markl[2], Andreas Eitzlmayr[1], Simone Schrank[1], Gerold Koscher[2], Eva Roblegg[3] and Johannes G. Khinast[1]

[1] Institute for Process and Particle Engineering, Graz University of Technology, Graz, Austria
[2] Research Center Pharmaceutical Engineering GmbH, Graz, Austria
[3] Department of Pharmaceutical Technology, University of Graz, Graz, Austria

Introduction

A novel image analysis system (Eyecon) is used to analyze pellets with a size of about 1-2 mm produced by Hot Melt Extrusion (HME) and Die Face Pelletizing (DFP). The method is based on photometric stereo imaging, which is achieved by three different-colored light sources arranged circularly around the lens. Several implementations, whereby the product stream was led through the optical sampling volume of the analysis tool, have been tested and evaluated. Furthermore, a particle size distribution (PSD) comparison between Eyecon and an off-line reference particle analysis (QICPIC) has been conducted (constant throughput and different cutting frequencies).

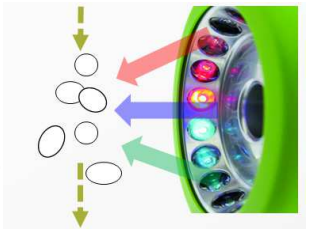


Methods and Materials

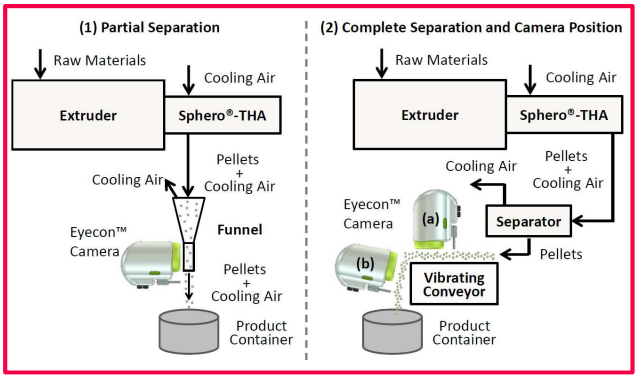
- **Formulation:** 80% Calcium Stearate (Werba GmbH, Austria), 20% Paracetamol (GL-Pharma, Austria)
- **Hot Melt Extrusion:** Co-Rotating Twin-Screw Extruder: ZSK 18 (Coperion, Germany)
- **Hot Die Face Pelletizing:** Sphero®-THA (Automatik Plastics Machinery GmbH, Germany)
- **Particle Analysis:** Inline: Eyecon (Innopharma Labs, Ireland); Offline: QICPIC (Sympatec, Germany)

Eyecon Technology

- Image-based particle analysis
- Detection size range: 50 – 3000 µm
- Optical sample volume: 9x6x4 mm
- LEDs arranged circularly around the lens
- LEDs flash and freeze particle motion
- No specific background needed, works with diffuse reflection
- Derives 3D information from a 2D image and is used for improved particle edge detection

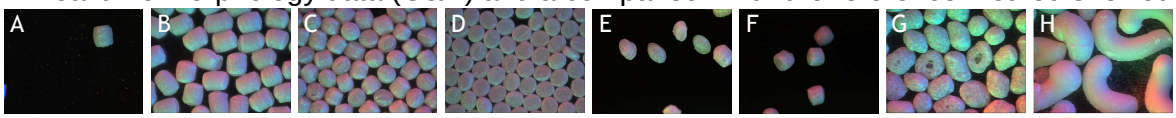


Implementation Approaches

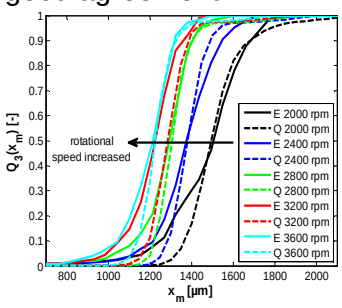


Results

- Particle representation and, therewith, PSD data are strongly impacted by the applied implementation approach
- Partial separation (1)&(A) led to an insufficient amount of analyzed particles due to low particle volume fraction
- Complete separation (B-F), increased the number of captured particles but uniform particle alignment falsifies the measurement with horizontal camera position (2a, B-D). Lateral camera position (2b) leads to statistical random particle representation (E-F) and sufficient particle count. This setup was used for the subsequent comparison.
- Real time morphology data (G&H) and a comparison with the reference method showed good agreement



Eyecon Images; A: Partial Separation; B-D: Complete Separation (2a) at low (B), middle (C) and high cutting (D) frequency; E&F: Complete separation (2b) random particle orientation; G&H: Examples for visual real time information, (G) cavities, (H) glossy surface



PSD Data for an experiment with constant throughput and varying cutting frequency from 2000-3600 rpm (E: Eyecon; Q: QICPIC)

Conclusion

It has been shown that photometric stereo image analysis is a suitable tool to monitor the particle size distribution and shape of pellets produced by HME with DFP. Challenges like low particle concentration and particle representations were solved by complete separation and through the use of a vibrating conveyor.

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