New Driving Forces for Dry Fractionation

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Background

Current wet bio-refining techniques or waste valorisation processes, e.g. purification of wheat proteins from wheat, are carried out under extreme conditions (temperature, acids, etc.), and usually require the suspension or dissolution into large amounts of water (or other solvents). The harsh conditions degrade the functionality of individual components, while the use of copious amounts of water generates large quantities of waste water, and requires the use of large amounts of energy (dehydration).

A dry fractionation method will reduce or even eliminate waste water generation, strongly reduce energy usage and maintain the functionality of product.

In this project, separation of dry particulate streams is achieved by applying a novel driving force – electrostatic force. Particles are charged by means of triboelectrification and then separated in an external electrostatic field.

Principle

Triboelectrification is the static charging of two materials when they come into contact with each other and then separate.

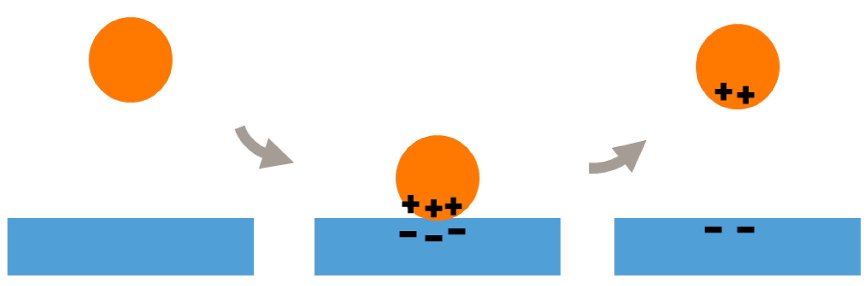

Figure 1. Triboelectrification

Objective

- Understanding the charging and subsequent segregation dynamics by using a model particulate system in combination with a discrete particle (DP) model approach.
- Developing an efficient electrostatic separation process for (industrially) relevant feed streams.

Experimental set-up

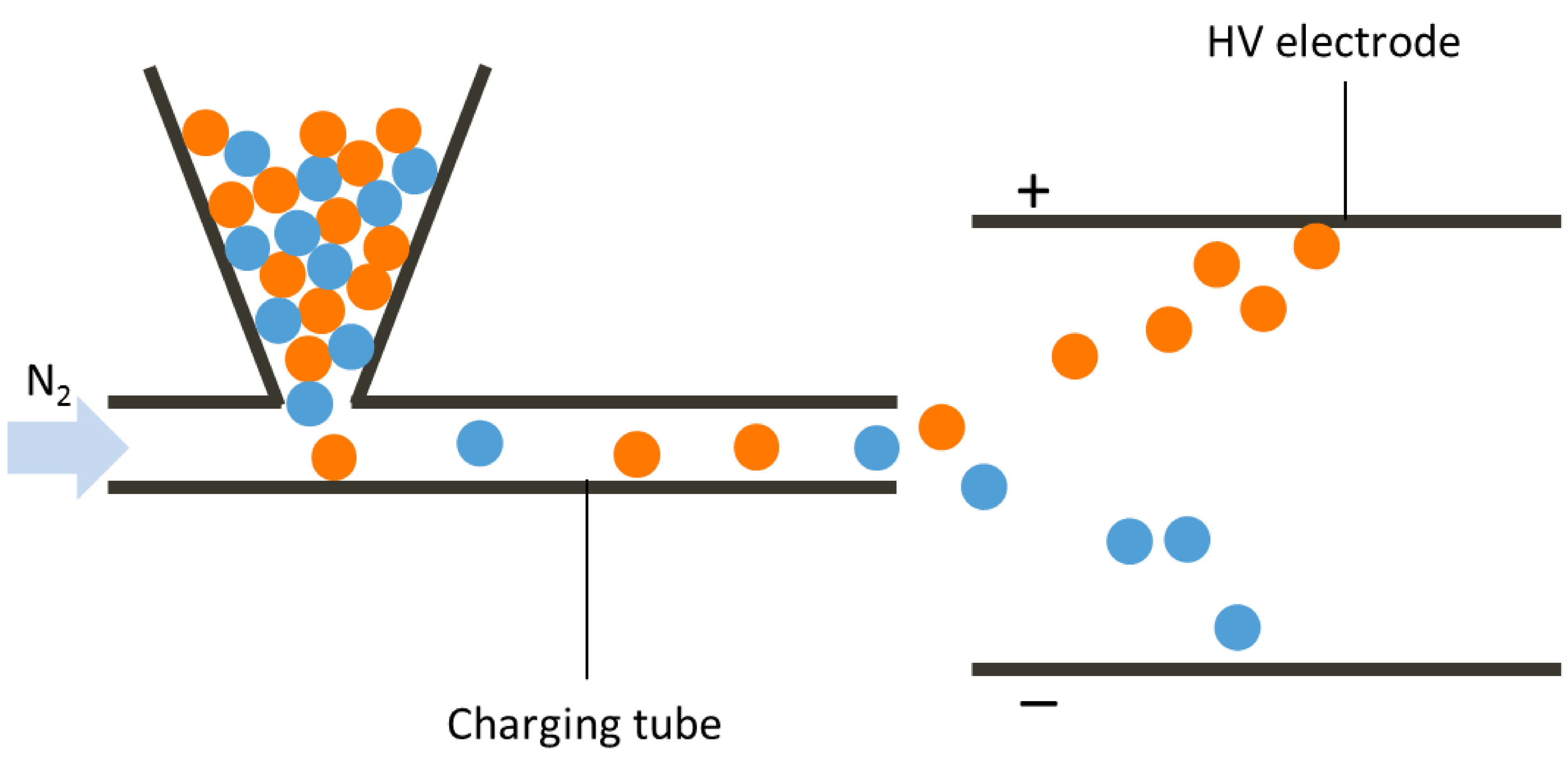

Figure 2. Schematic drawing of the electrostatic separation process: particles are blown through the tube by gas flow to let the particles take charge by triboelectrification. Then the two fractions with different charge are separated in an high-voltage electrostatic field.

Preliminary Results

Triboelectrification of wheat gluten and starch

- The influence of gas flow rate on triboelectric charging was tested with wheat gluten and starch. As shown in figure 3 and 4, the specific charges of both gluten and starch increased with increasing gas flow rate.

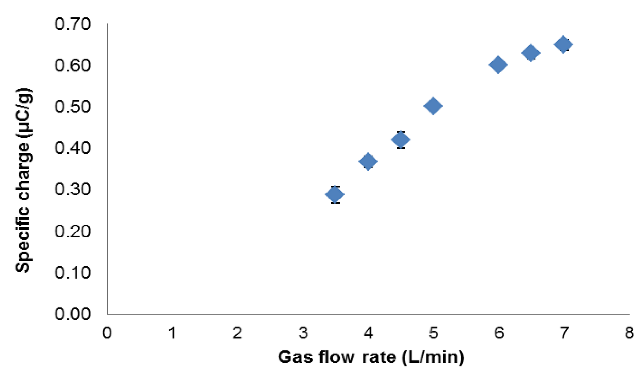

Figure 3. triboelectrification of gluten

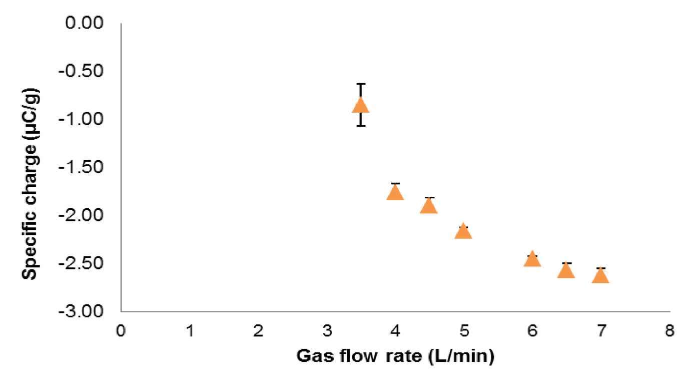

Figure 4. triboelectrification of starch

Separation of ideal wheat gluten and starch mixture

- As shown in table 1, when the gluten/starch ratio is higher than 40/60, the purity of the fraction on negative electrode is close to the purity of the gluten before mixing.

Table 1. Protein content of separated fractions from ideal wheat gluten and starch mixture

Composition of Gluten – Starch	Mass fraction (wt %)			Original protein content (wt %)	Protein content (wt %)	
	+	-	Loss		(+) electrode	(-) electrode
0 : 100	58	6	36	0.0	0.0	0.0
15 : 85	49	22	29	11.6	0.1	52.4
40 : 60	47	36	17	32.0	0.6	76.1
60 : 40	33	47	20	49.3	1.6	77.9
100 : 0	1	56	43	79.7	79.2	80.0

Approach

- Start with simplified model system
  - dp= 200 or 450 μm polystyrene and opposite charging material (e.g. nylon).
  - Experimentally study effect particle size, gas flow and concentration on charging.
  - Use DPM to evaluate hydrodynamics and forces (gravity, drag, electrostatic) in model system. (by TU/e)
- Analysis
  - Video camera
  - Charge measurements
- Inventory applications close to model system.
- Evaluate charging characteristics

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