Influence of Potassium Iodide product forms on material rheology

Introduction

Potassium iodide (KI) is well known for its use as a heat stabilisation additive in polyamide engineering plastics, in pharmaceutical drug synthesis and in the regulation of negative side effects in radioactive treatment after human exposure.

The general chemistry principles and benefits of KI in these applications are known and understood. However, different operational and changing practices in existing applications may require different product forms of KI to optimise the feeding accuracy and dispersion quality of KI in their resulting formulations. KI's increasing and diversified use is demanding new capabilities in controlling the particle size, particle size distribution and improving production consistency to meet customers' expectations.

To support formulators and process engineers in choosing optimal KI product forms, work was undertaken to characterise the solid state rheology of three alternative product forms; William Blythe's standard KI powder and two compacted powder flakes, < 1 and < 5mm.

Product flow characteristics of 'compacted' and standard KI grades are presented as options to make improved use of these product forms to broaden and optimize the processing envelope for powder based KI grades.

Background: Product Form Rheology Dimensions

The inherent physical characteristics of a powder are readily described by average (mean size) and particle size distribution, bulk density, powder and crystal morphology, colour, and refractive index. Solid state material rheology properties can only be determined under dynamic conditions, when energy is applied to them in production and transport processes and subsequently observe how they behave.

As there are different powder and processing technologies (gravimetric, etc.), a specific product form can exhibit different flow characteristics depending on the combination of environmental conditions, equipment configuration and operator handling.

Addition of other processing aids to powder KI grades are possible, though often not desired as it can reduce flexibility and lead to unforeseen side effects in end formulations. There is thus a need for alternative product forms where the material flow characteristics are modified without processing aids and retain the freedom to formulate and improve processing characteristics as well.

Experimental

Product Form Preparation

Three KI powder grades were produced, one being standard, and two 'flake grades'. The 'flake grades' were produced through roll mill compaction into 1 and 5 mm flake forms.

Material Rheology Characterisation

The material product flow properties were performed at Freeman Technology using a FT4 Powder Rheometer. The FT 4 Rheometer allows for the simultaneous characterisation of a wide range of dynamic powder flow properties.

Bulk powder properties determined were permeability and compressibility. Dynamic properties determined were specific energy, stability index, flow rate sensitivity and conditioned bulk density. Shear properties were determined through wall friction. *A specific combination of these properties can be relevant to selecting the appropriate KI grade depending on the process and feeding conditions.*

Results

Table 1 summarizes the different product form characteristics and rheology differences between them.

Properties	*Standard*	*Flake*	*Flake*
D50	250 micron	< 1mm	< 5mm
Dynamic Measurements			
Stability Index, SI	1.0 (1.6%)	1.0 (4.9%)	0.8 (1.9%)
Flow Rate Index, FRI	1.2 (2.1%)	1.2 (1.5%)	1.0 (3.8%)
Specific Energy, SE (mJ/g)	3.1 (2.4%)	3.1 (6.7%)	4.0 (0.5)
Conditioned Bulk Density (g/ml)	1.78 (0.3%)	1.65 (0.8%)	1.60 (0.3%)
Bulk Property Density			
Pressure Drop, $PD_{12,2}$ (mbar)	6.4 (0.5%)	0.4 (7.8%)	0.3 (9.5%)
Permeability, $k_{12,2} \times 10^9$ (cm^2)	285 (0.7%)	4871 (7.9%)	7127 (9.3%)
Compressibility, CPS_{12} (%)	9.0 (2.2%)	6.0 (2.4%)	5.7 (5.1%)

Observations

The influence of particle size and morphology is demonstrated by the significant effects of moisture adsorption on the flow characteristics of the standard grade versus the compressed

KI grades into flakes. The standard grade demonstrates lower permeability and specific energy values, and a higher compressibility value. The 5 mm flake form exhibited the highest permeability values and a lower compressibility value. The results underscore again the critical parameter of inter-particle cohesive energy and how it can be influenced by particle size and shape.

Conclusion

Critical product form flow properties of potassium iodide can easily be controlled by modifying the product form of a KI powder to flakes, leading to reduced surface moisture adsorption and reduced cohesive energy between particles. This approach is of particular use in the pharma and polymer additives industries in cases where specific processing equipment and elevated humidity exposure may require a free flowing KI powder without the addition of any other additives.

September 2016