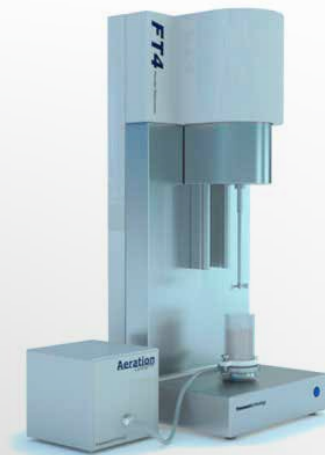


## PROFITABLE POWDER PROCESSING: ENHANCING EFFICIENCY WITH THE FT4 POWDER RHEOMETER®



In powder processing, analytical data is a primary driver of progress towards better products and more efficient manufacturing practice. Instruments that deliver novel, unique and relevant information enable an enhanced understanding of powder behaviour making it possible to solve problems that are otherwise intractable, potentially transforming profitability. For nearly twenty years, we've learned about some of the most demanding powder processing challenges and how the FT4 Powder Rheometer has facilitated their solution. This whitepaper summarises some of the key reasons that most often justify an investment in an FT4 Powder Rheometer, highlighting the rewards made accessible by the data the instrument generates.



**FT4 POWDER RHEOMETER®**

### Introducing the FT4 Powder Rheometer

The FT4 Powder Rheometer was designed for comprehensive powder characterisation, as a tool for solving powder processing issues. It differs from other powder testers in many ways but when assessing industrial value, three features are critical:

- The ability to simulate powder processing conditions, by testing samples in a consolidated, moderately stressed, aerated or fluidised state.
- The application of multi-faceted powder characterisation to assess dynamic flow, bulk and shear properties to construct the most comprehensive understanding of how a powder behaves.
- Unparalleled sensitivity, enabling the differentiation of powders that other testers classify as identical.

To find out more information about how the FT4 Powder Rheometer works then please visit the Freeman Technology website.

### To Manufacture Premium Product

*A precise, well-defined specification in combination with highly reliable quality control (QC) provides a foundation for market leadership.*

Manufacturers rely on the FT4 Powder Rheometer to determine which powder properties dictate optimal performance in an application, defining a specification to ensure excellence. By using the FT4 for product QC they also ensure exemplary consistency, with the high sensitivity of the instrument able to detect the subtlest deviation from that specification.

The flowability of a powder often defines performance but diverse applications subject powders to quite

different conditions. For example, powders may be fluidised in catalytic reactors or dry powder inhalers, compacted into granules, pellets or tablets, or extruded. Typically, the goal is to achieve precisely controlled, consistent flow under low stress conditions – through a continuous manufacturing plant, across the build platform in an additive manufacturing machine, into an intricate die, or with another powder in a blender.

It is the unique ability of the FT4 to measure flowability across the diverse stress conditions encountered in everyday processing that makes it possible to develop an optimal, relevant specification for every product, regardless of application. Well-defined measurement protocols, and a high degree of automation, ease the analytical workload associated with achieving exemplary QC to maintain that specification.

### **To Manufacture Premium Product**

*Comprehensive, multi-faceted characterisation of the behaviour of raw materials and products builds a secure base for rapid, knowledge-led progress.*

Researchers use the FT4 Powder Rheometer to develop the understanding required to make faster progress, by measuring the impact of variables that are otherwise inaccessible in order to rationalise complex behaviours. Learning how to control powder behaviour by manipulating physical properties such as particle size and shape, surface texture, and/or surface energy can transform the effectiveness of a research programme. Major commercial gains include abbreviated pilot trials, and the substantial prize of more rapid commercialisation.

Consider the development of a powder coating for a fluidised bed application. The response of the powder to the introduction air will be critical so behaviour in a low stress dynamic state and the ability to fluidise are likely to be highly relevant. These are not behaviours that can be predicted from primary particle properties, so researchers have two options. A 'trial and error' approach involves progressive adjustment of the constituents and the repeated quantification of performance on a pilot scale rig. The alternative is to identify bulk powder properties that define desirable behaviour and implement a research programme to target them. This is only possible if the bulk properties measured reliably quantify how the powder flows in low stress dynamic conditions and its ability to fluidise, essentially, how the powder will behave in the process. Once these are in place, properties such as particle size and morphology, can be specified or modified to produce powders with the required bulk properties – an efficient, knowledge-led approach.

Because FT4 measurements are sensitive to the most minor of physical changes, even subtle changes in raw materials and products can be detected and rationalised. Furthermore, the ability of the FT4 to provide comprehensive multi-faceted characterisation – via dynamic, shear and bulk powder testing – makes it relevant to the broadest range of processes and products. In combination these advantages make the FT4 a significantly more powerful research tool than other powder testers.

### **To Solve Processing Problems**

*Understanding why a powder is performing sub-optimally is the first step towards developing a successful remedy.*

Process engineers use the FT4 Powder Rheometer to collect the information required for successful root cause analysis of powder processing issues, and to determine the most effective solution. Powders have a reputation for erratic and unpredictable performance, largely because it is easy to underestimate or entirely miss the significance of a process or material change. Measuring flow behaviour with high sensitivity, in combination with complementary powder properties, often identifies the source of a problem.

Consider a hopper exhibiting erratic discharge, but only when used with one raw material not with another. Analysis of the two powders indicates that the flow properties of the problematic material change more markedly following consolidation. This powder will therefore be more sensitive to filling procedures, more likely to exhibit compromised flow as a result of consolidation under its own weight. A potential solution

might therefore be to implement a practice of maintaining a reduced hopper level and more frequent filling when working with this material.

Flowability is also associated, perhaps less obviously, with a wide range of other processing issues. Poor flow properties may compromise blend homogeneity, for example, or the mechanical strength of tablets and pellets, through inadequate die-filling and subsequently ineffective compaction.

In trouble-shooting, the ability of the FT4 to quantify flowability alongside other powder properties, with unparalleled sensitivity, maximises its value, with the resulting data providing the understanding needed to develop an optimal solution.

### **To Select the Best Equipment**

*Compatibility between the processing environment and the inherent properties of the powder is the key to long term, trouble-free operation.*

Equipment suppliers use the FT4 Powder Rheometer to define the properties of powders that will perform well in a certain piece of equipment and to specify equipment for powders with given properties. By measuring the properties of each new powder encountered, they can develop an extensive database of materials. Correlating these properties with observed in-process performance identifies the properties of powders that are compatible with each unit. Over time this enables the efficient selection of “right first time” processing solutions which has obvious cost benefits.

Powders aren't inherently 'good' or 'bad', but they are compatible, or otherwise, with a specific processing environment. The ideal powder for one application can be the worse-case scenario for another. Matching powders with equipment to which they are intrinsically well-suited sets a firm foundation for long-term, highly reliable manufacturing.

The ability of the FT4 to provide comprehensive, multi-parameter powder characterisation translates directly into a more extensive database, maximising the opportunity to build robust correlations for all types of processing equipment. High sensitivity makes it possible to detect minor differences between the suitability of different solutions ensuring that the most appropriate equipment is selected in each case.

### **To Optimise Raw Material Supply**

*Confidently switching to a more reliable or lower cost supplier relies on being able to determine whether a new raw material will perform well, before introducing it into the plant.*

Powder processors use the FT4 Powder Rheometer to develop secure specifications that robustly differentiate a poorly performing raw material from one that makes the grade. This makes it possible to select a cost effective, reliable supplier while at the same time safeguarding plant performance.

Discovering that a new raw material performs poorly in the process, despite meeting the specification, is surprisingly common in powder processing. A natural response may be to reduce risk by staying with a known supply, but this can have an adverse effect on production costs. The use of limited powder testing techniques is often the cause of the problem as these can generate specifications that are imprecise or not robust. Many traditional techniques measure just a single powder property, often with poor reproducibility. It is therefore quite possible for a new raw material to meet the generated specification but fail in the process due to differences that the measurement completely fails to detect, or fails to quantify with sufficient precision.

The advantages of the FT4 in this area therefore closely mirror its benefits for QC. Because it can simulate the conditions in the process, the FT4 can provide more relevant and comprehensive data allowing a

robust specification for a range of processes to be defined. Furthermore, the high sensitivity of the instrument makes it possible to reliably identify batches that fail to meet the specification, even if only by a small margin.

### **In Summary**

The FT4 Powder Rheometer was conceived specifically as a dedicated, universal powder tester to enable powder processors to generate data to help solve industrial problems. This paper highlights some key areas where experience has shown it routinely proves most valuable. Industrialists invest in an FT4 as they know it will help them resolve challenges more effectively than any other tester. Experience also shows that the resulting returns far exceed the original investment.

### *Resources for powder processors*

A large number of educational resources for all powder handlers are available on the Freeman Technology website, including the following eBooks:

- An Introduction to Powders
- Choosing a Powder Tester
- The Value of Powder Testing

Available at [www.freemantech.co.uk/learn/ebooks](http://www.freemantech.co.uk/learn/ebooks).