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Atomization of Melts

For Powder Production and Spray Deposition

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PREFACE

Atomization is the breakup of bulk liquid into droplets to form a spray. In melt atomization the liquid consists of a heated substance, which is a solid at room temperature. The spraying of molten metals is the most common form of melt atomization and this is carried out for the production of metal powders or, in spray deposition, for coating or the spray forming of shapes such as billets or tubes. Melt spraying can have many advantages over more conventional processes, both in the quality of product and the efficiency of the process. However, the formation of the spray and the interaction of the spray with its surroundings are complex phenomena which are difficult to measure, control, or predict, due to small particle sizes, complex drop formation processes, high velocities, turbulence, high temperatures, and many metallurgically related phenomena.

This book presents a compilation of information from the often separate spheres of industrial metallurgy practice and what is normally dealt with by chemical engineering and fluid mechanics specialists. The melt-spraying practitioner is provided with an authoritative and critical review of the subject. The student and academic researcher are provided with a source of information which brings together important aspects of the topic which have not been covered in one volume for many years, if at all. The reader may have one of several backgrounds including manufacturing, research and development in industry, and as a graduate or undergraduate student. Those involved in melt atomization often come from quite different fields which may include metallurgy, process engineering, mechanical engineering, and, increasingly, from areas such as computational fluid mechanics and instrumentation and control.

Following the introduction to the field in Chapter 1, fundamentals of the breakup of liquid into droplets are covered in Chapter 2. These theoretical treatments, although necessarily simplified, can give insights into practical melt atomization. Chapter 3 describes parameters which may be measured and how they may be presented, for example in the form of size distributions. In Chapter 4 the more important measurement techniques are described and compared, with coverage of newer laser and optoelectronic-based techniques. Melt spraying for powder production has a peculiar advantage compared with the spraying of normal liquids: performance is clearly evidenced by the characteristics of the collected powder which can be analysed in great detail. Measurements of the droplets 'in flight'

during spray deposition or for sprays of normal liquids is an interesting, although difficult, task.

Assessment of atomization methods for normal liquids is helpful and this is presented in Chapter 5. In Chapter 6 melt atomizer designs and their performances are described. Both 'practical' industrial plant and research atomizers are discussed. Research into melt atomizer design can be directly relevant to understanding the performance of industrial plant and also research techniques have a history of development into practical systems. Chapter 7 describes the application of these techniques to specific cases of metals and non-metals. Chapter 8 is devoted to the subject of spray deposition. The particular requirements regarding the properties of powders in different applications are described in Chapter 9.

At the forefront of research and development in melt atomization are the interrelated areas of (a) computational modelling and prediction, (b) advanced '*in situ*' measurements of spray structure, and (c) process control, sometimes referred to as *intelligent processing*. These fields are described in Chapter 10. Finally, the successful design and operation of atomizer plant require more than the achievement of satisfactory breakup of the melt and solidification. Many of the practical aspects of plant construction and operation are discussed in Chapter 11 and Chapter 12 discusses economic aspects of plant utilization.

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