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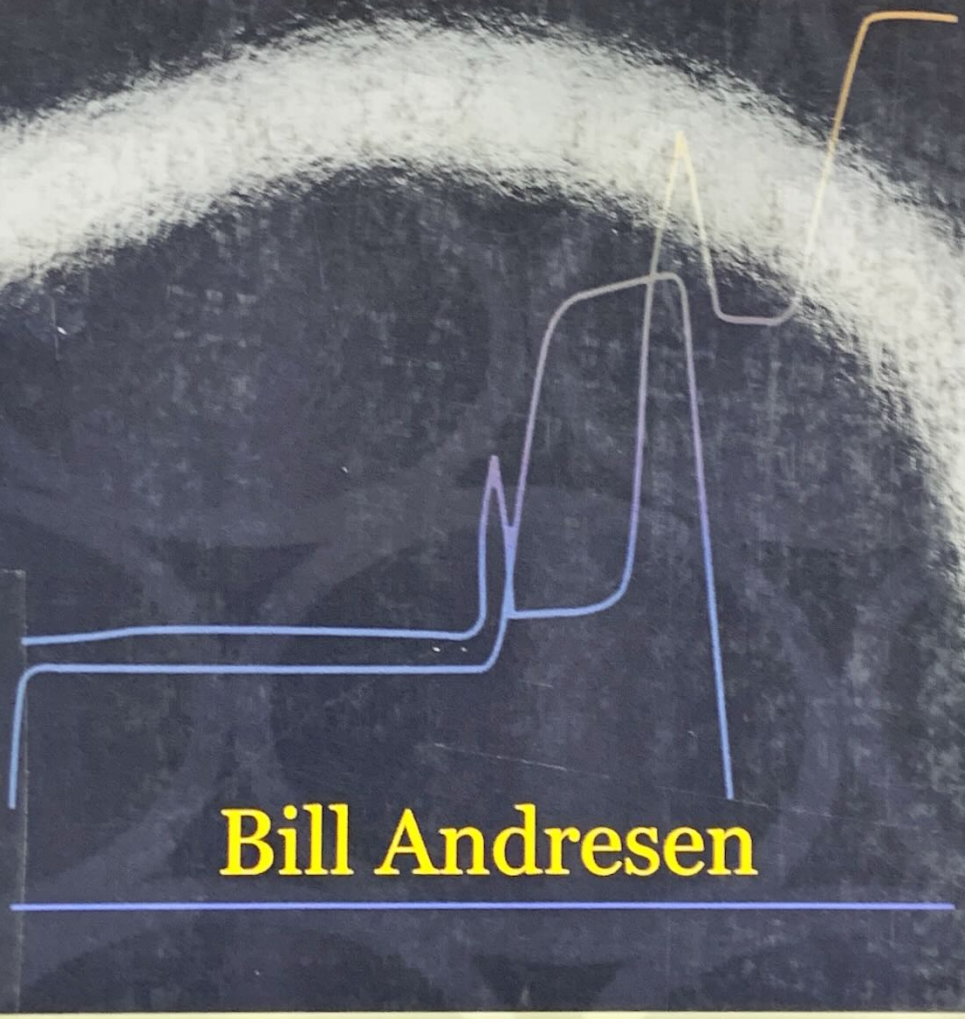
DIE CASTING ENGINEERING

A Hydraulic, Thermal, and Mechanical Process



Bill Andresen

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Preface

This is a broad technical presentation for participants in the die casting process. It is intended that the material presented will help to reduce manufacturing costs, increase productivity, and enhance quality through failure avoidance. While the scope is broad and covers the many facets of casting, the focus is on function, problem identication and solution, and strategic logic.

All casting processing are a function of velocity and pressure. Die casting is at the high level of both, a fact that presents unique challenges discussed in this book.

Die casting is the shortest route between raw material and near net shape.

Acknowledgment

To Barb, who totally supports a hectic career in die casting, which is so enjoyable that it can hardly be considered work.

Bill Andresen

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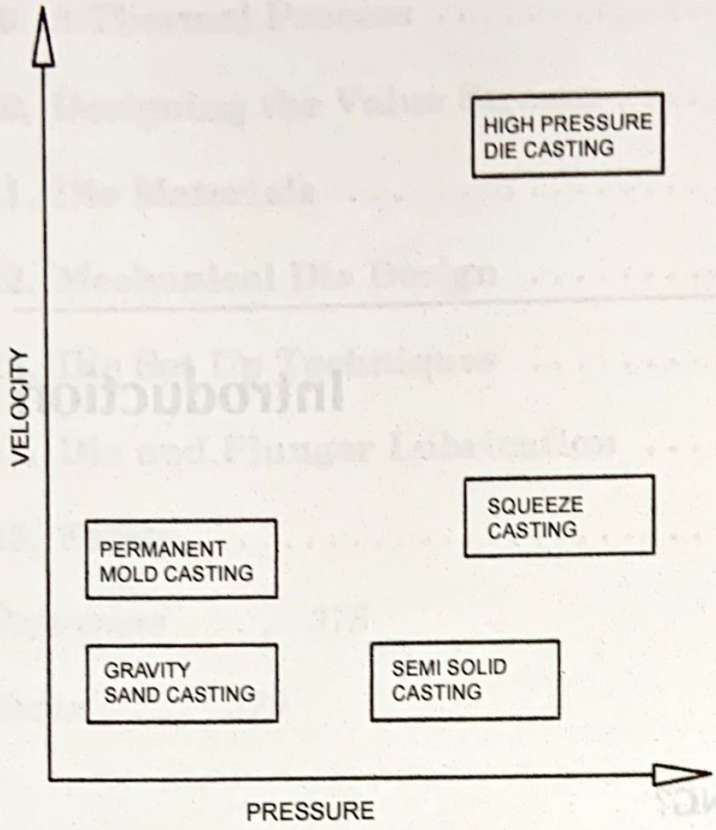
Introduction

WHAT IS DIE CASTING?

Die casting is a manufacturing process for producing accurately dimensioned, sharply defined, smooth or textured surface metal parts. It is accomplished by injecting liquid metal at fast velocity and under high pressure into reusable steel dies. Compared to other casting processes, die casting is at the top end of both velocity and pressure. The high velocity translates into a very turbulent flow condition. The process is often described as the shortest distance between raw material and the finished product. The term die casting is also used to identify the cast product.

HOW ARE DIE CASTINGS PRODUCED?

First, a steel mold, which is usually called the die and contains the cavities that form the castings, is made into two halves to permit removal of the castings. This die is capable of producing thousands of parts in rapid succession. The die is then mounted securely in a die casting machine with the



RELATIONSHIP OF VARIOUS CASTING PROCESSES TO PRESSURE AND VELOCITY

Figure 1

individual halves arranged so that one is stationary (cover die) while the other is moveable (ejector die).

The casting cycle starts when the two dies are clamped tightly together by the closing mechanism of the machine. Liquid casting alloy is then injected into the die in an extremely short period of time and at very high pressures, where it solidifies rapidly. The die halves are then drawn apart when the machine opens, and the shot which includes the castings is ejected.

Die casting dies range from simple to complex and have moveable slides and cores as determined by the configuration of the part. They consist of mechanical features; a metal flow system called runners, gates and vents; and a thermal system because the die also acts as a heat exchanger.

The complete cycle of the die casting process is by far the fastest method known for producing precise nonferrous metal castings. This is in marked contrast to sand casting which requires a new sand mold for each casting cycle. While the permanent mold process uses steel molds instead of sand, it is considerably slower and, like sand casting, not as precise as die casting.

BASIC TO THE PROCESS

The die casting process is fundamentally simple but it is complicated by a massive array of ancillary equipment and details. There are only three basic factors (see below) that affect the final product that results from the rapid conversion of metal in the ingot form to a net shape.

Some assumptions are usually made when dealing with die casting that help to visualize the logical chain of events that occur during each cycle. These assumptions are:

- Since the casting alloy is injected into the die cavity at a superheated temperature, it behaves like a hydraulic fluid during the very brief period of cavity fill.
- The metal travels in a straight line until it meets an obstruction and then the stream splashes and breaks up into turbulent eddies. During cavity fill, it follows the path of least resistance.
- Die casting is a turbulent process since liquid casting alloy travels through the system at extremely high rates of speed.

The three fundamental factors are:

- The thermal behavior of the casting alloy that can be quantified by the thermal constants.
- The shot end of the casting machine and the shot sleeve or goose neck that provide the liquid metal required to fill the die cavity.
- The shape of the part that defines the flow path of the liquid metal as it travels through the cavity. The

surface area to volume ratios and the distance that the metal must travel are important mathematical characteristics of each net shape.

This text will attempt to present the details of die casting process in a logical manner. It is definitely predictable and controllable.

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