The Efficient Application of Die Lubricant

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The Challenge

In the past several years, the light metal die casting industry in North America has had little real growth. Just now, however, with the automotive industry anxious to reduce the weight of its vehicles, the rate of growth is certain to increase considerably.

Automakers are extremely demanding. Their blanket orders are huge, but as a result of their current emphasis on inventory reduction, production releases to their suppliers are now usually quite small, with priority on just-in-time delivery. This rapidly growing market has great potential, but the challenge to die casters is to profit from short runs and low prices. To remain competitive, in fact to remain in business, many aluminum die casters must improve their productivity.

The most obvious way to increase productivity is, of course, to improve process efficiency by optimizing the working cycle.

The Production Process

Cold chamber light metal die casting is a short-cycle repetitive process. Each production cycle typically lasts 35-45 seconds. This means that a reduction of only a few seconds at any point in the cycle will have an immediate and substantial effect on the overall rate of production. A decrease of 4 or 5 seconds in the time taken for the complete process cycle can increase productivity, and consequently profit, by more than 10 percent. This certainly warrants the close scrutiny of any die caster.

The problem, of course, is that the times taken for very few segments of the cycle are actually controllable. One of these is the length of time required to spray the lubricant or release agent onto the die.

The Casting Cycle

The time required for the five sections of a typical casting cycle in a well-run plant can be broken down approximately as shown in the table to the right.

Die Lubricant

In cold chamber die casting, the die is sprayed with lubricant before every shot for the following reasons:

1. *To form a thin film on the surface of the die that will provide a barrier between the molten casting metal and the die, and thus prevent soldering.*
2. *To provide a release agent that will facilitate the easy ejection of the casting from the die.*
3. *To cool the die.*

Soldering

By far the most important function of effective die lubrication is to prevent soldering of the cast metal to the die. If soldering is mechanical, costly downtime is required to clean the die. If it is chemical, irreparable damage may be done to an expensive die.

Soldering of aluminum to components of the die such as core pins, slides, and inserts, results in costly downtime and die wear. It causes increased friction that can affect the ejection force required for the die casting operation. If insufficient force is available, the casting has difficulty releasing. On the other hand, increasing the release force too much can bend ejector pins, cause casting drag marks, and make castings bend or lose tolerance. Any of these will result in unnecessary scrap.

Soldering is usually due to hot spots in the die that can cause the lubricant to be almost instantly dissipated. The molten aluminum then adheres to the die in these areas. The residue of this type of mechanical soldering can normally be fairly easily cleaned off the die if it is caught early enough, and no corrosion has occurred.

Chemical soldering, however, can also result from loss of the protective lubricant barrier. This type of soldering is much more serious, as it erodes the surface of the die, and can also alter the tolerances. It occurs when the aluminum reacts chemically with the die steel.

Casting Cycle Operation	Time (Seconds)
Dwell	9
Die Open	9
Die Spray	**8**
Die Open	8
Die Closed	6
Total	**40 sec.**

With chemical soldering, some elements of the cast metal permeate the surface of the die, while alloy elements of the die steel diffuses from the die into the cast metal. The bonding of the electrons of the two element's atoms creates an intermetallic compound between the cast metal and the die surface. This new component appears much like mechanical soldering, but is quite difficult to remove from the die without destroying the integrity of its surface.

The consequences of soldering emphasize the importance of an effective release agent being sprayed into the die cavity to cover it completely, uniformly, and quickly.

Die Spraying

One segment of the casting process that is sometimes taken for granted by the die caster is the application of the die lubricant. Die casters often concentrate on the lubricant itself, mistakenly assuming that not much improvement can be made in their existing method of application. There are now many brands of die lubricant available. Most are quite effective. But the efficiency of the spraying equipment being used actually varies widely.

The function of the die spraying equipment is more difficult than it may at first appear. The spray must almost simultaneously cover the entire cavity of the die with a measured and equal amount of the parting agent, then immediately shut off and withdraw from the die interior. If the die is quite large and complex, this is no easy task.

Spraying Time

A generally accepted "rule of thumb" is that in an efficient die casting operation, the time in seconds taken to spray the die lubricant will be about one hundredth of the tonnage of the casting machine. For an 800 ton machine, for example, the spray time would therefore usually be about 8 seconds. And for a 1200 ton machine, about 12 seconds.

An achievable target time to aim for is 20 percent of the total cycle time. This is now the standard acceptable maximum of most large and competent die casters.

Gerlieva

The town of Heitersheim in Germany is home to Gerlieva Spray Technology GmbH. Founded by Gerd and Armin Linbrunner nearly three decades ago, since its inception, Gerlieva has concentrated primarily on improving the technology of spraying fluids. Their research and development has kept pace with advances in CAD, CAM, and NC techniques. Their seminal work in the development of increasingly effective die lubricant spraying equipment is well known in the aluminum die casting industry.

The Product

The company's range of die spraying equipment is modular in design, and can therefore be adapted to any individual situation. The demand for shorter casting cycles calls for fast, dynamic spraying systems. Gerlieva systems satisfy these requirements by using high-tech, innovative drive components.

The heart of this die sprayer is the horizontally moving frame. Rapid dynamic movement is achieved through sturdy steel construction which permits extremely high acceleration and braking forces.

The integration of both AC servo drives results in an unusually low center of gravity. The motor requires minimal maintenance because of its brushless design. The high efficiency non-slip toothless belt is maintenance-free. Linear, low-friction guides ensure long term accuracy.

Oversized supply lines provide an optimal supply of spraying medium and air to the spray head. They are guaranteed to be maintenance-free and to have an unusually long working life.

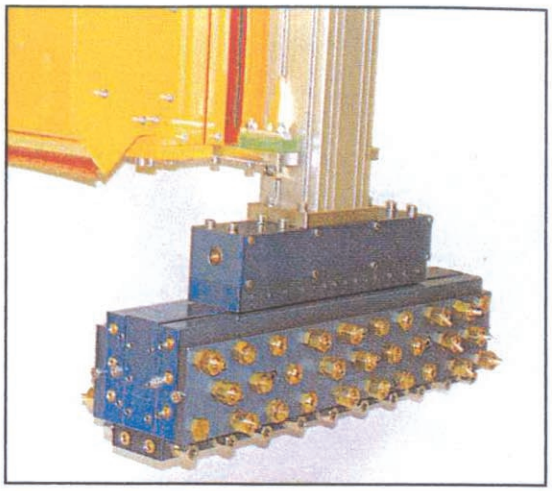

Fig. 1 - *Gerlieva die sprayer.*

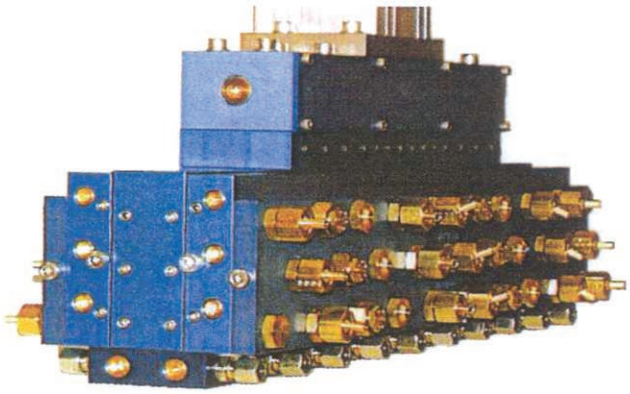

Fig. 2 - *Gerlieva six circuit spray and blow-out head.*

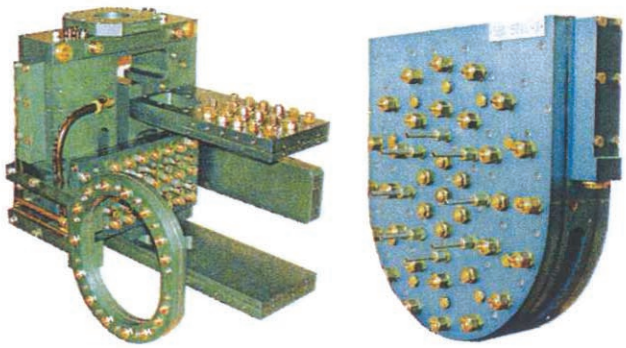

Fig. 3 - *Special sprayhead for automotive gear bell. (l) Special sprayhead for automotive gearbox body valve box. (r)*

Custom Sprayheads

Because of the importance of rapid and complete spraying for high volume casting, the design of the sprayheads is critical. The two special purpose sprayheads shown in figure 3 are examples of the range that is available.

The pre-control valves for the spray and blow-out air, and for the lubricant, are easily accessible in the valve box. Only flanged valves with optical switches are used. The spray and the blow-out air have separate supply lines.

Controls

The control systems are assembled with standard components from well known manufacturers. This assures that spare parts are easily accessible, if required.

Three basic types of controller are available:

CNC CONTROL: For programming using CNC instructions. It is based on the Siemans 840 D controller.

TEACH-IN-CONTROL: For teach-in programming. It has 50-100 applications with buffering, plus eight freely programmable auxiliary outputs and inputs for controlling auxiliary peripheral functions.

PC-CONTROL: Incorporates spraying equipment software with user interface for PCs or notebooks using the operating systems DOS, Windows 95/98, or Windows NT.

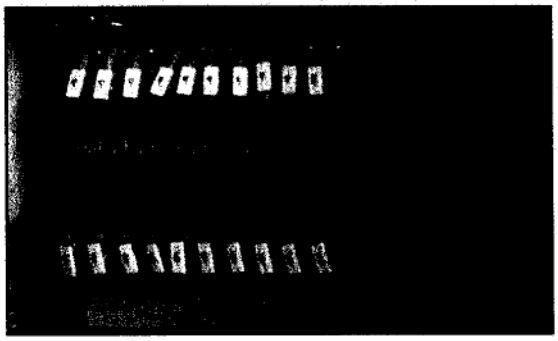

Fig. 4 - *Valve Box.*

Unique Exchange Plate System

Machine downtime is the traditional enemy of productivity. A die casting machine generates profit only while it is running. A major problem in improving productivity during short runs is the amount of downtime incurred while changing the spraying equipment from one die to another. The manufacturer has developed a solution to this problem.

The spray and blow-out head consists of a basic anodized aluminum body with an integrated control diaphragm. Attached to this is a unique quick-change adapter plate, equipped with spray and blow-out nozzles, and flanged-on blow-out air channel. With this system, when the equipment is changed over to another casting die, only the adapter plates have to be changed, not the entire spraying head. The savings in costly downtime can be easily calculated.

Conclusion

"This is how long it always takes." This unfortunate phrase has done more to limit the efficiency, the productivity, and the profit of many die casters than any other factor. As a vast potential market emerges, competition between suppliers becomes ever more intense. Maintaining the status quo is no longer an option. The assumption of the die caster must be that improvement is not only possible, it is essential.

An often-overlooked opportunity for improvement is found in the time taken during the production cycle to apply die lubricant, and also in the time required to replace spraying equipment when dies are changed.

If a die caster has been using the same die spraying equipment for a number of years without keeping informed of the technological improvements that have been made in the interim, s/he may find a modern spraying system to be an excellent investment. The improvement in productivity can be immediate and considerable, and the amortization period surprisingly brief. It's certainly worth investigation.