

- Producir piezas existentes en una aleación alternativa donde las herramientas disponibles no serían adecuadas para la *alloy steels*.
- Hacer piezas de repuesto a corto plazo, como reemplazar equipos obsoletos cuando no se pueden justificar nuevos patrones.

El moldeo por impacto y el proceso Replicast sirven como buenos ejemplos de la tecnología en constante evolución de la fundición de metales. Otros procesos están en desarrollo. Cada uno está dirigido a satisfacer las necesidades del cliente, ofreciendo alternativas económicas a otras técnicas de conformado de metales y expandiendo la ya amplia variedad de tecnologías de fundición de metales.

Desarrollos de procesos. También se están produciendo desarrollos significativos en el área de las operaciones de fundición. Dos procesos relativamente nuevos demuestran los avances realizados en la producción de piezas de fundición ferrosas y no ferrosas de pared delgada y limpias. Una de estas técnicas para producir piezas de fundición de aluminio se llama proceso Cosworth. El otro, desarrollado para fundición de hierro y acero, es el proceso FM.

El proceso Cosworth se desarrolló para satisfacer la necesidad de componentes altamente especializados para los motores de autos de carreras de Fórmula Uno fabricados por Cosworth Engineering, Ltd., en Inglaterra (Ref. 5). Los moldes de arena de acción con un sistema de aglutinante de fusión se llenan desde el fondo del molde utilizando una bomba electromagnética. Un lavador vertical se encuentra en el medio de un horno de retención, y mueve el metal a una velocidad controlada dentro del molde rígido de arena. Ubicar el tubo de llenado en el medio del horno ayuda a garantizar que solo el metal más limpio ingrese al molde, reduciendo así la posibilidad de que la escoria o la escoria entren en la cavidad del molde.

Con una capa de gas inerte que cubre el metal fundido en el horno, el aluminio fundido está protegido del oxígeno y de otros gases que pueden conducir a la porosidad en la fundición. Además, debido a que la velocidad de llenado del molde está estrechamente controlada, la turbulencia se minimiza, y esto también evita la absorción de oxígeno y otros gases que pueden conducir a la porosidad.

Las principales ventajas reclamadas para el proceso incluyen rendimientos de 85% o más, piezas de fundición que son típicamente de 10 a 12% más livianas que las producidas por otros métodos, excelentes propiedades mecánicas y físicas y la capacidad de especificar márgenes de mecanizado en el rango de 1.5 a 2 mm (0.06 a 0.08 pulg.). Varias fundiciones estadounidenses están en proceso de adoptar o investigar seriamente el proceso de Cosworth para sus operaciones de fundición de aluminio.

El proceso FM se ha desarrollado específicamente para producir fundición de hierro y acero de pared delgada (Ref. 6). El nombre FM form proviene de *fine metalcast*, que significa a hierro delgado. Desarrollado y utilizado por la firma francesa Pons-a-Mousson, el proceso FM es una técnica de llenado de moldes (en comparación con el vertido de moldes) que utiliza una presión diferencial controlada para llenar moldes con metales de alto fundido, incluidas las superaleaciones.

Al igual que el proceso de Cosworth, el proceso de FM utiliza una técnica de llenado de fondo que se controla y, sin embargo, permite el llenado rápido del molde. Se puede usar cualquier tipo de molde (arena verde, metal, concha, etc.) con el proceso FM. Las tasas de llenado rápido se logran ejerciendo una baja presión sobre el metal líquido y una presión negativa sobre el molde y, en ciertos casos, sobre el horno mismo. La inversión de gases del molde también se logra durante el llenado del molde.

Se han obtenido espesores de pared de fundición de 2.5 a 3.0 mm (0.10 a 0.12 pulg.) en fundiciones grises, dúctiles y aleadas y en aceros bajos en carbono. Las propiedades de las superaleaciones a base de níquel y los aceros con alto contenido de cromo también se mejoran con este proceso.

Desarrollos de materiales. La investigación sobre materiales de fundición en los últimos años también ha producido algunos resultados significativos. Típicamente estos se encuentran fundiciones de inversión de hierro dúctil aceros y aluminio-90.

El hierro dúctil austempleado, con propiedades que se encuentran entre las de los aceros endurecidos por completo y los aceros case carburizados, ya ha comenzado a crear nuevos mercados para los hierros fundidos porque se está convirtiendo cada vez más en una alternativa económica a las soldaduras de acero, forjas, estampados y otros productos metálicos (Ref. 7). Algunas de las aplicaciones actuales para el hierro dúctil austemperado incluyen engranajes, cigüeñales, piñones de cadena, muelles de estampación, ruedas de ferrocarril y otros componentes estructurales y de carga (consulte el artículo "Hierro dúctil" en este volumen para obtener información adicional).

Aleaciones de aluminio-90. La investigación sobre aluminio-90 como material de fundición de inversión también promete abrir nuevos mercados a la fundición de metales, particularmente en la industria aeronáutica. El principal beneficio de las aleaciones de aluminio-90 es una reducción en la densidad del material, que es la principal propiedad para reducir el peso estructural en los aviones (Ref. 8). En

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