Aluminum-Fly Ash Metal Matrix Composites for Automotive Parts

Report for April 1, 1999 to June 30, 1999
July 16, 1999

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Highlights:

- During this quarter's field trials, sand mold castings of parts and permanent mold tensile testing bars, K mold bars, and ingots were made from aluminum alloy–fly ash melts.

- Another objective was met, i.e., to use class "F" type precipitator fly ash consisting of particle sizes less than 100 microns. It was possible to pour the composite melt into the sand mold through a filter.

- Trials were run to determine the required amount of the wetting agent, magnesium, to ensure appropriate mixing of the aluminum alloy and fly ash. The magnesium content required to mix "F" fly ash was much lower compared to that required to mix hybrid "C-F" fly ash in similar melts.

Progress:

Fly ash particles of less than 100 microns were mixed in aluminum melt. Large scale field trials were undertaken at Eck Industries with the goal of standardizing procedures for producing aluminum-fly ash composite melts and to analyze the structure and properties of the resulting material. Limited testing of tensile properties has been done on pressure die cast parts, and attempts are underway to improve the distribution of fly ash in both sand cast and pressure die cast samples. Eck Industries performed radiographic, heat treatment, and tensile tests on permanent mold cast tensile test bars.

After fly ash mixing experiments, the Lanxide high speed-high shear mixer (originally designed for mixing Al-SiC melts) was employed in an attempt to avoid fly ash agglomeration. It led to demixing (instead of deagglomerating) of some fly ash. However, the permanent mold tensile bars poured after high shear mixing displayed good distribution of fly ash in castings. A modified impeller design is being considered for high speed-high shear mixing of aluminum-fly ash melts.

Milestones:

A second round of sand castings including intake manifolds as well as permanent mold castings including K mold bars, tensile bars, and ingots will be made using the classified "F" fly ash during August. A third round of castings will be made during October including pressure die cast mounting brackets and squeeze cast motor mounts.

The castings will be examined for microstructure and selected properties. If satisfactory, sample parts will be sent to auto companies for their evaluation by the end of December.

Aluminum-Fly Ash Metal Matrix Composites for Automotive Parts

Report for July 1 to September 30, 1999
October 15, 1999

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Highlights:

- Large scale heats of aluminum-fly ash composites (400 pounds) were made at Eck Industries using fly ash classified as less than 100 microns in size. It was possible to pour the composite melt containing <100 micron fly ash particles into the intake manifold sand mold through a filter. An intake manifold tested at Eck was found to be pressure tight.

- During this industrial-size field test, permanent mold cast tensile testing bars, K mold bars, and ingots also were successfully made from aluminum alloy–fly ash melts.

- Preliminary properties data are being generated from parts cast in development runs. A representative properties data list prepared from parts cast at the TAC foundry was transmitted to PNL. At the Eck foundry, tensile strength of aluminum–fly ash composites was measured at both room temperature and high temperature (600 F). The tensile strength of composites containing up to 8 wt% fly ash was measured at 34 to 40 Ksi, compared to handbook data of 38 to 45 Ksi for base alloy. The tensile strength at 600 F of composites is 7 to 10 Ksi compared to handbook data of 4 Ksi for base alloy at the same temperature.

Progress:

The second round of sand mold castings including intake manifolds as well as permanent mold castings including K mold bars, tensile bars, and ingots have been made using the classified "F" fly ash at Eck Industries. Limited testing of tensile properties has been done on tensile bars. The leakage test of one intake manifold has been done. Microstructure analysis was undertaken on sand and permanent mold castings to study the distribution of fly ash particles in castings.

Another heat to pressure die cast brackets of A380–classified fly ash will be made at Eck. The brackets will be examined for their strength and fly ash distribution. Ingots of A356–fly ash are being made at Eck to remelt at Thompson Aluminum for squeeze casting of motor mounts.

Milestones:

As properties and fly ash distribution continue to improve, parts will be sent to auto companies for testing. It is projected that parts will be installed in some cars for evaluation during the year 2000.

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