ALUMINA REINFORCED ENGINE BEARING MATERIALS

In order to impart Engine bearings higher fatigue strength and better wear resistance and seizure resistance (compatibility) their metal based overlays may be reinforced with dispersed alumina particles (0.5-2%) [28].
Metal matrix composite anti-friction coatings of engine bearings are fabricated by Electrolytic co-deposition from an electrolyte solution containing Al_2O_3 particles.
Polymer Matrix Composites filled with 2-5% of hard alumina particles are also used as coatings applied over the engine bearing surface.

The author of the present article studied the effect of reinforcing alumina particles on the seizure resistance of aluminum alloys.
The metal matrix composite was prepared by an addition of 2% vol. of alumina particles with the sizes 0.4-0.8 mil (10-20 µm) into aluminum-5% tin-1% manganese alloy. The Al5SnMn and Al5SnMn2Al_2O_3 samples were cast at a horizontal continuous casting machine controlling gravity segregation during Solidification of metallic systems. The technology is based on applying horizontally crossed electric and magnetic fields to the solidifying metal [29] (Fig.3).

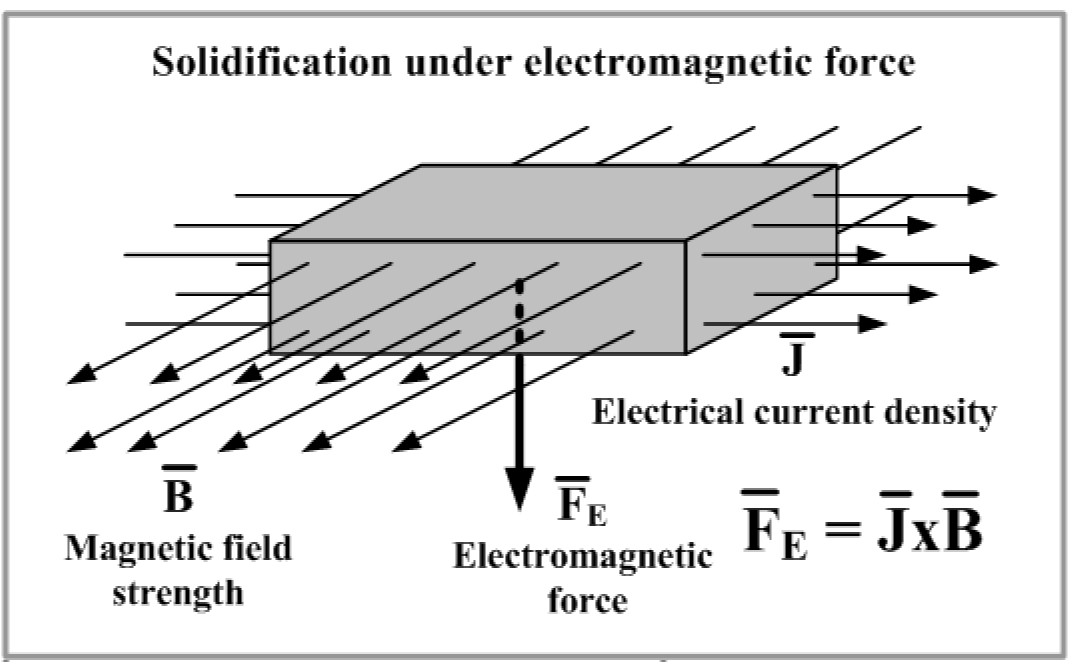

Fig.3 Solidification under electromagnetic force

The method allows producing predetermined distribution of the second phase (alumina) in the matrix (aluminum) phase (bottom segregation, homogeneous distribution or top segregation).

Due to the difference between the specific weights of liquid aluminum 143 lb/ft^3 (2.3 g/cm3) and aluminum oxide 250 lb/ft^3 (4.0 g/cm3) continuous casting without electromagnetic force results in a gravity segregation of alumina particles at the bottom part of the samples (Fig.4).

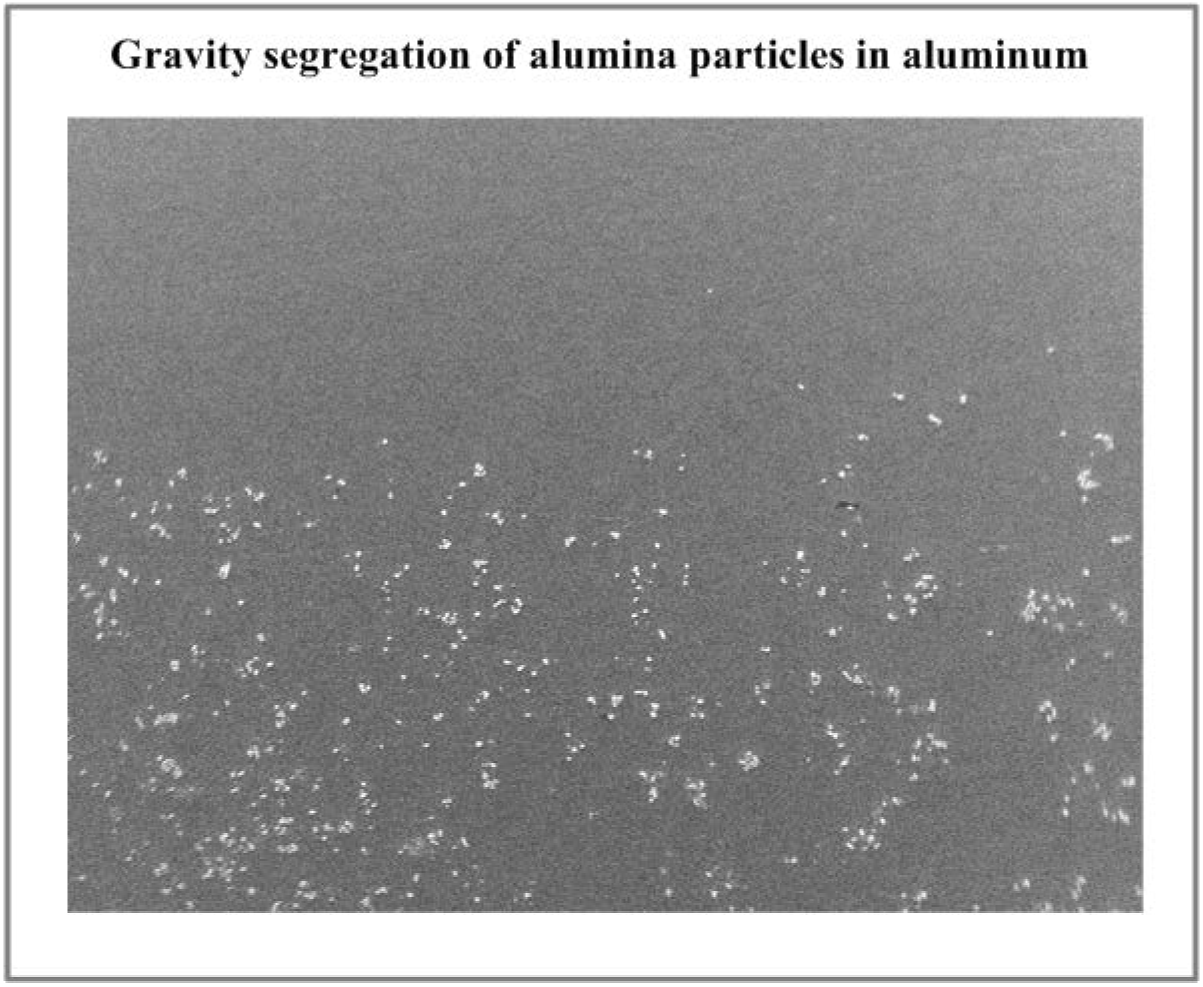

Fig.4 Segregation of alumina particles in aluminum at the bottom of the sample (no electromagnetic force)

Electro-magnetic force applied to the solidifying material equalizes the apparent densities of aluminum and alumina.
No visible gradient of alumina particles concentration was observed on the specimens solidified under the action of the electromagnetic force.

The Fig.5 illustrates different behaviors of Al5SnMn and Al5SnMn2Al_2O_3 materials tested in the mixed regime of lubrication. The results are obtained from theTest Rig of King Engine Bearings Ltd.

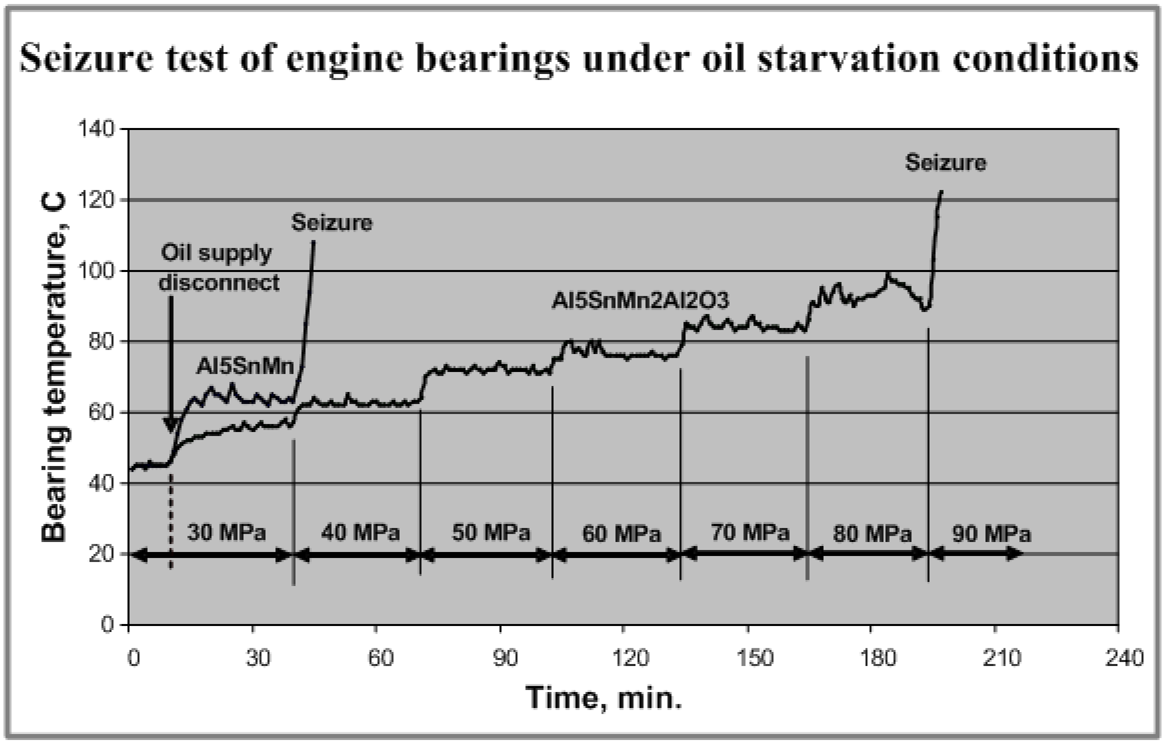

Fig.5 Seizure test of engine bearings under oil starvation conditions

The tested bearings worked with insufficient oil supply provided by splash lubrication. The load applied to the bearing was increased every 30 min. by the increments of 1450 psi (10 MPa). The bearing back temperature was continuously recorded.

After the disconnection of the lubricant supplying pipe from the Al5SnMn bearing at the initial load 4350 psi(30 MPa) the bearing temperature rose and stabilized at the level of 145°C (63°C) with a few peaks indicating pre-seizure conditions. Increase of the load to 5800 psi (40 MPa) has caused immediate seizure of the aluminum alloy with the journal material (steel) accompanied with a sharp temperature rise.

The behavior of the $Al5SnMn2Al_2O_3$ bearing was quite different. It demonstrated good anti-seizure properties. At the initial load 4350 psi (30 MPa) the bearing temperature stabilized at 131°F (55°C) and after each load increase the temperature rose by about 10°F and stabilized. Full seizure did not occur even at the high load of 11600 psi (80 MPa). Only at 13050 psi (90 MPa) the sliding materials ($Al5SnMn2Al_2O_3$ and steel) have seized.
Very good seizure resistance of $Al5SnMn2Al_2O_3$ alloy was achieved due to the presence of hard alumina particles, which have prevented seizure due to its polishing.

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