

# Coated Gears Provide Slick Solution for Human-Powered Boat

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**Design Problem:** Develop a gear drive for a pedal-powered water craft that will be easy to manufacture, use and maintain; that will be lightweight enough for the boat to be portable; and that will eliminate the environmental risk of lubricants leaking into the water.

**T**he above describes the situation that faced engineers at Micro Marine, builders of the MicroCAT, a new class of human-powered water craft being produced at the company's Mendon, MA facility.

After careful consideration and testing, Micro Marine decided on a combination of high-tech gear coatings that provided better lubrication than traditional methods and demonstrated resistance to wear, abrasion and corrosion that makes the unit virtually maintenance free.

"We wanted to have an environmentally friendly drive unit on our boat," says Tony Scappaticci, engineering manager for Micro Marine. The boat should be able to go places motors aren't allowed. It should operate quietly and not be a hazard to the environment, he says.

#### About the Boat

The MicroCAT is available with either an inflatable or a rigid hull. The 64-lb. inflatable version breaks down into 15 pieces that fit in an

18x18x36-inch space—easily portable in a car trunk or even a duffel bag. One hundred MicroCATs have been sold, and they're being used in locations such as Hawaii, Alaska, Puerto Rico and Chile, in fresh water and salt water.

The gear drive, consisting of two sets of bevel gears, gives the boat a much greater performance ratio than a chain drive would have allowed. The 8:1 ratio means that a person pedaling at 60 rpm drives the prop at 480 rpm. This makes the boat much faster—at 5–6 knots—than a typical pedal-powered boat. But having a gear drive means that the entire drive unit has to be enclosed to protect the gears from water.

#### Why Dry Lube?

With a traditional wet-lubricated gear drive, keeping the lubricants out of the water and the water out of the drive would have required complicated seals, Scappaticci says. With the dry coatings, engineers had only to seal the entire unit to keep water from getting in.

Also, even the best lubricants eventually break down and have to be replaced. Dry lubricant coatings allowed the designers to completely enclose the drive to make it maintenance free.

After testing various products, Micro Marine turned to Microfin Corp., developer of high-tech coatings in Providence, RI. After more testing, the companies discovered that not only would coated gears help them solve the environmental problem, but that incorporating coated gears made the rest of the drive less expensive and the whole product simpler and more lightweight.

#### About the Coatings

The engineers tested various configurations of coatings for the pinions and bevel gears in the drive unit and chose Lubralloy® for the gears and Microlube® for the pinions.





Lubralloy is a chemically deposited nickel alloy coating with a hardness of Rc 45-49. The hard surface provides increased resistance to wear, abrasion and corrosion. At the same time, it provides exceptional lubrication, with a coefficient of friction of 0.12. Lubralloy was originally developed for use in demanding military and space applications, according to Microfin.

Microlube is an even harder coating (Rc 68-72) with an even lower coefficient of friction (0.05-0.10) as well as resistance to abrasion, wear and corrosion. The higher torque on the pinions of the MicroCAT drive unit required the harder surface and better lubricating ability of the Microlube coating. In tests, Microlube eliminated metal-to-metal pickup, galling, seizing and excessive wear, even under heavy torque loads and aggressive environments such as salt water. According to Microfin, this process produces its most dramatic reduction in coefficient of friction under heavy loads where petroleum-based lubrication and other systems fail most often.

#### The Results

Because they weren't using a traditional wet lubricant, Micro Marine was able to eliminate the oil seals, drain hole, fill hole and plug. The result was a much simpler product to manufacture and maintain.

Furthermore, because of the hardness of the coatings, the company was able to specify a more machinable, lower grade material (4140 steel) for the gears.

The gear drive itself is resistant to corrosion, abrasion and wear. Exposure to water and salt water won't harm it. The gear drive should never have to be replaced, and because it's enclosed, it never has to be maintained. In addition, the lubricity of the coatings makes the pedals easier to operate.

Finally, the enclosed drive with no wet lubricants created an environmentally friendly product that was appropriate for the areas where it would be used.

#### Other Applications

The MicroCAT inflatable boat is just one example of the many applications that could benefit from coated gears. Others include food industry products or drives used in environmentally sensitive areas and enclosed mechanisms that cannot be lubricated on a regular basis, according to Microfin.

The coatings used on the gears in the MicroCAT have been used successfully on other types of moving parts, including valves, couplings, bearings, pistons and pumps. Ⓞ



### HOW COATED GEARS HELPED BUILD A BETTER BOAT.

#### Made the Rest of the Drive Less Expensive

1. Reduced the number of parts: Fewer seals and no plug, drain or fill hole.
2. Allowed the use of a more machinable (less expensive) gear material.
3. Reduced assembly time.

#### Improved Performance and Operation of the Gear Drive.

4. Reduced friction, making the boat easier to operate.
5. Made the gear drive corrosion resistant without using stainless steel or other high-tech materials.
6. Made the gear drive environmentally safe.
7. Eliminated the need for gear drive maintenance.

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