Hydrofoil Paddlewheel Catamaran Concept: Lift, Power, and Performance Analysis for a 60 Foot Electric Vessel

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Technical assessment of a 60 foot lightweight power catamaran using corner-mounted hydrofoil paddlewheel modules. Includes lift calculations, induced drag power requirements, performance limits, and engineering tradeoffs at 5 knots and 20 knots.

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A hybrid propulsion concept combines paddlewheels for low-speed efficiency with hydrofoils for high-speed lift. This article evaluates whether a 20,000 lb, ultra-slender catamaran can sustain hydrofoil operation at 20 knots using 4 ft by 2 ft foils and 80 total horsepower, and explains where physics supports the idea and where it imposes hard limits.

Concept Overview
The proposed vessel is a 60 foot long by 30 foot wide power catamaran with very slender hulls, each measuring approximately 2 feet in width to minimize wetted surface and wave-making drag. At each of the four corners of the catamaran is a modular propulsion unit consisting of:
• A 12 foot diameter paddlewheel driven by a 10 HP electric motor for low-speed operation.
• One paddle per wheel shaped as a hydrofoil, measuring 2 feet in chord and 4 feet in span.
• Two 5 HP electric motors with propellers mounted on the hydrofoil paddle for propulsion in hydrofoil mode.
Total installed power is 80 HP. The design intent is to operate in paddlewheel mode at 5 knots and transition to hydrofoil mode at 20 knots, with the hydrofoils providing lift and the foil-mounted propellers providing thrust.

Hydrofoil Geometry and Lift Capability
Each hydrofoil paddle has:
• Chord: 2 feet
• Span: 4 feet
• Area: 8 square feet, equivalent to 0.743 square meters
• Aspect ratio: span squared divided by area, equal to 2.0
This is a low aspect ratio foil, which can generate substantial lift but incurs relatively high induced drag.
At 20 knots, the vessel speed is 10.29 meters per second. Using seawater density of 1025 kilograms per cubic meter, the dynamic pressure is approximately 54,000 newtons per square meter.
To support the full vessel weight of 20,000 lb using four foils, each foil must carry 5,000 lb of lift, equivalent to about 22,240 newtons.
The required lift coefficient per foil is calculated as:
Lift coefficient equals lift divided by dynamic pressure times foil area
This results in a required lift coefficient of approximately 0.55 per foil, which is a realistic and controllable operating point for an optimized hydrofoil section operating below stall.
At this condition, each foil is capable of producing the required lift at 20 knots.

Induced Drag and Power Requirement
While lift capability is sufficient, the dominant limiting factor is induced drag due to the low aspect ratio.
Using the standard induced drag relation:
Induced drag coefficient equals lift coefficient squared divided by pi times aspect ratio times efficiency factor
With:
• Lift coefficient of 0.55
• Aspect ratio of 2.0
• Efficiency factor of 0.8
The induced drag coefficient is approximately 0.060.
The induced drag force per foil is then:
Induced drag equals dynamic pressure times foil area times induced drag coefficient
This yields approximately 2,440 newtons, or about 550 lb of drag per foil.
Across four foils, total induced drag is roughly 2,200 lb.
The power required to overcome this drag at 20 knots is: