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Abstract

Sprocket Size Optimization for Derailleur Racing Bicycles

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1. Abstract

The traditional design goal for sprocket size on racing bicycles is for it to be minimized for a given gear ratio. However, optimum sprocket size is actually a trade-off: larger sprockets have the advantage of producing lower transmission losses whilst small sprockets have the advantages of lower mass, inertia and frontal area. This study analyses this trade-off to determine if there are advantages in increasing sprocket sizes for a given gear ratio.

Two methods of enlarging gears in a derailleur racing bicycle, while maintaining gear ratio for the rider, are addressed: (i) to increase the size of pulley wheels and (ii) to increase the size of all gears. Efficiency improvements from these two cases arise from different mechanisms and come at different detriment to mass and frontal area. Models for chain articulation efficiency and overall power required for constant velocity cycling are presented and used to show the effect of increased sprocket size on overall performance.

In the scenarios presented, increased pulley wheels can reduce overall losses by up to 0.7W, representing 0.3% overall power reduction compared with a benchmark case. This is modest compared with a benefit of up to 3.3W, representing 0.6% overall power reduction, when all sprockets are increased. This difference is particularly pronounced for heavier, more powerful riders when riding minimal gradient courses at maximum effort. For some riders and racing scenarios, increased gear size can result in an increase in the power required of up to 0.4W, representing 0.1% increase in power required.

For elite cyclists and triathletes searching for marginal reductions in power losses, using larger sprocket sizes sometimes has clear benefits but it depends on rider physiology and race profile. Choosing larger gears also has the advantage of increased smoothness of pedal action by reducing polygonal action in the top span of the chain. Further, reduced wear will lead to better longevity in components and longer optimal performance of the transmission.