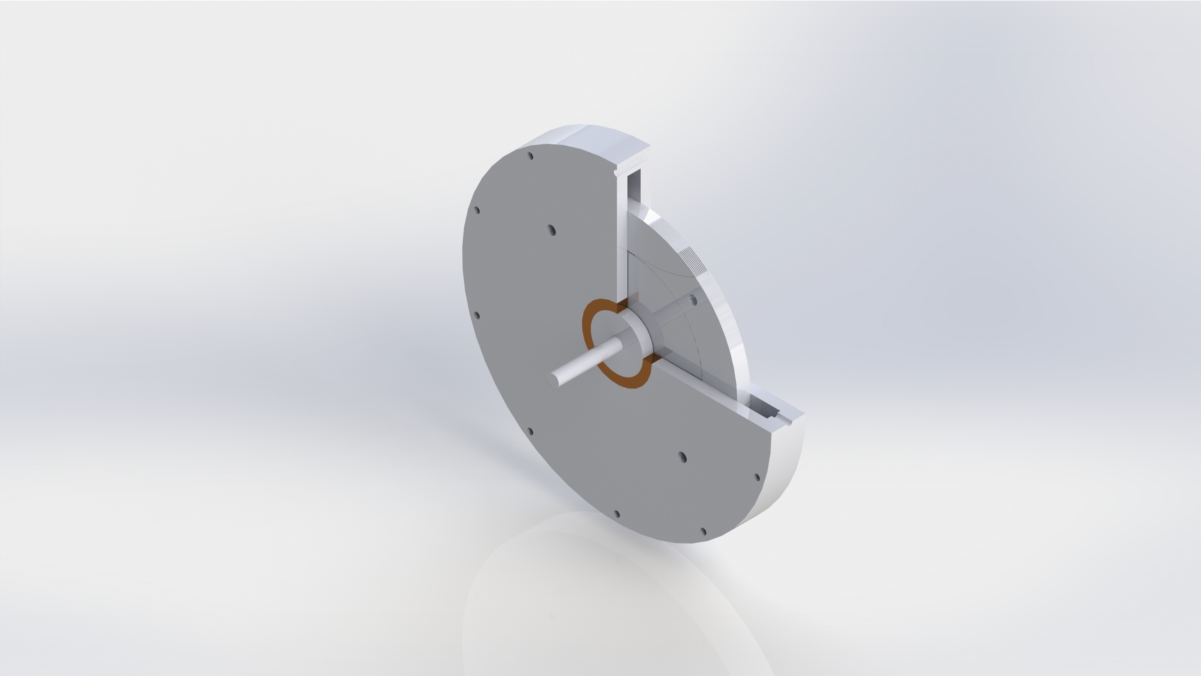
Greensteam Design Report: Tesla Turbine

Tae Rugh, Summer 2020



Modern bladed turbines can reach unparalleled efficiencies and are the unanimous choice for large-scale power plants. These turbines cannot be effectively scaled down though, so an alternative type of engine is needed for small-scale power generation. While Greensteam mainly considers external combustion piston engines for this purpose, the Tesla turbine has come up as another possible alternative. Unlike bladed turbines, the Tesla turbine can be scaled down while retaining high efficiency. Nikola Tesla invented the bladeless turbine in 1913, but was never able to achieve commercial success mainly due to the material constraints of his time; the disks must be extremely thin and also withstand high rotational speeds without warping. With modern materials such as stainless steel, carbon fiber, and titanium, this can now be accomplished. Another issue that has plagued the Tesla turbine's development is that, despite its impressive theoretical efficiency in the rotor, the nozzle geometry disrupts inlet flow and severely harms overall efficiency. By incorporating recent research breakthroughs in nozzle geometry and inlet flow, thanks to modern computational fluid dynamics, the Tesla turbine can be a viable and competitive option for small-scale power generation.

Part Breakdown

The rotor array consists of the driveshaft, 3 rods, spacers, disks, and end caps. Rather than having a shaft run through the center of the disks, 3 equally spaced rods are used to make space for a central exhaust channel, which is more ideal for efficiency. The spacers keep the disks at correct spacing. The end caps hold the entire array together and provide a surface to press-fit into the bearings.

The stator array consists of thin plates which are stacked to create the nozzles. This turbine uses 2 diametrically placed 1-to-1 nozzles, which means that each channel in between disks has its own 2 nozzles on opposite sides. The specific camber radius, height, and width of the nozzle has been optimized using computational fluid dynamics.

The still chamber is perhaps the most important innovation for the Tesla turbine. Before entering the nozzles, inlet steam opens into a significantly larger volume space, sometimes called a plenum chamber, which reduces the fluid’s velocity and turbulence, promoting more efficient laminar flow.