Published in "ExtraOrdinary Technology" magazine – July 2003

Tesla Turbine Primer

By Ken Rieli

The Tesla Turbine is a remarkable machine in terms of simplicity, robustness, efficiency, and applicability but little is known, even among today's' engineers, about how it works and how well it performs alongside conventional turbines. Let's take a brief look at turbines in general and how the unique design and characteristics of the Tesla engine stack up.

Turbines, for the most part, can be classified as either impulse or reaction engines. Impulse turbines convert kinetic energy to shaft power by deflecting the gas path using buckets or blades, resulting in decreased gas velocity.

Reaction turbines use blades only in a compound energy conversion mechanism - which decreases both gas velocity and pressure, resulting in higher energy conversion efficiencies.

Figure 1 shows a close up view of a typical impulse turbine blade array. High velocity gases (steam or direct combustion) pass through the blades, imparting radial motion to the rotor and shaft. Gas velocity is decreased while pressure remains constant across the blades.

Equal gas pressure on both leading and trailing edges of the blades is characteristic of the impulse turbine.

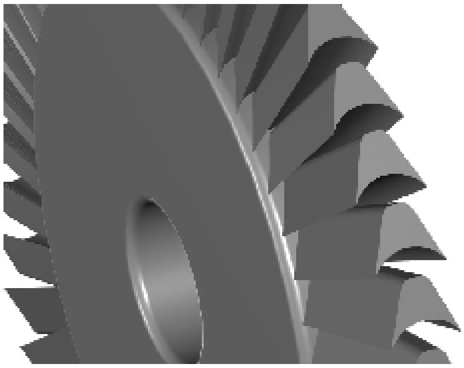

Figure 1 - impulse turbine blades

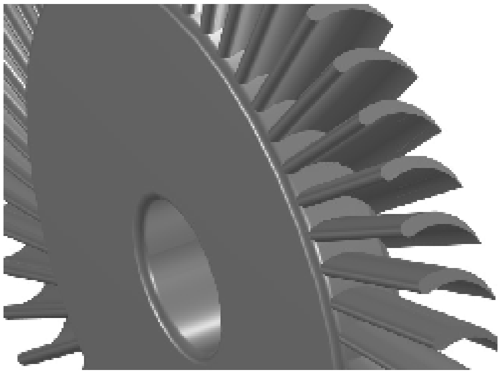

Figure 2 - reaction turbine blades

Figure 2 shows a close up of typical reaction turbine blades. They are shaped to create a pressure drop across the blade surface resulting in a reaction force in a radial direction. Since there is both a decrease in gas velocity and pressure, reaction blades are more efficient than impulse types in imparting shaft power.

The difference in gas pressure (lower pressure on the trailing edge) results in a greater axial load on the rotor assembly.

Figure 3 shows a typical Tesla/boundary layer disk turbine configuration. Notice that there are no blades whatsoever - parallel, closely spaced disks use aerodynamic skin adhesion effect to resist gas flow between the plates. Resistance to fluid flow between the plates results in energy transfer to the shaft.

High velocity gas enters the disk pack through the inlet (upper right) in a path tangent to the outer edge of the disks. Outer-periphery round washers convert high velocity gas to shaft power through impulse and drag forces. As the lower-energy gas spirals toward the central exit port, adhesion, drag and centrifugal forces continue to convert kinetic gas energy to shaft rotational power.

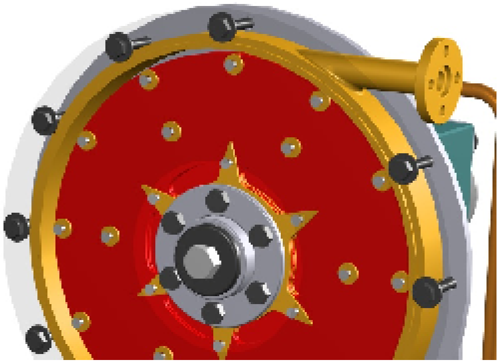
Figure 3 - Tesla Turbine disks

The energy conversion mechanism of boundary-layer turbines is so efficient - even in just one stage - Tesla recorded an astounding 60% under ideal lab conditions using direct combustion. Compare this to bladed turbine best efficiencies of around 30% - 35%!

The only area in which bladed turbines beat out Tesla turbines is in power density or horsepower per pound - but that advantage could be completely overturned through advances in disk turbine design.

As you can see from Figure 4, the Tesla turbine is manufactured from simple stock materials - flat plate, tubing, round stock and aluminum square stock. This translates into potentially very low engine manufacturing costs (in large quantities). That, combined with the all-fuel capabilities of this engine, makes it the only choice for 21st century global power needs.

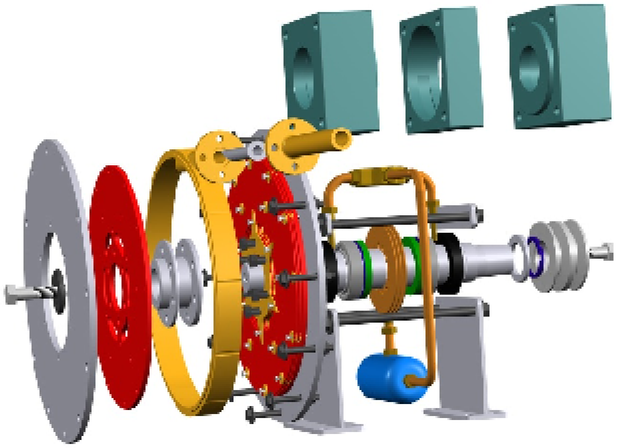
Figure 4 - PNGinc Tesla Turbine design