# TORQUE CONVERTER

A torque converter is a hydraulic fluid coupling that is used to transmit power from one or more engines or motors to a driveshaft or other output shaft. It takes the place of a mechanical clutch, and, within certain operating speed ranges, multiplies input torque, providing the equivalent of a reduction gear.

**Uses**

Torque converters are commonly found in automotive automatic transmissions, but are also used in marine propulsion systems and in various industrial machine tools.

**Construction**

A torque converter, like any fluid coupling, is a sealed chamber filled with hydraulic fluid (typically light oil) and containing a pump (or impeller) driven by the engine(s) and a turbine connected to an output shaft. The impeller is a toroid disc connected to the engine's crankshaft (or output shaft of the motor or other power source).

## Stator torque multiplication

A torque converter differs from a simple fluid coupling by the addition of a stator, a disc with fan-like blades connected to the transmission via a fixed shaft with a one-way clutch that allows it to rotate only in the opposite direction of the fluid's radial motion. Without the stator, fluid leaving the turbine would strike the impeller with a radial motion opposite its rotation, causing a braking effect. With the stator, the returning fluid strikes the stator blades, which reverses the radial direction of the fluid's motion so that it is moving the same direction as the impeller when it reenters the impeller chambers. This reversal of direction greatly increases the efficiency of the impeller, and the force of the fluid striking the stator blades also exerts torque on the turbine output shaft, providing additional torque multiplication equivalent to a higher numerical gear ratio.

## How it works

When the engine or power source is operating it turns the impeller at the same speed. The rotation of the radial chambers on the inner surface of the pump imparts a centrifugal radial flow to the fluid in the converter, which causes hydraulic fluid to strike the outer edges of the turbine.

The radial chambers on the surface of the turbine transmit the angular momentum of the fluid centripetally, reversing its direction and exerting a twisting force torque on the turbine disc that causes it to rotate in the same direction as the impeller. The fluid exits the center of the turbine and returns to the impeller to begin the cycle again.

Because some of the kinetic energy imparted to the fluid is lost to friction (raising the temperature of the fluid rather than causing motion within it), the turbine always slips (rotates slower than the impeller), particularly at very low speeds. If the speed of the impeller is very low, such as at idle speed for an automobile engine, the torque exerted on the turbine output shaft will not be enough to overcome the shaft's inertia, allowing the shaft to remain stationary without stalling the engine and eliminating the need for de-clutching.

As engine speed increases the speed of the impeller and the turbine become nearly the same (reaching their point of minimum slippage). Because the turbine is spinning faster than the fluid can exit its radial chambers, the net angular momentum of the exiting fluid is in the same direction as the turbine's rotation, rather than opposite it. As the impeller approaches this speed, the torque multiplication provided by the stator decreases. At that critical speed (the converter's stall speed) the fluid strikes the back of the stator blades, causing the stator to freewheel so that it will not interfere with the return flow of fluid.

The maximum amount of torque multiplication provided by the stator depends on the angle and design of its blades. Typical torque multiplication ranges from 1.8 to 2.5:1 for most automotive applications, up to 5.0:1 or more for static industrial applications or heavy maritime propulsion systems. The blade angle and shape also affects the stall speed of the stator (although actual stall speed is also a function of the engine's input torque; an engine with less torque will stall the stator at lower rpm).

While stator multiplication increases the torque delivered to the turbine output shaft, it also increases the slippage within the converter, raising the temperature of the fluid and reducing overall efficiency. For this reason, the characteristics of the torque converter must be matched to the torque curve of the power source and the intended application. For example, drag racing transmissions often use converters with high stall speeds to improve off-the-line torque because converter efficiency at cruising speeds is not significant.

Some torque converters, such as certain versions of General Motors's Turbo-Hydramatic, have a variable-pitch stator that can alter the angle of the stator blades between two or more positions depending on engine speed and throttle position, usually by means of a solenoid that moves the blades to a higher angle when engaged.

Some torque converters use multiple stators and/or multiple turbines to provide a wider range of torque multiplication. Such multiple-element converters are more common in industrial applications than in automotive transmissions.

The use of torque convertors with multiple stators are short lived in such automobile systems as Buick's, Triple Turbine Dynaflow and Chevrolet's. They dispensed with mechanical gearing entirely except for reverse, relying instead on torque multiplication by the converter to provide the equivalent of a continuously variable transmission. Automakers had largely stopped manufacturing these transmissions by the early 1960s because they were expensive to produce and suffered excessive slippage and poor reliability.

**Advantages**

Despite the efficiency loss, moderate slippage of the coupling provides a smoother, more even flow of power by absorbing engine and powertrain vibration rather than allow it to be transmitted to the output shaft or surrounding equipment.

**Lock-up torque converters**

Because slip within the torque converter reduces efficiency and may generate excessive heat, some converters incorporate a lockup mechanism: a mechanical clutch that engages at cruising speeds to physically link the impeller with the turbine, causing them to rotate at the same speed with no slippage.

The first automotive application of the lock-up principle was Packard's Ultramatic transmission, introduced in 1949, which locked up the converter at cruising speeds, unlocking when the throttle was floored for quick acceleration. The demand for increased automobile fuel economy brought about a gradual but widespread application of the lock-up converter for automotive transmissions between the late 1970s and mid-1980s.

**Capacity**

Torque converters have a rated torque capacity, the maximum input torque that the converter can safely withstand. Torque capacity is a function of the diameter of the converter housing, the volume of hydraulic fluid, available cooling, seal strength, and the materials used for the construction of components such as shafts and bearings.

Source: http://engineering.wikia.com/wiki/Torque_converter