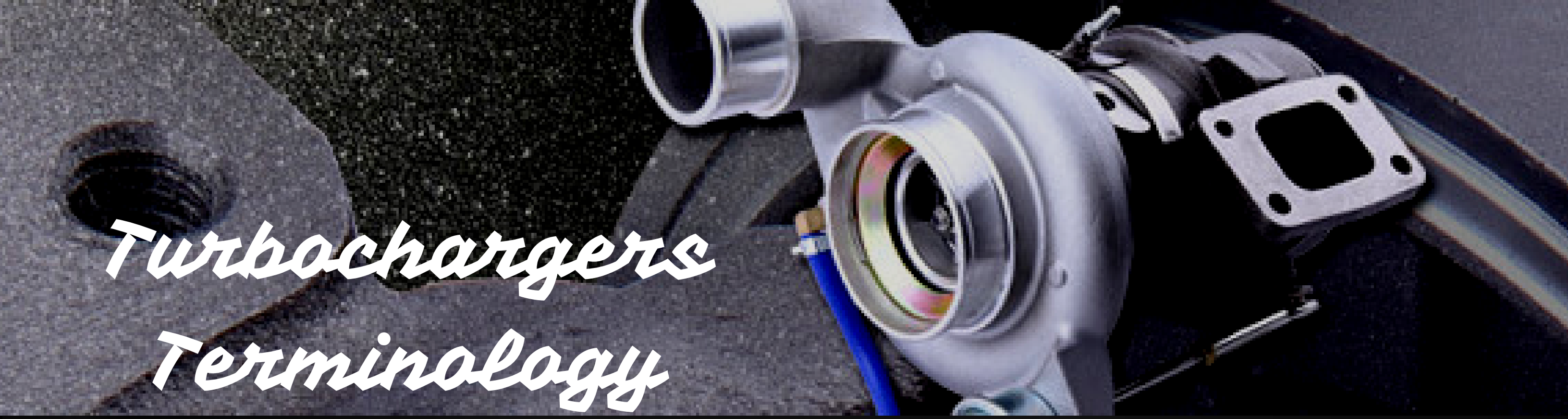
TURBOCHARGERS TERMINOLOGY

PHESSIO



Turbochargers Terminology

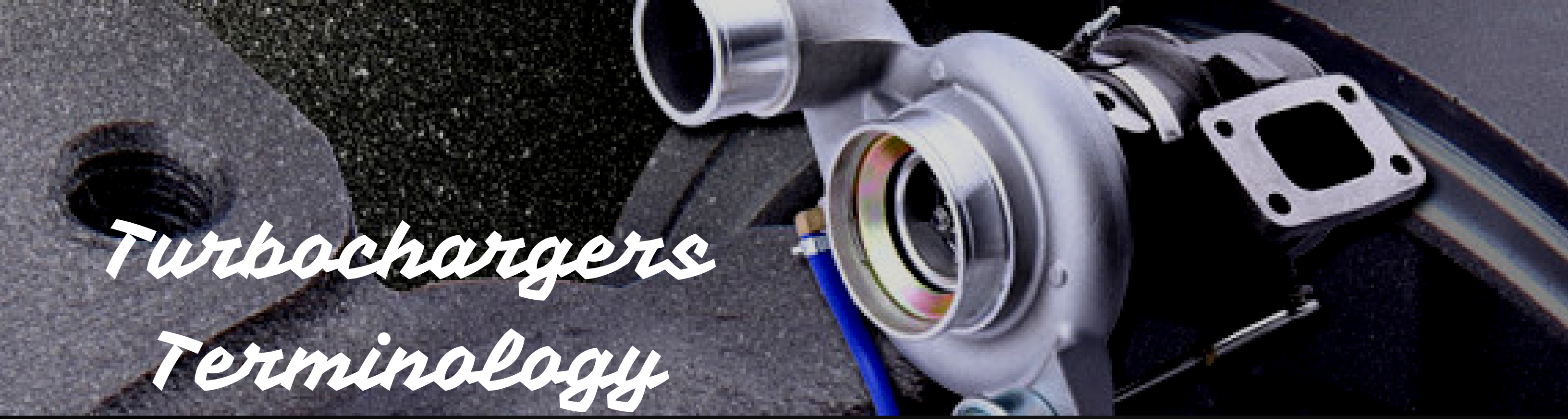
Turbochargers while simple in design, can get very complex in theory. From deciding what compressor trim is desired, to what turbine housing to be used is confusing to most who enter the field of forced induction. Before knowing turbochargers, terminology must be learned. Here is a list of the more commonly used turbocharger terms:

Compressor

Essentially a fan that spins and compresses air within an enclosed area (compressor housing). In order to allow the air to compress and build pressure within the housing, the fan must be spun at certain rpm levels.

Compressor Housing

Housing that encloses the compressor. Pictured is a compressor housing.



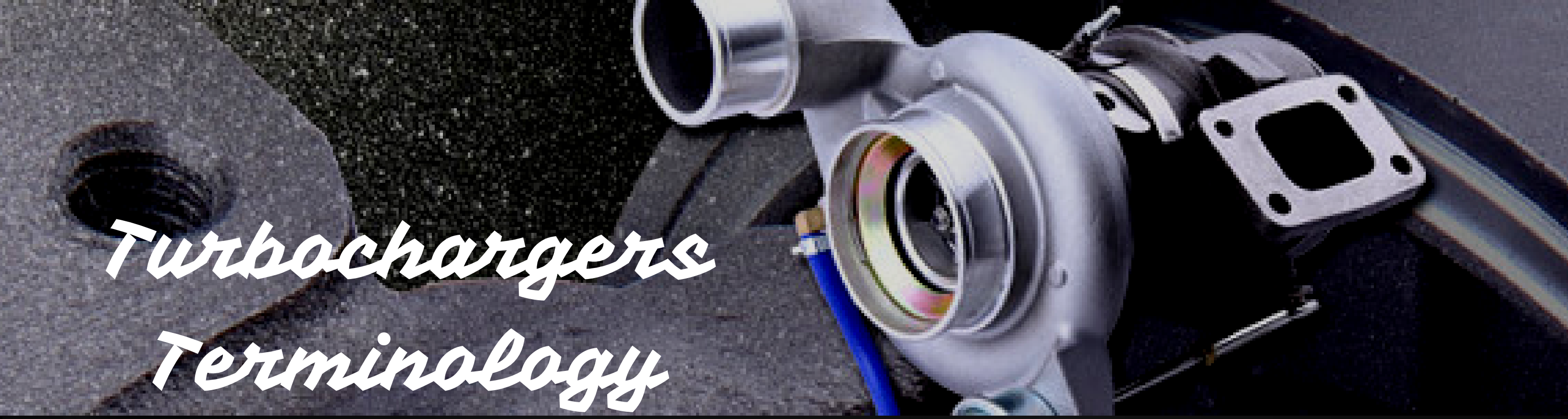
Turbochargers Terminology

Compressor Map

A map that allows the ability to plot compressor pressure ratio vs. engine airflow. An ”island” shape is created on the plot showing where the compressor is efficient.

Compressor Efficiency

Compressors efficiency is the ability to produce lowest possible temperature from the compressor air. When air is compressed heat is generated, at certain range of speeds of the compressor rotation the heat can be keep to a minimum. This is what is known as ”being in the efficiency range of a compressor” Higher efficiency, lower outlet temperatures. Highest possible efficiency of compressors are 78~82%. Lower outlet temperature=lower intake air temperature. Lower intake air temperature=more dense mixture of air=more oxygen available in the combustion to burn. The greater amount of oxygen present with fuel provides more energy. More energy=more heat=more torque=more power.



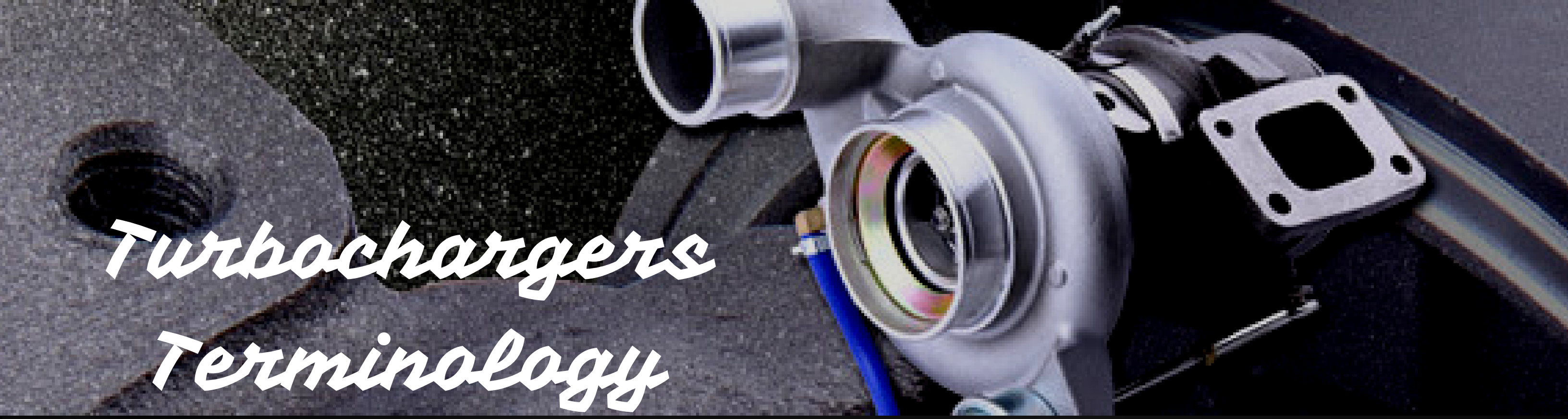
Turbochargers Terminology

Compressor Trim

The trim of the compressor refers to the squared ratio of the smaller diameter divided by the larger diameter multiplied by 100 of the compressor wheel. The smaller diameter of the wheel is known as the inducer, and the larger diameter of the wheel is known as the exducer.

Compressor Families

Beyond compressor trim levels there is compressor family of wheels. In the Garret turbo line of older technology compressors there is T22, T25, T3, T350, T04b, T04e, T04s and T04r families. In each family there is trim levels to the family. Although there is a 60 trim in both the t3 and to4e family wheels, the main difference is the inducer diameter of the wheels. The trim is only a ratio of the exducer/inducer, so while the inducer size of the compressor wheels are vastly different, the ratio between the exducer/inducer remains constant since it’s the comparison between the exducer to inducer size.



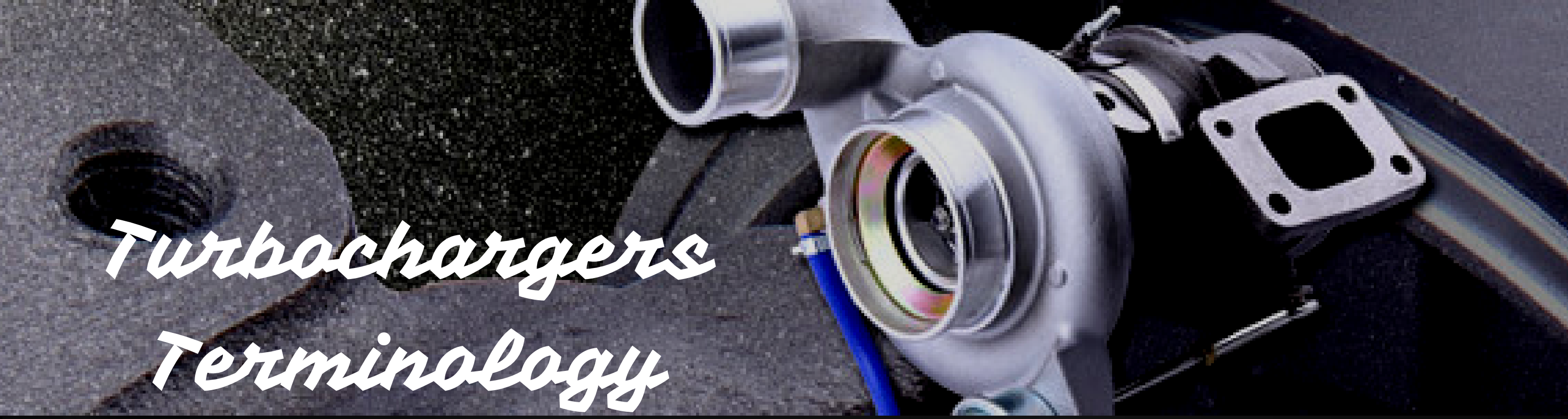
Turbochargers Terminology

Turbine

A fan that uses exhaust energy to rotate. The rotation of the turbine is transmitted through a shaft that is connected to the compressor. Faster the turbine spins, faster the compressor spins. Compressor uses the rpm translation through the turbine/compressor-connecting shaft to compress air at the rpm level that dictates compressor flow.

Turbine Housing

Housing that encloses the turbine wheel. Turbine housing size affects the ability of the turbine to transmit rpm to the compressor wheel. Smaller turbine housing, quicker spool up due to quicker translation of RPMs to compressor. Trade-off is increased low-end response for less high-end response from turbocharger. Picture below is a turbine housing.



Turbochargers Terminology

Turbine Trim

The trim of the turbine refers to the squared ratio of the smaller diameter divided by the larger diameter multiplied by 100 of the compressor wheel. The smaller diameter of the wheel is known as the inducer, and the larger diameter of the wheel is known as the exducer.

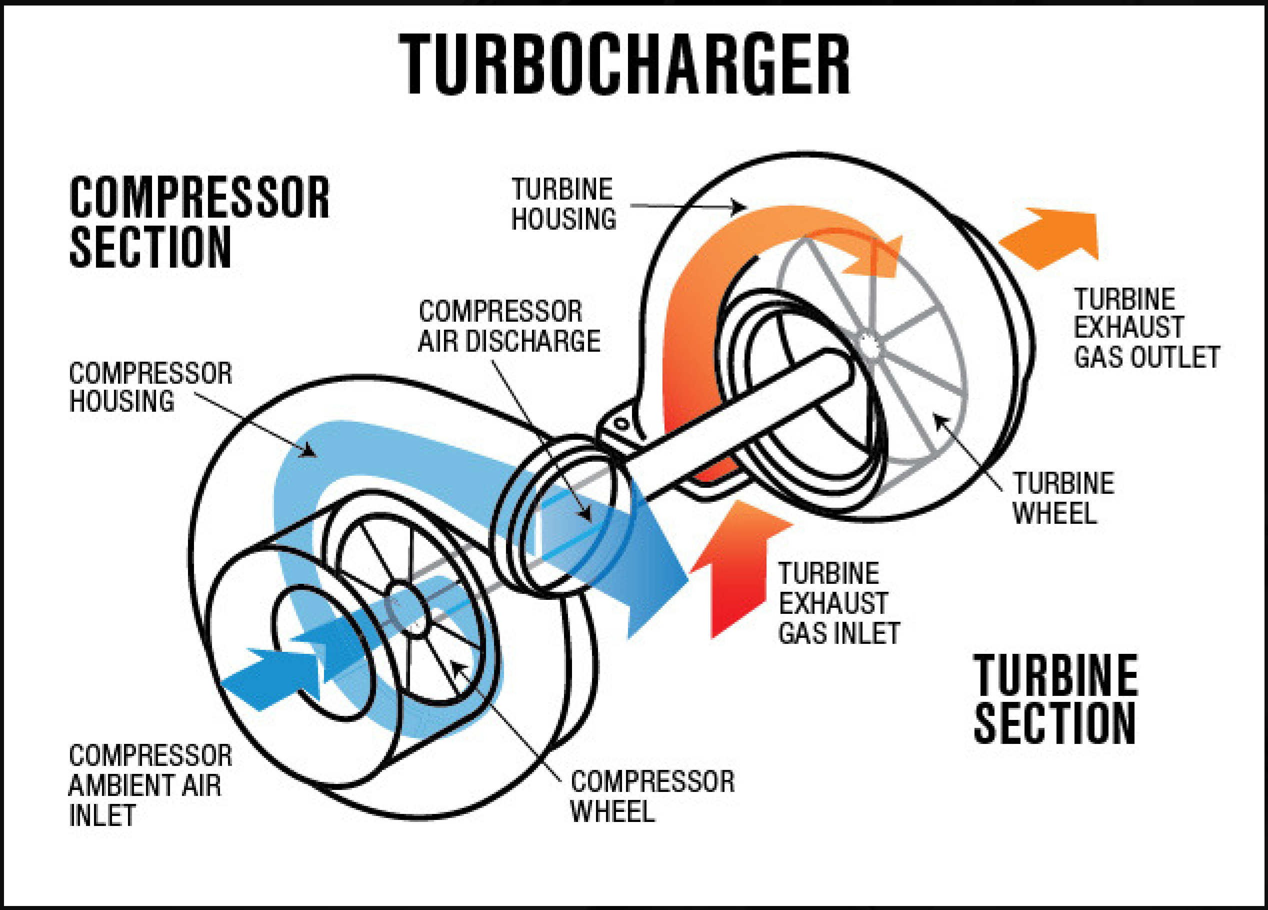
Turbine Families

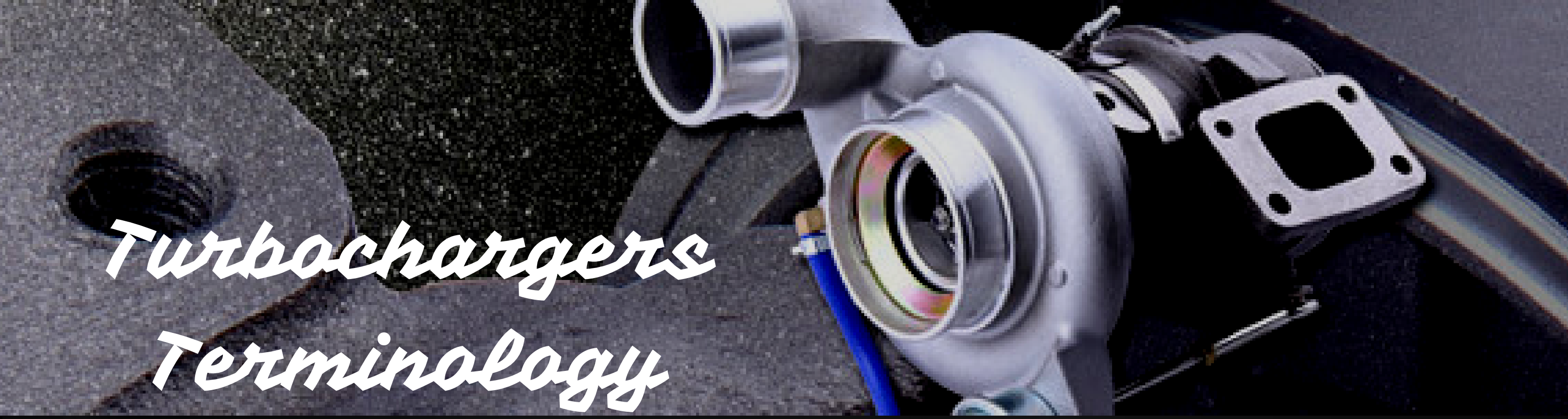
As with compressor families, there is turbine families. The most common evidence of the turbine families is the t31, t350 and t04 wheel used in the t3, t3/t4 turbos sold on the market. Precision offers the t31, aka stage 3 blade in their smaller line of sport compact series turbochargers. The t31 comes in two different trim levels the 69 and 76 trim. The t350, aka stage 5 blade comes in two different trim levels as well, 69 and 76 trim. The t31 will spool faster than the t350 due to the physical size differences (t31 being smaller). The smaller the trim level the quicker spool, but less top end. Essentially you are changing the turbine pressure ratio when you are selecting the family and trim level of the turbine wheel you are using. The larger family and trim level you choose the more power the turbocharger will produce at the expense of lag. As with the compressor trim levels both the t31 and t350 have the 69 and 76 trim levels, which are not the same. The turbine trim is the ratio of the exducer compared to the inducer size of the turbine wheel, since its only a ratio the size of the inducer/exducers are completely different.

Turbochargers Terminology

Turbine Map

A map that allows the ability to plot turbine expansion ratio vs. engine airflow. An "island" shape is created on the plot showing where the turbine is efficient.





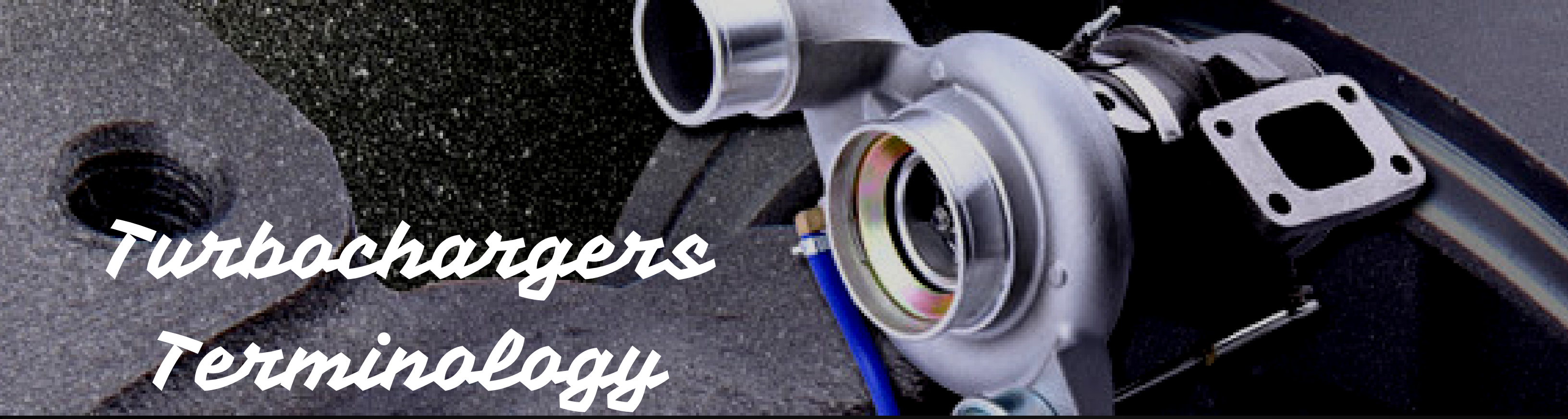
Turbochargers Terminology

A/R

Ratio of the area of the compressor/turbine housing to the radius of the compressor/turbine wheel.

In order to find out the A/R of the compressor or turbine housing select a point where the compressor/turbine housing begins and measure the cross-sectional area at that point. Cross sectional area is A=P*(Radius)2. Next step is to measure the distance between the center of the area and the center of the compressor/turbine wheel, this is the radius measurement. If you choose a different point on the compressor/turbine housing and remeasure the area and radius, you'll find that it stays constant. This is due to the housing getting constantly smaller in diameter as it gets closer and closer to the compressor/turbine wheel.

When you upgrade from a .48 to a .63, or .63 to a .82 A/R you are essentially increasing the area of the housing. Increasing the area increases the amount airflow to the turbine wheel. The smaller area of the smaller turbine housing builds pressure quickly and transmits this pressure to the turbine. The pressure gives the turbine enough RPMs to allow the compressor to compress air at lower engine speeds (less engine speed, less airflow from engine). The trade off is that pressure builds up quickly in the housing to obtain quick spool up, but the pressure quickly becomes to great and backpressure builds up. The backpressure is the restriction that limits shaft speed of the compressor, and as the rpm increase (engine airflow increases) the torque curve begins to drop off due to the volumetric efficiency of the engine decreasing. Think of the turbine housing sizing as increasing/decreasing inlet pressure to the housing in order to gain low end, midrange or top-end response from the turbocharger. The smaller turbine housing wont carry the torque curve to a high rpm, limiting the amount of peak whp. Excellent low-end and midrange gains are felt through smaller housings.



Compressor/Turbine Mismatch

When "matching" a compressor and a turbine you are seeking to balance the turbine characteristics to the compressor characteristics. When you increase the size of the turbine wheel you are decreasing the pressure ratio of the turbine, essentially decreasing the shaft speed connecting the compressor/turbine. When pairing a larger turbine wheel to a small compressor wheel, the smaller the compressor wheel the higher the rpm the wheel has to be spun at to compress the air. This becomes a problem in that the smaller compressor cannot generate adequate shaft speed to compress air. The same can hold true when pairing a huge compressor to a small turbine wheel. The larger compressor needs less shaft speed to compressor airflow, but the smaller turbine wheel will spin at a much higher rpm level that is what is necessary. The result is crossing over the choke or surge line on the compressor map (this will be explained in part 2 of this article). Note the two different compressor maps, one of a 60 trim t3 compressor wheel, the other a t64 compressor wheel.

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