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A/R

A/R is a numerical rating assigned to radial flow housings in order to distinguish the relative volumetric flow capacity of the housing. ***A/R*** does have units of length (inches or cm) based on the "***A***" over "***R***" description. One must be careful because the A/R values can only be compared within a single family of housings. 0.86 ***A/R*** of a GT28R and a 0.85 ***A/R*** of a GT40 have very different flow capacities. The term ***A/R*** is derived from:

Q = volumetric flow rate

A = cross-sectional area of the volute at the tongue

R = radius to the dynamic center (The dynamic center locates that point which divides the scroll area such that half the flow passes above and half the flow passes below the dynamic center.)

V = tangential component of velocity

Q = A x V (where V = K (flow rate constant) / R)

Q = A x K/R

Q = K x A/R

Since ***K*** is a constant then ***A/R*** defines the flow capacity of hsgs within the same family.

Compressor ***A/R*** - Compressor performance is largely insensitive to changes in A/R, but generally larger ***A/R*** housings are used to optimize the performance for low boost applications and smaller housings are used for high boost applications. Typically there are not ***A/R*** options available for compressor housings.

Turbine ***A/R*** - Turbine performance is greatly affected by changing the ***A/R*** of the housing. Turbine ***A/R*** is used to adjust the flow capacity of the turbine. Using a smaller ***A/R*** will increase the exhaust gas velocity into the turbine wheel, causing the wheel to spin faster at lower engine RPMs giving a quicker boost rise. This will also tend to increase exhaust backpressure and reduce the max power at high RPM. Conversely, using a larger ***A/R*** will lower exhaust gas velocity and delay boost rise, but the lower backpressure will give better high-RPM power. When deciding between ***A/R*** options, be realistic with the intended vehicle use and use the ***A/R*** to bias the performance toward the desired powerband.

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Choke Line

The choke line is on the right hand side of a compressor map and represents the flow limit. Properly sizing a turbo is important to prevent the compressor from operating past the choke line. When a turbocharger is run deep into choke, turbo speeds increase dramatically while compressor efficiency plunges (very high compressor outlet temps). Additionally, the turbo's durability is compromised by the resulting high thrust loads.

CHRA (Center Housing & Rotating Assembly)

The CHRA is essentially a turbocharger minus the compressor and turbine housings

Clipped Turbine Wheel

When an angle is machined on the turbine wheel exducer (outlet side), the wheel is said to be "clipped". Clipping causes a minor increase in the wheel's flow capability; however, it dramatically lowers the turbo efficiency. This reduction in efficiency causes the turbo to come up on boost at a later engine speed (ex. increased turbo lag). High performance applications should never use a clipped turbine wheel. All Garrett GT turbos use modern unclipped turbine wheels.

Corrected Air Flow

When plotting actual airflow data on a compressor map, the flow must be corrected to account for different atmospheric conditions that affect air density.

Example:

Air Temperature (Air Temp) - 60°F

Barometric Pressure (Baro) - 14.7 psi

Engine air consumption (Actual Flow) = 50 lb/min

Corrected Flow= Actual Flow SQR([Air Temp+460]/545)/ Baro/13.95

*Corrected Flow= 50*SQR([60+460]/545)/ (14.7/13.95) = 46.3 lb/min*

Efficiency Contours

The efficiency contours depict the regional efficiency of the compressor stage. When sizing a turbo, it is important to maintain the proposed lugline with a high efficiency range on the map.

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Free-Float

A free-floating turbocharger has no Wastegates device. This turbocharger can't control its own boost levels. For performance applications, the user normally must install an external Wastegates.

GT

The GT designation refers to Garrett's state-of-the-art turbocharger line. GT-series turbos use redesigned bearing systems and modern compressor/turbine aerodynamics. These new compressor and turbine wheels represent huge efficiency improvements over the old T2, T3, T3/T4, T04 products. The net result is increased durability, higher boost, and more engine power over the older T-series product line.

On-Center Turbine Housings

On-center turbine housings refer to an outdated style of turbine housing with a centered turbine inlet pad. The inlet pad is centered on the turbo's axis of rotation instead of being tangentially located. Using an on-center housing will significantly lower the turbine's efficiency. This results in increased turbo lag, more backpressure, lower engine volumetric efficiency, and less overall engine power. No Garrett OEM's use on-center housings.

Pressure Ratio

Ratio of absolute outlet pressure divided by absolute inlet pressure

Example:

Intake manifold pressure (Boost) = 12 psi

Pressure drop, intercooler ($DP_{Intercooler}$) *= 2 psi*

Pressure drop, air filter ($DP_{Air\ Filter}$) *= 0.5 psi*

Atmosphere (Atmos) = 14.7 psi at sea level

$PR = (Boost + DP_{Intercooler} + Atmos) / (Atmos - DP_{Air\ Filter})$

$PR = (12 + 2 + 14.7) / (14.7 - .5) = 2.02$

Surge Line

The surge region, located on the left-hand side of the compressor map, is an area of flow instability typically caused by compressor inducer stall. The turbo should be sized so that the engine does not operate in the surge range. When turbochargers operate in surge for long periods of time, bearing failures may occur.

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Trim

Trim is an area ratio used to describe both turbine and compressor wheels. Trim is calculated using the inducer and exducer diameters.

Example:

Inducer diameter = 88mm

Exducer diameter = 117.5mm

Trim = $Inducer^2/Exducer^2$

Trim = $88^2/117.5^2$ *= 56 Trim*

As trim is increased, the wheel can support more air/gas flow.

Wastegates

A Wastegated turbocharger includes an integral device to limit turbo boost. This consists of a pneumatic actuator connected to a valve assembly mounted inside the turbine housing. By connecting the pneumatic actuator to boost pressure, the turbo is able to limit its maximum boost output. The net result is increased durability, quicker time to boost, and adjustability of boost.