ARK PERFORMANCE INC
INFO ABOUT OUR EXHAUST SYSTEMS

ARK CATBACK EXHAUST SYSTEMS:

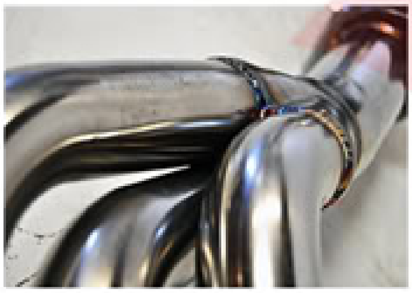
Basic defintion of a Catback Exhaust

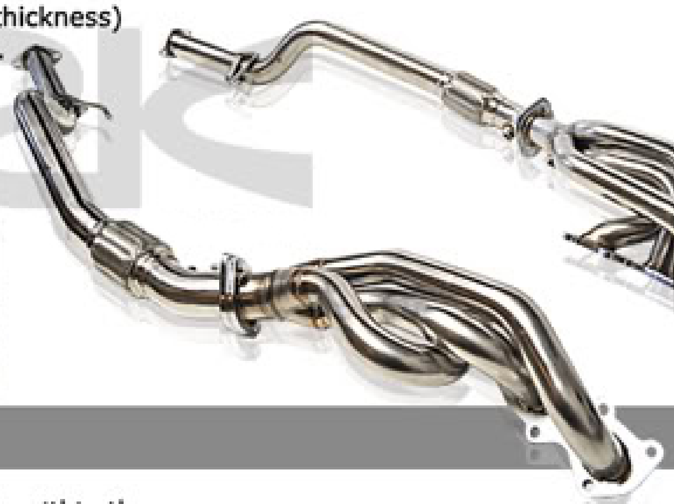
Refers to the portion of the exhaust system from the outlet of the catalytic converter to the final vent to open air. This generally includes the pipe from the converter to the muffler, the muffler, and the final length of pipe to open air.

T304 Stainless Steel Construction

First and foremost, we engineer all of our exhaust systems with only the highest grade metal, T304 Stainless Steel. Each component of our exhaust systems are thoroughly tested before it goes into production. With over 150 different type of steel, ARK and other reputable companies choose T304 SS for these reasons.

- Heat Resistance
- Prevents Corrosion
- Ability to control the thickness of piping (ARK uses 1.5-1.7mm thickness)
- Ability to design the piping structure of each unique automobile.

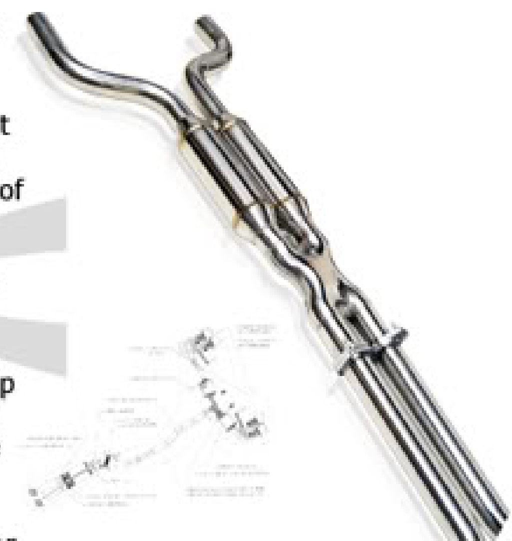




Piping Design

Piping design is essential to the tone and volume of the exhaust.
With the amount of room each platform gives us, we have to stay within those limits and create an innovative and unique exhaust system that sets the ARK exhausts apart from other exhaust manufacturers.

We've seen quite a few "experienced" racers tell people that larger piping exhaust means a better exhaust. This statement cannot be further from the truth.



Exhaust gas is hot and we'd like to keep the tempurature of the exhaust consistent throughout the exhaust system. Why? The answer is simple. Cold air is dense air, and dense air is heavy air. We don't want our engine to be pushing a heavy mass of exhaust gas out of the tailpipe. An extremely large exhaust pipe will cause a slow exhaust flow, which will in turn give the gas plenty of time to cool off en route. Overlarge piping will also allow our exhaust pulses to achieve a higher level of entropy, which will take all of our header tuning and throw it out the window, as pulses will not have the same tendency to line up as they would in a smaller pipe. Coating the entire exhaust system with an insulative material. such as header wrap or a ceramic thermal barrier coating reduces this effect somewhat, but unless you have lots of cash burning a hole in your pocket, is probably not worth the expense on a street driven car.

Unfortunately, we have no accurate way to calculate optimal exhaust pipe diameter. This is mainly due to the random nature of an exhaust system -- things like bends or kinks in the piping, temperature fluctuations, and different muffler designs, makes selecting a pipe diameter inaccurate without trial and error. This is where hours of R&D comes into play. For engines making 250 to 350 horsepower, the generally accepted pipe diameter is 3 to 3 ▯ inches. Over that amount, you'd be best off going to 4 inches. If you have an engine making over 400 to 500 horsepower, you'd better be happy capping off the fun with a 4 inch exhaust or an open exhaust.

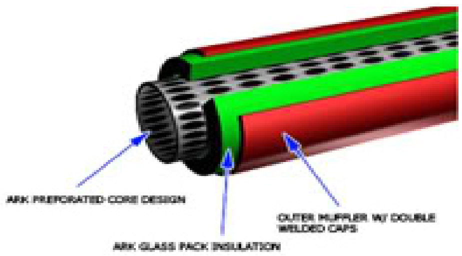
ARK PERFORMANCE RESONATORS

In reality, the sound coming from the engine is a mixture of many different frequencies of sound, and since many of those frequencies depend on the engine speed, the sound is almost never exact at the right frequency for this to happen. The resonator is designed to work best in the frequency range where the engine makes the most noise; but even if the frequency is not exactly what the resonator was tuned for, it will still produce some destructive interference.

Some cars, especially luxury cars where quiet operation is a key feature, have another component in the exhaust that looks like a muffler, but is called a resonator. This device works just like the resonator chamber in the muffler -- the dimensions are calculated so that the waves reflected by the resonator help cancel out certain frequencies of sound in the exhaust.

There are other features inside this muffler that help reduce the sound level in many ways. The body of the muffler is constructed in three layers: Two thin layers of metal with a thicker, slightly insulated layer between them. This allows the body of the muffler to absorb some of the pressure pulses. Also, the inlet and outlet pipes going into the main chamber are perforated with holes. This allows thousands of tiny pressure pulses to bounce around in the main chamber, canceling each other out to some extent in addition to being absorbed by the muffler's housing.

ARK resonators are infact glassed packed with a straight through design. We also utilize our preforated pipes inside the resonators to reduce the overall volume of the exhaust. Our resonator design never tapers down to maintain a constant flow of exhaust gases. The main function if our resonators is to reduce volume without any sacrifice in performance at any RPM range.



ARK PERFORMANCE MUFFLERS

If you've ever heard a car engine running without a muffler, you know what a huge difference a muffler can make to the noise level. Inside a muffler, you'll find a deceptively simple set of tubes with some holes in them. These tubes and chambers are actually as finely tuned as a musical instrument. They are designed to reflect the sound waves produced by the engine in such a way that they partially cancel themselves out.

ARK Mufflers incorporates straight through mufflers with a perforated core. This design have the lowest backpressure, about the same as an open exhaust. With calculated designs of the pipe diameter and preforations, they can be fairly quiet as well. The noise waves go through the perforations and are absorbed by the packing. The ARK PERFORMANCE muffler above has stainless mesh to protect the glass pack wool from the exhaust heat while the muffler below has all stainless mesh packing. The glass pack material is better at absorbing high frequencies and reduce the low frequencies created by stainless steel.

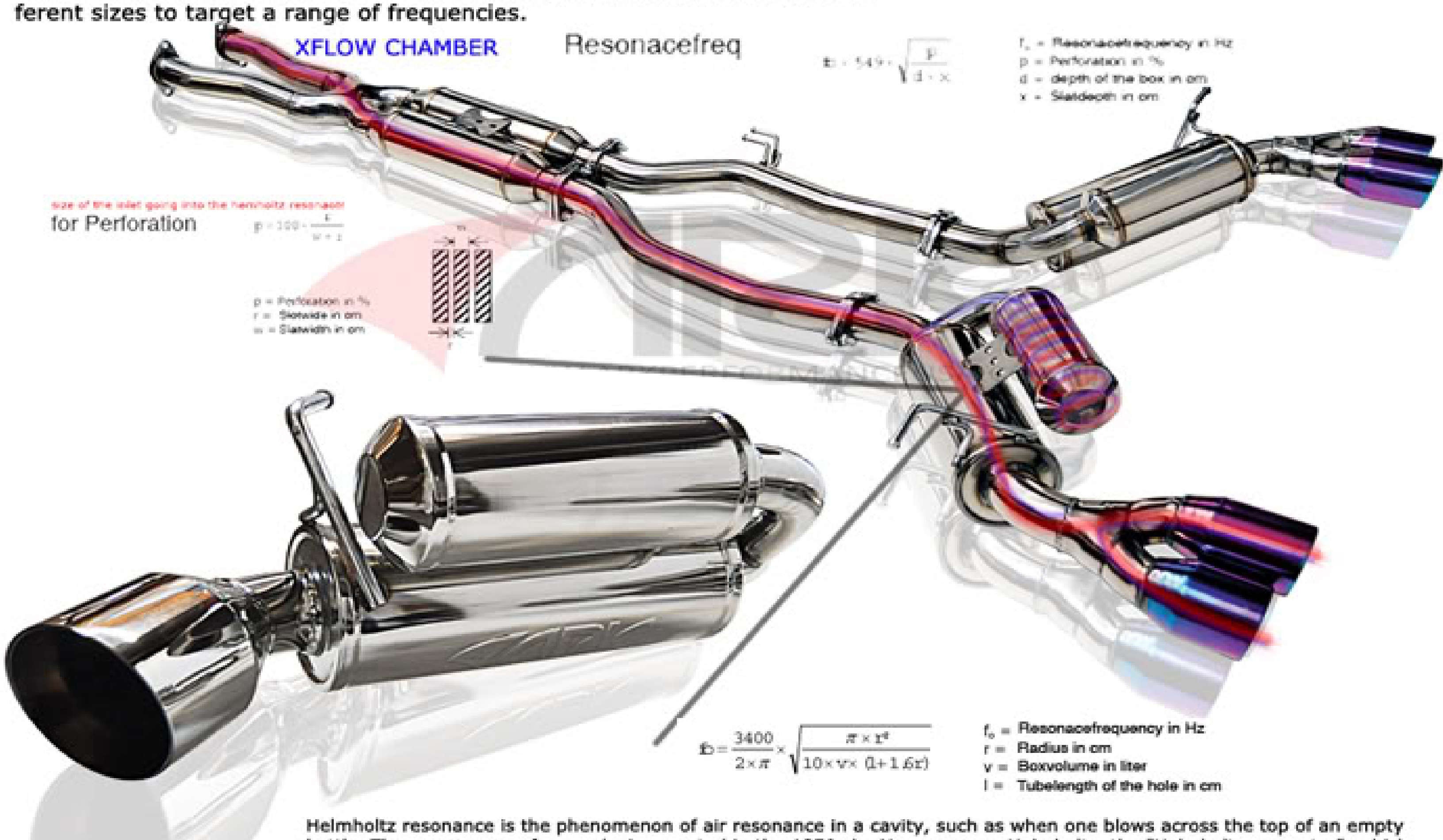
To get the least amount of backpressure most of the good high performance mufflers available today have what is called a straight-through design. These types of mufflers quiet the exhaust by the absorption of high frequency vibrations in heat resistant packing, usually consisting of stainless steel mesh and heat-resistant ceramic fibers. They typically have an inner core that is straight through with no baffling at all, much like a straight pipe with many small holes in it. The pipe is louvered or perforated when it passes inside the mufflers shell allowing sound energy to pass through the holes but leaving the exhaust gas flow unimpeded. You can see straight through these types of mufflers. The louvered or perforated core is usually wrapped with either fiberglass wadding, hence the old school term Glass-Pack or on the better mufflers, stainless steel mesh backed by ceramic fiber to help further absorb the sound.

Basic Concept

Internal combustion engines are typically equipped with an exhaust muffler to suppress the acoustic pulse generated by the combustion process. A high intensity pressure wave generated by combustion in the engine cylinder propagates along the exhaust pipe and radiates from the exhaust pipe termination. The pulse repeats at the firing frequency of the engine which is defined by f=(engine rpm x number of cylinders)/120 for a four stroke engine. The frequency content of exhaust noise is dominated by a pulse at the firing frequency, but it also has a broadband component to its spectrum which extends to higher frequencies. Measurements of the exhaust pipe pressure pulse on a Continental O-200 engine [4] show that the majority of the pulse energy lies in the frequency range of 0-600 Hz. Exhaust mufflers are designed to reduce sound levels at these frequencies.

In general, sound waves propagating along a pipe can be attenuated using either a dissipative or a reactive muffler. A dissipative muffler uses sound absorbing material to take energy out of the acoustic motion in the wave, as it propagates through the muffler. Reactive silencers, which are commonly used in automotive applications, reflect the sound waves back towards the source and prevent sound from being transmitted along the pipe. Reactive silencer design is based either on the principle of a Helmholtz resonator or an expansion chamber, and requires the use of acoustic transmission line theory.

In a Helmholtz resonator design a cavity is attached to the exhaust pipe. At a specific frequency the cavity will resonate and the waves in the exhaust pipe are reflected back towards the source. However there are also pass band frequencies where the resonator has no effect and so resonator muffler design is targeted to specific frequencies where the majority of the attenuation is required. In some designs, the muffler has several resonators of different sizes to target a range of frequencies.



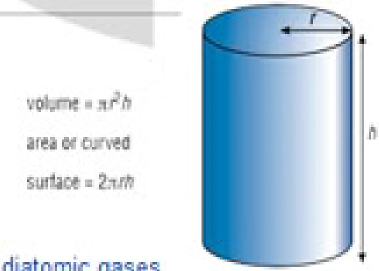
Helmholtz resonance is the phenomenon of air resonance in a cavity, such as when one blows across the top of an empty bottle. The name comes from a device created in the 1850s by Hermann von Helmholtz, the "Helmholtz resonator", which he, the author of the classic study of acoustic science, used to identify the various frequencies or musical pitches present in music and other complex sounds

When air is forced into a cavity, the pressure inside increases. When the external force pushing the air into the cavity is removed, the higher-pressure air inside will flow out. However, this surge of air flowing out will tend to over-compensate, due to the inertia of the air in the neck, and the cavity will be left at a pressure slightly lower than the outside, causing air to be drawn back in. This process repeats with the magnitude of the pressure changes decreasing each time.

Quantitative explanation

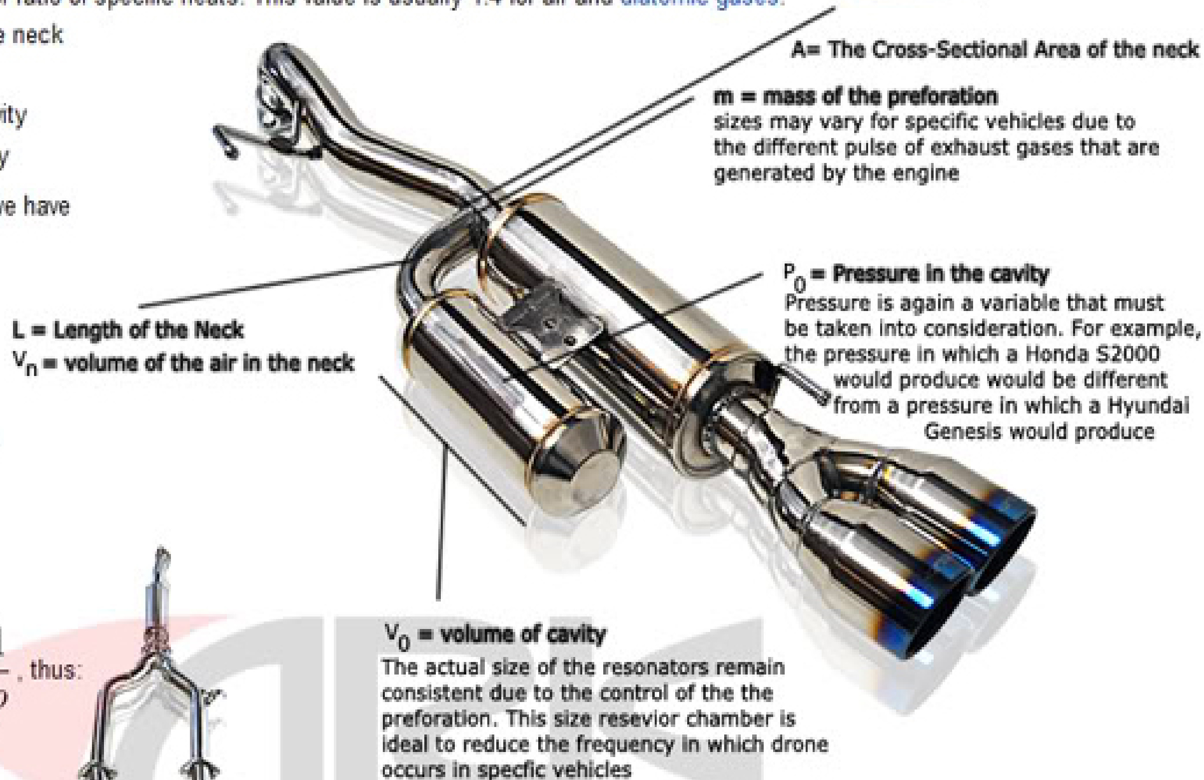
It can be shown[2] that the resonant angular frequency is given by:

$$\omega_H = \sqrt{\gamma \frac{A^2}{m} \frac{P_0}{V_0}} \text{ (rad/s)},$$



where:

- γ (gamma) is the adiabatic index or ratio of specific heats. This value is usually 1.4 for air and diatomic gases.
- A is the cross-sectional area of the neck
- m is the mass in the neck
- P_0 is the static pressure in the cavity
- V_0 is the static volume of the cavity



For cylindrical or rectangular necks, we have

$$A = \frac{V_n}{L},$$

where:

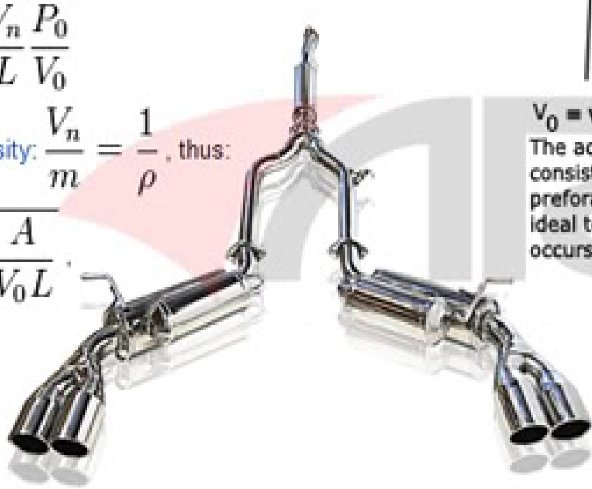
- L is the length of the neck
- V_n is the volume of air in the neck

thus:

$$\omega_H = \sqrt{\gamma \frac{A}{m} \frac{V_n}{L} \frac{P_0}{V_0}}$$

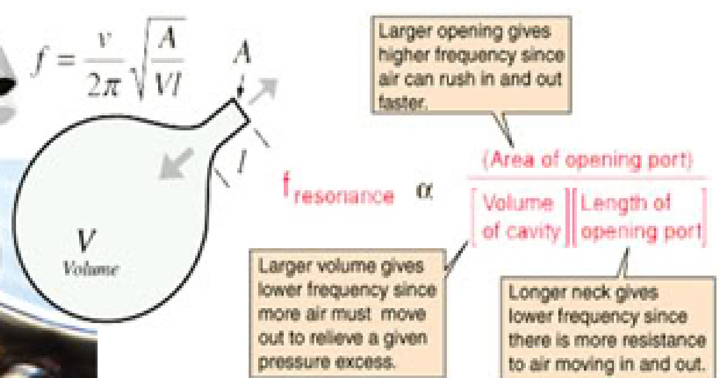
By the definition of density: $\frac{V_n}{m} = \frac{1}{\rho}$, thus:

$$\omega_H = \sqrt{\gamma \frac{P_0}{\rho} \frac{A}{V_0 L}},$$



and

$$f_H = \frac{\omega_H}{2\pi},$$



where:

- f_H is the resonant frequency (Hz)

The speed of sound in a gas is given by:

$$v = \sqrt{\gamma \frac{P_0}{\rho}},$$

thus, the frequency of the resonance is:

$$f_H = \frac{v}{2\pi} \sqrt{\frac{A}{V_0 L}}$$

The length of the neck appears in the denominator because the inertia of the air in the neck is proportional to the length. The volume of the cavity appears in the denominator because the spring constant of the air in the cavity is inversely proportional to its volume. The area of the neck matters for two reasons. Increasing the area of the neck increases the inertia of the air proportionately, but also decreases the velocity at which the air rushes in and out.

Depending on the exact shape of the hole, the relative thickness of the sheet with respect to the size of the hole and the size of the cavity, this formula can have limitations. More sophisticated formula can still be derived analytically, with similar physical explanations (although some differences matter). See for example the book by F. Mechels.[3] Furthermore, if the mean flow over the resonator is high (typically with a Mach number above 0.3), some corrections must be applied.