AFTER-MARKET MUFFLERS

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I believe it is not productive to juggle resonances (AKA "scavenging") in the intake or exhaust systems. Resonances are used by manufacturers such as BMW to boost high-end torque (and hence advertised max HP). But top rpm is the place least useful to the street rider. While you can use the boosting power of resonances to overcome some other deficiencies in the rpm compass, for every boost you introduce, there will matching cuts at the sub- and super-octave points, resulting in what I'd consider a net loss to the rider.

Most after-market mufflers are in effect just straight-through pipes. Sometimes these mufflers put obstacles in the gas path to bounce-back some sound with the result that the obstacles will cut some flow, some noise, and some power. Best to think of after-market mufflers as two largely independent circuits: (1) gas flow and (2) sound absorption. There are additional important circuits not further discussed in this write-up for (3) heat flow and (4) the particulate crap coming down the pipe (but my guess is that the particulates mostly follows the behaviour of the sound circuit). Gas and sound are circuits discussed below and it should be kept in mind that these generally interact little with one another in the after-market designs. So a muffler really is like two separate mechanisms in one can.

An oval cross-section for the can makes good acoustic sense (see "ragged" comments below). But oddly, it is plain stupid to have two cans instead of one for a twin, esthetics and structural spaces permitting. I think some manufacturers find economies in making a single can size for many bike models.

Gas flow

There is nothing much to say that isn't self-evident about a straight-through pipe as far as scavenging. And there's nothing to say about maintenance that isn't self-evident. The straighter the better and the manner of best mating of multiple cylinders with a single muffler depending on the engine and application.

Sound absorption

Sound absorption is very hard to accomplish within the constraints of a motorcycle and particularly for the original equipment manufacturer. There are vast numbers of patents for mufflers. Among the interacting trade-offs are: cost, weight, noise, durability, power, size, appearance, being free of annual maintenance, etc.

Some people believe that The Factory always knows best. Given the priorities of the manufacturer, they often (not always) devote the needed resources to getting things the way *they* want them to work. I'd say that for mufflers, the big difference between stock and after-market is maintenance requirements. OEM simply can't ask the rider to repack the filthy muffler as a matter of routine maintenance, and that's that. Therefore,

manufactures use (A) elaborate (read: heavy) designs to "eat" the sound while impairing the flow as little as possible instead of (B) straight-through cans requiring repacking every 30,000 miles.

After-market manufacturers are less constrained by maintenance requirements (hell, they can just lie about it) and apparently are also unconstrained by cost and noise. With performance as their typical prime criterion, almost all opt for easy to engineer and easy to make straight-through pipes… with the money going for blingware (carbon fiber and titanium cases).

Straight-through exhausts have, by definition, no obstacles or sharp bends in their paths. They require what is generically called a "gun muffler" and the parallel to gun muffling requirements is clear. Reducing the effective amplitude of the sound wave reaching the neighbours can be accomplished in various ways from the science of acoustics: absorption, impedance matching and broadening, control of dispersion, preferential control of sound colour, attention to intelligibility criteria, voice frequency avoidance, masking by riding next to Harleys, external baffling, etc.

Most typically, the exhaust pipe is surrounded by a "can" containing some fantasy version of an absorbent and rarely, a good (read: expensive) absorbent. The exhaust gases are conducted down the can by an acoustically transparent pipe (that is also porous to particulate pieces).

It's very hard to absorb the powerful lower frequencies of an IC engine. After all, 3000 rpm is also 50 Hz. That's particularly so since the best friends of low-frequency absorption are long dimensions and deep absorption; but space is tight on a bike. Without the help of wide-open spaces and trick acoustic layouts (as found in stock mufflers), you are relying on the goodness of the absorbent alone (as ought to be found in after-market cans).

There are a few good absorbents for these low frequencies: organic felts (such as rug underlayer from carpets in old houses… if you like fiery exhausts!), ceramic foam, melamine-impregnated foam, and mystery Japanese substances; very high-density fiberglass (not the fluffy long-strand stuff sold by motorcycle suppliers) may be so-so. There are shredded metal substances but even the ones that actually have a designer with acoustical smarts behind them are without much benefit in a bike muffler. There are other trick acoustical materials by they are generally not resistant to the heat found in mufflers because it is generally the case that the stuff that is gooey enough (read: organic) to eat sound is often gooey enough to burn.

A professional design that works well for flow and produces a wonderful baritone note is made by one European company [name upon request[1]]. If replacement kits from this manufacturer can be used in your cans, buy them.

[1] They screwed me around some, so why should I give them a plug here?

Running rich or running long

If you are running rich you should repack your mufflers maybe sooner than 15,000 miles because the crud is compromising the acoustic qualities. If you are running reasonably lean, maybe every 30,000.

If you have a fine stainless steel wire screen wrapped over the big holes in the core pipe running through the muffler, you especially need to keep to that schedule to keep performance unchanged. I'm not sure if there is likely to be any power loss or gain when the screen "solidifies" into a solid pipe with impacted crud, but the sound level will certainly rise dramatically. If you don't have a fine screen, you need to check your cans because the stuffing may have blown out like a cat in the night.

Earlier I said the two circuits don't much interact. Well, if the pipe turns solid the circuits become sort of the same. The sound is constrained to remain inside the pipe right till the tailpiece.

As far as power, when the tail end of your gas exhaust circuit is "ragged" (I am talking here about impedance matching) you are able to keep sharp resonances at bay. But when the muffler pipe is solid and the exhaust dumps from a solid pipe to the open air, you will be getting resonances with attendant boosts and cuts.

By the way, a megaphone is a wise approach at impedance matching both for sound and for the gas flow. The best approach is to create a megaphone that is also sound absorbent. But when the absorbent becomes carbon-packed, I'm not sure how the megaphone deteriorates with respect to sound or with respect to flow.