[■] TECH STOP

# AIR SCOOP SIZE

*by Robert Szabo*

A question always arises: how big a hood scoop inlet opening? I heard of a test on a motorcycle many years ago. Some standard size opening was determined that was appropriate for the motorcycle power envelope. That size was based on tradition and optimum performance. Then a larger air scoop was installed to boost power from ram air. The motorcycle had more power, however, performance was down from the increased wind resistance.

**AIR SCOOP @ LE MANS:** After watching and studying Le Mans racing I observed various engine layouts: V-6's, V-8's, V-10's, normally aspirated and turbocharged combinations all running the same class. After wondering how the engines were all competitive, I found out that each combination had a restrictor in the air inlet system. The new twin turbocharged diesel from Audi, for example, is required to run a pair of 1.5 inch openings. That is one of the largest opening dimensions. Further analysis revealed that often the air goes sonic through those openings. That limits power to about 600 horsepower. All of the various engines are limited with various small restrictor openings to around 600 horsepower.

**AIR SCOOP @ DRAG RACING:** Then I looked at the hood scoop size in drag racing. According to Bruce Allen of Reher • Morrison Racing Engines, they determine minimum hood scoop size that does not reduce dynomometer horsepower. Allen said they are looking for a positive pressure in the hood scoop that typically goes up to one psi at high speed, although it does not go beyond that. Jerry Bickel of Jerry Bickel racecars said that 55 square inches of inlet opening is the target for a Mountain Motor (such as 800 cubic inches in an IHRA Pro Stocker). Bickel said they are looking for positive pressure at least by third gear in a run. That is about a couple hundred feet out from the start or about 100 to 115 MPH. Robert Mortensen of Glasstek said their GT4500 scoop is about 10.25 inches by 4.25 inches. That is a typical inlet size. That was determined by trial and error and feedback from the racers as a typical preference. Mortensen said inlet size is less of an issue with Sportsmen racers. Vinny Budano, with Scott Shafiroff Racing, stressed that aerodynamics was most important for their nitrous assisted 738 cubic inch, NOS Pro Street racecar. Budano did comment that peculiarities have been seen with unplanned throttle restrictions that did not result in a corresponding loss of performance. Nitrous oxide in the intake adds complexity to the air inlet requirement. There is also quite a disparity between hood scoop size of other racing vehicles, such as Le Mans for limiting power, and drag racing for maximizing power.

**BALL-PARK SIZING:** One method for ball-parking the size of a hood scoop is to look at the column of air that the hood scoop takes in from the speed of the vehicle. That amount is a function of the engine air demand, the velocity of the vehicle, and the inlet scoop area.

***The equation for that relationship is:***

$$\text{vehicle velocity} = \text{engine air demand} / \text{scoop area}$$

This equation basically describes the speed of the vehicle for a column of air into the front of the scoop that matches the demand of the engine. Unfortunately, common values for these parameters are expressed in different units. For example, vehicle velocity is MPH (miles per hour). Engine air demand is cfm (cubic feet per minute). Scoop area is thought of in square inches. Bringing all of those units to a common standard, the following is the adjusted equation:

$$\text{vehicle MPH} = (\text{engine cfm} / \text{scoop area in square inches}) \times (60 \times 1/5280) / (1/144)$$

where: 60 = minutes (m) per hour (H)
1/5280 = miles (M) per foot (f)
1/144 = square feet per square inch

$$(60 \times 1/5280) / (1/144) = 1.64$$

$$\text{vehicle MPH} = \text{engine CFM} \times 1.64 / \text{scoop area (square inches)}$$

IHRA PRO STOCK EXAMPLE: The cfm for a Pro Stock Mountain Motor is 1,800+ CFM. In an IHRA Pro Stock racecar with the air inlet of 55 square inches, the following occurs:

$$\text{vehicle MPH} = 1{,}800 \times 1.64 / 55 = 54 \text{ MPH}$$

Below 54 MPH, the engine is drawing air in through the front of the scoop and, in effect, pulling the vehicle forward. At 54 MPH, there is a balance between the air that the engine is using and that air gulp from the air scoop going through the air. Above 54 MPH, there is more air in front of the scoop than the engine is using. Some of it backs up into the scoop, and some of it spoils around the scoop. That assumes the engine is at a constant demand.

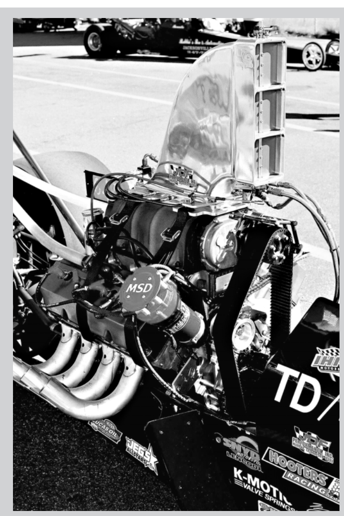

*Bug's eye view of Mark Thomas' Top Alcohol blower hat inlet and throttle that gulps 4,200 CFM of air in a 230+ MPH run; Funnycar blower inlets such as this are contained within the cross sectional area of the race-car body and contribute less to aerodynamic drag than others that hang out in the wind*

In fact, it is a varying demand. The mountain motor will vary from about 1,600 cfm to over 1,900 cfm depending on the engine RPM in each gear. Matching a hood scoop size is even more complicated by that event.

IHRA PRO MODIFIED EXAMPLE: Lets examine a Pro Modified, supercharged combination.

The cfm for a 20% overdrive 14-71 supercharger is 3,400 CFM. The blower hat inlet opening is limited to 65 square inches by some rules.

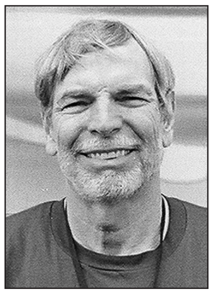
$$\text{vehicle MPH} = 3{,}400 \times 1.64 / 65 = 86 \text{ MPH}$$



*Special throttle valve hood scoop in Top Drag #424 provides exceptional air inlet to the supercharger for a 6.18 second ET dial in.*

Below 86 MPH, the blower hat is drawing air in from the front. At 86 MPH, there is a balance between the blower air and the hat inlet air from forward velocity. Above 86 MPH, more air is in front of the air scoop than the blower is using. Some of it backs up in the blower hat. The remainder spoils around the scoop. Again, that is assuming a constant demand. In fact, it will vary from about 2,600 cfm to 3,400 cfm also depending on engine speed in each gear.

***Special thanks to the following references for information for this article:***
***• Bruce Allen with Reher • Morrison Racing Engines, 817-468-3147***
***• Jerry Bickel, Jerry Bickel Race Cars, Inc., 636-356-4727***
***• Robert Mortensen with Glasstek, 630-978-9897***
***• Vinny Budano, with Scott Shafiroff Race Engines & Components, 800-295-7142***



***About the Author***
***Bob Szabo is an owner / driver of a blown alcohol drag racecar and author of the technical book: "Fuel Injection Racing Secrets." The author's next book is on methanol racing fuel that will be out shortly. Check the DRM Yellow Pages for Szabo Publishing or look on the Internet at http://www.racecarbook.com or call (707) 446 2917. If you have any comments about this article or any previous articles by the author, feel free to e-mail directly to the author at bob@racecarbook.com or to the DRM staff: pamelamarchyshyn@livenation.com or michaelperry@livenation.com NOTE: If you have spam controls and you Email any of us & want a response, please enter our Email address to clear your spam blocker. Time may not permit us to register to your spam blocker.***