Gas Engine Cooling!!

This is some very good information from Pe Reviers in the Netherlands on Gas Engine cooling. Pe is renowned for his expertise in R/C gas engines and we can all learn from this.

<u>Many thanks to Pe for allowing us to copy and distribute this info.</u>

<u>Gas Engine Cooling – by Pe Reviers</u>

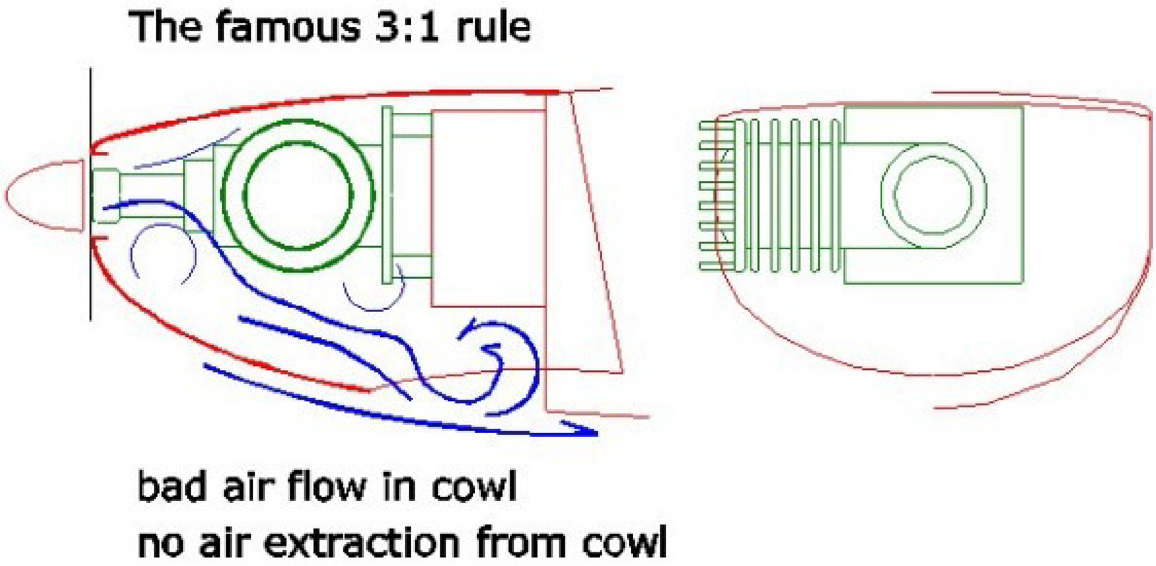
I hope this post can provide some guidance on how to set up a cooling for your cowled air cooled gas engine.

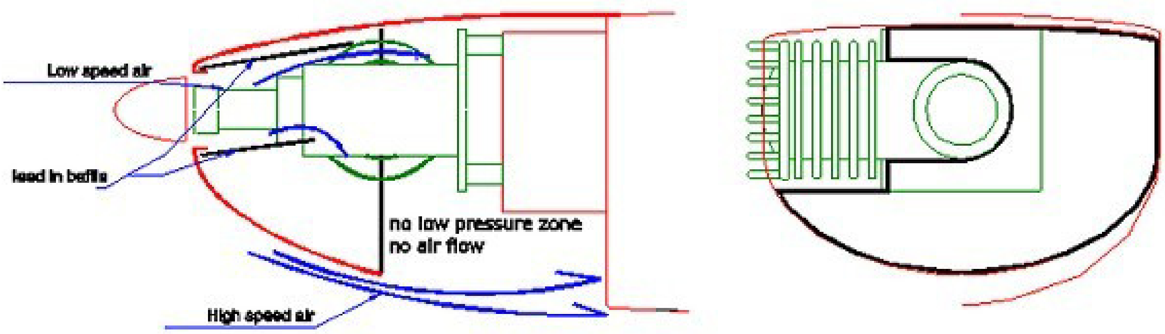
For good cooling, only two things are really needed:

1] The air should pass through the engine cooling fins and not take the easy route around the engine with less resistance. In order to achieve this, one has to use:
1.1) engine baffles
1.2) jackets to guide and force the air through the fins which must have adequate dimensions.

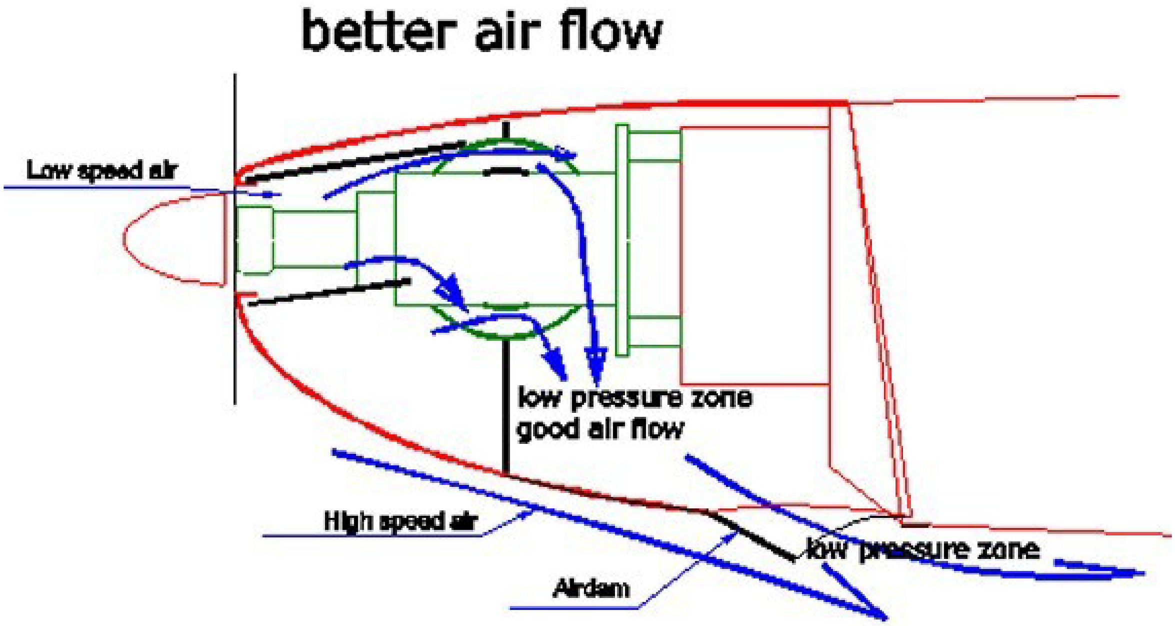
2] To achieve an air flow, there must be a pressure difference.
To set up a pressure difference a high pressure is needed in front of the baffle, and a low pressure after the baffle.
2.1) High pressure: The centre of the prop is a very lousy fan design, and all it does is stir up the air. This turbulent air is however good for cooling the front of the engine. If the plane has a decent forward speed, the incoming air will provide a pressure high enough. At low speeds and in long verticals, this speed is very low, and thus the high pressure will be absent.
2.2) Low pressure. This can be achieved by carefully looking at the flow around the cowl and making use of the high speed prop blast that hugs the fuselage.

Some principle images of the above:

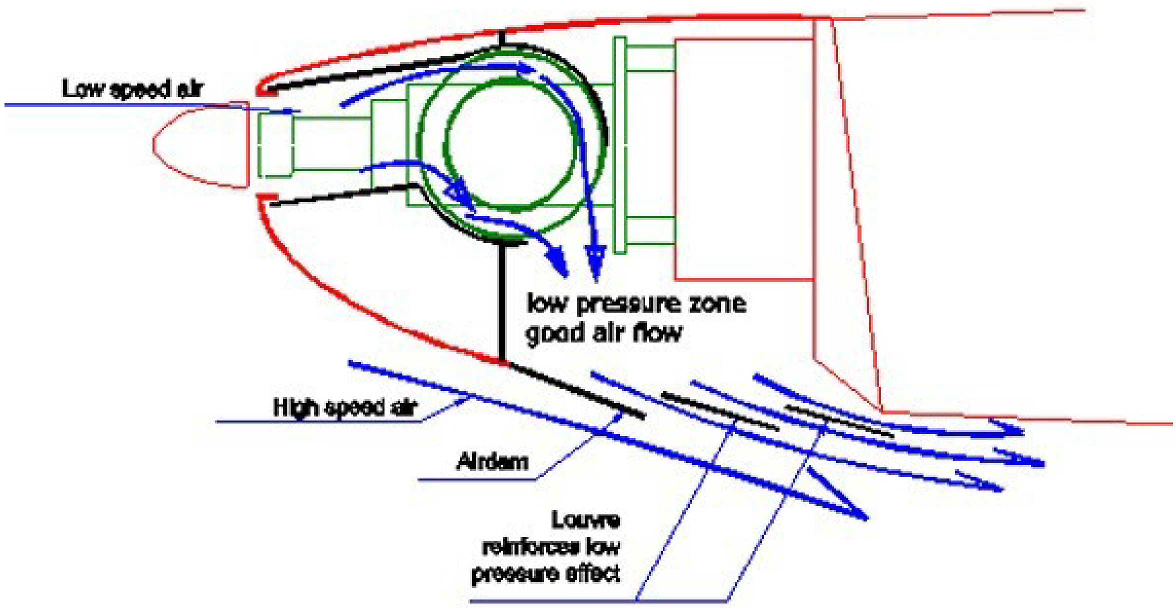


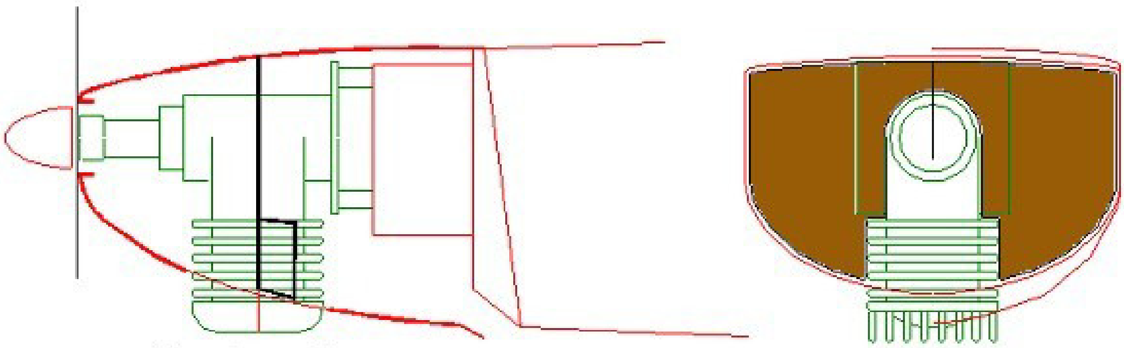


The famous 3:1 rule
bad air flow
regardless of baffles

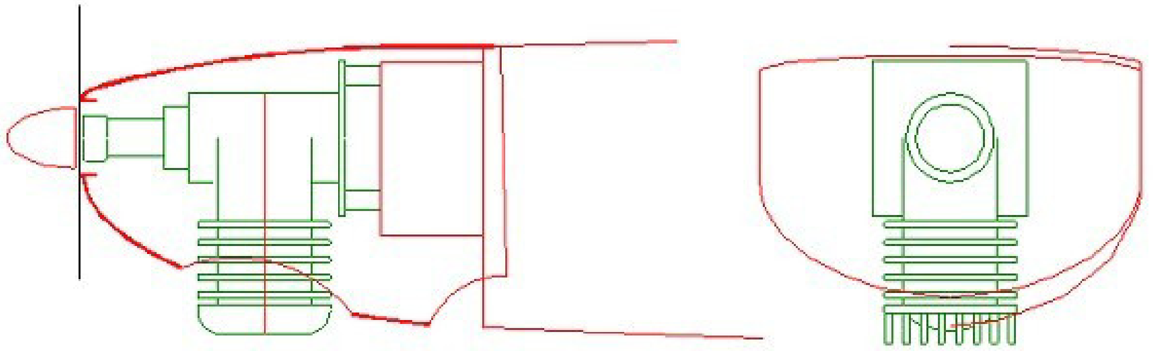

better air flow
Low speed air
low pressure zone
good air flow
High speed air
low pressure zone
Airdam

best air flow



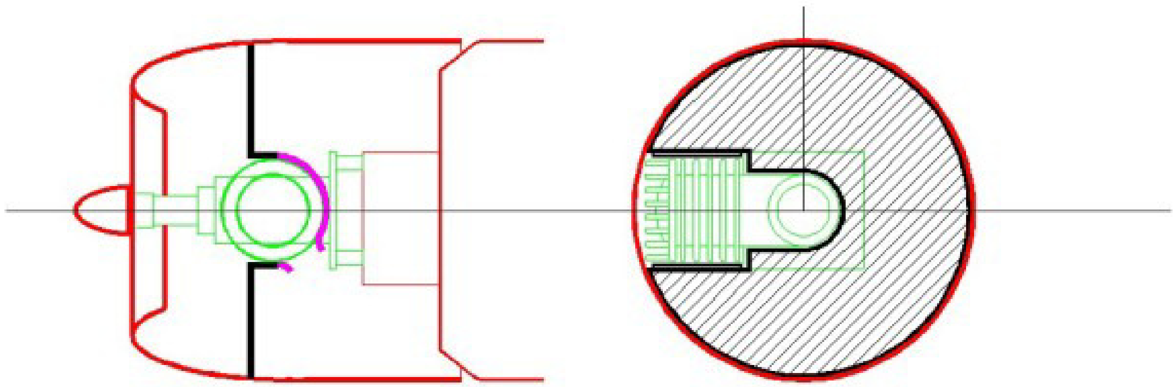


Good cooling



Poor cooling

For radial cowls it looks like this:
If the cowl rear edge flares to a slightly larger diameter than the fuselage, it will greatly enhance the cooling. Black is the basic baffle. The added jacket (in purple) is the ultimate in cooling.
A good example can be seen here: http://www.mini-iac.se/forum/topic.asp?TOPIC_ID=277

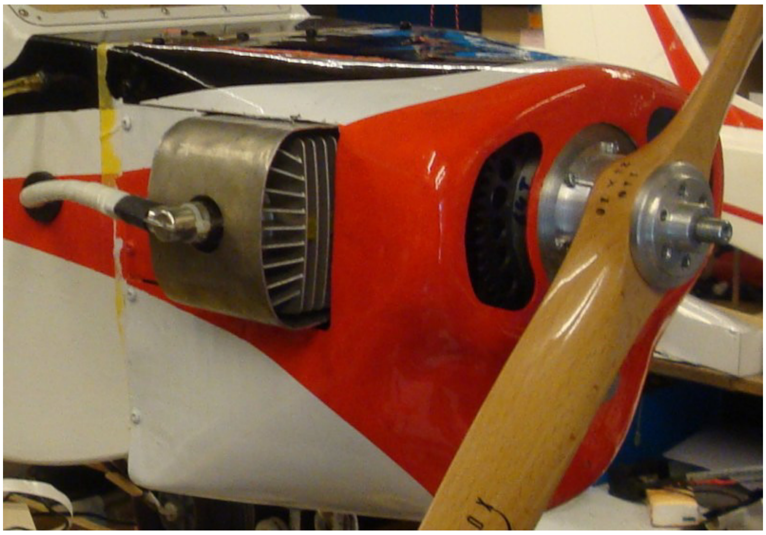


Today, I finished a personal test case, using my old trusted and power tuned MVVS58 tow plane engine in different cooling configurations.
To pull the 13.5 kilo tow plane vertically out of sight, 7.0 HP at low rpm is required, which the engine delivers using a TD75 canister muffler. For tuning, an extra boost port with sub-piston flow is added, and a larger reed block is used for better mixture flow.

Observed temperatures after one minute full power (except run 3):
1) Standard engine, Static, full power, In excess of 200°C, (no provisions for extra cooling, not hopped up yet with power ~6.0 hp).
2) Engine as in 1), Power 7.0hp, Static, full power, cylinder jacket added, 158°C
3) engine as in 2), Static, **60% power**, cowled in, In excess of 200°C.
4) Engine as in 2), Static, full power, cowled in, air extractor added, 128°C (mixture little rich)
During tests, outside temperatures were about 12°C

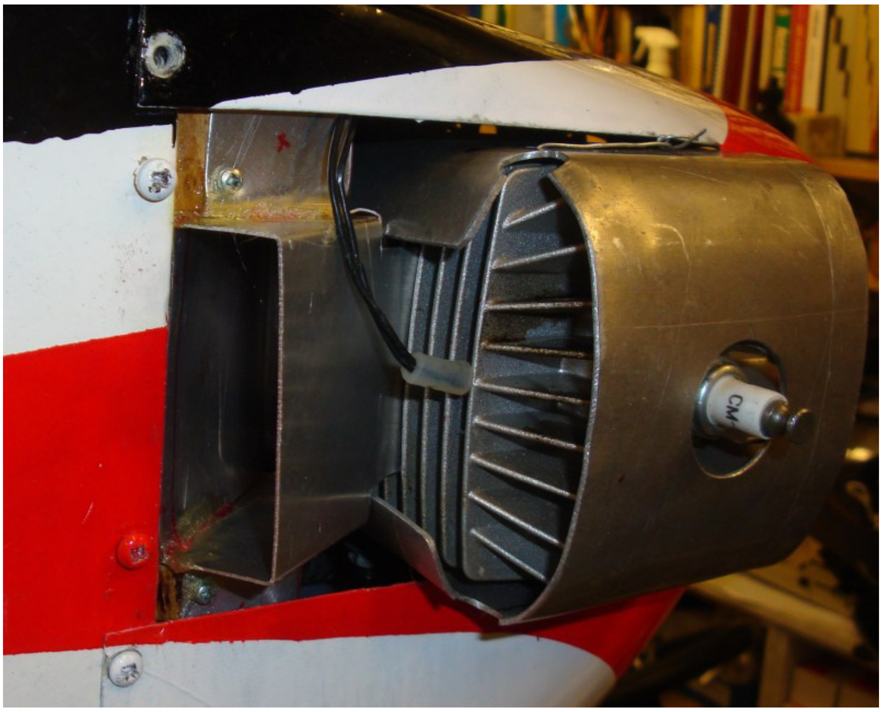
Engine 2) with cylinder jacket added for cooling air guiding through the fins. (158°C). The sensor is tied to the back of the cylinder wall.

Engine 2) in plane with cowl fitted, air extraction at cowl bottom only and good flow over the engine head.
This is considered good cooling by most people.
200++°C. 200° degrees was obtained at slightly over half throttle.
WOT lifted temperatures even higher into the danger zone, but was not sustained. Engine did not show any distress!



Engine 2) special air extractor lower duct wall in place to extract air over the lower cooling fins using the cylinder jacket air guiding. (no temps taken)

Upper duct wall added to guide upper cylinder air flow away from, and provide low pressure exit for lower cylinder airflow. 128°C



The cooling jacket exit is a quite narrow chute; it's cross section reduces towards the end thus accelerating the cooling air flow before it merges into the main flow. This has a suction effect on the main flow, and reduces drag. The effective exit area is quite a bit less than a 1:1 area rule, let alone a 3:1 rule (sic!). Working on reducing air entry surface and directing all entry air onto the cylinder could further drive peak temperatures down whilst further reducing plane drag for quicker aerotows or more effective prop thrust at all speeds.

What I really wanted to show is how the 3 times larger exit just does not work out. A real small low pressure exit works a lot better, even though the air entry is not even aimed at the cylinder yet. All provided that the air must pass through the engine cooling fins.

And finally - some food for thought!

A rule of thumb is that for cooling 1000W engine power, at least 10 litre of cool 20°C air must pass the engine cooling fins each second, with the engine at 150°. Cylinder temperature will follow the changes in ambient temperature on a 1:1 basis.