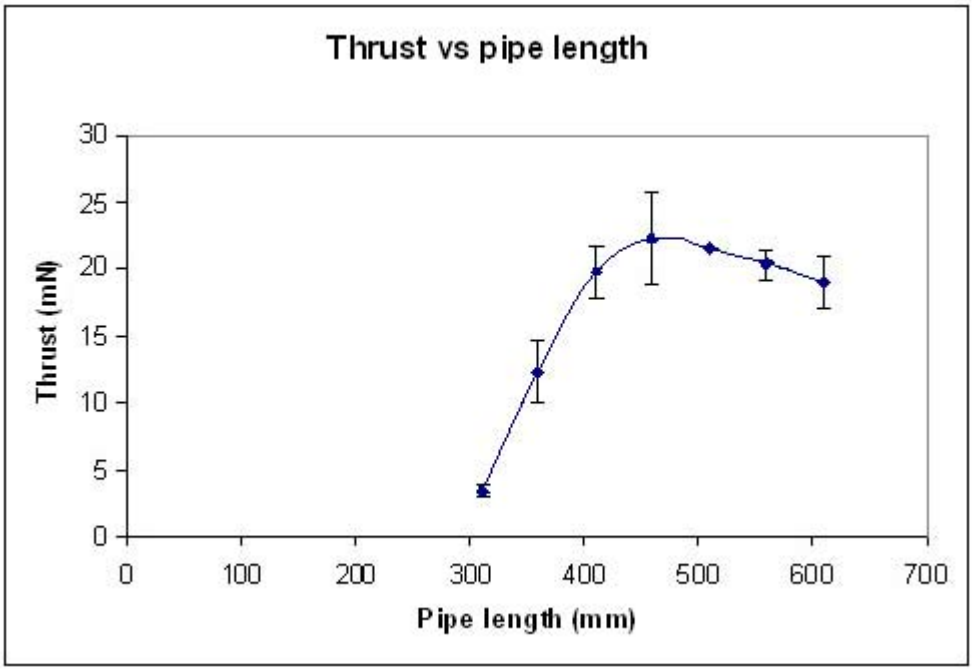
Optimum length of a pop-pop engine

By Jean-Yves

The physical characteristics of a pop-pop engine being known (drum volume, pipe inner diameter, nozzle shape and diameter), what is the pipe length that would give the best thrust?

To know that we built a new engine with a pipe obviously too long (length 610mm for inner diameter 5.4mm) and we tested it to know the thrust. Then, we shortened the pipe by 50mm and ran another series of tests. Then another piece of 50mm was removed… The results of all the tests have been plotted on a diagram.



Each blue diamond is the average of 4 measurements. The vertical dashes show ± 1 s.d.

This graph sets as evident that there exists an optimum length. In this case it is 460mm, but every engine is a particular case. We cannot say what would be the best length for engine so and so. The only way to determine it is to run a series of tests like the ones we ran and to draw the curve… and then the pipe that became too short will have to be replaced by a new one, the length of which would have been determined thanks to the graph.

Additional knowledge brought by these tests: (Nothing new, but what follows was set as evident)

- The longer the engine, the more stable is its running, and the least are the risks of burn out. A long engine withstands a wider heating power window.
- The shorter the engine (compared to optimum) :
  - the weaker the thrust
  - the narrower the heating power window
  - the more are the risks of burn out. (For instance, at the first test with 310mm there was a burn out without any pulsation preceding it).
- Whatever the length, an increase of the heating power involves a bigger thrust (up to 50mN during our tests), but the burn out caused by excess heat arrives soon.
- The optimum length between hot source (>100°C) and nozzle is for this engine quite in accordance with the law we have determined before for many other engines (without diaphragm): length = approx 62 times the diameter.