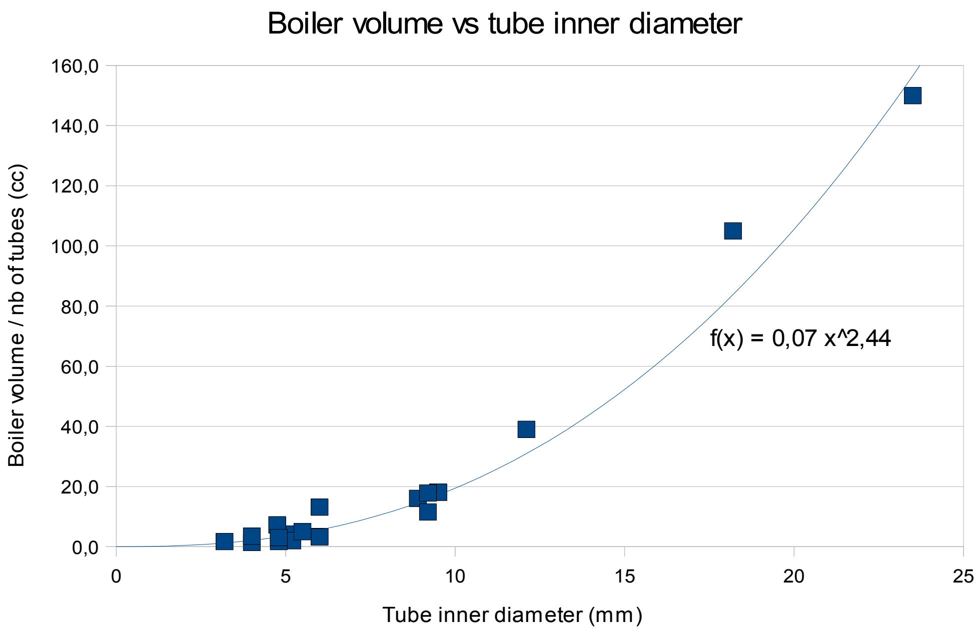
# Relationship between boiler volume and tube inner diameter

I use to say, and on a test bench with electrical heating it is easy to demonstrate that... **any tube closed at one end can work as a pop-pop engine**.

In fact, this assertion is exaggerated. There must be a minimum length. Then, depending on the tube length, its inner diameter, slopes, bends, drum or no, diaphragm or no, materials...the engine is more or less powerful, and more or less sensitive to heating power, and it can work for more or less time.

If several tubes are connected to the same boiler, each one works as if it was alone connected to a boiler, the volume of which would be divided by the number of tubes. A good example can be given when looking at a coil engine. Pinch the tube at the middle of the coil and each half will work as before (despite the difficulty to fill such an engine with water).

For boat propulsion we are looking at engines which are able to deliver a reasonable thrust for several minutes with a rather wide heating power window. Hereafter for such engines the diagram V/n versus d has been drawn. 21 engines, 11 of them being Daryl's ones.




Note 1: Due to the fact that the performance of a diaphragm engine depends on its softness we have not considered such engines. Only rigid engines are plotted on this graph.
Note 2: What is called boiler is the whole hot section; i.e. where the temperature is hotter than 100°C (212F).
Note 3: Having drawn the trend curve we have looked at the design of engines of which the dots are above it. Their basic design and the parts available to build them lead to these characteristics, but they could have been built with a smaller volume (and maybe slightly better performances).

**Conclusion:**

The boiler volume (in cc) of rigid performing engines is approximately $0.07 \times d^{2.44}$ with d in mm.

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