Pressure in a pop-pop evaporator

By Jean-Yves

When I started to write a theory of the pop-pop engine, I gave an example with a peak to peak value of 160mmWG. It was a very rough estimate for a small pop-pop engine that unfortunately is no longer working (rusty and leaking). Recently I built a bigger diaphragm engine to check the validity of this estimate.

The engine was provided with a horizontal diaphragm made of a very thin and soft aluminum sheet. Its free surface was 31mmx50mm. While the engine was running I put a light flat weight on the diaphragm. The engine continued to emit its pop-pop sound. The weight was a piece of steel slightly smaller than the diaphragm (25mmx40mm).
During this test, the hull on which the engine was fitted was floating and connected to a thrust measuring device.

Then the weight has been increased progressively by adding pieces of metal on the top of the first weight until the sound was no longer emitted. It could be seen that the engine was still jerking.

The total weight of the pieces that were loading the diaphragm was 260g.

Remembering the time I worked with pneumatic controllers, the equivalent diaphragm area is (31+25)/2x(40+50)/2=1260mm2
Pressure: 260.10^{-3}x9,81/1260.10^{-6}=2000Pa=20mb, which corresponds to approx 200mmWG.

During this test, the diaphragm was 30mm above the water level. Therefore, if we consider that the pressure variations were centered, the peak to peak value was:
(200+30)x2=460mmWG

<u>Other results :</u>

- Without sound, the frequency measurement was not so easy. According to the vibrations, it seems that when the diaphragm was loaded the frequency was higher by approx 50%.

- Though it was not the first purpose of the test, we could check that when the diaphragm was blocked the thrust was roughly twice the one measured just before with the same flame.

The test was repeated several times with different heating powers. Every time we got approximately the same result: thrust doubled when the diaphragm was loaded.

Note: One could object that the mean volume of the evaporator is bigger when the diaphragm is not loaded. To be totally objective we should have compared three engines of the same size:
One with a classic moving diaphragm
One with a rigid convex diaphragm
One with a rigid concave diaphragm
When we (or somebody else) have time… (see also "diaphragm engine tests")