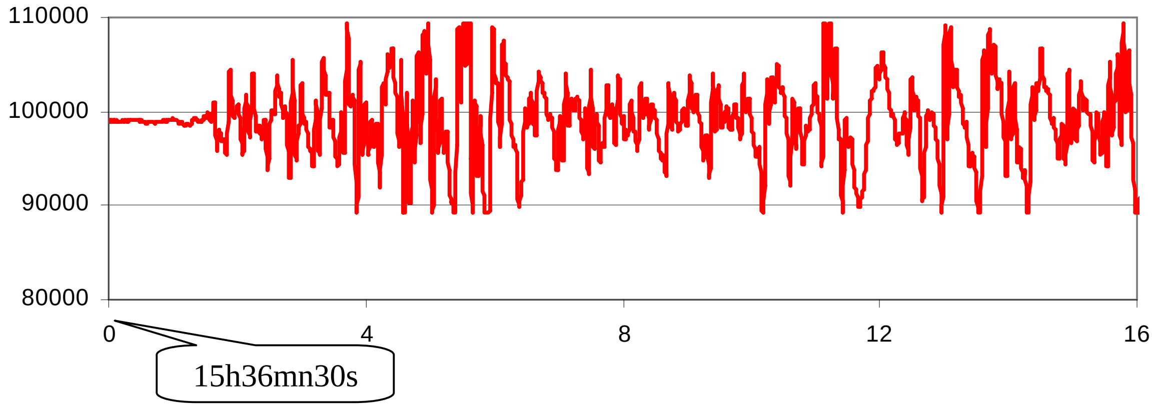
Pop-pop : P and V during transitional phases and near border of operating range

A) Starting   B) Power increase   C) Insufficient heating power

A) Starting of a pop-pop engine

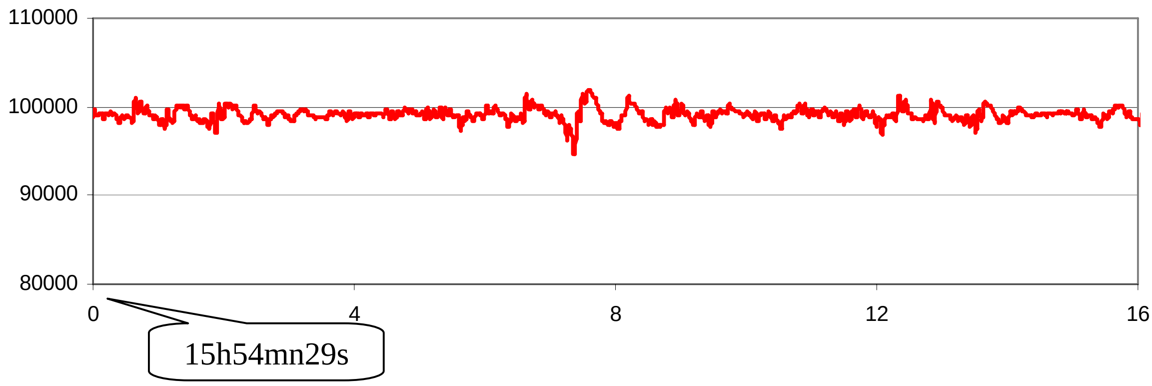
1°) Water starts boiling locally. Consequently there are big pressure variations which are too sudden to allow a visible movement of the water column.

Pressure (Pa) vs time (s). Boiling water.



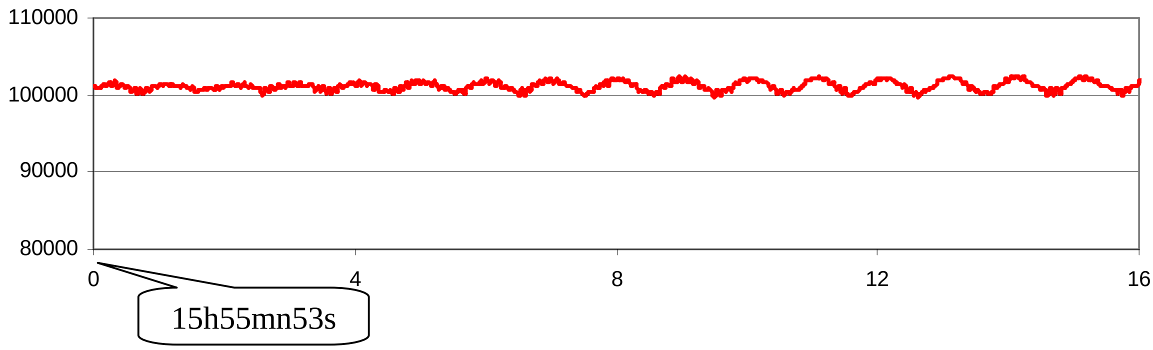
2°) A steam bubble is created and it damps the amplitude of the pressure variations.

Pressure (Pa) vs time (s) just before starting.



3°) The steam bubble grows and the pressure variations are more and more regular, and their amplitude increases.

Pressure (Pa) vs time. Engine starting.

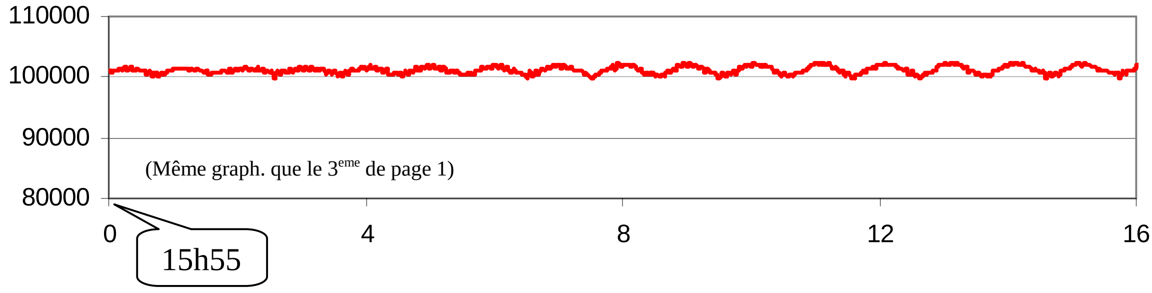


Note: Between the 2nd and 3rd graphs it can be seen that the mean pressure has increased. This is due to the fact that the water column climbed down by approximately 20cm (8"). Knowing the geometry of the engine, this gives an idea of the mean volume of the steam bubble.

B) Power increase of a pop-pop engine

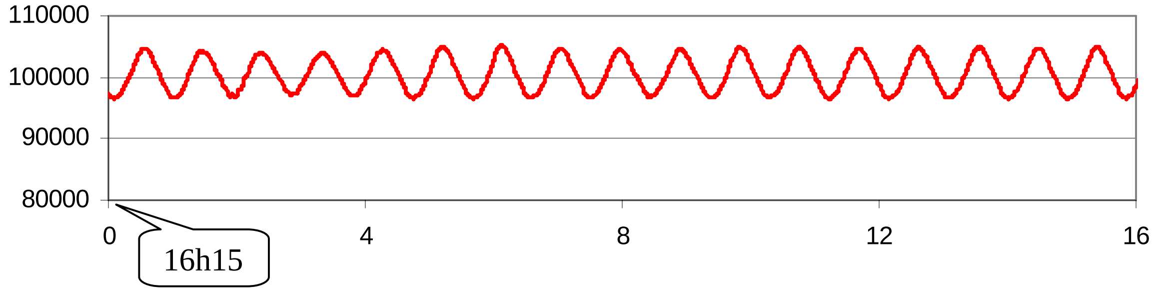
First the mean pressure increases a little bit (because the water column climbs down in the tube), and then the engine starts.

Pressure (Pa) vs time (s). Engine starting.



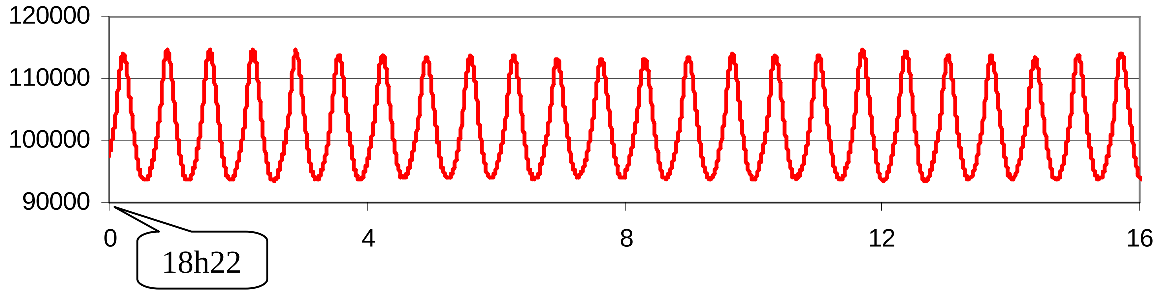
Then, without changing the heating power, the pressure variations and water movements increase slowly.

Pressure (Pa) vs time



And if we wait for long enough (several hours in our example) the pressure variations can become relatively big.

Pression (Pa) vs time (s)

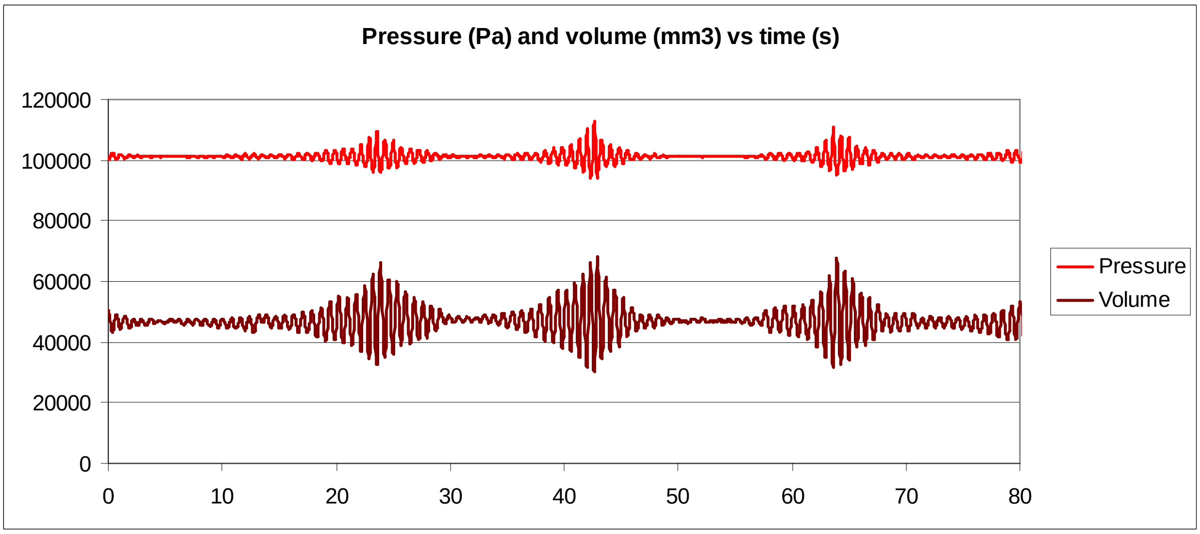


Note: When the engine *delivers its maximum* there is not only steam and water inside. This is due to the degassing of dissolved gasses, mostly nitrogen and oxygen. To get this working point could require several hours. However, one can get it soon by introducing voluntarily some air inside the engine.

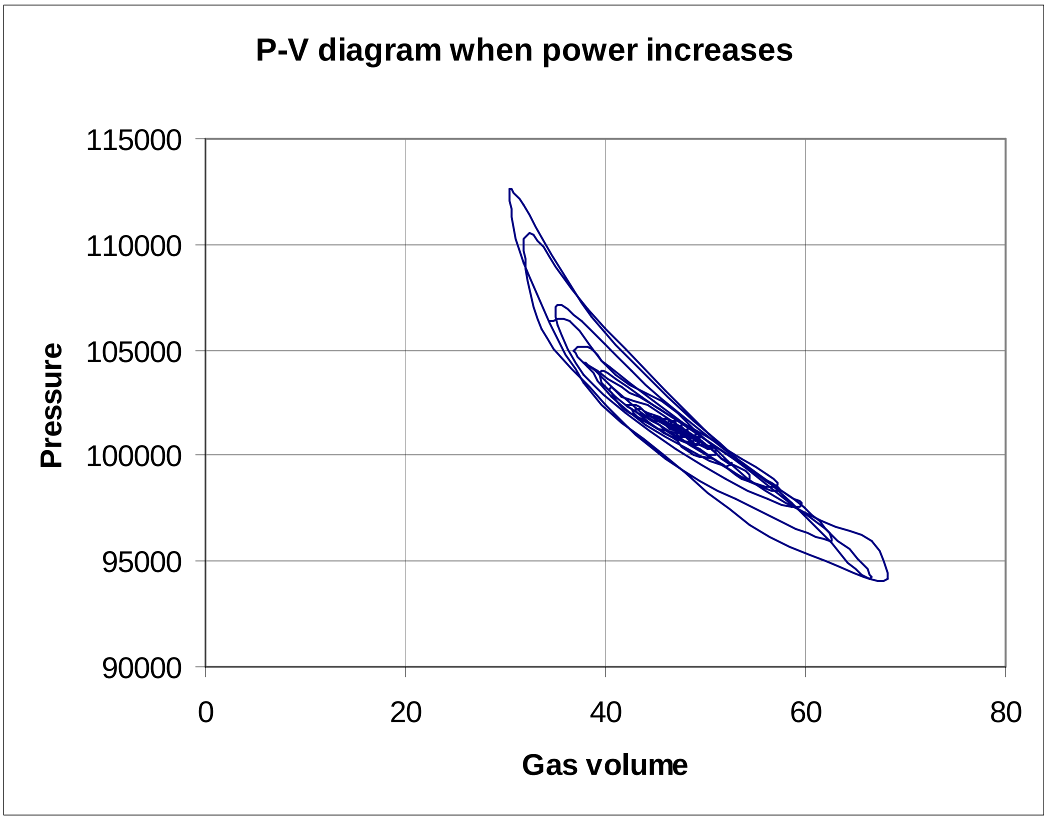
C) Consequence of an insufficient heating power

When the heating power decreases slowly and becomes just too little to keep the engine running continually we get modulated amplitudes for the pressure and for the volume. This is quite visible when both recorded signals are displayed on the same graph.

1°) En fonction du temps

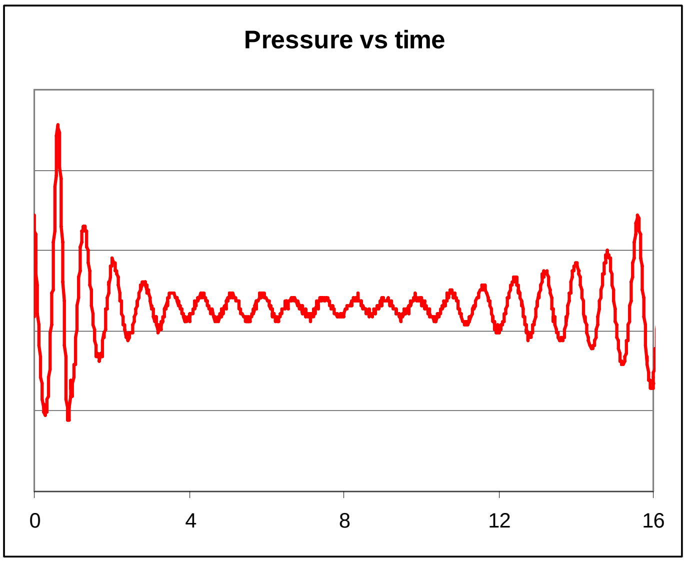


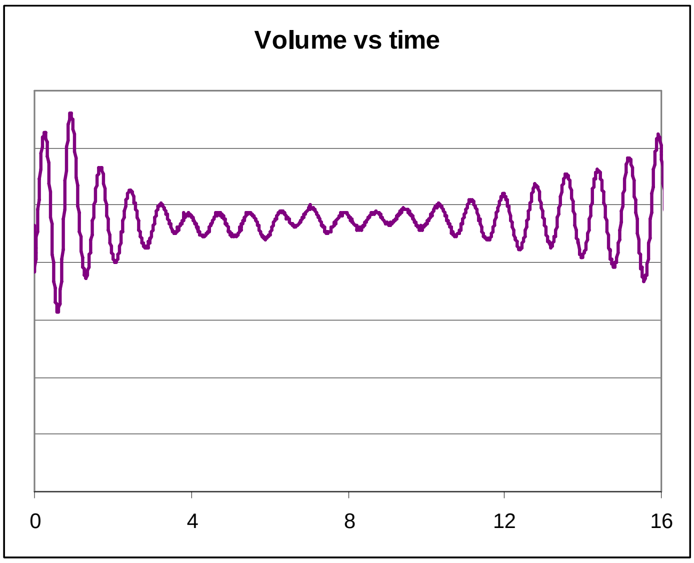
2°) Without seeing the time on the diagram. (In fact, here between t=31 and t=43)



It can be seen that the "bean" grows around the resting dot (here 47cm3 and 101hPa).

Detail of this type of modulation (recorded at another moment).





Here (between t=0 and t=4 seconds) the “bean” diminishes but it keeps the same shape.