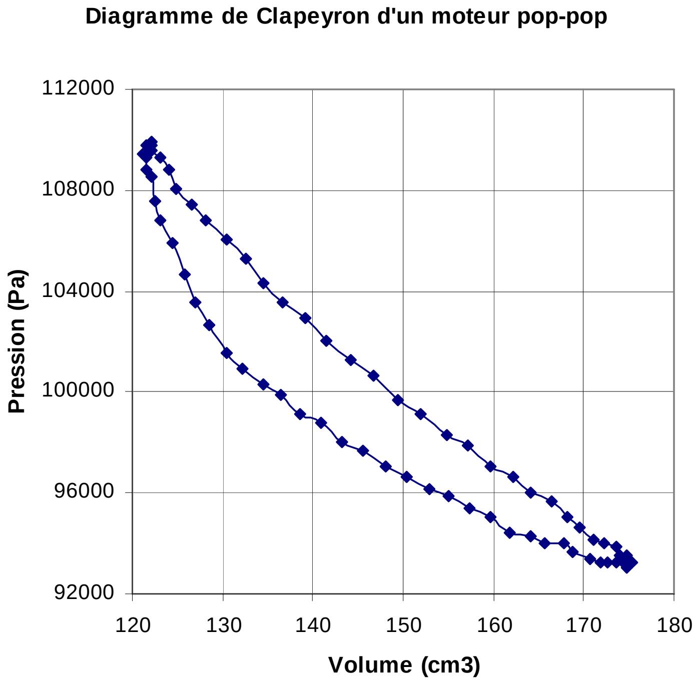
Pop-pop cycle and Stirling cycle

The pop-pop engine, as the Stirling one, is an outside combustion engine. Due to the fact its efficiency could be excellent the Sterling engine has been object of many studies and buildings. This is not the case for pop-pop engine because its pathetic efficiency reduces it to a recreational role. But this is not enough to stop us. Late 2009 and early 2010 we recorded on several occasions the cycle (P-V diagram, or Watt, or Clapeyron diagram) of a pop-pop engine. An example is given here-under.



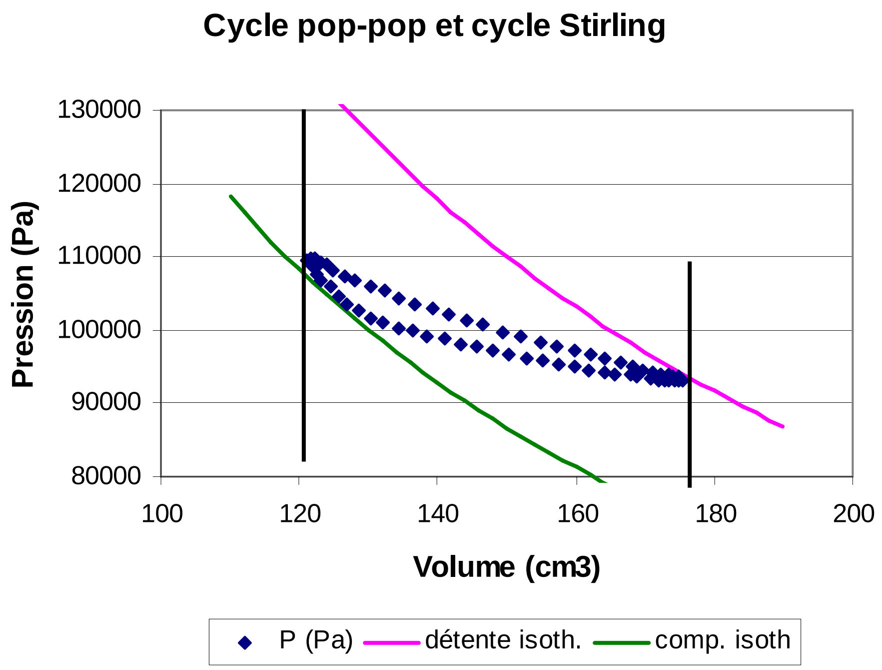
The shape of this diagram looks like the one of a Stirling engine.

The theoretical cycle of a Stirling engine (isochoric heating, isothermal release, isochoric cooling and isothermal compression) with sharp angles is entirely imaginary.

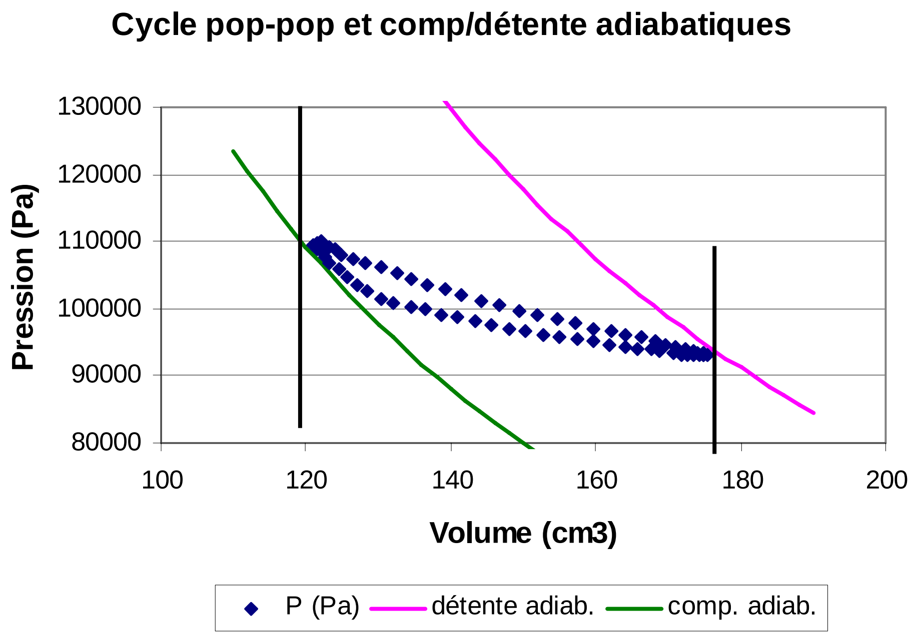
The (as well theoretical) cycle taking into account the kinematics is a potatoid of which an example (taken on www.webphysique.fr) is displayed opposite. In this example the pressure and temperature variations are big but the global shape of the Clapeyron diagram looks like the one pf a pop-pop engine.

However, while on a Stirling engine the release and compression are almost isothermal, this is far from true on a pop-pop engine. The difference is enormous as it can be seen on the next page.

We reused one of the records on which we added the isothermal and isochoric curves.



And to add to this analysis we also framed the pop-pop cycle with adiabatic compression and release curves.



It is worse !

Conclusion :

The cycle of a pop-pop engine is specific to this type of engine. It could be guessed due to the presence of a diphasic mixture. No need to say it, but better to say (or write) it.

Simplistic explanation:

Very approximately the cycle can be split into 4 phases.

1°) Expansion.

When the water column climbs down, the gas volume (including steam) increases. As the heat transfer from the heat source is weak, the pressure decreases. But at the interface the water temperature doesn't change much because of its big calorific coefficient. Consequently, there is some steaming which slows the pressure decrease.

2°) Heat-removal.

The movement of the water column being nearly sinusoidal, the time spent a reach the bottom dead center is rather long. Therefore, the gas cools down due to the relatively cold wall, this one having been cooled by the water column before it climbed down.

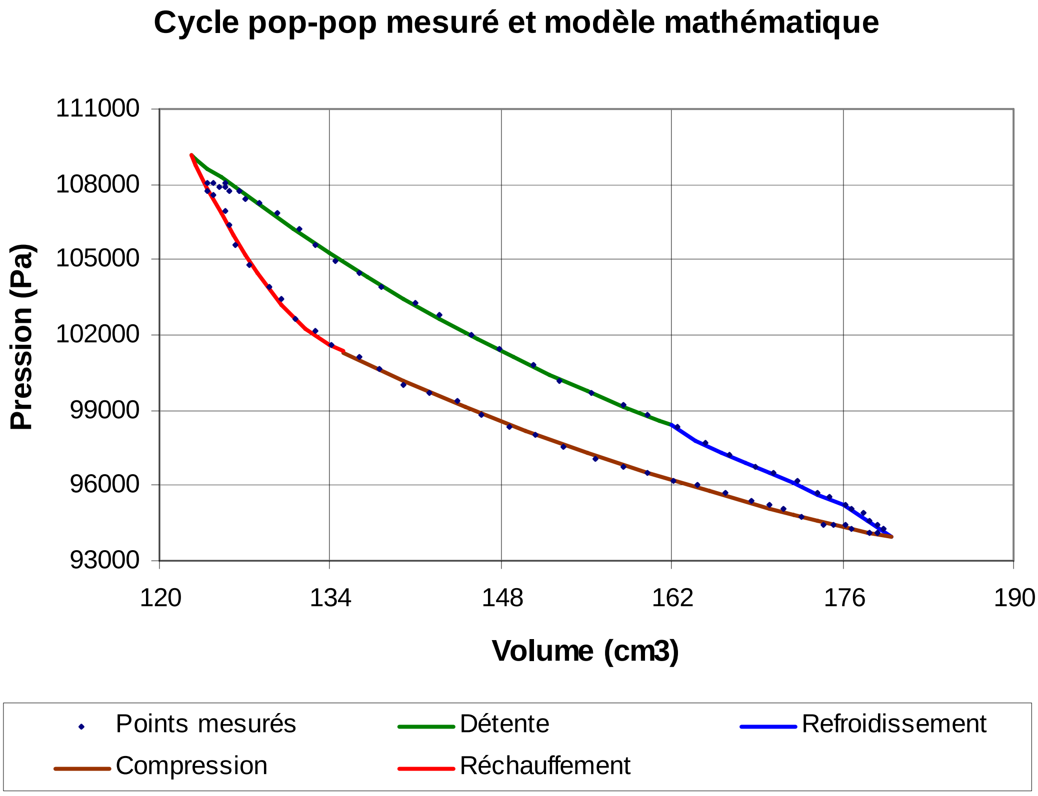
3°) Compression.

The process, opposite of the one used for release, is of the same kind. When the water column climbs up the pressure rises and due to that some steam condenses.

4°) Heat-addition.

The time necessary to reach the top dead center is rather long for the same reasons as for BDC. The gas that is humid, already compressed by the inertia of the water column warms up when meeting the heat source. Its pressure rises.

The diagram of this simplistic engine would be the following one.



This is a math model. Obviously there would be no such sudden change from one phase to the next one.