

Conclusions of HEKYOM (Kees and Maurice) Visit to IPUL

21-24 of July 2015:

HEKYOM visit was decided to provide support to IPUL for their work on the installation of the thermoacoustic engine and setup of the test environment

Every parameter of the thermoacoustic device has been checked.

Pipe lengths were controlled and show some mistakes. Two small “stub” necessary for getting right matching condition between TAC engine and MHD engine were added.

A new precise drawing is provided and joined to this report. (Figure 1)

A static Test (with no acoustic wave) of heating supply has been made and the result is pretty good, with a global thermal conductance of $0,5\text{W}/^\circ\text{C}$ between the hot source coupled to the hot heat exchanger and the external environment. As an example, 650°C has been reached with 300Watts input. It means that the dynamic test could be performed next times. Another characteristic is the very big heat capacity ($\text{MCp} - \text{J}/^\circ\text{C}$) of the heating sample composed by HHEX and its Inconel housing. The fact that the required thermal energy will be of the order of few hundred joules seems likely to make quite difficult a precise heating power measurement and suggests for looking at acoustic power and cold HEX power measurements. Thus a particular attention will be given to these last parameters. It can be also noted that in general for a thermoacoustic engine, hot temperature is a consequence of energy balance between thermal power, acoustic power, viscous dissipation and thermal losses. In our case, due to this enormous heat reservoir (HHEX+housing), hot temperature would be imposed but with a quite long time constant and thus a relative difficulty for reaching a quasi-stationary state.

Instrumentation have been carefully checked: pressure sensors (a new company much cheaper is proposed), indication for location and mounting procedure – indication for thermocouple location – flow meter for cooling system.. (Figure 2)

It was also proposed to take in account these improvements for the final report given by IPUL.

A list of different operation to be performed at IPUL, before the next experimental run, is given:

1. Safety pressure test with water at 60bars must be performed

2. M5 screws used for fixing the (08) flange connecting CHEX to the next pipe must be checked because they look like too feeble. This gives opportunity for controlling all used screws
3. New lengths for acoustic circuit are provided and must be made
4. Pressure sensors adapter pieces drawing are provided
5. 4 new Tees (smooth angle) to be mounted are to be bought. The sharp angle Tees used will give a strong acoustic dissipation and lower the available acoustic power for driving MHD engine.
6. 4 Special pieces are to be made for Thermocouple connector: cooling water circuit (see photo from HEKYOM)
7. Mass flow rate sensor for cooling water circuit to be added
8. For **separated TAC tests**, a special U tube(with heating wire) filled by sodium connected to TAC engine in place of MHD device with a valve in the middle will be manufacture and mounted
9. A safety valve is to be mounted on one "stub" extremity
10. A filling valve is to be mounted on the other "stub" extremity

Concerning the critical problem of liquid gas interface:

Experiments were made with IPUL set up until 50 Hz. They used a solid separation between the two phases as shown in the IPUL report. They show some 'splash' of liquid above the solid separation.

It was noticed that the gap between this solid bloc and the wall, about 3 mm, was much too big and could explain the presence of these droplet splashes. But using such a moving piston with a small friction seems to be the right purpose.

HEKYOM suggests making some more experiments with:

1. A glass or Plexiglas tube with a nice wall and small rugosity
2. A light cylinder compatible with Sodium whose length would be tested, 1cm or 2 cm..
3. Taking new pictures

Further TESTS

It was decided that the **TAC engine test** will be made after the separated **MHD test** will has been already achieved. Then, it will be possible to make in the next visit (HEKYOM)

1. MHD test before 24 08 15
2. TAC test 24 08 15
3. Global test 26 08 15

HEKYOM, 24th of July 2015

Maurice-Xavier FRANCOIS, Kees de BLOK