

## 1. Motivation

- Create a pulse-tube cryocooler with regenerator, pulse-tube, inertance tube and reservoir made from glass;
- Generate frosty effect from at the outside of the cold head in order to create curiosity for first-time observers who will notice the lack of any moving parts;

## 2. Design Process

### The Dimension of the Regenerator:

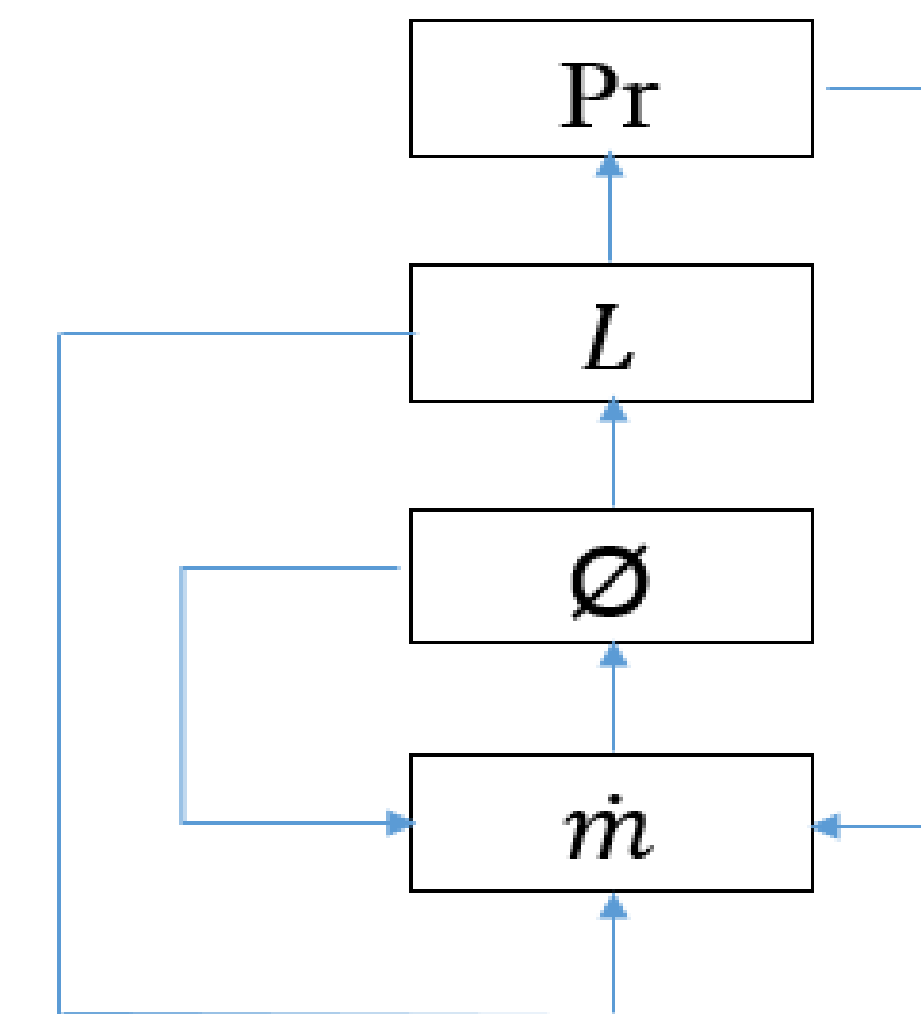
Properties of the porous media and the pressure-wave generator operating condition are fixed.

- The copper screen mesh inside the regenerator is 19.05[mm] mesh size with 66[ $\mu$ m] wire diameter. The calculated porosity of screen is 0.6939;
- The pressure-wave generator unit is a 2S132W TwinStar motor. The operating frequency is 60[Hz];



The 2S132 Pressure Wave Generator made by CFIC Inc.

- The working pressure should be around 9.6[bar] in order to avoiding glass shattered;
- The regenerator is optimized by REGEN 3.3 based on the properties of screen mesh and the pressure-wave generator working condition;



The sequence of the parameters that being optimized in order to achieve the optimized performance of the regenerator in the result of REGEN 3.3.

- REGEN 3.3 optimized results: PR=1.35, L=59.94[mm].The adjusted gross refrigeration power is 32.88[W]

### The Dimension of the Pulse Tube:

- To keep cold gas localized,  $V_{pt} > 3 - 5 \times V_{s\_he}$ ;
- Minimum pulse tube diameter limited to avoid turbulent flow:  $Re_{crit} = 280$ ;
- For fabrication convenience  $D_{pt} = D_{reg}$ .



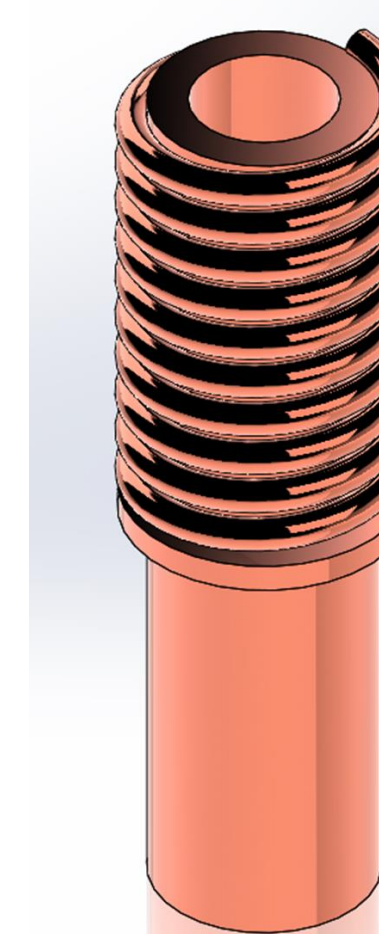
A rib feature making process is being presented by the glass blower. The rib separates the regenerator and the pulse-tube

### The Dimension of the Pulse Tube:

- The geometries of inertance tube and the reservoir are determined by the SAGE.

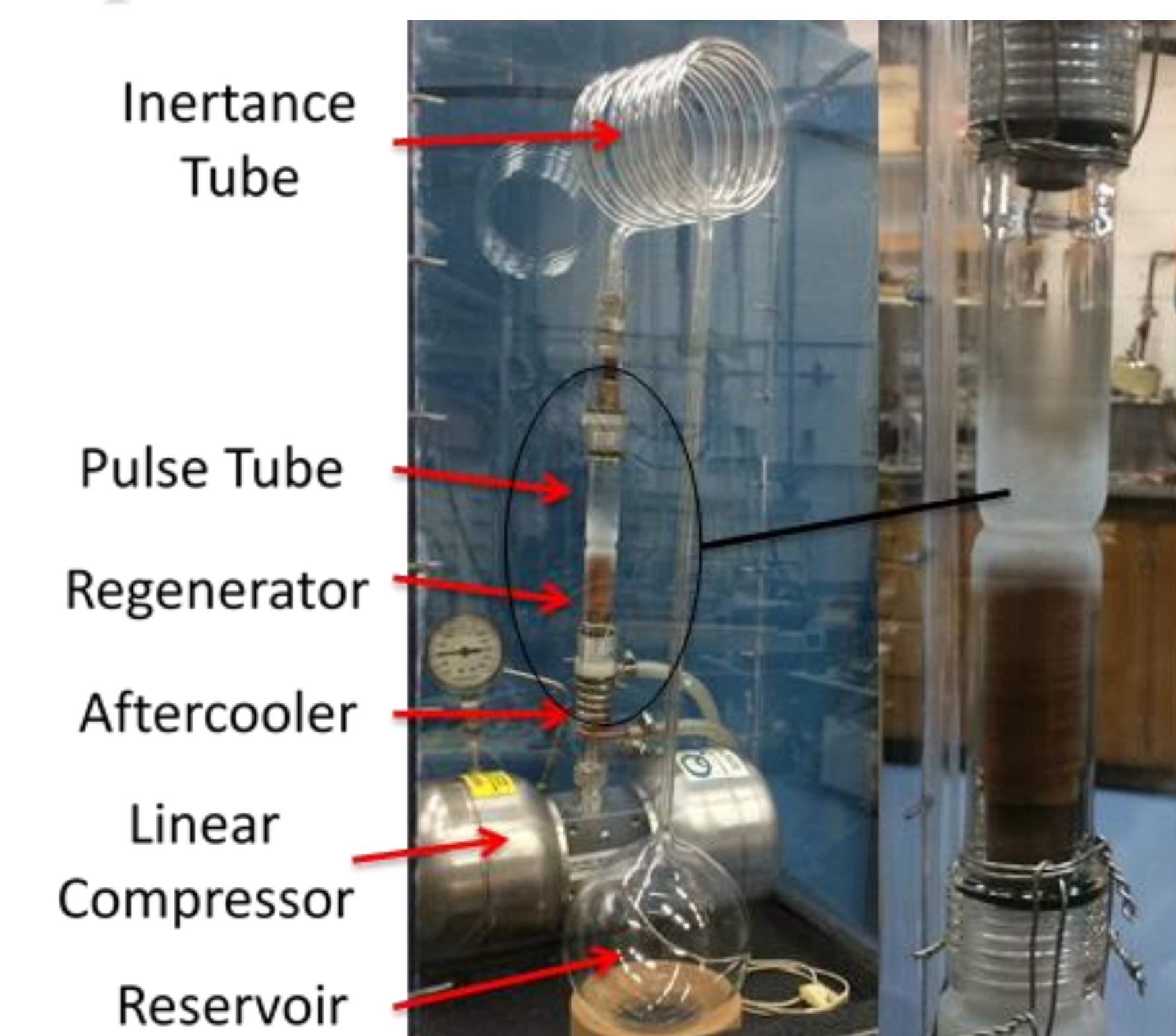
### The Design of the Aftercooler:

- A aftercooler is installed to cool down the helium gas before entering the regenerator. The size of aftercooler is defined by ISOHX
- The length of the aftercooler is 38.1[mm] with a 19.05[mm] inner diameter.



The CAD model of the aftercooler is presented at the left. The water flow through the aftercooler is pumped at around 1.2[L/min].

## 3. Experimental Result



The device is tested with a charging pressure of 6.8[bar] for being conservative. A frost effect is observed within 1[min] after the machine is turned on.