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TESLA TEST FACILITY :

Helium tank

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Abstract

The present design of the helium tank is discussed in term of simplicity, cooling process, liquid level control and questions related to the cold tuning system and magnetic shielding.

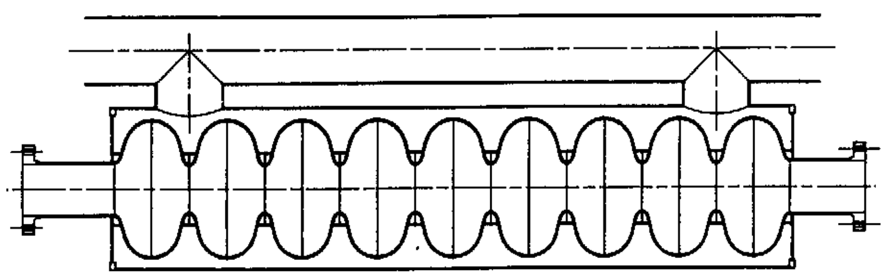
1. COOLING AND FILLING THE HELIUM TANK.

In the Tesla concept, in order to have a row of helium vessels filled with liquid He II, they are connected at the top by a large single pipe (Ø 100 mm).

This pipe transports the overfilling liquid from one vessel to the following , as well as the vapour produced by the heat load distributed throughout the whole row of cavities.

The principle is straightforward. One has just to make sure that each vessel is not at a higher level than the preceding one and that the pipe diameter is large enough so that the vapour pressure drop is lower than the maximum required by the operating temperature specifications.

This pipe is also used for cooling the vessel from normal temperature down to liquid helium temperature. The simplest concept for the helium tank is a Ø 242 mm cylinder with the same axis as the cavity and it is connected by two vertical ports to the filling Ø 100 mm pipe (see drawing 1).

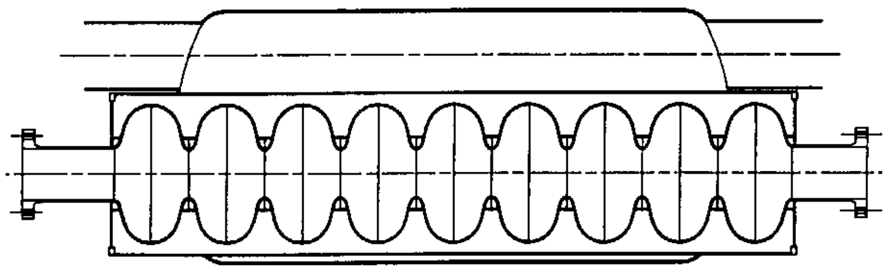


drawing 1

One cannot avoid the straight Ø 100 mm horizontal pipe between two ports : it is necessary to have a low pressure drop line for the vapour and to provide a free liquid-vapour interface. As a result, one can fear with such a design that the helium vessel, being not directly traversed by the cold gas, will not be cooled down within a reasonable amount of time (≈ 24 hours). One can also fear that a large part of the liquid phase being dispersed as microscopic drops within the high speed vapour will not fall into the cavity. This would lead to a lack of replacement of the evaporated liquid during RF operation.

These two problems have not been proven serious and simple solutions as shaping entrance and exit ports in order to intercept a part of the straight flow, have not been thoroughly explored. This would require specific studies and test models. This means time !

In order to have immediately a safer design, we have decided to enlarge the helium tank up to Ø 380 mm and to have a direct Ø 100 mm connection between helium tanks (see drawing 2).



drawing 2

Thus, during cooling, the helium gas flow spreads inside this large vessel and large convection patterns are allowed. It insures a positive cooling of the cavity and vessel. Later, during RF operation, the flow speed reduction inside the large vessel improves the probability of intercepting microscopic liquid drops.

This safe behaviour is obtained at the expense of a much larger Helium inventory (x3) and a much heavier cold mass (x2).

The solution cannot then be considered as definitive. For this reason, we have proposed a design which can be transformed back from drawing 2 to drawing 1. In particular, the design of the cold tuning system would not be affected by such a transformation.

2. COLD TUNING SYSTEM ON THE HELIUM TANK

Tuning the frequency of the cavity is obtained by changing its length. An effort must be transmitted from one end to the other through the helium tank. The helium tank must then be rigid enough to transmit the deformation force and to be a good mechanical reference for the cavity frequency. Hence, the transmission of the effort is done symmetrically through a complete cylinder (Ø 242 mm) surrounding the cavity from one end to the other. A second vessel (Ø 380 mm) surrounds the first cylinder thus encircling the Ø 100 mm pipe to provide the safe cooling behaviour as discussed on § 1.

A flexible part has to be provided in the design of the helium tank so that the cavity length can vary. A flexible diaphragm made out of niobium as part of the cavity has been preferred to a large stainless-steel bellow so that the moving surface is of the same order of magnitude as the equivalent surface of the deforming cells. Thus, the sensitivity of the system to pressure variations is minimised.

The transmission of gas and liquid from the outer vessel to the inner one is done through four Ø 50 mm holes (2 on top and 2 on bottom of the Ø 242 mm cylinder).

A magnetic shield is placed on the inner surface of the Ø 242 mm cylinder. This shielding must not obstruct these four holes.

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