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Memorandum : Design parameters of the lower tower baking system

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General specifications:

The central building vacuum chamber has to be baked at 200ºC in order to evacuate water and hydrocarbons adsorbed at the surface of the stainless steel vacuum chamber.

To allow for a step by step conditioning, the central building vacuum chamber is sectioned in single compartments which can be baked individually. As injection and detection compartments require singular, less stringent vacuum conditions, they are dissociated from the beam chamber with optical windows. They will not be baked. The two input compartments, the beam splitter and the two recycling compartments require the high level VIRGO vacuum conditions and will thus be implemented with a baking system. There are thus 5 well identified compartment to be baked as shown on figure 1.

One could design either a dismountable or a fixed baking system. The central building has to be kept at a cleanness level compatible with the work on vacuum components. It is also the transition space protecting the sensitive area where optical components are processed. Insulating materials employed in the oven construction are fragile and generate easily dust particulates. Their handling has to be minimised. The narrow space available in the central building minimises also these handlings. We decided thus to design a fixed baking system: it will not be moved from compartment to compartment. Moreover, its structure will provide the basement for the scaffoldings needed to access the upper tower components.

In the following we go through the details of the design paramaters of the baking system defined according to those prescriptions.

1.The supporting structure of the lower tower oven.

The oven structure is implemented on a basement anchored to ground. This basement is used to control the tower dilatations. It provides also a buffer against the forces generated by neighbouring towers conditionned at a different pressure. Its roof supports pumps, scaffoldings and insulation. It allows for the link installation and for an easy access to the lateral tapes. Figure 1 shows how the different structures are arranged inside the central building.

The lower tower protection plate joins with the oven roof. The oven extension along the beam line is chosen to provide access to the cameras. As a consequence, link valves are enclosed inside the oven. Due to their function and location, these valves will be baked for their own. There is no mechanical coupling between the structure and the lower tower. Sealings will be performed with soft insulating material. Details of the structure are shown on figure 2.

A minimum of hardware is located inside the oven. Vacuum instrumentation is installed on the links. Cameras and calibration devices are installed behind the lower tower optical ports. On bakings, cameras and lightings are removed with their cables. A dedicated taped port will be available on the oven in order to pass these cables. Details of the oven structure are shown on figures 3 and 4.

Several design considerations have to be explicited to guaranty the accessibility of the hardware implemented in the tower vicinity:

1.1- Link dismountability.

Monolithic links have been designed in order to minimize their amount of gaskets. As a consequence, their size makes them difficult to install in an obstructed environment. If their first installation is easy, their dismounting is complicated: it may imply the partial destruction of the oven, unless one decides to saw the links.

Links could be dismounted to move the towers or to increase the link diameter: in both cases they have to be replaced by a new design which respects the oven structure. So, their sawing can be envisaged.

Provision will be made for the link diameter increase by implementing oven walls able to fit links with diameter 1200 mm.

1.2- Tower mobility.

This is a major operation which has to be minimised. Links have to be removed. The oven can be lifted as a whole and moved at the same time as the the tower.

1.3- Ground floor obstruction

Accessibility is needed to deserve cameras, pumps, heating elements, or to install the lower tower lighting, the oven control command, the slow control racks. The control of the tower displacement during baking requires also some accessibility. Figure 5 shows the corresponding clearance requests.

Safety requires also a clear evacuation.

Space between oven and wall of the building is close to 2m. Injection and detection towers inhibit the passage. A way has to be found to cross the beam line and to access to oven roof.

The vacuum tank can only be crossed via its 1st floor. Possible access are via scales along the detection and injection (MC side) towers.

1.4- The installation of the pumping system

The oven roof, which is at the level of the lower tower protection plate, is the platform on which the pumping system is installed. Acces has to be preserved to remove the pumps by crane.

1.5- The clean air supply pipes.

Their height has to be watched to preserve the acces to the pumping platform.

1.6- Cable trays.

The oven supply is made with cables layed in the ground floor.
Cale trays for the suspension have to account for the accessibility of the hardware installed on level 1: pumps, racks,..

Figure 6 shows an elevation of the west arm: A continuous first floor is possible. The level of the 2nd floor is an open question. Figure 7 shows that it is possible to access easily either side of the vacuum chamber.

2. The lower tower insulation.

The lower tower insulation is adapted to fit the roof, the walls and the base of the supporting structure. The idea is to attach insulation to the supporting structure and to fit it from inside with some low cost insulating material.

Using BX ROCLAINE of 60mm thickness one achieves an external temperature of 30ºC with 200ºC inside. The heat deperdition is then 100W/m2.

3.1- The roof.

It fits the lower tower supporting plate. The supporting plate is covered with insulation material protected by a metallic sheet to support the rough pumping.

The roof stops at 3cm from the supporting plate. The interval is tighten with an elastomer gasket.

Camera and lighting cables are extracted via the roof.

We would like to suppress the valve fit on the clean air pipe. It obstructs the space. It is not really usefull: after baking, a tower stays under vacuum. So the bypass can be closed by a metallic flange. This operation is not a charge compared to other work to be done to go back to clean conditions.

3.2- The walls.

The best price and insulation is obtained with monolithic insulation plates to be fit into the structure from the top. A porch is reserved to fit the links. Its radius accomodates 1200 mm diameter links. A hole is necessary to fit the pumping bypass.

The dismountability of the lower tower lateral windows is a basic requirement in the lower tower design. To be clear, additions or modifications on the vacuum tank are excluded, while they are possible on the lateral windows. So, lateral windows have to be removable and a porch has to be available on each side of a lower tower.

Small insulating modules facilitate the handlings in the hall. The bigger the modules, the bigger the difficulties to go around.

3.3- The base.

Space between tower and ground has to be properly insulated. A dedicated matress is installed on the floor, fit to the hole in the gallery roof.

A matress is used to fill the space between the tower square pedestal and the insulating walls.

The tower glides on insulating plates....

3.The lower tower heating elements.

The idea is to limit obstruction induced by the lower tower heating elements. It was found that a number of small elements is easier to manage than a unique element.

8 heating elements (fans and resistors) adequately fit on the basement provide a uniform heating of 1/8 of a lower tower. Air is extracted near the roof and reinjected at the tank basis. Such a system is efficient and makes the economy af an air feeding distribution system. Weights and sizes allow for an easy handling. Being installed on ground, they don't affect the insulating structure.

The number oh heating elements is still an open question. It may be 8 or 4 depending on the availability of the generators.

Computations show that some 20KW/h are requested to rise the oven temperature to 200ºC in 24 h and to keep it at 200ºC for the baking.

4. The additional elements.

The bottom of a tower closes the roof lower tower access gallery. A small oven is fit there to heat the bottom of a tower. The volume to be baked is isolated from the other towers by 2 sectioning valves installed on the links. The tower vacuum instrumentation is installed outside the oven and is baked for its own.

4.1- The gallery oven.

- The gallery is an unclassified clean room. However, a lower tower access volume can be installed as a class 100 clean room in a minimum amount of time. The gallery oven is a kind of cake build with a stainless steel sheet holding insulating material and a resistor. It is fit in the tower/gallery linkage. Only one gallery oven will be purchased.

4.2- The Ti pots.

A standard equipment is foreseen for the 5 Ti Pots

4.3- The bypass region

A standard equipment.

4.4- The valves

There are two sectioning valves. One is in a hot oven and the other in a cold oven. To get them under control, one has to process for their own, i.e. with their own heating and insulating elements.

The valve which closes presently the clean air feeding pipe complicates the oven shape. It could be replaced by a blind port.

4.5- The instrumentation bottle

A standard equipment is foreseen for the 5 available botles.

4.6- Insulation of the upper compartment of the lower tower.

The upper part of the lower tower needs some insulation, at least for safety. An insulating jacket, made with a high Q product is fit close to the tower. As the pumps are implemented at that level, the material has also to be chosen clean.

6. Regulation, power supply and cable layout.

It is proposed to minimise the cabling and to install the regulations near the baking site. As a consequence, each of the 5 baking site has to supply and control an oven, a gallery oven, 2 Ti pots, 2 links, 1 instrumentation bottle, several sectioning valves (1, 2 or 4), 1 bypass.

Following table specifies the number and power of the requested heating elements. It shows also the number of temperature sensors requested for the survey of the baking.

Element	Number	Power	Temperature sensors
Lower tower ovens	**5**	**30 KW**	**8x5**
Gallery oven	**1**	**4 KW**	**2x5**

Ti Pots	**10**	**2 KW**	**3x5**
Instrumentation bottles	**5**	**.5 KW**	**1x5**
Sectioning valves	**4**	**.5KW**	**1x4**
Bypass with valves	**5**	**1 KW**	**1x5**
Links	**8**	**5 KW**	**1x8**

7. Slow control.

Temperatures, pressures and power consumption are registered at each baking by the standard tower control system..

8. Assembly scenarios

Depending on the installation scenario, there are several choices for the delivery of the ovens. In a one by one scenario, each tower is fit with its structure, insulated and pumped. Cabling has to be ready at an early date. Work on vacuum is mixed with installation of hardware.

For a question of cleanness, it may be wise to postpone the installation of the pumping system until most (all) of the dusty work is achieved. Injection and detection towers could be installed at an early date. The cabling of the hall could proceed in parallel with the delivery of the towers. Once cabling and air conditionning are achieved, one proceeds with the structures, the links, the pumps.

9. Priorities

Today, the priorities are as follows:

1. The insulation matress of the base
2. The supporting structures
3. The oven insulating (walls and roof) and heating elements
4. The rest.

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