Development of a CO_2 cooling prototype for the CBM Silicon Tracking System*

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The CBM Silicon Tracking System is based on silicon sensors with double-sided strip readout. These sensors must be kept at least at -5° C to ensure the required performance. Due to this cooling demand the design and manufacturing of a 1 kW prototype called TRACI-XL, shown in Fig. 1, was chosen as the best option as starting point for specifying the technical features and requirements of the final cooling plant.The main heat sources of the detector are the read-out electronics, which dissipate about 40 kW according to the current specifications and they must be removed completely. This does not mean that the final plant will be 40 times bigger but it will allow to scale the experimental results and to get conclusions about the CO_2 nucleate boiling behavior and to start the engineering development of the cooling plates, fluid distribution and other important aspects.

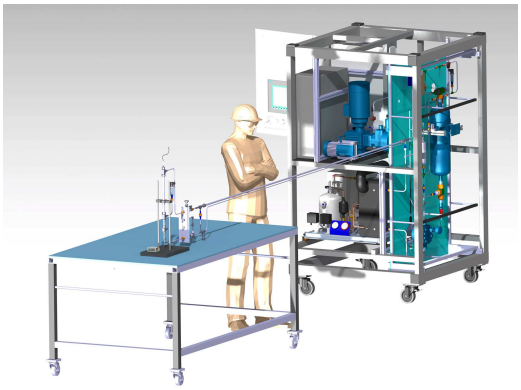

Figure 1: A CATIA model of TRACI-XL.

Preparations for the commissioning phase

In order to ensure a correct performance of the plant an exhaustive protocol has been defined. The commissioning phase comprises the following tests:

- Safety verifications: Electrical safety (Electrical cabling, PLC I/O testing, alarms testing), mechanical safety (Pressure test and leak test).
- Basic functionalities tests: Real conditions analog alarm testing, chiller operation, pump operation, accumulator pressure regulation.
- Advanced performance tests: Automatic procedure testing, stable chiller operation over the full operating range, stable pressure (temperature) regulation in every condition, stable flow control.
- Thermodynamic performance: Test with a 1 kW dummy load in a wide range of temperatures, test with gradual power supply, shock test: sudden disconnection of electronics.

The PLC parameters such as pressures, temperatures, mass flow, alarms, interlocks etc. can be forced to bring the plant to extreme conditions and to check that all the safety and recursive procedures work as expected. In addition a 1 kW dummy heat load which simulates the future connected read out electronics was developed. This experimental heat source is based in a 3/4” pipe with a concentric fire rod providing a power of 1 kW and the respective sensors.

Finalizing the assembly stage

Once the concept design phase finished, the mechanical assembly stage (Fig. 2) takes a great relevance because it is the moment to introduce changes into the design after analyzing the evolution of the prototype and detecting possible defects or improvements. Parts of the mechanical frame were adapted to gain in stability and to reduce noise installing materials for vibration damping. Some other parts were relocated in order to facilitate the accessibility to every component in case they must be replaced, or distributed to ensure sufficient ventilation in the plant.

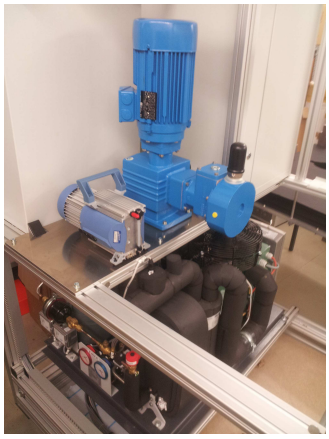

Figure 2: Vacuum pump set-up with condensing unit.

References

[1] R. W. Lockhart, R. C. Martinelli, Chem. Eng. Progr., Vol. 45 (1949), p. 39-45

* Work supported by EU-FP7 CRISP.

DOI:10.15120/GR-2015-1-MU-NQM-CBM-29