

Minutes of the 04.11.2014 meeting at TE-VSC-SCC group: First discussion of the project to study C6K fluoroketone for cooling applications at CERN

(Addendum: 05.11.2014 discussion with M. Battistin: is C6K hydrolysability a showstopper?)

Present: M. Taborelli, R. Stedescu, B. Teissendier, P. Gorbounov

- PG informed about the initiative [1] to study the C6K fluoroketone (3M Novec 649 thermal fluid) as an alternative to C6F14 in cooling applications at CERN. The likely medium-term application is the SciFi project of LHCb, with the expected total ionization dose of ~ 100 Gy and the slow neutron fluence of $\sim 10^{12}$ neq/cm²
- MT: re-iterated his proposal to start with a pilot study, to assess the radiation resistance of the purest possible C6K sample to the doses of 0.1, 1 and 10 kGy
- We briefly reviewed the available irradiation facilities: CERN (GIF, GIF++ in 2015, PS IRRAD-2) [2] and the external firm IONISOS Dagneus (Lyon, FR) [3]
- BT commented on a usability of old containers used for the 2006 study [4] of the chemical and radiation resistance of C6F14. One, expectedly most contaminated, container has to be cut for a visual inspection and an assessment of a possibility of cleaning. BT is in favour of making new containers, by copying the existing ones at the EN-CV workshop. PG: we can also try to order the containers at the PH-DT gas group workshop. The container walls are ~ 1 mm thick, they transparent for ~ 1 MeV gammas and neutrons.
- RS explained the role of hydrogen (from water and impurities) in creating corrosive acids in C6F14 via the radiolysis. BT showed the (quite spectacular) samples of corroded Al and SS strips, described in [4b], Fig. 4.
- RS remarked about the commercial availability of C6K, as a “CAS 756-13-8” compound, from Chinese and Western suppliers [5]. PG: the 3M fluid has a much higher purity ($>99.9\%$ according to MSDS [6], in reality $>99.5\%$). MT said that for the clean GC study a small sample of ultra-pure C6K compound should be, possibly, used.
- PG: the main concern about C6K is its reactivity with liquid water under normal conditions, resulting in formation of a corrosive acid, PFPA. The effect is mitigated by a very small solubility of C6K in water (and vice versa), the high volatility of C6K and a big difference in the densities (>1.6 g/cm³ for C6K). There is not so much information about this effect ([1], Section 3.5). It comes mostly from 3M and is presented in a biased way. MT opined that this might become a *showstopper* for critical detector cooling applications. PG will discuss this matter with M. Battistin (see the Addendum)
- The time frame. PG wants to complete the pilot study before end of May 2015. MT: this is hardly possible, but we can give it a try. PG: the project should be officially launched by May 2015, at least.
- Bottom line: PG will contact GOF and IRRAD-2, and R. Guida of the gas group. BT/RS will contact IONISOS. MT believes that the 0.1..1 kGy irradiation should not be expensive at IONISOS.

References:

1. PG Memo (latest update): https://twiki.cern.ch/twiki/pub/LHCb/SciFiDemoCooling/NOvec_Memo_1.3.pdf
2. Irradiation at CERN:

- a. GIF: <https://gif-irrad.web.cern.ch/gif-irrad/>; GIFF++ <https://espace.cern.ch/sba-workspace/gifpp/SitePages/Home.aspx>
 - a. Neutron irradiation (IRRAD-2 facility): <http://testing-irradiation.web.cern.ch/testing-irradiation/irrad2.htm>; CERN irradiation facility: <http://ph-news.web.cern.ch/content/new-proton-mixed-field-irradiation-facility-cern-ps-1>
 3. IONISOS <http://www.ionisos.com/fr/dagneux.htm>
 4. M.Battistin, S.Ilie, R.Setnescu, B. Teissandier "Chemical and radiolytical characterization of some perfluorocarbon fluids used as coolants for LHC experiments":
 - a. Chemical characterization TS-Note-2006-010, EDMS 804849 <https://edms.cern.ch/file/804849/1/TS-Note-2006-010.pdf> ;
 - b. Radiolysis effects in C6F14, EDMS 842110 TS-Note-2007-005 <https://edms.cern.ch/file/842110/1/TS-Note-2007-005.pdf>
 - c. Inox containers: <https://edms.cern.ch/document/735483>
 5. LOOKCHEM.COM: http://www.chemicalbook.com/ProdSupplierGWCB2238274_EN.htm;
 6. 3M Novec 649 MSDS: <http://www.mgchemicals.com/downloads/3m/649-msds.pdf>
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Minutes of 05.11.2014 discussion with M. Battistin: is C6K hydrolysability a showstopper?

- PG summarized the outcomes of the 4.11.2014 meeting, emphasizing everybody's concerns about the C6K reactivity with liquid moisture. The undesirable scenario: C6K leaks and gets in contact with condensation water, causing stains and corrosion around leaking connector. Somewhat similar effects can be observed with demineralized water, but PFFA is (?) more aggressive than carbonic acid.
- MB opined that this issue, if properly addressed by the cooling system design, is not critical. He encouraged to continue with preparation for the radiation resistance study, but agreed that this issue should be better studied by CERN chemists (water solubility in C6K etc). He also agreed that the existing installations at CERN might be reluctant to switch to C6K because of this factor.
- PG: asked about a possibility to make the test containers in EN-CV. MB suggested to get one container from Benoit (presumably the one that has to be cut for inspection) and have it "reverse-engineered" by one of Michele's technicians.

Remark: on 6.11.2014 PG collected the container from Benoit