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Development of new gas recuperation systems for particle detectors using greenhouse gases

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Particle detectors at the LHC experiments are very often characterized by large detector volumes and by the need of using very specific gases. Since the early phase, the gas consumption optimization was one of the design criteria. CERN is today strongly committed to reduce GHGs emissions from particle detector operation. In addition, GHGs are now subject to a phase down policy in Europe that started to affect the market with price increase and, in the long term, may cause a decrease in their availability.
Four different strategies have been identified to optimize the GHGs usage: gas recirculation systems optimization, gas recuperation, new environmentally friendly gases, and gas abatement. This contribution will focus on results obtained for the present gas systems' optimization and on the R&D studies for the development of gas recuperation plants. Gas recuperation plants are systems designed to extract GHGs from the exhaust of gas recirculation systems allowing further re-use and, therefore, reducing drastically GHGs emissions without changing detectors operation conditions. Recent developments are concerning systems for CF4, C2H2F4 (also called R134a), C4F10 and SF6 recuperation.

A R&D studies to design a R134a recuperation plant is ongoing. The use of R134a for the ATLAS and CMS RPC detector systems operation represents about 80% of the GHGs emission from particle detectors at CERN experiments. The separation process resulted more complicated than expected because R134a and iC4H10 forms an azeotropic mixture. To overcome this complication, after removal of the most volatile components (i.e. air and SF6), the R134a and iC4H10 remaining mixture is firstly totally liquified and then it is sent to a volume kept at about 4 °C: the azeotropic mixture present at the bottom of the second stage buffer enters the warm buffer and it is slowly heated up. During this process, the liquid is enriched of pure R134a while the vapor, enriched of the azeotrope, escapes from the exhaust. Several tests performed with an input RPC gas mixture flow from 100 to 400 l/h confirmed the good quality of the recuperated R134a. The overall recuperation efficiency is 80-85%. Final studies are on-going in order to develop a second prototype, which should pave the way for the final R134a recuperation systems, which will be installed in the ATLAS and CMS experiments during Run 3.

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