Advantage of Reusing Distilled over Recirculated C_4F_{10} for Gas System of Low Threshold Cerenkov Counter

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To minimize contaminant level in the Low Threshold Cerenkov Counter's (LTCC's) C_4F_{10} gas system and to reduce operation cost, distilling rather than recirculating C_4F_{10} vented gas prior to reuse is recommended.

LTCC's sector 3 and sector 5 each has a gas volume of 7,500 L (~75 kg of C_4F_{10}). Contaminants O_2 and water vapor in the gas system reduce the detector's particle identification efficiency. While water vapor is easily removed, O_2 is not.

In a one-shot flow system, 100% of the gas is lost to the atmosphere after a single pass through the detector. In such a system, flowing pure C_4F_{10} at a higher rate than the leak rate maintains the detector's fill level and aids the removal of contaminants that enter the system—the higher the flow rate, the lower the contaminant level—until the contaminants reach a baseline level. In addition to the leak rate from the piping and the detector itself, which in principle can be made zero, from time to time significant quantity of gas is vented out of the detector to the atmosphere due to ambient pressure changes.

The one-shot flow system has a high operating cost because of its gas usage; C_4F_{10} costs ~$300/kg. By developing a recirculating system or a cryogenic distillation system, the operating cost is reduced because a large fraction of the gas flowed from the supply to the detector is reused.

In a simple recirculating system, the contamination level increases over time. During normal operation, the contamination level in the recirculated gas is diluted when pure C_4F_{10} from the supply tank is added to the system to compensate for C_4F_{10} loss, Fig.1. Another disadvantage of the recirculation system is that it requires an expensive gas chromatograph to monitor the contamination levels accurately.

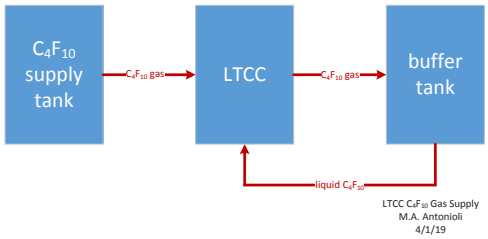

FIG. 1. Recirculating system. C_4F_{10} from supply tank used for filling detector and to compensate for gas loss.

To recirculate after cryogenic distillation, the vented gas is recovered and stored in a buffer tank for distillation. The gas flow to the detector is uninterrupted because multiple buffer tanks can be used, and the one that is filled with the vented gas is manually or electronically switched to stop receiving gas and flow its stored gas to the distillation unit. The distillation cycle depends on the quantity of gas that is to be distilled. Once distilled, the distilled gas is transferred to the supply tank for re-use, Fig. 2.

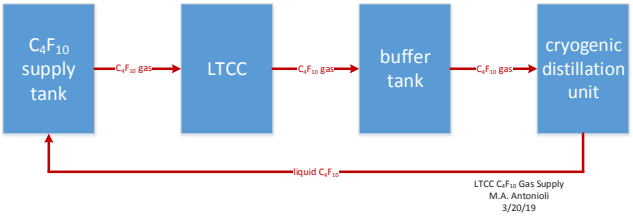

FIG. 2. Flowchart for distillation system.

To sum up, there are disadvantages in using a recirculating gas system. Additionally, a recirculation gas system requires the use of an expensive gas chromatograph to monitor the contamination level. Distillation of the used gas would help extend gas usage, thereby reducing operations cost as well as keep contaminants as low as a pure gas flow-through system.