Preventing Contamination related to Global and Climate Change using Key Enabling Technologies

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Per- and polyfluoroalkyl substances (PFAS) are considered "forever chemicals". These compounds are a subgroup of aliphatic fluorinated substances composed of one or more carbon atoms in their structure, where the substituents are replaced by fluorine. PFAS are a set of long-lasting chemicals mobilized in different media such as soil, water, air, and food. Their presence is harmful due to their toxicity and bioaccumulation. High exposure levels to these compounds increase the risk of dangerous health issues for humans, such as kidney and testicular cancer, thyroid problems, hypertension during pregnancy, and ulcerative colitis, among others. Governmental entities have taken steps to limit the production of PFAS listed in the Stockholm Convention on Persistent Organic Pollutants. Remediation techniques have been demonstrated not to be useful to reduce the presence of these compounds in the environment because: (i) they are limited to sequestration technologies which are often not efficient; (ii) their treatment is based on incineration (of PFAS-containing wastes) emitting harmful air pollutants, such as fluorinated greenhouse gases (F-gases). These emissions contribute to those coming from refrigerants based on F-gases, by far the most relevant F-gases group from a climate perspective, with a global warming potential up to 23000 higher than CO_2. Although F-gas emissions have been falling since 2015 and most of these refrigerants are currently being phased out, recycled pure F-gases are valuable because they can be reused in new-generation gas blends with much lower global warming potential. Since the recycling rates of F-gases in the EU are extremely low (to date, depleted refrigerants are either collected and sent to incineration in the best scenario or released to the environment), the development of green technologies for the selective separation of these gases is vital to apply a circular economy model for the refrigeration market and to achieve the European goals for the climate.

This work is focused on the possibility to develop and design (bio)materials to develop climate-friendly processes to separate PFAS. The most appropriate solvent will be custom designed and evaluated for each specific application. The F-gases that are usually used in air conditioning and commercial refrigeration equipment, such as R-134a (1,1,1,2-tetrafluoromethane), R-32 (difluoromethane) and R-125 (pentafluoroethane) have been studied. Furthermore, (bio)materials have been designed to extract PFAS present in wastewater effluent from aqueous solutions. The results are promising, opening a very interesting path to the optimization of a more sustainable process, which helps to solve one of the current environmental and health issues of great concern in Europe achieving a cleaner environment for the species and ensuring the well-being of species.