

What are 'Forever chemicals'?

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In news—New study has found that rainwater from many places across the globe is contaminated with “per- and polyfluoroalkyl substances,” (PFAs), which are called “forever chemicals” because of their tendency to stick around in the atmosphere, rainwater and soil for long periods of time.

What are PFAs/forever chemicals?

- **PFAs are man-made chemicals used to make nonstick cookware, water-repellent clothing, stain-resistant fabrics,** cosmetics, firefighting forms and many other products that resist grease, water and oil.
- **PFAs can migrate to the soil, water and air** during their production and use.
- **Since most PFAs do not break down,** they remain in the environment for long periods of time.
- Some of these PFAs can build up in people and animals if they are repeatedly exposed to the chemicals.
- **Health risks that are attributed to PFA exposure are decreased fertility, developmental effects in children,** interference with body hormones, increased cholesterol levels and increased risk of some cancers.
- Recent research has also revealed that long-term low-level exposure to certain PFAs can **make it difficult for humans to build antibodies** after being vaccinated against various diseases.

Destroying PFAS-

- While **there is no known method that can extract and remove PFAs from the atmosphere itself,** there are many effective, albeit expensive, methods to remove them from rainwater that have been **collected through various rainwater harvesting methods.**
- **One way to do this would be to use a filtration system**

with activated carbon. The activated carbon will need to be removed and replaced regularly. Also, the old contaminated material must be destroyed.

- **Current methods to destroy PFAS require harsh treatments, such as incineration** at extremely high temperatures or irradiating them with ultrasonic waves.
- And incineration isn't always foolproof, with one New York plant found to still be releasing some of the compounds into the air through smoke.
- PFAS' indestructability comes from their **carbon-flouride bonds**, one of the strongest types of bonds in organic chemistry.
- Fluorine is the most electronegative element and wants to gain electrons, while carbon is keen to share them.
- **PFAS molecules contain long chains of these bonds**, but the US research team was able to identify a glaring weakness common to a certain class of PFAS.
- At one end of the molecule, there is a group of charged oxygen atoms which **can be targeted using a common solvent and reagent at mild temperatures of 80-120 degrees Celsius**, decapitating the head group and leaving behind a reactive tail.
- Once that happens, that provides access to previously unrecognized pathways that cause the entire molecule to fall apart in a cascade of complex reactions.
- A second part of the study involved **using powerful computational methods to map out the quantum mechanics behind the chemical reactions** the team performed to destroy the molecules.