New Process for Recycling of Fluoropolymers

Target: A Pilot Plant for Industrial Recycling

Fluoropolymers are high-performance plastics, used all over the world in a large number of different products. Polytetrafluoroethylene (PTFE) is an essential material in many sectors of industry. It is characterized by very high resistance to heat and chemicals, and the fact that is practically "non stick". Not only frying pans, but also many seals and bearings - for example in motor vehicles - are coated with PTFE. The textile industry also makes use of PTFE as a material for breathable membranes in functional textiles, whilst in the electrical sector PTFE is an important material for cable insulation.

But what happens to industrial waste and end-of-life products containing PTFE? There is no industrial recycling facility for fluoropolymers anywhere in the world at the present time - and the problem is becoming ever more acute. In the waste incineration processes which have been usual up to now, highly-corrosive vapors are released which also damage the incineration plant itself. Dumping of waste will in future be restricted due to EU regulations. Waste that contains organic materials will in future have to be recycled or destroyed in such a way that the materials are themselves destroyed or irreversibly converted into non-hazardous substances.

A New, Cost-Efficient Process
So what can be done with the fluoropolymers, if they can be neither incinerated nor dumped? A research project at the University of Bayreuth has now made a decisive breakthrough in solving the problem. Three partners have been working on the project; the Chair of Material Processing under its professor, Dr. Monika Willert-Porada; the research institute InVerTec e.V., linked to the university as an affiliated institute; and Dyneon, which is one of the leading producers of PTFE and has a great deal of interest in finding a suitable recycling solution. Now, the project partners, working closely together, have succeeded in finding an economically efficient process for the decomposition of the fluoropolymers into recyclable components that is completely acceptable from the ecological point of view. The German environmental foundation, Deutsche Bundesstiftung Umwelt (DBU), has
funded the project for two years with € 211,000. The new process is characterized in that a very large percentage of the PTFE polymer molecules are broken down into smaller molecules, so called monomers. These components are tetrafluoroethene and hexafluoropropene. Up to 93% of these gases, from which PTFE is composed, can be recovered by means of the process trialed in the high-tech laboratories in Bayreuth - and in such a way that no effects ensue that could be hazardous to the health of those working with the process.

The monomers can now be reused by the PTFE producers under environmentally safe conditions and used afresh for industrial production of PTFE. This means that the fluoropolymers are almost completely returned into the material cycle. Together with Dyneon, the engineering scientists in Bayreuth have developed a concept as to how this recycling can be implemented on an industrial scale.

**From Recycling Concept to Pilot Plant**

Breaking down the PTFE into its component parts is a process that is called depolymerization within the research field. The process developed for this in Bayreuth is a so-called fluidized bed reaction. Very short heating of the fluoropolymers and resulting pyrolysis are central to the process, in which microwaves, among others, are used as an energy source. However, the project partners have not simply stood still with regard to these results. In a further step they have investigated what technology is particularly suitable for implementing the process on an industrial scale. In doing this, they have taken a large variety of economic, ecological and technical criteria into consideration.

Based on these findings, the Chair of Material Development and Dyneon are currently working on a concept for a pilot plant using this process. "Construction of this pilot plant would open up the path to industrial recycling and therefore contribute to solving a very urgent problem", explains Dr. Willert-Porada. "We have now acquired the scientific and technological know-how required for this. So, all the project partners are hoping that the necessary funds will be made available for construction of the pilot plant." "With this positive result in research and development we will be able to close the process cycle of PTFE in the future, by coincidentally reducing the consumption of monomers", Dr. Klaus Hintzer, head of research at Dyneon, emphasizes.

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