A new lease on life: recycling automotive plastics

- **Chemical Recycling pilot project aimed at recycling mixed automotive plastic waste successfully completed**
- **Plastic waste used to produce high-quality pyrolysis oil that Audi intends to use in the production of new plastic automotive components in the future**
- **Follow-up project planned with the objective of developing an industrial chemical recycling process**
- **Chemical Recycling can play a key role in the intelligent use of resources in the supply chain and in efforts to combat climate change**

Ingolstadt, June 17, 2021 – As part of the THINKTANK Industrial Resource Strategies, researchers at the Karlsruhe Institute of Technology (KIT) have been working with Audi for a good six months on the pilot project "Chemical Recycling of plastics from automotive manufacturing." Now that the project has been completed, it is clear that the Chemical Recycling of mixed plastic waste is both technically feasible and environmentally and financially promising. The plastic waste from automotive manufacturing can be processed into pyrolysis oil and could replace petroleum as a raw material for the production of high-quality plastic components in Audi models. The material cycles closed in this way save valuable resources, energy, and reduce greenhouse gas emissions. As such, Chemical Recycling represents a viable alternative to energy recovery and complements mechanical processing. In this way, Audi could use fossil resources for longer and thus scale back the procurement of additional fossil resources accordingly. Together with partners from the chemical industry and KIT, Audi now plans to take the next step and research the industrialization of this cycle.

Fuel tanks, airbag covers, or radiator grilles – many components in cars are made of plastics. They need to meet stringent safety, heat resistance, and quality requirements. This is why plastic automotive components that are subject to particularly high levels of stress can, to date, only be manufactured from materials of virgin material quality, which mechanically recycled plastics usually do not achieve. Additionally, mixed plastic waste is often not available for mechanical recycling. For this reason, the THINKTANK Industrial Resource Strategies at the Karlsruhe Institute of Technology (KIT) launched a pilot project for Chemical Recycling together with Audi at the end of 2020. Within the scope of the project, tests were carried out to determine the extent to which mixed automotive plastic fractions can be fed back into a resource-friendly cycle via Chemical Recycling.

Recycled components made from pyrolysis oil have the same high quality as virgin materials

Under the leadership of Prof. Dr. Dieter Stapf from the KIT Institute of Technical Chemistry and Dr. Rebekka Volk from the KIT Institute of Industrial Management and Industrial Production (IIP), scientists investigated the technical feasibility of the process as well as its cost-effectiveness and its impact on the environment. The results show that Chemical Recycling can

be used to process the mixed plastic waste from automotive manufacturing into pyrolysis oil, which can replace petroleum as a chemical raw material. This means materials made from it exhibit the same high quality as virgin materials. This means that plastics made from pyrolysis oil can be reused in automotive manufacturing to produce plastic components that are subject to high levels of stress. Audi is one of the first automakers to test this recycling method in a pilot project with automotive plastic waste. Audi intends to intensify its research together with its partner KIT. As such, the partners plan to test its industrialization potential in a follow-on project. This would allow fossil resources to be used for longer and reduce the use of additional fossil resources. “An initial assessment shows that Chemical Recycling may be superior to energy recovery from both a financial and environmental perspective. We are comparing this process with energy recovery, as this is the current recovery route for the automotive plastic waste we analyzed. An initial comparison of the figures shows that the costs for Chemical Recycling are on par with the prices that have to be paid for energy recovery. Furthermore, Chemical Recycling offers the opportunity to recycle much of the carbon and reuse it in the production of new plastic components,” explains Dr. Rebekka Volk from IIP. As a result, carbon dioxide emissions from Chemical Recycling are significantly lower than from the current energy recovery process – which benefits the climate. Complementing mechanical recycling, pyrolysis also converts mixed waste plastics and composites into a liquid chemical feedstock while separating out unwanted constituents. After a purification step, this pyrolysis oil can be processed into new plastic using conventional industrial processes, thus replacing primary raw materials from fossil energy sources, such as petroleum. This conserves resources and energy.

The vision: significantly increasing the percentage of automotive components manufactured sustainably

The aim of the “Chemical Recycling of plastics from the automotive industry” pilot project was to test intelligent cycles for plastics by means of Chemical Recycling and to evaluate this method as a supplement to mechanical recycling and as a substitute for energy recovery. Now that the research has proven its technical feasibility, Audi intends to scale up the process together with its partners. “We want to establish intelligent cycles in our supply chains and use resources efficiently,” says Marco Philippi, Head of Procurement Strategy at Audi. “Chemical Recycling harbors tremendous potential in this regard, because if plastic components can be manufactured from pyrolysis oil instead of petroleum without any loss of quality, it would be possible to significantly increase the percentage of sustainably manufactured components in cars. Over the long term, this process may also play a role in end-of-life vehicle recycling.”
In short, Chemical Recycling of plastic waste could make Audi products more sustainable and eliminate greenhouse gas emissions along the value chain.

Using innovative methods to proactively shape the market for secondary raw materials

For Philipp Eder, project manager for Chemical Recycling in the supply chain at Audi, Chemical Recycling is not just about meeting the legal recycling requirements stipulated by German and European waste legislation. “Audi wants to use intelligent methods to proactively shape the market for secondary raw materials and take responsibility in line with our mission of achieving a

competitive edge through the use of innovative technologies." As such, Audi has identified Chemical Recycling as an opportunity and has set out to successively increase the amount of recycled plastic in its models. Up to now, Audi has primarily used recycled single-variety plastics. A current example is the use of PET in the Audi A3. PET is a plastic that consists of a single-variety chemical compound. These materials are easier to process than mixed plastics. The A3, for example, is available with three different fabric covers for the car seats that contain up to 89 percent recycled material. The new Audi Q4 e-tron electric SUV also contains components with recycled content – including mounting brackets, wheel arch liners, fender covers, floor paneling, and wheel spoilers. A total of 27 components contain recycled material. But in the future, mixed high-performance plastics produced via Chemical Recycling could also be added.

Combating climate change in Audi manufacturing: recycling and avoiding the use of plastic

Audi's cross-site environmental program "Mission:Zero" also focuses, among other issues, on resource conservation, waste avoidance, and closed recycling loops in production. For example, plastic waste from A6 and A7 assembly at the Neckarsulm site has recently been sorted, shredded, and then processed into 3D printing filament in a filament maker. This plastic thread is used to produce precision-fit assembly aids for production with the help of 3D printers. Audi's 3D printing team is working closely on this with the Dutch start-up 3devo, which also supplied the necessary technology.
In another recycling project, plastic sheets from Audi assembly have been recycled into trash bags since the beginning of the year and then used at the site. Logistics, in turn, has optimized several component packages together with suppliers. This has already enabled Audi to eliminate almost 23 tons of non-recyclable packaging at the Neckarsulm site alone.

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In 2020, the Audi Group delivered to customers about 1.693 million automobiles of the Audi brand, 7,430 sports cars of the Lamborghini brand and 48,042 motorcycles of the Ducati brand. In the 2020 fiscal year, AUDI AG achieved total revenue of €50.0 billion and an operating profit before special items of €2.7 billion. At present, 87,000 people work for the company all over the world, 60,000 of them in Germany. With new models, innovative mobility offerings and other attractive services, Audi is becoming a provider of sustainable, individual premium mobility.