RESOURCE-EFFICIENT RECYCLING OF COMPOSITES VIA PYROLYSIS

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Fibre reinforced polymers (FRP) have excellent strength and weight properties, resulting in a greatly increasing number of applications in transport, sport, and construction industries. However, FRP are complex materials, consisting of different parts, fibres and different polymers with fossil origin. Currently the recycling is often inadequate, mainly based on energy recycling and only limited material recycling. Hence, to be aligned with the environmental legislation, improved resource efficiency and material recycling of FRP is necessary. Pyrolysis is a promising chemical recycling technology that has potential to recover both the polymers and the high-quality fibres from FRP. Therefore, this project is a collaboration between research institute (RISE), technology owner (Scandinavian Enviro Systems) and users (Volvo cars, Saab and Skellefteå kraft) to verify, from lab to industrially relevant scales, the entire chain of recycling of FRP from the aerospace and wind power industries to produce new Sheet Moulding Composite (SMC) materials intended for reuse in the automotive industry. The FRP studied in this project were provided from automotives and pre-impregnated carbon fibre mats as well as wind turbine blades. At the beginning of the project, the different types of FRP were evaluated using analytical methods such as thermogravimetric measurements and analytical pyrolysis. These primary tests aimed to determine appropriate decomposition temperatures and composition of the pyrolysis oil product. The reinforced polymers were also pyrolyzed using various process conditions in lab-scale batch pyrolyzer to determine product yields and composition. Results showed that for example the vapor residence time had a significant effect on the cracking of the pyrolysis vapors. Besides, the results from lab-scale pyrolysis verifies that it is possible to recover both high-quality fibres and polymers from FRP. The pyrolysis liquid product contained monomers, such as phenols, phthalic anhydride, and styrene, corresponding to the building block polymers of composites. To verify the positive lab results in larger scale as well as be able to reuse the fibers and polymers in composite prototypes, a pyrolysis pilot plant was constructed and commissioned within this project. The pyrolysis reactor is, similar to the commercial scale facility at Scandinavian Enviro System, based on a batch reactor reducing the need for pretreatment and pre-decomposition of material before pyrolysis which results in long fibers with high quality. In this pilot, the heat will be supplied mainly by a recirculated non-condensable gas flow in direct contact with the composites, which resembles an industrial relevant solution. Further, in this project, recycling of the pyrolysis products, i.e. both the oil and the fibres, will be evaluated and a composite prototype from the recycled products will be developed. The monomers from pyrolysis liquid will be separated to synthesize new thermoset resins and the fibres will be reused in SMC materials. Material recycling using pyrolysis seems a promising technology to recover both the fibres and the polymers of FRPs, resulting in a more sustainable material use with minimized resource consumption and environmental impact. The project is financed by Swedish Energy agency through the program “The industries energy and climate transition” and by the project partners.