Development of Asphaltene-Derived Carbon Fiber

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Abstract:

In industry, repurposing waste streams can considerably reduce operational costs of a process. This report discusses the conversion of an asphaltene waste stream into carbon fiber, which could be used to make products like activated carbon fiber. Some of the main challenges in creating carbon fiber from asphaltenes are purifying the asphaltene precursor and mitigating imperfections in the fiber caused during the extrusion process. In this report, the extrusion process that is used to spin material into a fiber is pressure spinning, a batch process that uses a nitrogen over-pressure to force the liquid precursor through an orifice to form a fiber. Fiber spun from the as-received asphaltene product had poor spinning characteristics including high filament surface roughness, indicative of impurities in the sample. Tetrahydrofuran (THF) was used to separate the impurities/insolubles (the THF insoluble fraction) from the asphaltene sample. Once recovered as a solid, the THF soluble fraction had more stable spinning characteristics, and made better quality carbon fiber. However, it still contained voids which detract from the fiber's mechanical properties. The voids occurring in the fiber were found to be attributable to volatiles evaporating during the extrusion process, forming micro-bubbles inside the fiber. To mitigate the voids, a vacuum distillation process was done on the recovered THF solubles to remove volatile compounds at the spinning temperature. As a result of removing the THF insoluble fraction and using the vacuum distillation, the spun fibers collected during extrusion were smooth and void-free, which converted to carbon fibers well.