

Greener process oils for rubber production

Replacing tires — a common routine for every vehicle holder. Did you know that rubber particles are carcinogenic when the tire is produced with the wrong rubber process oil? Treated distillate aromatic extracts (TDAE) are non-hazardous rubber process oils. However, TDAE manufacturers struggle to deliver high-purity products. Sulzer's Kühni™ agitated column (ECR) provides a key solution that enables manufacturers to increase this yield.

Process oils are softening additives, and experts estimate the world's demand for these substances is around 1'000'000 tons per year. They are essential for the manufacture of a wide range of rubber-based products, including tires, tubes, battery containers, belts and hoses. In fact, these oils facilitate the processing of the rubber. Additionally, they lower the cost of the final product and contribute to the rubber performance, for example by improving the adherence properties of tires.



Greener process oils for the rubber industry

Distillate aromatic extracts (DAE) have been traditionally used as process oils. Recently, these substances have come under scrutiny because of their high polycyclic aromatic hydrocarbon (PAH) content. Some PAHs are highly carcinogenic, mutagenic and reprotoxic pollutants. Therefore, the European Union and countries worldwide are replacing DAE with nontoxic process oil alternatives with low PAH content.

New standard

The new industry standard is treated distillate aromatic extracts (TDAE). These are obtained by processing a DAE feed to reduce the concentration of PAHs, and meet the current environmental regulations.

Removal of PAHs from process oils

PAHs are best removed via liquid-liquid extraction. This method is based on the different solubilities of DAE components in the presence of solvents, which remove or extract the PAHs from the process oil. The DAE, because of its high viscosity, is dispersed as droplets in the solvent (Figs. 1 and 2). The many small droplets provide the large interfacial area needed for the extraction process to take place. After sufficient contact between the solvent and the PAHs, the droplets coalesce and leave from the top of the column as purified TDAE, while the solvent carrying the PAHs leaves from the bottom (Fig. 1). As a result, only a single extraction step needs to be added to the existing DAE production line.

Despite the advantages of using TDAE, the post-treatment of DAE is particularly challenging due to the level of expertise required in the extraction step. As a result, only low volumes of PAH-free TDAE are currently available and these are insufficient to ensure a reliable supply to rubber manufacturers.

Agitated columns for optimal separation

Thanks to its expertise in separation processes, Sulzer was able to provide an innovative process for the efficient removal of PAHs from DAE. The best-suited extraction column, known as an agitated Kühni column (ECR), features a number of turbine agitators. In this way, the DAE that are mixed with the solvents not only flow axially through the column but are also rotated. The rotation reduces the droplet size of the dispersed phase while increasing the interfacial area between the DAE and the solvents.



Video of the Kühni-column.

Directives on PAHs

In recent years, legislation worldwide has become stricter to protect humans and the environment from the toxic PAHs found in DAE. According to the Commission Regulation (EU) No. 1272/2013 amending Annex XVII to Regulation (EC) No 1907/2006, articles whose rubber or plastic components can come into direct, prolonged or short-term repetitive contact with the human skin or the human oral cavity may not contain more than 1 mg/kg (0.0001% by weight of this component) of any designated PAH compound.

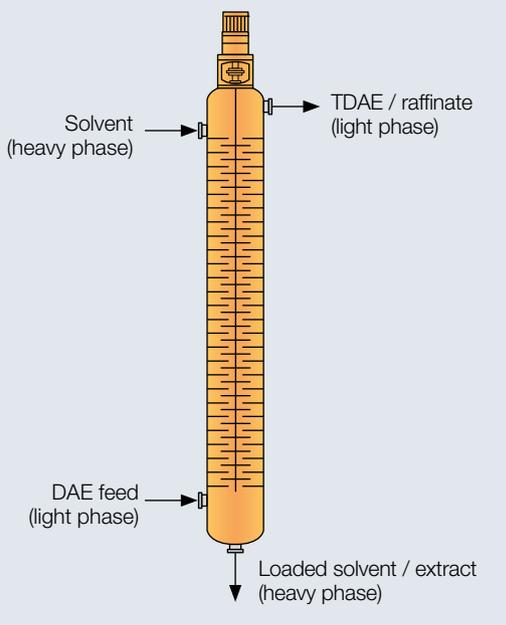


Fig. 1 The separation of DAE and TDAE in an agitated column.

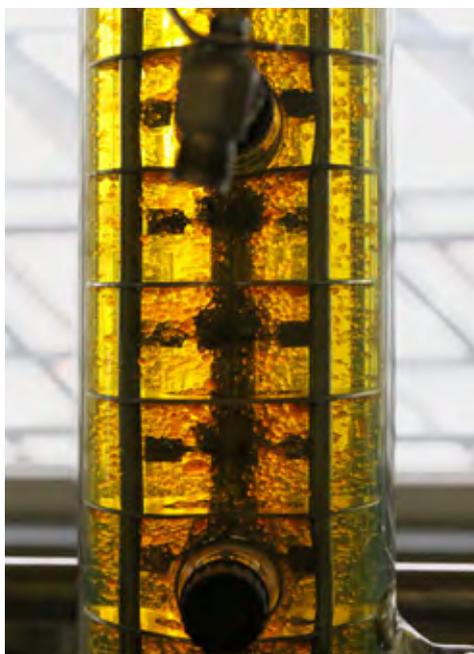


Fig. 2 Droplet distribution of DAE in the agitated Kühni column (ECR).



Fig. 3 The internals of the Kühni agitated column are tailored to the customer's needs.

“ Anyone can help to reduce pollution by buying tires produced with TDAE. It's nice to know that we can actively do something to reduce carcinogenic materials in our world. Our team is always looking for new process technologies that allow us to produce safer or less hazardous end materials. Additionally, we design new products and engineer or optimize processes in close cooperation with customers. Refineries and petrochemical plants around the globe make use of our specific processes, and we are proud to offer this sustainable solution for safer process oils for rubber components.

Mark Pilling, Head Engineered Solutions Refinery Group, Tulsa, OK, United States



Fig. 4 Sulzer conducts customer-specific trials for TDAE in Allschwil, Switzerland.

Sulzer's solution offers a flexible geometry for the internals which allows optimization of the throughput and mass transfer. More precisely, the perforated plates along the column can be spaced differently, defining the optimal height of the agitated compartments (Fig. 3). The rotating internals are adapted to the compartment geometry. This enhances the extraction performance by reducing back-mixing and compensating for changing conditions over the column height. Also, by reducing the number of components and the robust design, Sulzer can deliver a smaller, easier-to-maintain agitated column that has a longer service life. These advantages further reduce the carbon footprint of TDAE production.



Mark Pilling,
Tulsa, OK, United States

Pilot testing and comprehensive support

The Sulzer engineers ensure the correct design of extraction equipment at its world-class pilot test center in Allschwil, Switzerland (Fig. 4). The trials enable a safe scale-up to an industrial-size unit and to provide full process guarantees for customers. Thus, Sulzer can provide the most reliable and effective solution for PAH extraction.

Based on the customer's individual process requirements, Sulzer engineers customize the Kühni agitated column (ECR). Customers can benefit from a complete solution out of one hand: Sulzer creates the initial design, conducts pilot testing and fine-tuning of the equipment, and commissions the finalized column at its customers' sites.



Ronan Goude,
Allschwil, Switzerland

By adopting tailored columns, oil refineries can benefit from energy-efficient solutions that minimize the volumes of solvents required while increasing extraction efficiency. In particular, the TDAE obtained with the Kühni agitated column (ECR) contains residues of PAHs that are well below the threshold set by the European environmental regulations. In this way, Sulzer is leading the global transition towards safer and greener process oils, which will result in less hazardous rubber for tires.