Green chemistry strengthens Orion's environmental responsibility

6/24/2021

Orion's long-term work to promote green chemistry has laid a solid foundation for responsible operations. The principles of green chemistry are used in pharmaceutical research, all the way from the beginning to process optimisation during the commercial phase. The results are reflected in improved environmental friendliness, safety and cost-effectiveness.

"It's clear that green chemistry is good for the environment and nature," says **Sirpa Rasku**, Head of Discovery Chemistry and Radiolabeling at Orion. "In addition, it often reduces the production costs of pharmaceutical ingredients and consequently the medical costs incurred by patients. We believe that we can also accelerate pharmaceutical research by means of green chemistry."

"As a Nordic operator, Orion is well-positioned to operate responsibly and lead the way in green chemistry," says **Elina Tienari**, Research and Development Manager at Fermion. "Overall, we have a solid foundation based on excellent operating principles. We will be able to do even more in the future in this respect."

"Everyone likes to contribute to green chemistry," Elina continues. "It means building a better future in line with Orion's values for everyone, including our children, so that they too will have better conditions to live in."

Green chemistry aims for naturally harmless processes

The term 'green chemistry' was coined by Paul Anastas in the United States in 1998. Green chemistry aims for the use of safe and environmentally friendly substances, as well as ensuring that as much of the raw materials as possible are contained in the final product. Green chemistry also aims for the use of renewable raw materials and energy sources and energy-efficient processes. The principles of green chemistry give form to these opportunities.

The 'greenness' of chemical processes is assessed and compared using various indicators. Differences in material and energy efficiency are relatively easy to measure, while differences in toxicity and process safety are more challenging to consider. The indicators should be selected so that they provide reliable information from various perspectives simultaneously. The 'greenness' of a process is based on the combined impact of multiple factors.

The IMI CHEM21 project extensively promoted green chemistry in the pharmaceutical industry

Orion participated in IMI CHEM21, an international project implemented between 2012 and 2017. Sirpa sees the project as an important step for Orion and the pharmaceutical industry. The project sought to integrate the principles of green chemistry more closely into pharmaceutical development and manufacture. A report on the socio-economic impacts of the project was published in November 2020. The report shows that the project significantly contributed to the development and deployment of environmentally sound production technologies in the pharmaceutical industry.

For example, Orion's long-term work to promote green chemistry is evident in the results of a study published by the Royal Society of Chemistry in 2016. In their article *Medicinal Chemistry: How 'Green' is Our Synthetic Tool Box?* Orion's researchers Josef Messinger, Leena Otsomaa and Sirpa Rasku proved that the selection, amount and good availability of solvents are the key factors affecting the 'greenness' of pharmaceutical chemistry.

The IMI CHEM21 project resulted in a selection guide that provides information about the environmental impact of various solvents. The project also produced quantitative indicators for assessing the environmental soundness of chemical reactions. Freely available learning materials ensure that future chemists will also be able to benefit from the results of the project.

Pharmaceutical research in line with the principles of green chemistry

"In pharmaceutical chemistry, we produce very small amounts of thousands of new ingredients for research purposes every year," Sirpa Rasku explains. "The environmental impacts of an individual ingredient may seem insignificant. However, the combined impact is significant when all the reactions and ingredients are considered. This is why we seek to minimise the environmental impacts of the synthesis laboratory as a whole."

Sirpa describes how the generation of waste can be reduced through good synthesis planning and atom economy, meaning that as much of the atoms in the precursors as possible are contained in the ingredient produced. "We also seek to select safe chemical reactions and synthesis routes, as well as environmentally friendly and safe solvents. In addition, energy consumption is minimised through the selection of reactions or by optimising air flows in fume hoods, for example."

Production processes are optimised during development and the commercial phase

"The principles of green chemistry are integrated into our operating guidelines and standard operating procedures," says Elina Tienari. "We don't choose routes with toxic reagents, and we consider atom economy – that is, how many atoms from the precursors end up in the final product."

When optimising processes, the solvents and reagents are chosen that burden the environment, human health and safety the least. The amounts of precursors, reagents and solvents are optimised to be as small as possible. "Environmental friendliness and financial benefits go hand in hand here," says Elina.

When the production batch size of a pharmaceutical ingredient increases to production scale, the significance of the choices related to its synthesis route and production process grows materially. These are sought to be optimised at a high level even before validation. "We aim for high material efficiency, which means low process mass intensity," Elina continues.

"Our plants have the expertise to optimise the production process in terms of recycling, solvent combustion or energy recovery, for example," says Elina. "Solutions of this type often become possible when the production volume increases, but the high purity requirements of the pharmaceutical industry must also be taken into consideration. The strict quality requirements always take precedence."

Aiming for the best possible result

“We seek to do our best and create the best possible process,” says Elina. “Many criteria must be considered, but environmental friendliness and process safety are always important. Our ability to create safe processes is one of the factors that motivate us.”

Sirpa agrees: “When our values were last updated, we particularly liked the explanation of *We aim for the best*, because it discussed a sustainable way of working. It resonated with our synthesis chemists.”

“We have achieved a great deal,” Sirpa points out. “With green chemistry, many functions have been changed completely. That said, we still have a lot of work to do. Science develops, and new reagents and chemicals emerge. We must keep up to date with developments and change our ways of working in light of new information.”