

# METALLURGY - Rami Saario, Jussi Vaarno, Henri Fredriksson, Jussi Pajala, Juri Matinheikki



Sustainable use of  
Earth's natural resources

Outotec

This team developed Outotec's VSF®X plant - "a modularised revolution for efficient solvent extraction". Numerous studies and analyses have shown that the industry faces serious challenges, including complex ores and declining grades together with increasing capital costs, exceeded project schedules and environmental regulations. In regard to solvent extraction (SX), Outotec is helping to address these issues with the introduction of this innovative, standardised modular plant design. The VSFX plant provides a novel way to design, manufacture,

transport, install, operate and maintain an SX plant. It is designed to handle flows from 25 m<sup>3</sup>/h up to 10,000 m<sup>3</sup>/h and metal content from 1 g/litre up to 50 g/litre. SX is a key process step in various metals extraction processes and has been used for solution concentration and purification since the 1950s. Outotec's VSFX mixer-settler technology is suitable for all metals for which an extraction reagent is available, such as copper, uranium, cobalt, nickel, zinc and REEs, to mention just a few. The elegance of the modular product lies in the use of prefabricated VSFX settler modules enabling the construction of a settler consisting of independent sections. Outotec's renowned SX expertise is built into these modules, which are fully suitable for intermodal transportation as standard freight containers. The modules are procured, manufactured and transported via a predefined supply chain enabling more reliable delivery. This supply philosophy allows the flexibility for SX-plants to still be custom designed, but built from standard modules which enable faster and more economic project implementation. In addition to this, a modular solution provides predefined costs, state-of-the-art documentation and implementation in the engineering phase as well as fast procurement, installation and plant commissioning - all this in an environmentally friendly and sustainable way. The modular solution allows flexible capacity since more capacity can be built while the plant is running by adding extra sections. Due to the elevated construction, soil contamination of each mixer-settler is totally avoided and possible leaks are easy to detect and repair. Combined with the optimised usage and selection of material, this enhances the sustainability of the delivered solution. Furthermore, the settlers have extra residual value, since they are easy to disassemble and transport to a new site. The VSFX equipment is enclosed, making the SX process stable against organic phase oxidation and enhancing work safety by minimising organic evaporation and preventing operators falling into the settler. Advanced mixer-settler design ensures low entrainments, high availability and lower operating costs. The optimised SX process also enables the use of higher settling rate (up to 10 m<sup>3</sup> /m<sup>2</sup> /h) resulting in noteworthy reductions in equipment size and the plant footprint as well as organic inventory. In previous projects Outotec has achieved 30% reduction in organic inventory, giving signi-

cant savings in plant CAPEX and OPEX. Fire safety is also maximised due to the low oxygen presence and limited combustion space. There are no carbon steel parts inside of the equipment, reducing the re risk during maintenance. A major advantage of the modular SX-plant product lies in the installation phase. Installation of the modules is designed to be simple and time-saving and the construction is elevated to minimise excavation work. The modules can be installed by a using mobile or overhead crane. The reduced number of installation personnel and the standardised working procedures allow for easier supervision on site and an improved work safety environment. Better operation and maintenance derives from preventive maintenance that can be performed without a complete plant shutdown by by-passing one settler or single settler section. The world's rst modular such plant is currently being delivered to a customer in Turkey. This represented Outotec's internal record from product launch to signing rst delivery contract. In addition, multiple promising sales prospects are ongoing. Prospective customers have acknowledged the benets of modular plants and demand for modular solutions is increasing. In particular, deliveries in harsh conditions, such as high altitude, can be significantly simplified by using modular design. The VSFX Plant is a true modular revolution in mining industry offering numerous benets such as:

- 20% shorter lead time
- Predened concept and modular design
- Lower investment, installation and operating costs
- Increased availability
- Proven environmentally sound technology
- Enhanced safety

Outotec says that "due to these indisputable benets the VSFX Plant is a true innovation in mining. It is the rst truly modular plant and might act as a spark for the whole industry to start developing modular solutions. Modularisation has been proven an efficient and efficacious method of producing complex solutions in many industries and mining can be the next beneficiary. The future vision of the development team is that modularisation will make its breakthrough and revolutionise the project delivery methods in mining and metals extraction". The Modular SX-plant, VSFX, was developed through an internal product development project. The following key-personnel were responsible for the idea, concept and product development as well as technology commercialisation of modular plant:

Rami Saario - Senior Product Manager - has over a decade-long experience in designing and implementing SX plants around the world. He was the inventor of the initial idea, which was infused during the years when he was solving various problems related to designing and delivering SX plants. He was in charge of the development project and is currently a product manager for VSFX Plant.

Dr Jussi Vaarno - Vice President, Flotation - has a doctoral degree in fluid mechanics and was irreplaceable in the idea and concept development phase. His profound experience was also valuable in evaluating the commercial and nancial aspects of new product. Currently he is responsible for Outotec's whole flotation offering where modular thinking shall be further developed.

Henri Fredriksson - Product Manager - has over 10 years experience in designing process equipment. Especially he has profound understanding of the mechanical aspects of process equipment and provided valuable knowhow from the very beginning of the project by further refining the concept to meet the mechanical requirements. He is currently product manager of process equipment related to VSFX plant.

Jussi Pajala - Engineering Manager - also has a decade of experience in designing and implementing SX and other hydrometallurgical projects. Through his deep understanding of various engineering constraints in implementation projects, he was the one responsible for the concept idea and valuable support through the whole project. He is leading the engineering phase of the rst implementation project.

Juri Matinheikki - Diploma Student - has an education in mechanical engineering and industrial management. He gave valuable insights especially in the commercialisation phase of the development project by applying modern marketing methods to the new product and evaluating and stating the capital expense benets of the new modular plant. Currently he is conducting a thesis related to hydrometallurgical plant proposal management. In addition to these individuals the whole Outotec organization should be recognised for more than a decade of R&D of the SX process as well as providing the unique environment, facilities and organization which support the innovative thinking and made this innovation and new way of thinking possible.

<http://www.outotec.com/vsfx> Related publications R. Saario, H. Fredriksson, J. Vaarno, J. Matinheikki. CAPEX Comparison between Conventional and Modular Type of Mixer-settlers And Plants, Copper International Conference Vol. IV, The Chilean Institute of Mining Engineers (IIMCH), 2013, Santiago, Chile, pp. 149 - 161 M. Weatherseed, J. Matinheikki, R. Saario, H. Fredriksson. Modular Mixer-settlers for SX-Plant Sustainability, Proceedings of ALTA 2014

Nickel-Cobalt-Copper Conference, 2014, Perth, Australia J. Matinheikki, R. Saario, H. Fredriksson. Modular Mixer-Settler technology for medium scale satellite mining operations, ISEC 2014 - International Solvent Extraction Conference, 2014, Würzburg, Germany.