# Reducing water consumption in mining

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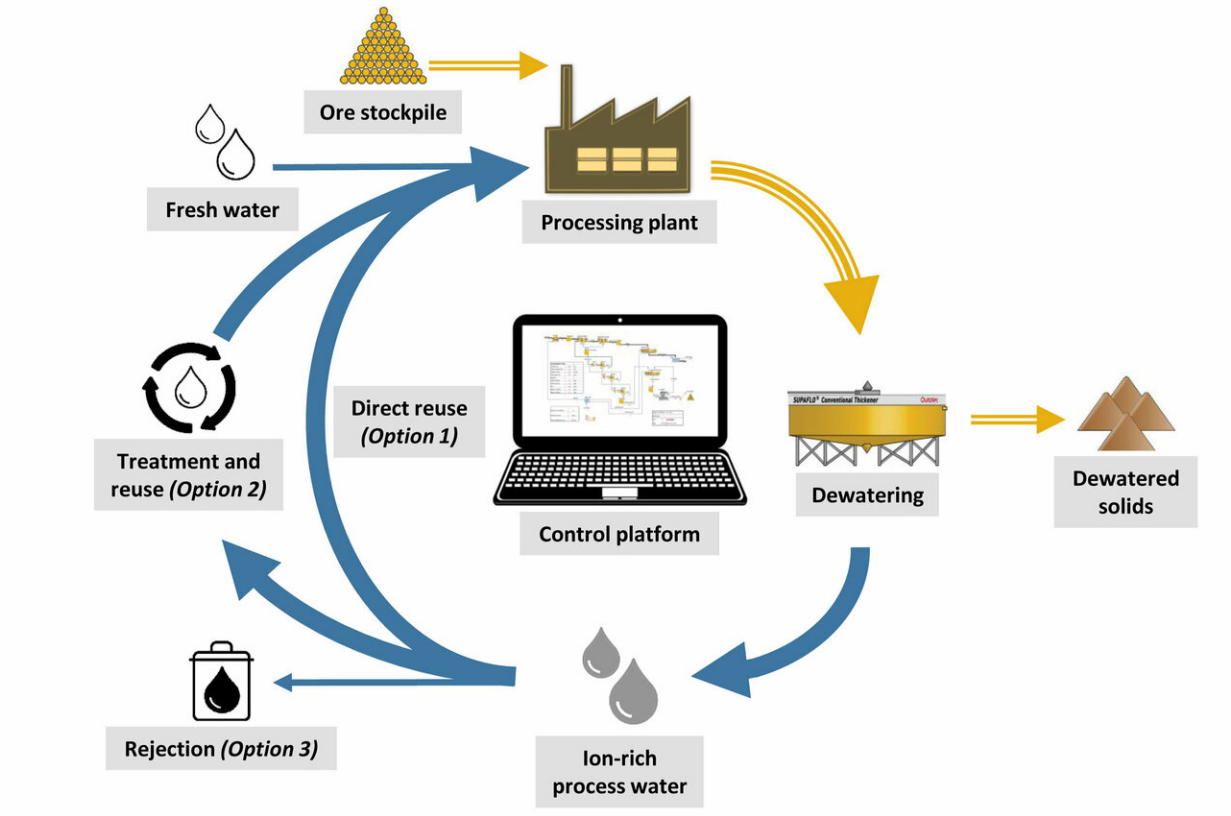


The potential of digitization is enormous: real-time monitoring and truly intelligent process simulation make it possible to extract more raw materials while using less energy and fewer natural resources. Credit: HZDR/ Bruno Michaux

Water is a vital resource on which many industries rely and which should be used more sparingly. An example is the beneficiation of mineral ores.

Taking the raw material fluorite as their example, researchers at Helmholtz Institute Freiberg for Resource Technology (HIF) have now shown how water usage can be optimized. They have developed a new procedure that extends the simulation of the beneficiation process. It indicates the circumstances in which it makes sense for water to be recycled without incurring losses during ore enrichment. The consumption of fresh water can thereby be significantly reduced. This not only benefits the environment but also the mining companies, because it makes the extraction of raw materials more efficient. The researchers have presented their new procedure in the *Journal of Environmental Management*.

Found in smartphones, modern cars, climate-friendly photovoltaic units and used in many other industries, hi-tech materials have become an indispensable constituent of modern technology. Although recycling can partially cover the demand for raw materials, most are still sourced from mining. The environmental impacts are well known: land use, the generation of additional traffic infrastructure and the industrialization of often remote areas. Mining also requires vast quantities of water and produces correspondingly large volumes of wastewater. Working in partnership with colleagues in Finland, a team of researchers at HIF led by process engineer Bruno Michaux has developed a method of making water usage in the processing of mineral raw materials more sustainable. Taking the mineral fluorite as an example, they have shown how the water consumption can significantly be reduced by the aid of process simulation.

Fluorite—also known in mineralogy as fluorspar and by its chemical name of calcium fluoride—is an important raw material for industry. It is used, for example, in the smelting of iron, in aluminum extraction and in the chemical sector as a raw material for producing fluorine and hydrofluoric acid. Probably the best-known product of fluorine chemistry is PTFE, a fluoropolymer which is sold in membrane form

under the trade names Teflon and Gore-Tex.

**Ore beneficiation as a water guzzler**

"The extraction of fluorite consumes a lot of water," explains Bruno Michaux. "Depending on the local climate, but even more so on the design of the mineral beneficiation plant, it can be up to 4,000 litres per tonne of ore." There is obviously nothing that the HIF researchers can do about the weather, but they can certainly contribute to optimizing the processing itself. In this step of the process, waste rock is separated from the extracted ore in order to raise the fluorite content from below 50 percent to around the 98 percent mark.

To accomplish this, the engineers apply the flotation process. In simple terms, it works as follows: the ore is ground and mixed with plenty of water; then various chemicals are added to the mixture to render the fluorite surface water-repellent (hydrophobic). Air is then pumped into said mixture, creating small bubbles that carry the hydrophobic particles to the surface. The fluorite thus accumulates in the resulting foam while the waste rock is left behind. Before the latter can be deposited on a waste dam or returned underground as a filling material, a dewatering step is needed. In order to achieve the desired concentration of fluorite, flotation is repeated several times, which consequently requires a lot of water.

"Mining companies are trying to reduce their consumption of water by using it multiple times," says Michaux. "However, used water contains substances that can interfere with the process performance, and that is something to be avoided." Examples of such substances would be calcium and magnesium ions, which hamper the hydrophobization of the fluorite surface. The potency of this effect depends on the concentration of the ions. The new method now takes into account the influence of the chemical composition of the water on the flotation. As a result of

extensive laboratory experiments with a fluorite ore, the researchers obtained data that reflected the complex interaction of the dissolved substances and integrated them into the HSC Sim simulation software. HSC Sim is already used in the mining industry to map the processing plant and to control mineral beneficiation process.

**Digital monitoring of water and energy consumption**

"With the additional features we developed, the software is now able to take into account the composition of the process water," explains Michaux. "This enables the possibility of recycling the water without compromising the process efficiency." The simulation also allows operators to optimize the use of different water reservoirs in the vicinity of the mine such as lakes, rivers, aquifers or the sea. Further process steps, such as the grinding and dewatering of the ore, are to be integrated in the future. In an ideal scenario, water consumption could then fall below 1,000 litres per tonne of ore.

The research team hope to subject the new method to a practical test in an actual mining operation very soon. "As this requires a fully digitized treatment process in which sensors are continuously measuring and reporting the properties of the streams to process control, it is only larger mines that will venture such an investment at this early stage," adds Michaux. "The potential of digitization is, however, enormous: real-time monitoring and truly intelligent process simulation make it possible to extract more raw materials while using less energy and fewer natural resources." This applies to all ores and not just to the recycling of water in fluorite processing, for which the simulation method was developed by the HIF team.

**More information:** B. Michaux et al, Water-saving strategies in the mining industry – The potential of mineral processing simulators as a tool for their implementation, *Journal of Environmental Management*

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