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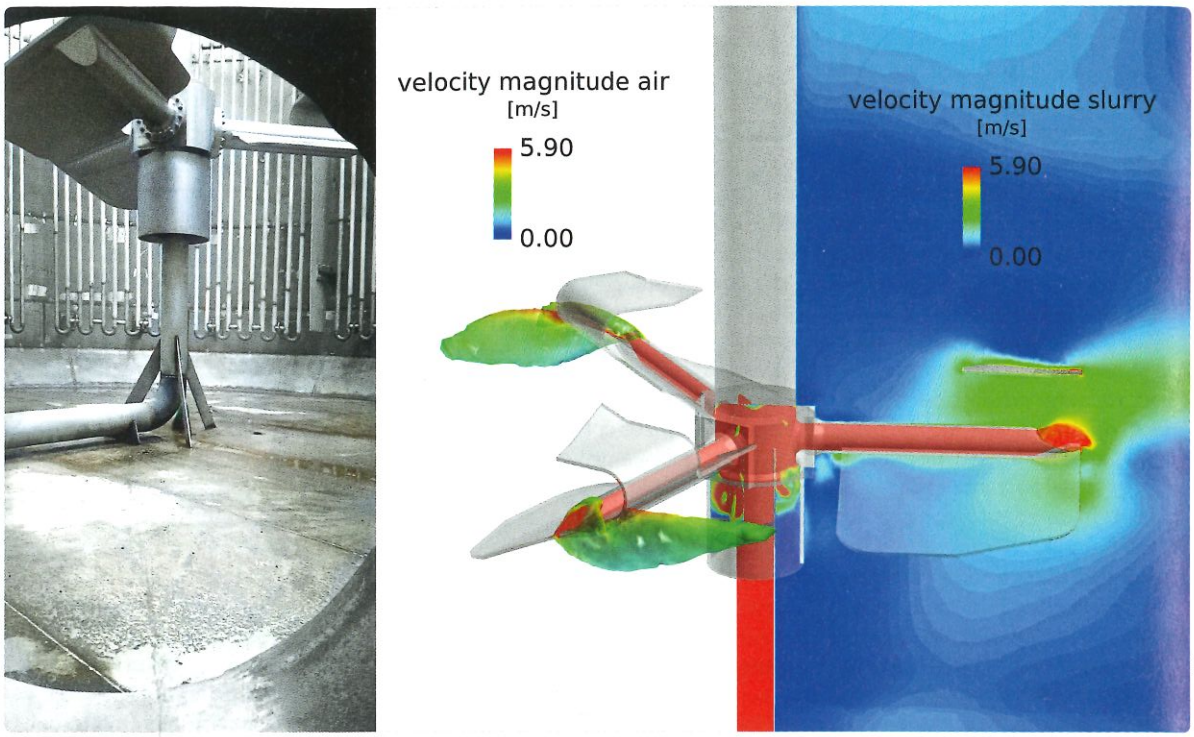
VOGEL COMMUNICATIONS GROUP



Sources: Ekato

Fig. 1: Combijet+ impeller (diameter 4.4 m) in a 800 m³ bioleach reactor. The CFD simulation shows the air and the slurry flow velocities around the impeller.

ON THE PLUS SIDE OF MIXING

Urban mining made profitable by improved mixing technology — On first sight process requirements in urban mining seem to be much less complex as in the classical mining of primary ore bodies since numerous metals are available in high concentrations. Anyhow the presence of many different metals makes the separation to pure end products very demanding and complex.

WOLFGANG KELLER, ANNETTE RÜMMELE, DR. WOLFGANG LAST*

Besides the direct recovery of metals from waste the recycling from sources as tailings from former ore processing plants gets more and more common. This is mainly due to the fact that technological developments and state-of the-art production processes nowadays allow the reclaiming of these former dumps. Other aspects of the reprocessing of tailings are the extraction of by-products, which were previously not the main focus of the operators. In addition to the expansion of resources such reprocessing of heaps can also serve the protection and preservation of the environment, for example, if the uranium content is reduced or in sulfide ores, the uncontrolled formation of acid is suppressed. However, again the processing methods, especially in the extraction of additional metals, can again become quite complex.

Many of the established and new processes required recovering metals and other raw materials necessitates agitated process steps. Some of the many examples include the recycling of clothing, PET bottles and wood. When it comes to metals examples are the extraction of metals from batteries (e.g. lead), red mud (aluminum), gold tailings and the extraction of zinc or aluminum from fly ashes of waste incineration or coal fired power plants. Many of these recovery processes can be designed using available technologies and

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know-how, but some require the development of new technologies or process steps. This applies for agitation as for other unit operations as well. Many of the solutions provided rely on the experience and know-how of the equipment suppliers gained over many years for similar or related applications.

During the development and implementation of new technologies a close cooperation between licensors or end customers with the expertise of equipment suppliers allows developing optimum solutions. This of course applies to the optimization of existing technologies as well and is not limited to the process result itself but also include more economic routes and process steps. Reduced operating and investment costs allow processing low grade or more complex ore bodies with low cost-effectiveness. Mixing as one of the important mechanical unit operations offers diverse opportunities to achieve these objectives. Besides mixing itself other important aspects as materials of construction or mechanical sealing systems have to be included into considerations.

Main Focus on Efficiency and Yield

As already described, many recovery processes are barely cost-efficient, meaning each process step has to be highly efficient and ensure maximum yields. For example in a biological leaching process of gold ores from primary or secondary resources multiple basic mixing tasks have to be fulfilled simultaneously. In a complex biological-chemical reaction sulfur constituents are degraded with the aid of bacteria. These catalyze the breakdown of e.g. pyrite by oxidizing the sulfur and metal using oxygen which is provided by added air. Air feed rates in state-of-the-art reactors with volumes up to 1,500 m^3 exceed 10,000 Nm^3/h which can only be efficiently dispersed by means of agitators.

Here the efficiency and ability of the impeller to cope with multiply mixing task simultaneously is of utmost importance. One result of a specific new development to accept this challenge is the Combijet impeller. A further technological progress is the implementation of the patented "+"-technology where the added gas is delivered via a central supply line to a rotating distributor integrated into the impeller and transferred into the fluid via hollow agitator arms in the zone of the highest turbulence. The Combijet impeller and the "+"-technology already have proven their superiority over other systems in multiple installations. Here power savings of up to 40 % are possible, which for single 1,500 m^3 bioleaching reactor resulted in a power saving of approx. € 170,000 per year.

Such new developments are engineered in the Ekato Technology Center. Here test scales from several liters to 100 m^3 are available. For the Combijet+ development work was conducted in the 1 m^3 and 30 m^3 scale as well as directly in a production plant with original ore suspension in a 30 m^3 tank. Additional in-house CFD simulations contributed to a further optimization of the impeller geometry (figure 1). Apart from new impeller solutions novel materials of construction quite often play a vital role enabling the success of new processes. These are likewise tested in the Ekato Technology Center and implemented if assessed to be advantageous. For example abrasion and corrosion are common phenomena in many applications, especially in minerals processing and are challenges in "urban mining" applications as well. An optimized process design and the correct choice of material are of utmost importance to prevent or reduce wear and corrosion of impeller blades and other components. This increases the life-time of the equipment and the time between maintenance works.

Practical Example: Extraction of Metals from Fly Ash

One example of a process being operated at extremely violent conditions is the extraction of metals from fly ash of coal fired power plants, which were previously deposited after separation from the flue gas. These metals, such as

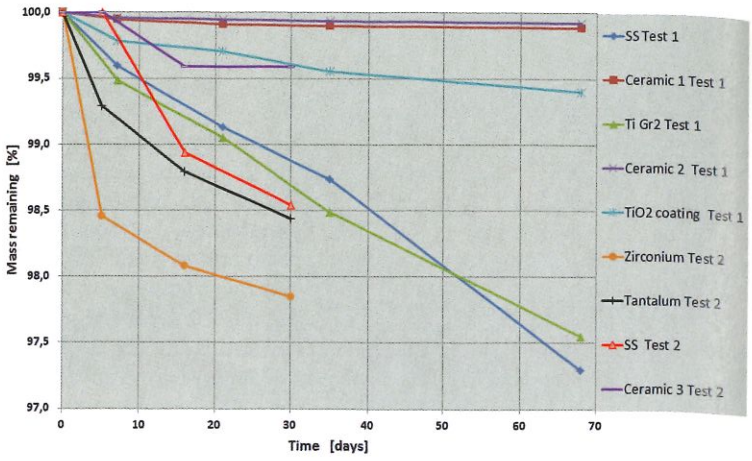

Fig. 2: Mass loss of different blade materials tested in the 1 m³ scale as a function of time

aluminum, can be extracted from the fly ash in autoclaves at elevated temperature and thus pressure with hydrochloric acid. From the process point of view, the know-how and experience from conventional autoclaves can be applied. However due to the corrosive properties even typically used titanium is no longer an option as material of construction. In this specific application only zirconium or tantalum product-wetted parts are suitable, which increases the investment and maintenance costs and thus puts the economic viability of the process into question again.

Besides the high investment costs for these materials, the maintenance costs have to be considered since fly ashes are very abrasive and impeller blades will wear out quite fast. Not only costs for the direct replacement of the agitator blades but also plant downtimes must be taken into account. Here solid ceramic materials offer the great advantage that, due to their chemical and mechanical resistance, the service life and thus the maintenance intervals in the described process can be considerably extended.

Before new materials as ceramics can be adapted and approved for new applications an extensive test program has to be conducted. Here mechanical as well as chemical aspects have to be considered. To determine the abrasion performance of different ceramic materials atmospheric abrasion tests in the Ekato Technology Center were conducted in a model system to compare the performance to standard materials. A flat blade disc turbine with different blade materials was operated in the 1 m³ scale at high tip speeds in an abrasive environment for a period of several weeks. In order to quantify the wear, the chronological weight loss of the impeller blades was determined as shown in figure 2. Based on the measurements, it was then possible to draw conclusions concerning the relative wear resistance of the materials and their differences in service life. A direct comparison of solid ceramic with coated components revealed that the lifetime can be increased by a factor of 10–15 with solid ceramic components. Figure 3 as an example shows an impeller with solid ceramic blades already in use with a diameter of 2.1 m.

PROCESS-Tip

- Meet the Ekato experts at **Powtech** in Nuremberg/ Germany (April 9–11): Hall 2, Stand 346

Fig. 3: 2.1 m diameter impeller with solid ceramic blades

Why Urban Mining Has to Be Expedited

For many materials to be recovered urban mining still is in its infancy. But there are multiple reasons why urban mining has to be expedited. One of them is the environmentally responsible stewardship of available primary resources. But there is as well the necessity since in the production of metals where ore grades are declining or deposits are less available or have to be extracted at higher costs (e.g. underground mining). For other materials as lithium as used in lithium ion batteries the demand will increase drastically in the next decades and the demand cannot be met without controlled recycling procedures.

Many of these currently developed and future new processes to recover raw materials require new or more economic technologies. For an engineering and equipment supplier as Ekato this poses the challenge to come up with new solutions and developments. As discussed the development of new or adapted impeller types allow, to run processes more efficiently from an investment and operation point of view. Here substantial power savings are possible with impeller types as the Combijet+. Not to be forgotten that reduced motor sizes for agitators additionally reduce the mechanical footprint of other plant components as well and therefore the overall investment costs.

Furthermore, more reliable equipment and new materials of construction allow increasing the lifetime of components and therefore maintenance intervals. Some very promising materials are ceramic components which compared to metallic materials are much more resistant from an abrasion and corrosion point of view. Particular ceramics have the potential to boost the lifetime of impeller blades up to 10–15 times compared to the state-of-the-art technology.

New or optimized solutions and technologies are ideally developed in cooperation with licensors or end customers and a competent equipment manufacturer. Besides the many decades of experience in the entire process industry Ekato in its technology center offers the possibility to run tests with original materials or model tests to support its customers. Additional services as CFD and FEM analysis can be conducted in house by Ekato engineers.