PROCESS WORLDWIDE

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EXPERT'S KEY TO SUCCESS

One-Stop turnkey solutions for process automation and explosion protection

Amin H. Nasser
President and CEO of Saudi Aramco:

"If we look at the present business and operating model and ask if it's up to the tasks ahead, I'd say the answer is no."

Modular vs. Mega Plants

THE FIGHT FOR THE FUTURE OF ENGINEERING

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Vogel Business Media

WEAR PROTECTION CUBED

Extending lifetime of agitator parts in three different ways — Wear of impellers is a problem that is often encountered in mixing applications. It is possible, however, to maximize the lifetime of agitator components by implementing appropriate measures with respect to their shape, coating or solid ceramic design or a combination of the above.

BENJAMIN MULTNER, WOLFGANG KELLER*

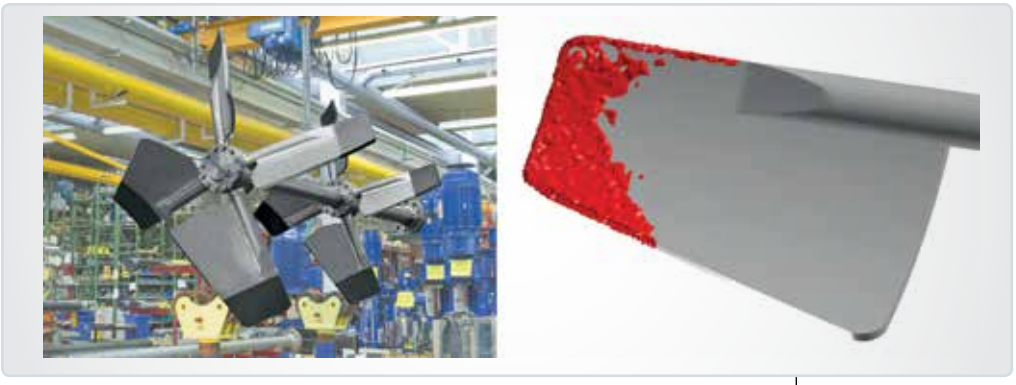
Even in every day life, wear is a common phenomenon. Who has never known the feeling of mourning over a pair of worn-out jeans or old shoes? Technically, wear can be defined as a progressive surface material loss of a solid body caused by a relative motion against yet another solid, liquid or gaseous media resulting in grinding, rolling, hitting or thermal stress.

In process plants, rotating equipment and piping components are subject to wear especially if the process media contains solids. Consequences of wear here are not only the costs to replace the worn out parts but also the loss in production time. In most industries, the consequences of wear are an accepted since principally unavoidable problem. However plant operators demand that suppliers of components provide the highest possible service life that can be achieved by implementing various measures. On the one hand, a wear-balanced design of the agitator will be aimed for with respect to the mixing technology, on the other hand the agitator manufacturer is also requested to develop and implement wear-optimized impeller geometries. Additional indirect wear protective measures are the use of surface-hardening processes or special materials. In this context, ceramic materials must be mentioned as their processing and manufacturing possibilities have taken great developmental strides particularly with respect to shape.

Source: Ekato; © sveta/Fotolia.com; [M] GötzelHorn

One of three possibilities to master wear: the use of solid ceramic impeller/mixer

B. Multner is Head of Mechanical Development R&D and W. Keller Senior Process Engineer R&D at Ekato, Schopfheim.
Phone +49-7622-29-0



Source: Ekato

An EPAL impeller coated with metal oxide (left) and simulation of the vorticity at the blade tip (right).

1. Appropriate Design

Wear is a very complex process which makes it difficult to provide a specific description of the wear process let alone an exact prediction of an expected lifetime. It is possible to perform tests with original products in laboratory scale to optimize the agitator design for mixtures in which the composition, particle size distributions and concentrations are not exactly known. This empirical approach has proven particularly useful for products with rheological anomalies, i.e. mainly non-Newtonian flow behavior with yield stress.

Computational Fluid Dynamics (CFD) can be used to investigate the flow around the impeller blades and optimize blade geometries concerning wear. One result of such an optimization is the EPOX-R. Due to its optimized shape vortex shedding and therefore wear is suppressed without losing the performance capability

2. Coatings

A variety of coating methods and materials exist in order to increase the lifetime of equipment components. These materials are so designed to increase the surface hardness or permit impacting particles to "bounce off". When selecting the coating material, however, boundary conditions such as the operating temperature, corrosive characteristics of the medium or the presence of solvents must all be taken into consideration. Possible materials and methods for coating agitator components are as follows:

- Metal oxide coatings,
- Weld cladding / hard-facing,
- Ceramic linings,
- Rubber and polymer coatings,
- Filled polymers based on epoxy resins or polyurethanes.

Based on the type of coating selected, typical layer thicknesses lie within the range of a few micrometers to several millimeters. In determining the scope of coating to be used, it is often interesting from an economic point of view to only protect the component areas exposed to wear — for example titanium impellers with a diameter >2 m. Only the darker areas at the outer ends of the blades are hard coated. To be able to define the coated areas selectively, the wear-exposed areas must of course be well known. This can be determined in laboratory scale or by using CFD studies.

3. Ceramic Components

In addition to the possibilities described above to increase equipment service life, it is also possible to manufacture impeller blades or complete impellers using solid ceramic components. As opposed to coatings, a solid construction offers the advantage that the same surface hardness exists throughout the entire component. Then once the protective coating is worn off, the base material will again be subject to high wear rates.

Complex geometries can be manufactured thanks to recent developments in the field of ceramic materials and their improved processing options. Nevertheless, it is still especially important to exactly know the hydraulic and vibrational loads on the agitators when designing impellers using brittle ceramic materials.

These are decisive factors for an operationally reliable design. A ceramic-compliant design of the composite — metal and ceramic — or solid structures is a critical factor for the technical feasibility and economic viability of the project. When designing industrial impellers, composite structures are usually used where only the wear-exposed areas are designed of solid ceramic components. Those areas that are not so affected by abrasion — for example blade holders, hub and hub connections — are made of metallic materials.

It is possible to compare uncoated, coated and solid ceramic components with each other in regard to their abrasion behavior on the basis of pilot wear tests at the Ekato test center in 1 m^3 scale. Based on measurements, it was possible to draw conclusions concerning the relative wear resistance of the materials and their differences in service life. A comparison of solid ceramic components with coated components revealed that the lifetime can be increased by a factor of 10 to 15 with solid ceramic components. The use of advanced ceramics is not only worthwhile in areas where components wear out very quickly and plant shutdowns cause high costs, but their use is equally attractive if metallic attrition or dissolved metal ions due to corrosion are not permitted. Highly pure and fine-particle silica serves here as an example.

Summary

Impeller wear is a frequently encountered problem in mixing applications. The lifetime of agitator parts can be extended using the measures described. The increase in cost and time pressure during maintenance work can make an investment using impeller coatings or ceramic materials profitable within a short period of time. Apart from the direct investment for parts to be replaced, downtime costs can be reduced and unplanned breakdowns caused by wear issues can be avoided. Ekato offers for this purpose individual, custom-made solutions. These range from an optimization of mixing processes based on tests in pilot plants and the scale-up to industrial scale as well as an operationally safe design of all agitator components and the vessel.

PROCESS-Tip

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