Solutions against hydro-abrasive erosion
Optimized design and SXH™ coating
What is hydro-abrasive erosion?
The problem for hydropower plants

Hydro-abrasive erosion is the loss of material on those parts of the turbine where water is passing with high velocity and high concentration of hard particles (e.g. quartz).

This leads to changes of the original shape of the turbine parts and therefore to efficiency and power output losses.

Additionally to this, damages can become so severe that the mechanical integrity of the turbine is not ensured any more.

▲ Alfalfal (Chile): Highly particle loaded water leading to very extensive damages
▲ Nathpa Jhakri (India): Uncoated runner with extensive erosion damages
▲ Malana (India): Uncoated Pelton runner after one monsoon season
Influences on erosion
Combination of design and water parameters

To predict how much hydro-abrasive erosion will occur in the hydropower plant, the following information has to be available:

- Future operation frame work, including operation mode (e.g. base load, peak load)
- Representative particle parameters of the water, which will pass the turbine
- Reservoir or desander characteristics, if planned
- Hydropower plant and turbine design (e.g. type and size of turbine)

With the know-how of ANDRITZ HYDRO and the previously described information a prediction of efficiency loss, damage extent and overhaul period can be done.

Long term sampling showing fluctuation of concentration
Holistic approach to the problem

When a hydropower plant will experience hydro-abrasive erosion this should be taken into account from the start of the planning and design process. In the table the main optimization possibilities for the whole process are shown. To minimize the impact of hydro-abrasive erosion the design of the overall hydropower plant, of the turbine and of each part needs to be optimized.

These optimizations influence each other and have an impact on investment and future revenue. Due to this each possibility has to be looked at, to find the overall best solution in terms of investment and revenue.

The analysis if hydro-abrasive erosion will occur and to which extend has to be done as early as possible to be able to implement all necessary changes. The design changes are for Francis (and Kaplan) turbines more extensive than for Pelton turbines.

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Research & Development

R&D on hydro-abrasive erosion:
- Quantitative influence of parameters to gain a better predictability
- Design optimization
- New coatings
- Quality check of coating workshops
Additionally also measurement techniques are tested for future operation in hydropower plants.

![Test rig for erosion tests](image1)

![Erosion on a splitter of a Pelton runner](image2)

![Erosion on a Pelton splitter sample, tested in the wear-lab](image3)
Minimizing the impact of erosion

The strength of ANDRITZ HYDRO is the comprehensiveness of the competencies, ranging from research to hydraulic and mechanical design of turbines, manufacturing and coating. ANDRITZ HYDRO has a long experience in designing turbine for hydro-power plants with high particle loads and almost 30 years of experience with SXHTM hardcoatings. During these years continuous improvements were done regarding the design of the coated parts, as well as for the coating process. This development in minimizing the impact of hydro-abrasive erosion, is mainly possible due to:

- Feedback from customers and field tests due to close and good relations
- R&D on coating and hydro-abrasive erosion
- Coating and hydraulic know-how

Combining feedback from customers and internal know-how on computational fluid dynamics, areas with high damages are analyzed to see if design changes are possible.
Coating development

In the last years following main developments in coating components were done:

- Possibility to fully coat Francis runners by robot
- Increased stabilization of the splitter for Pelton runners (SXH™8X)
- Repair of hardcoating

If coated parts operate under severe hydro-abrasive erosion conditions the SXH™ hardcoating gets locally damaged and the base material is worn away. For these damages certain repair procedures with hard coating or polymer coating have been developed.
Referencedes

Alfalfal (Chile)
Maximal possible power depending on the amount of turbined particles for an uncoated Pelton runner, a runner with standard SXHTM70 coating and a runner with increased stabilization of the splitter, with SXHTM8X coating.

Nathpa Jhakri (India)
Damages after one year of operation are on a fully coated runner very small compared to the uncoated runner. Therefore almost no efficiency losses occur.

Worldwide coated parts
SXHTM are coatings by ANDRITZ HYDRO to significantly reduce the damages due to hydro-abrasive erosion.

SXHTM80 and SXHTM8X:
Type: WC-CoCr Coatings
Micro hardness: >1,000 HV0.3
Adhesive strength: min 70 MPa
Roughness: as sprayed: 4.5-8 µm
Polished: 0.5-1.2 µm

Pelton*
since 1996
- 295 runners
- 2,690 needles and mouthpiece
- 375 other components

Francis/Kaplan*
since 1996
- 302 runners
- 2,827 guide vanes
- 447 labyrinths
- 291 facing plates

* all figures by 12/2014
Coated parts by ANDRITZ HYDRO

Figures present the number of coated parts by ANDRITZ HYDRO.  

Coating workshops of ANDRITZ HYDRO and subsuppliers:  
- Switzerland (Center of Competence)  
- India  
- Chile  
- Brazil

(1) - all figures by 12/2014