DESANDER SYSTEMS FOR HYDROPOWER PLANTS – STATE OF THE ART

Patented removal HSR systems have been convincing customers of their safety, economic viability, efficiency and operational reliability ever since 2001, as has been proven by the installation of over 61 desander plants in Switzerland, Austria and Italy. The HSR sander removal system is employed at small power stations, large water catchment plants, gravel rinsing channels and for several other special applications. Their implementation in renovation projects has also been shown to be successful in increasing efficiency.

The system meets operator requirements for large-scale plants with immense sediment precipitation; as well as in smaller plants and for the renovation of existing infrastructure. Several benefits have come to the fore, such as a very limited degree of wear, despite dealing with extreme loads; lower maintenance costs and work, while guaranteeing a higher degree of operational reliability; significantly improved safety due to a reduction of the susceptibility to build-up surges in the preflood channels, complete control of the rinsing process and a large degree of acceptance among the authorities responsible for granting licenses due to a reduction of negative environmental impact to an absolute minimum.
Fully automated, monitored, remote control systems offer reliable solutions for inaccessible plants, for the reduction of staffing expenses and compliance with environmental and safety directives. The HSR sand removal system stands up to the extreme abrasion generated by alpine stream catchments. Furthermore, it meets the current requirements of plant operators in terms of economical operation and minimisation of maintenance costs.

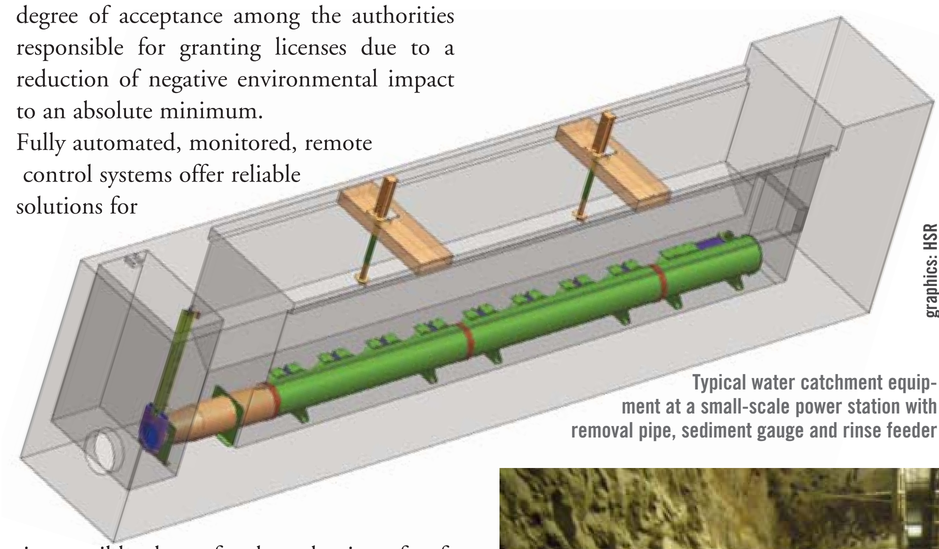
Large-scale projects in Austria:

Water catchment at Stanzertal power station:
- 3 Sediment-Abzugrohre DN 600 x 44m, 3 x 2 sediment gauging devices

Tumpen-Habichen power station:
- 6 sediment removal pipes DN 600 x 42.5m desander
- 1 sediment removal pipe DN 600 x 60m gravel rinsing channel

REQUIREMENTS FOR POWER STATION FACILITIES

Modern power station facilities have to adapt to the needs of the market. They must be safe for customers, conform to general standards, and offer operational reliability, availability and serviceability. They also have to meet client requirements, legal requirements, product and work safety standards, and be – and remain – in good working order. Optimised lifecycle expenditure has to be achieved with a minimum of investment, high efficiency and low costs of operation and maintenance.



graphics: HSR

Typical water catchment equipment at a small-scale power station with removal pipe, sediment gauge and rinse feeder

REQUIREMENTS FOR DESANDER SYSTEMS AND DESANDER EQUIPMENT

Desander systems are expected to remove the greatest possible amount of sediment from water passing through the plant. Rinsing channels and gravel removal devices often have to deal with very large sediment granule sizes. Furthermore, desander basins also have to remove very fine sedimentation. Almost all of this work is done in a long and narrow above-ground sand catchment channel that runs along the preflood basin and rinses in the same direction as the main flow; or below-ground in excavated rock caverns with rinsing against the direction of the water catchment. In both cases a small cross-section desander can raise the shaft in the rinsing channel and lower building costs. The cross-section of sedimentation is determined by the structures of the hydro-plant.
An efficient removal system can reduce the cross-section of sediment and the rinsing pipe can be positioned in a fairly high position. In combination with simple basin shapes, it is possible to achieve significant construction cost savings and implementation can be seen to be viable in various projects.

Large water catchment with extremely large amounts of abrasive sediment. Surges have been reduced to a safe level by rinsing.

photo credits: HSR

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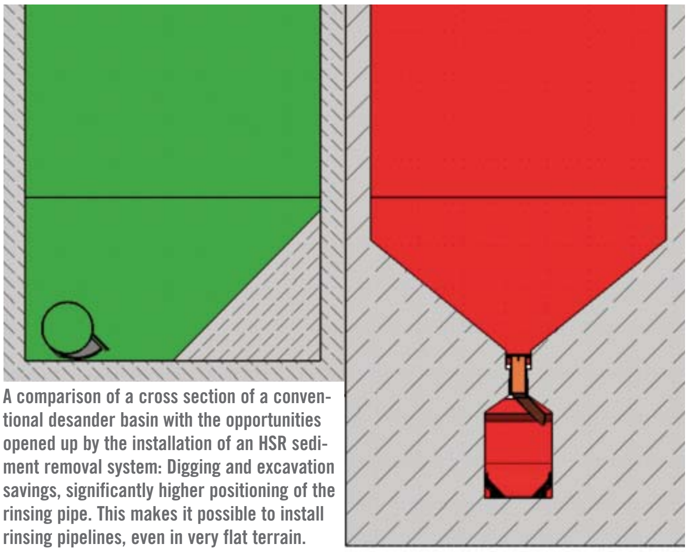


A comparison of a cross section of a conventional desander basin with the opportunities opened up by the installation of an HSR sediment removal system: Digging and excavation savings, significantly higher positioning of the rinsing pipe. This makes it possible to install rinsing pipelines, even in very flat terrain.

For reasons of safety and environmental protection it is necessary to be sure the preflooding basin is supplied in a careful and controlled manner. Minimal amounts of rinsing water and controlled concentrations of sediment, combined with flexible and adaptable automated controls, both remote and on site, are now realistic aims. Operations can completely avoid rinsing during the daytime and supply water to the preflooding basin gently and in a biologically friendly manner. Modern operative management requires maintenance and replacement to be conducted without downtime. Electro-technical devices are expected to be maintained and made operable with as little interruption, effort and expenditure as possible. Inspections and cleaning work need to be carried out with the necessary efficiency, while also corresponding with current work safety standards. Today, many moving electrical, hydraulic and mechanical components in desanding basins that deal with water with high concentrations of sediment, no longer meet all the latest specifications as regards reliability, availability, maintenance and safety. Flushing gates often require special technical set-ups.

PATENTED SEDIMENT REMOVAL SYSTEM HSR

The HSR sediment removal system was developed as a customised welded construction and was optimised during a series of elaborate hydraulic model tests. The diameter is selected according to the overall dimensions. In practice, in the majority of cases this involves the installation of removal systems with a diameter of 600mm. There are standardised solutions with a diameter of 800mm for larger desanders and also smaller 400mm diameter standardised solutions.

photo credits: HSR

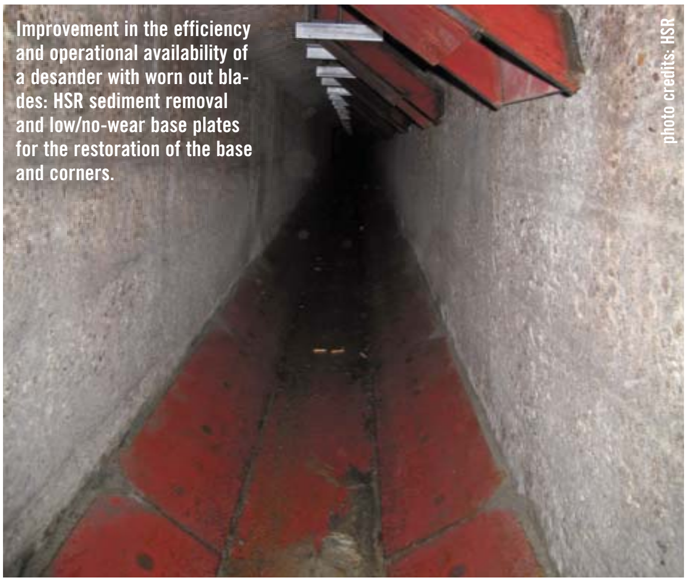
Efficient sediment removal with affordable construction and safe inspection access.

Based on the scale model experiments it was possible to reduce the amount of water required for rinsing to less than 20% of the volume needed by a conventional narrow rinsing channel, so for most versions of the preflooding basin, there is no need for alert-water. The resultant saving of rinsing water can rise to over 90%.
The removal pipes can be placed in a desander basin with a square cross-section without a drop in efficiency. This provides a simple, low-cost, high-volume desanding chamber with a minimal excavation section, or a higher installation height with less digging required. In the corners above the rinsing pipe and on the opposite side, dependent upon the angle of precipitation, there are persistent sloping sediment deposits. The rinsing and emptying processes do not remove them completely. However, for the ongoing removal of sediment this is not an issue. An ideal and clean solution is the setting in concrete of a 45° slope along the removal pipe.
An extension pipe is required in the removal units for cleaning purposes. The sediment removal pipes can be operated and maintained simply and cheaply. Repairs and replacements can be done easily and without great effort or expense. The sediment removal elements enable the sediment basin to be designed in such a way as to allow easy access; and maintenance can be conducted in a hazard-free environment.

The removal system consists of the following parts:
• Steel pipe (cone) connector integrated during construction and linking up to the rinsing pipe
• Extension pipe for viable servicing opportunities
• Modular rinsing pipe with evenly spaced rinsing chambers
• Adjustable lid to fine-tune the rinsing jet openings

Rehabilitation is possible by new rinsing chests and cover plates installed in the rinsing slot with a minimum of adaptive work. It has been designed in such a way as to allow problem-free installation in the narrow rinsing channels.

The rinsing pipe and rinsing chest are designed in such a way as to facilitate the following functions:
• Opening the rinsing organ triggers the rinsing process
• A hydraulic switch effect triggers the removal process
• The systematically established turbulent flow makes it possible to increase drag speed without additional loss
• The rinser can be directed from the initial opening to the rinsing opening, and closed once rinsing has been completed.



Improvement in the efficiency and operational availability of a desander with worn out blades: HSR sediment removal and low/no-wear base plates for the restoration of the base and corners.

photo credits: HSR

There are two distinct rinsing procedures:
• Rinsing procedure during operation (automatic operation possible): Uninterrupted catchment: Maximum efficiency of solid material removal using the least possible volume of water. To ensure full use is made of the sediment removal system it is necessary to be equipped with a rinsing pusher that can be set to operate at a suitably high speed.
• Emptying procedures (can also be done via remote control). Complete removal of all solids (according to the shape of the settling basin). This rinsing process is used when the water catchment system is switched off, to empty the precipitation basin, to ensure subsequent distribution of the preflooding basin, and for inspections.

In the case of desanders with a concrete ceiling, a maintenance hatch with an opening large enough for installation and servicing work is an imperative recommendation. This also goes for assembly and installation aids on the desander roof. The opening is designed to enable the installation of a rinsing pipe.
HSR sediment removal systems can also be built into gravel removal systems, gravel rinsing channels, driftwood and flotsam collectors, equalising basins and cold water basins. It can cope with stones up to the size of those used under railway tracks, and even larger stones if covered by sufficient water.


photo credits: HSR
Modern, low-cost sediment gauging device.

FLUSHING GATES
Good experiences have been made with low-cost, rust-free plate feed rods with self-cleaning guide grooves and covered seals. Minimal life-cycle costs can be achieved when replacement servicing is carried out. For heavy duty usage there are high performance rinsing feeders with self-cleaning guide grooves and non-rusting, well protected sealing surfaces. Robust hydraulic engines drive the feeders very effectively.

SEDIMENT GAUGING
Full capacity vibration probes meet today's maintenance requirements very cost effectively. There is no need to install underwater devices whatsoever. The probes can be serviced and replaced without interrupting operation or lowering water levels. Access shafts to sediment gauging devices are highly recommended.

STILLING GRIDS
Sedimentation basins react very sensitively to sudden additions to flow volumes. For this reason stilling grids are mostly installed at the end of a sloping inflow cone. The components can suffer damage if filling is too rapid or if there are sudden cloudbursts. The individual parts have to be light and easily replaced. Modern manufacturing methods enable the production of robust and affordable grids of non-rusting steel, thus fulfilling all current product safety and work safety requirements.


photo credits: HSR
Rust-free stilling grid construction - optimised for reliability, maintenance and safety.

WATER DISCHARGE FACILITIES
A constant water level and the correct placement of low-sediment-content water allow logically calculated and precise water discharge facilities for preflood channels and basins. Seasonal adaptions to discharge volumes are achieved simply. Compensation of rinsing water loss can be managed with the necessary effort. Separate water discharge facilities are more economically viable and provide clearer and exacter records of the amount of water discharged in comparison with direct discharge via the sediment removal facilities.

ADDITIONAL EQUIPMENT
Steps and access facilities enable maintenance work and inspections to be conducted safely. Inspection hatches, built-in lifting gear and the corresponding design of desander basins and sediment removal infrastructure make servicing a safe job.

Further reading:

- Bernhard Truffer, Martin Küttel, Jürg Meier: „Wasserfassung Titer der GKW – Entsanderabzüge System HSR in grossen Entsanderanlagen“, Wasser Energie Luft 2009 Heft 3, CH5401 Baden
- Prof. Dr. Robert Boes „Wasserbau Fassungen“; Professur für Wasserbau ETH Zürich
- Christoph Ortmanns: „Entsander von Wasserkraftanlagen“; Dissertation 2006, VAW ETH Zürich
- Heinz Patt, Peter Gonsowski: „Wasserbau“ 7. Auflage 2011, Springer-Verlag Berlin Heidelberg

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