REFURBISHMENT AND AUTOMATISATION OF TRASHRACK CLEANERS

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The Styrian electric supply company STEWEAG (today: Verbund) has been operating Hydroelectric Power Stations on the river Mur for decades. These power stations are equipped with various types of Trashrack Cleaners (TC) – all wire rope operated -, year of construction from 1927 up to 1981. From 1998 to 2001 the TC's of seven plants were refurbished, upgraded and fully automated. Today the standard trashrack cleaning procedure is carried out unattended by all engines.

1 Power Stations

The Trashrack Cleaners of the following Power Stations were refurbished:

Power Station	Debris Handling	Year of construction	Start of refurbishment
Gralla	driven container wagon	1964	1998
Pernegg	driven container wagon	1927	1999
Laufnitzdorf	backed-up container wagon	1931	1999
St. Dionysen	backed-up container wagon	1942	1999
Gabersdorf	Truck	1974	2000
Spielfeld	Truck	1981	2002
Obervogau	Truck	1977	2002

All Power Stations are equipped with travelling rope operated Trashrack Cleaners.

The power stations Pernegg, Laufnitzdorf and St. Dionysen ("SMALL Trashrack Cleaners") are diversion canal power stations, Gralla, Gabersdorf, Spielfeld and Obervogau ("BIG Trashrack Cleaners") are run-of-river power stations.

All TC's were operated by hand and only from the control station. Also the debris transport and disposal was handled only by manual control. Consequently for the operation of a TC at least one operator had to be continuously on site.

The rail-mounted driven container wagon is directed by the operator from the control platform to the dumping station. The debris is dumped to the low-lying debris disposal site (Power Stations Gralla, Pernegg).

The rail-mounted backed-up container wagon is pushed by the TC to the dumping station. A pushing plate mounted to the TC is lowered into the container behind the

debris. The TC starts moving and the debris is pushed by the push plate from the blocked container and falls to the low-lying debris disposal site (Power Stations Laufnitzdorf, St. Dionysen).

The trucks are small four wheel-driven dumpers, placed under the throw-off chute of the TC. Every time the TC changes its position, the driver of the truck also must change the truck's position. The full truck is driven to the debris disposal site and emptied (Power Stations Gabersdorf, Spielfeld, Obervogau).

2 Operating Conditions

Under normal operating conditions at both types of power stations the debris can be collected easily by the TC's.
The diversion canal power stations are less influenced by high water. The greater part of the big-sized floating debris passes the weir and doesn't reach the trashrack. Debris not removed by the rake is picked up by the crane with the timber grab.

Run-of-river power stations are much more influenced by high water. Enormous quantities of driftwood reach the trashrack and have to be drifted over the weir or picked up by the rake or the crane.

Accumulated debris & driftwood in Gralla (after refurbishment of the TC)

At normal water flow the floating debris can be pushed by the surface-rake from the trashrack area to the weir and then drifted over a lowered gate to the tail-water.
During rainstorms the driftwood comes with such a velocity and in such quantities that drifting over the weir is not possible anymore. Within a very short time a carpet of driftwood with a thickness of one meter and more is built up, compact enough to walk

on it. To drift this material is not possible any more: even a heavy duty surface rake is not able to rip up such a carpet in movable and driftable portions. In this case only a mobile excavator or the crane with the timber grab can help.

3 Requirements

Purpose of the refurbishment was the fully automatic, unattended operation of all TC's.

To achieve this purpose it was necessary to

- overhaul the structure and the mechanical equipment
- replace the electrical equipment and the control system
- replace the cranes of the big TC's and equip the small TC's with cranes
- equip the big TC's with heavy duty surface rakes for floating debris
- improve the debris handling and storage systems

All mechanical equipment of the TC's like rake, winch, travelling gear etc. had to be completely overhauled. Hydraulic power packs and hydraulic piping had to be replaced. The electrical control system including sensor technology (distance sensor, limit switches etc.) had to be changed to SPC, all control boards, cable drums, cablings had to be replaced, too.

According to the described requirements all TC's had to be equipped with a crane with timber grab or orange peel bucket.
The lightweight surface rakes of the TC's at the run-of-river power stations in Spielfeld, Obervogau and Gabersdorf had to be replaced by heavy duty equipment.
The debris handling equipment had to be overhauled or replaced, the capacity of the debris containers had to be increased.

4 Realization

4.1 Mechanical Engineering: Complete Overhaul

The overhaul and replacement of frames, winches, rakes etc. will be briefly described.
The winches of the TC's Laufnitzdorf and St. Dionysen were replaced, all others overhauled and equipped with the state of the art safety and control devices (e.g. slack rope detection).
The rakes were repaired, the wheel bearings replaced, the wheels tyred with Polyamid wheel-treads.
Most of the TC's were equipped with hydraulic operated throw-off chutes to simplify moving the container wagons and trucks.

New Winch, TC St. Dionysen

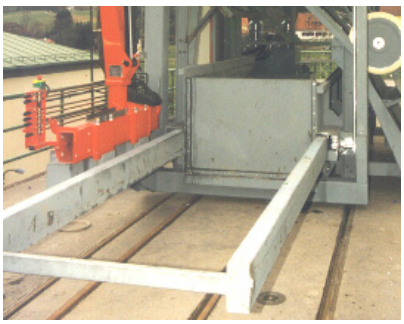
Repaired Rake, TC Gralla

4.2 Mechanical Engineering: Crane, Surface Rake

To accept the additional load by crane and surface rake operation the stressed structures of all TC's had to be considerably reinforced.

The existing structure of the small TC's was stiffened by a parallel structure of rectangular hollow sections.

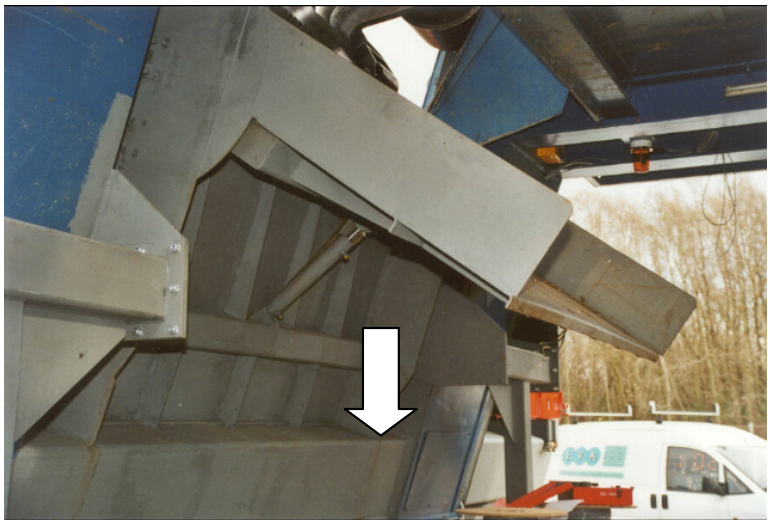
Hollow section frame, TC Laufnitzdorf



Integrated container
with pushing plate for debris

TC Pernegg with crane and container wagon

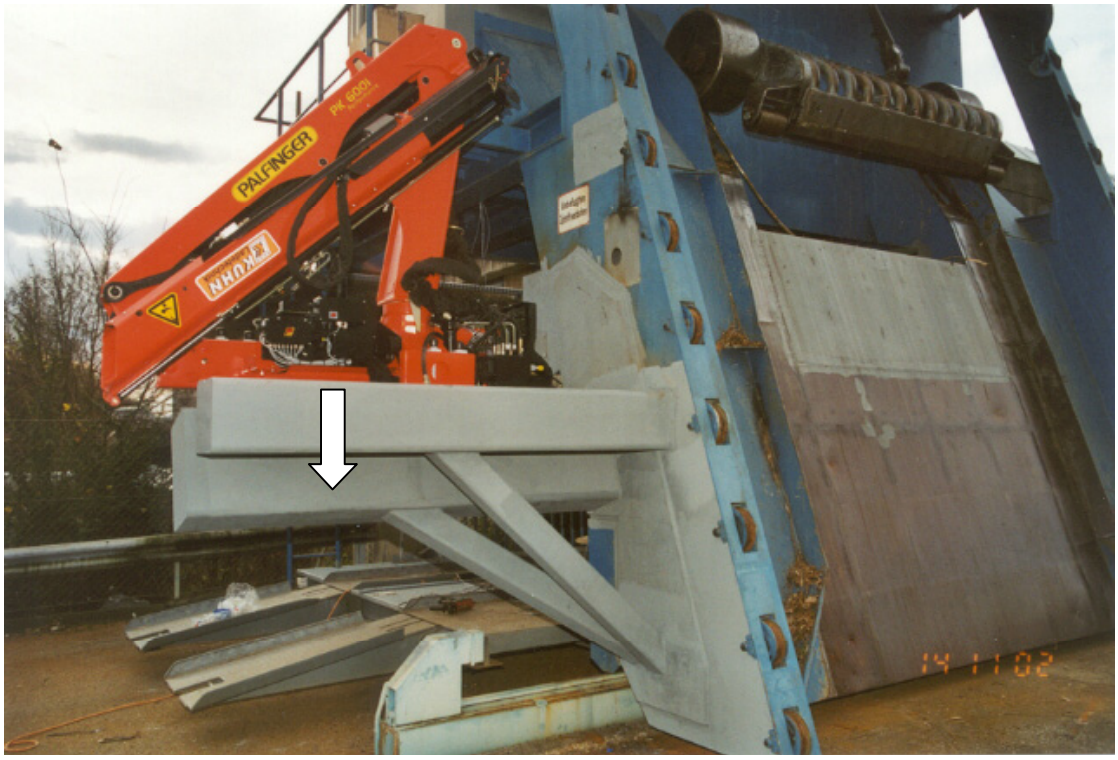
The big TC's were stiffened by a large-sized horizontal rectangular hollow section. This stiffening beam is placed above the wheels and has an overhang on both ends of the TC to carry the crane and the surface rake. On these both ends the beam is connected with an additional load spreader to the frame. So the torsion and bending loads from crane and surface rake operation are distributed to the frame of the engine.
A nearly vertical position over the total height of the frame was selected for the stiffener beam for the TC Gralla, as a horizontal position was not possible in this case.



⇓ Rectangular hollow section

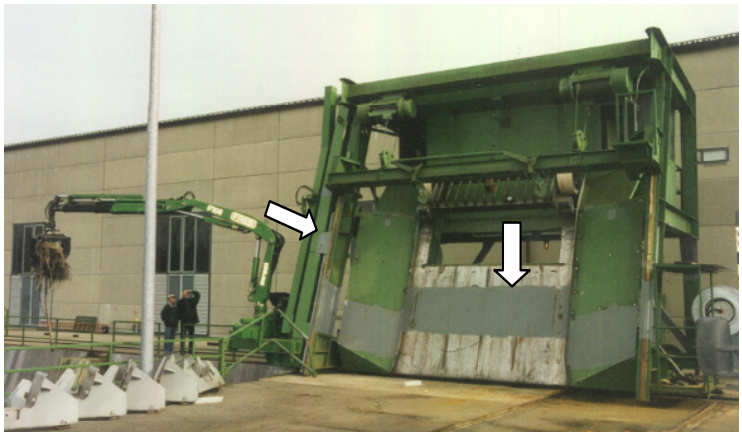
Load spreader
(Bracket for surface rake)

TC Obervogau



⇓ Rectangular hollow section as bracket for the crane
TC Obervogau

The winch house of the TC Gralla was lifted by 800 mm to get space for a bigger debris container.
The surface rake in this case has an additional vertical rotation axis to push the debris from the trashrack upstream and then turn it parallel to the trashrack to be able to pass the columns between the turbine entry ducts.



⇒ Stiffener beam

⇓ Lifted winch house

Rotating surface rake

Crane with timber grab
TC Gralla

4.3 Mechanical Engineering: Debris disposal

4.3.1 Container wagon, backed-up

The original system of the TC's Laufnitzdorf and St. Dionysen was fundamentally changed. The container wagon was omitted, the container is now an integrated part of the TC. To remove the debris a hydraulic driven pushing plate is placed in the container. During cleaning operation the pushing plate is retracted and nearly invisible. If the container is filled up, the TC drives to the debris dumping position. The hydraulic driven pushing plate moves the debris to the discharge point.

Pushing plate, lifted
Profile fits to container wagon

Container wagon

TC after refurbishment

Debris

Debris disposal

TC St. Dionysen

4.3.2 Container wagon, driven

The original container wagons (Pernegg, Gralla) were replaced. The new ones were fitted to the existing railways.
The small container wagon in Pernegg was designed as "wireless satellite". Electric energy is supplied by a vehicle-mounted set of accumulators. During cleaning operation the vehicle is coupled up to the TC, the accumulators are charged. The electromagnetic coupling between motor and drive wheels is released. If the container has to be emptied, the TC stops cleaning operation and releases the connection between TC and vehicle. Until the return of the vehicle the TC is at rest.

OLD NEW, tipped container

Container wagon TC Pernegg

By releasing the coupling between TC and vehicle the activity of the container wagon is started. Motor and wheels are connected by the electromagnetic coupling, the vehicle drives self-controlled to the dumping station. The container is dumped

automatically (side tipper) and emptied. The container returns to its prior position, the vehicle drives back and is coupled again to the TC. The cleaning program continues.

The big container wagon in Gralla is also designed as a satellite, electric energy is supplied by a cable drum. This container is a rear tipper.

OLD NEW

Container wagon TC Gralla

4.3.3 TRUCKS

The trucks have to accompany the TC for a considerable distance, that is, in both directions. As it is difficult to achieve a straight run of an unguided pulled and pushed truck, the solution used for the container wagons was not applicable.
So the TC's were equipped with platforms to carry the trucks, positioned under the throw-off chute The truck is on board of the TC moving synchronously. If the container has to be emptied, the TC stops the cleaning operation. An operator drives the loaded truck to the debris deposit area and the unloaded one back to the TC.

OLD NEW

TC Obervogau

The platform of the TC Gabersdorf was mounted to the supports of the winch house. The platforms of the TC's in Obervogau and Spielfeld were mounted upstream to the supports of the winch house leaving space for the railing along the trashrack area. Downstream the platform was hung up to the above girders of the winch house.
To enter the platform with the truck, moving access ramps are provided. These ramps are kept by rubber springs a few centimetres above the floor. By the weight of the truck the ramps are pushed down to ensure stepless access to the platform.

4.4 Electric Control System

The electric control system will be briefly described.
For the small TC's the electric control systems were made by STEWEAG.
The electric control systems of the big TC's were completely replaced including wiring, cable drums etc. Siemens Simatic S7-300 was used as SPC in connection with AST-bus-systems. Fully automatic, partial automatic and manual operation can be selected as operating modes.
All TC's are equipped with radio control systems. All trashrack cleaning functions and the surface rakes can be operated by remote control. At the TC Gralla also the crane is remote controlled.

For position indication a laser telemeter is used in Gralla and Gabersdorf.
For the other TC's a very simple heavy duty shaft encoder, consisting of a toothed wheel and a limit switch, is used.


Encoder

At a certain position of the TC an automatic reset of the encoder ensures accurate position indication.

5 Operating Experience

On the occasion of a visit to all Power Stations and meetings with the plant managers operating experiences were discussed. Generally all systems work satisfactory. Some remarks were made.

- The laser position indication system works very accurately, but it is not weatherproof. Dew on the mirror, rain, snow inhibit the reflection of the laser beam, the system fails.
- Because of the missing of a hydraulic driven movable throw-off chute at the TC Gabersdorf the truck cannot pass to the other side of the TC to be loaded by the crane. A retrofitting of the TC is desirable.
- For safety reasons a radio control system for the cranes of all TC's is desirable.

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