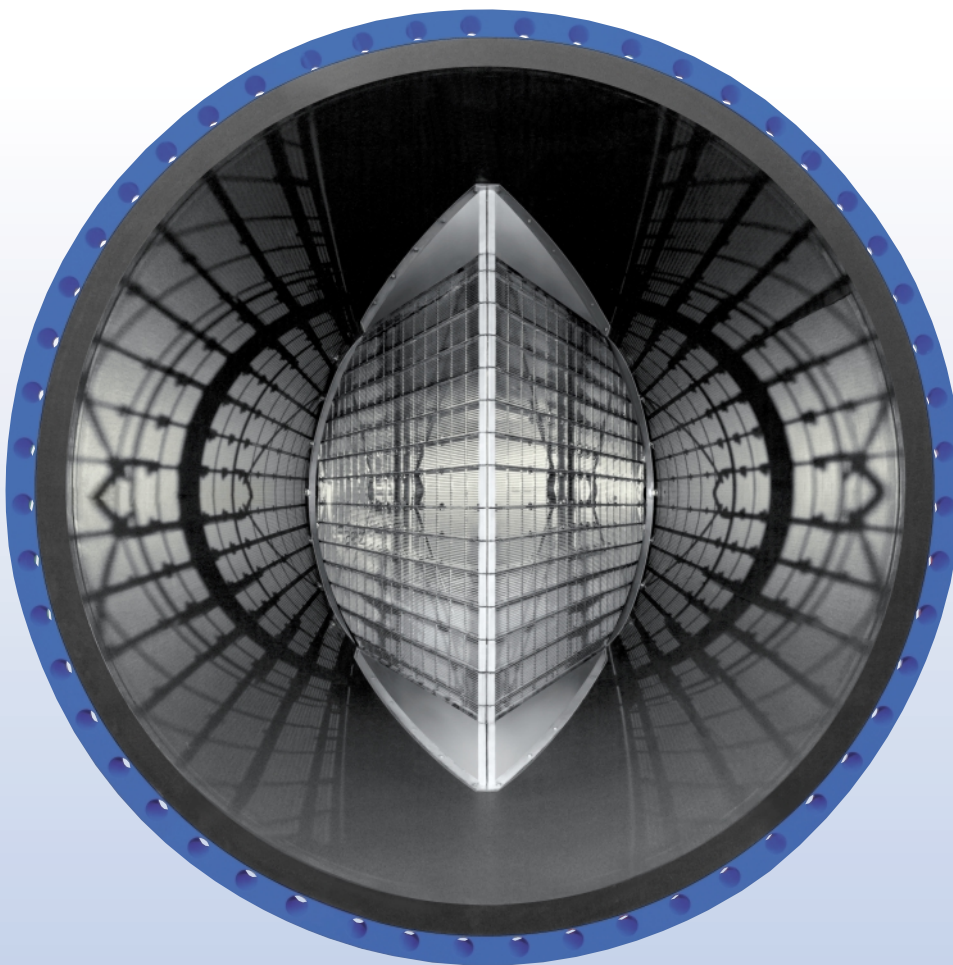


# IN-TA-CT<sup>®</sup>

Tube Cleaning for Power Stations and Industry



Tube Cleaning

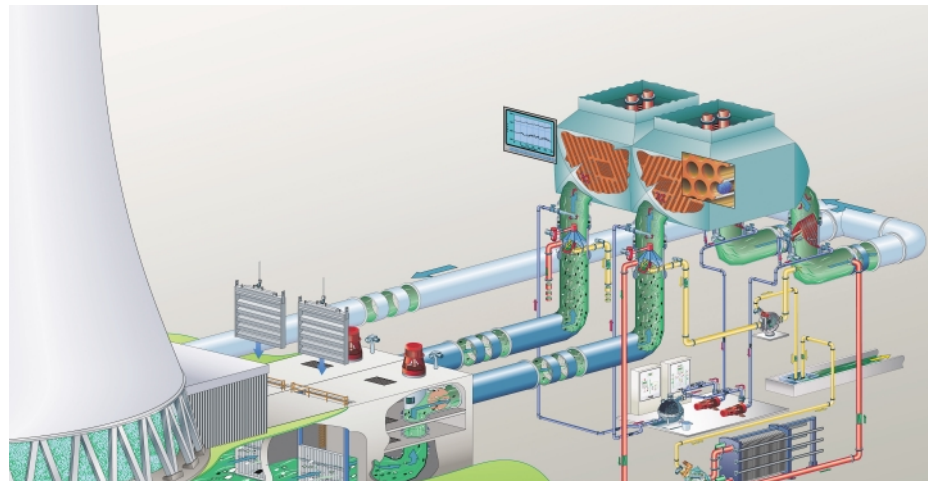
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## The TAPROGGE System.

*In 1950 it was still an idea and a vision. In 1952 it was patented and successfully operated for the first time. In 1953 it formed the first basis of business of the TAPROGGE company. Over the years it was perfected and its range of applications extended. Today it is the world standard: the TAPROGGE System - synonym and technical reference the world over for the continuous cleaning of cooling tubes in heat exchangers and condensers.*

*More than 10,000 TAPROGGE Systems installed in the cooling water circuits of power stations, seawater desalination plants and in industry yield thermal performance gains for the operators day by day. At the same time the environmental burden is reduced.*

TAPROGGE in power stations with cooling towers

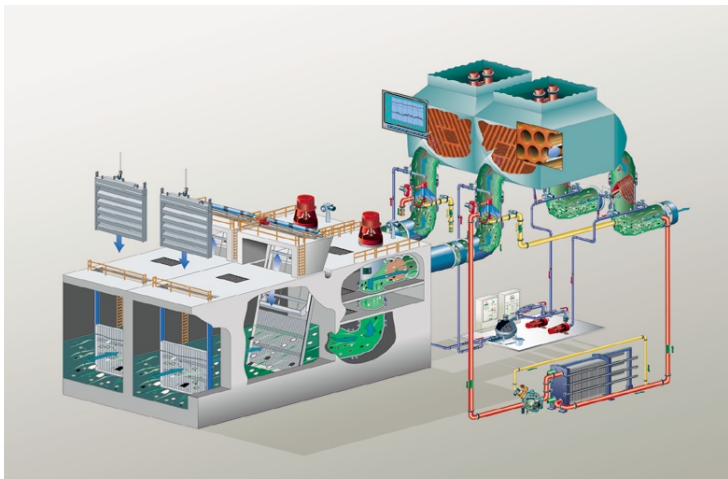


Although the TAPROGGE System is recognized initially as system engineering, at its core it is pure process technology. The comprehensive understanding of this process gained from the application experience of our installations guarantees our ability to provide the solution to macro fouling problems with most different types of cooling water and tube materials.

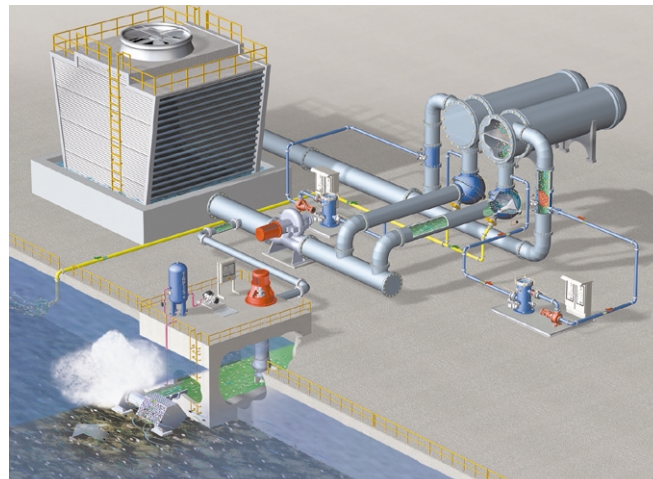
By their integration into our overall IN-TA-CT® scheme, TAPROGGE Systems are ideally harmonized with the TAPROGGE Debris Filters installed upstream.

With the integrated service concept IN-TA-S®, TAPROGGE Systems are smoothly complemented by a permanent, competent and successful aftersales service and application care.

TAPROGGE in power stations with once-through cooling



TAPROGGE in industry

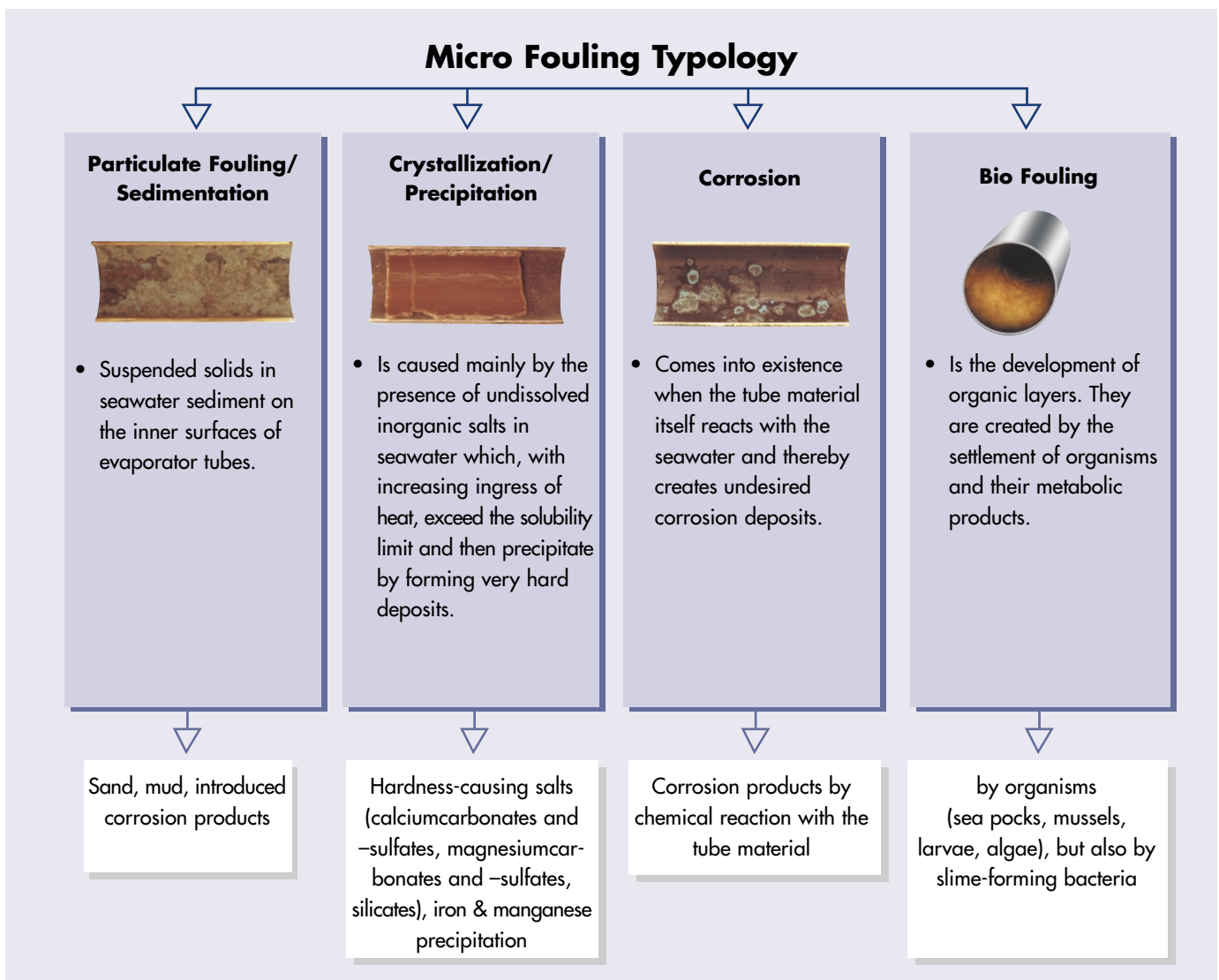


## A Challenge: the Micro Fouling Problem.

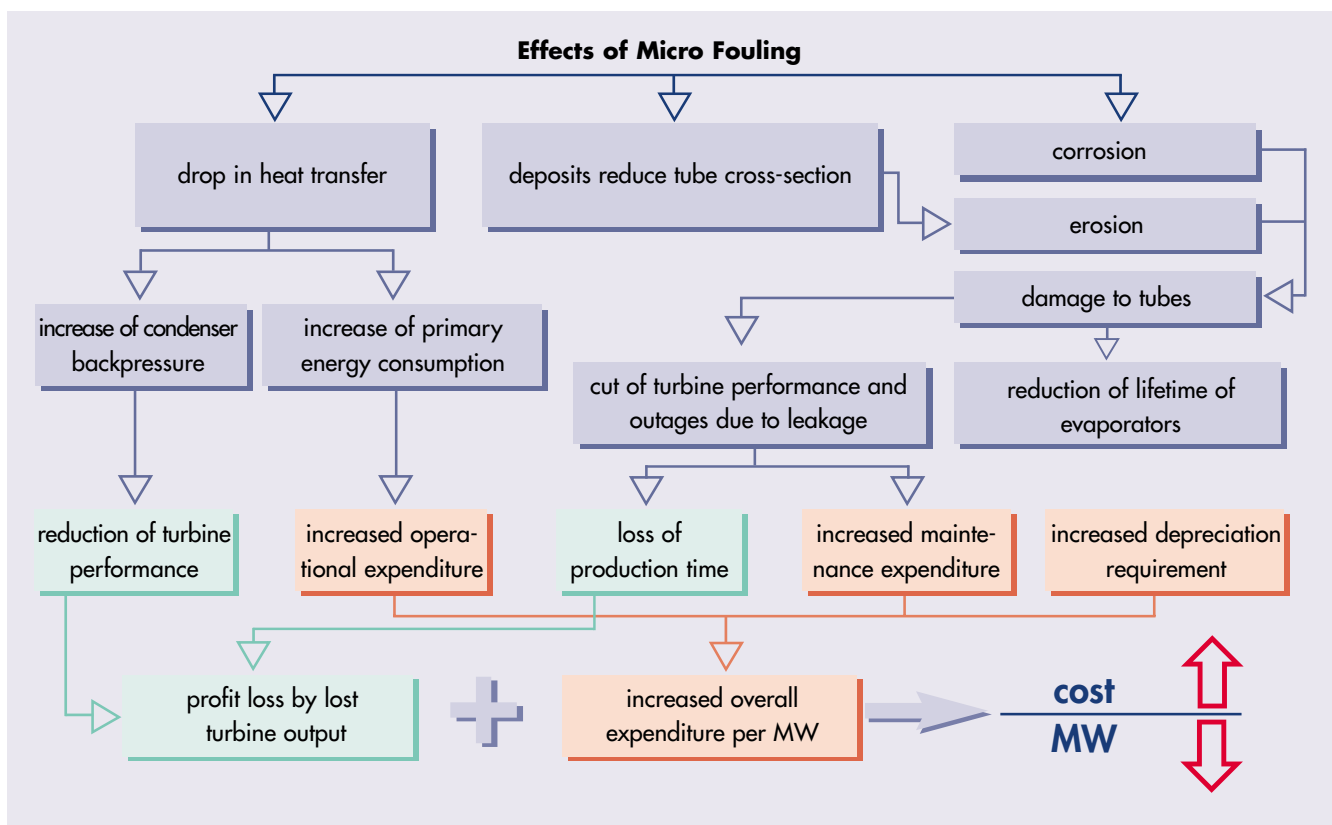
The surface waters used for cooling purposes in power stations or industrial plants contain dissolved and undissolved substances which, depending on location and type of prescreening system, can significantly vary in both, quantity and composition. The undesired deposition of these substances on the tube surfaces is designated as micro fouling. Normally several fouling mechanisms occur in cooling tubes at the same time and intensify.

Additionally the formation of micro fouling is strongly influenced by

- tube material (increased bio fouling with titanium and stainless steels, as well as corrosion tendency with copper materials), and
- cooling water temperature (tendency of hard precipitation)



Micro fouling impairs the heat transfer in cooling tubes. As a result, the efficiency of condensers and heat exchangers decreases. In addition, micro fouling can result in frequent unscheduled outages for manual cleaning purposes, and in damages to the heat exchangers.



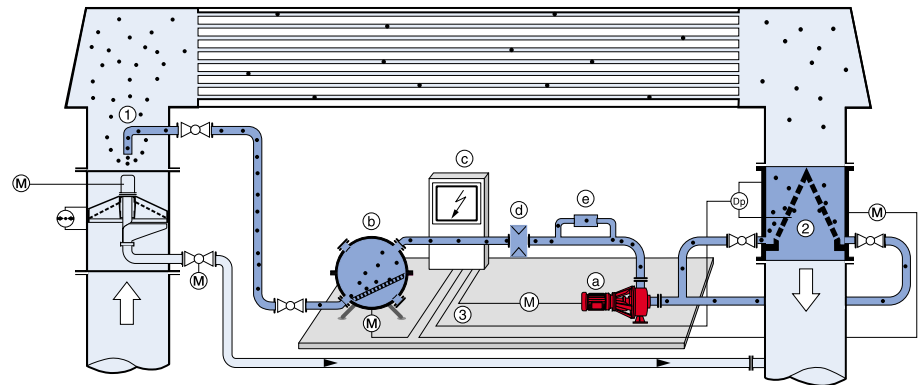
Performance losses due to the above which, when converted into MW, are in the range of 9 - 23 MW for a 1300 MW nuclear power plant unit, and of 4 - 10 MW for a conventional 600 MW turbine unit, are not acceptable in the international water business, especially when taking today's competitive conditions into account.

TAPROGGE Systems reliably solve micro fouling problems. They permanently maintain the heat transfer of the heat exchanger. Due to their high importance for the efficiency and availability of the plants and their short payback time of 0.5 - 2 years, they have been state of the art for power stations and industry for many years.

A good guide to the value of thermal losses from micro fouling in modern power stations is:

- micro fouling causes a rise of the heat consumption of a turbine unit by between 1 and 2 %
- an increase of the condenser back-pressure of 10 mbar due to micro fouling causes a loss of electrical output of 0.7 - 1.8 %

## From the Idea to the Solution.



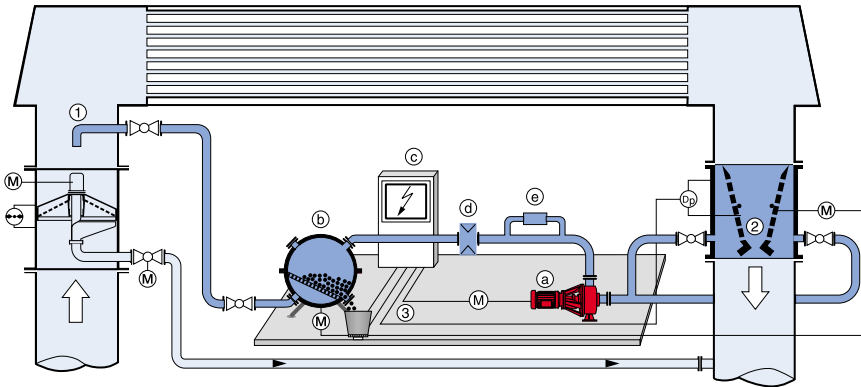
TAPROGGE System (cleaning operation)

The process that was named after its inventor, Josef Taprogge, results in the permanent cleanliness of the inner surfaces of heat exchangers and condenser tubes. According to the TAPROGGE principle, flexible sponge rubber balls with diameters slightly larger than the diameters of the tubes to be cleaned circulate through the tubes.

### A. Cleaning Operation

The cleaning balls are injected into the cooling water pipe via the ball injection (1) in the inlet area of the heat exchanger. By the water flow they are distributed in the cooling water and moved through the tubes where they do their cleaning job.

After passing through the cooling tubes the balls are separated from the flow via a strainer section (2) arranged in the cooling water outlet and re-transported to the cooling water inlet by a ball recirculating pump (3a) in the recirculating unit (3) where they are fed again into the cooling water flow via the ball injection (1). This procedure is continuously repeated. To safeguard a long-term cleaning result, the quantity of circulating balls is principally selected so as on an average every cooling tube receives twelve ball passages per hour. Optionally the recirculating ball number can be ascertained automatically by our Ball Recirculating Monitor BRM (3d).



TAPROGGE System (screens in backwash position / extraction of cleaning balls)

## B. Backwash of Strainer Section

As the cooling water may contain fouling that can settle on the screens, the strainer section (2) is designed as backwash type. Backwash is initiated in dependence on the degree of fouling (differential pressure across the screens), and according to pre-set time intervals.

To avoid ball losses, all cleaning balls circulating in the cooling water circuit are caught in the ball collector (3b) before the start of the screen backwash. Only then the screens are moved in backwash position and are passed by the cooling water from the rear side. In such a way, fouling is detached from the screen and removed with the cooling water flow. Upon return of the screens into operating position the balls are released from the ball collector (3b) whereupon ball circulation starts again.

All processes are centrally monitored and initiated by a controller (3c).

## C. Extraction and Charging of Cleaning Balls

Depending on tube condition, the cleaning balls are subject to stresses of different levels. Before they are worn down to the same diameter as the cooling tube they must be replaced by a fresh ball charge.

Although no general indications can be made about the period until the ball exchange, the ball life amounts to 4 weeks or longer with a good tube condition. The determination of the ball diameter and thus of the appropriate time of ball exchange is very easy, either manually by means of a calibrated gauge, or optionally by the automatic Ball Efficiency Monitor BEM (3e).

For the ball extraction, the catching process is first initiated by the controller (3c). The balls are then exchanged and subsequently the controller re-starts the continuous cleaning operation.



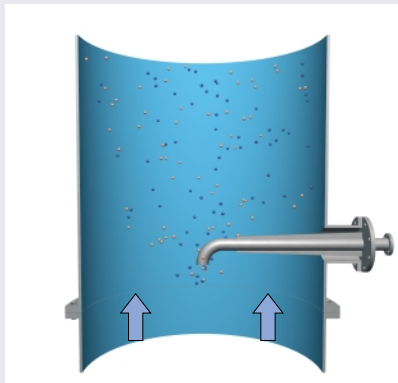
## A modular Construction Kit.

From our application experience gained through more than 10,000 installations in different cooling water qualities of the world, the TAPROGGE System has been perfected over the years and now constitutes a sophisticated modular construction kit that is able to meet the full extent of the operators' requirement profiles.

The packaging of the modules to suit the relevant operational environment is the daily task of our project and planning engineers. They make use of a basic kit that may optionally be complemented by further components.

### The basic Construction Kit. In the basic Version, the

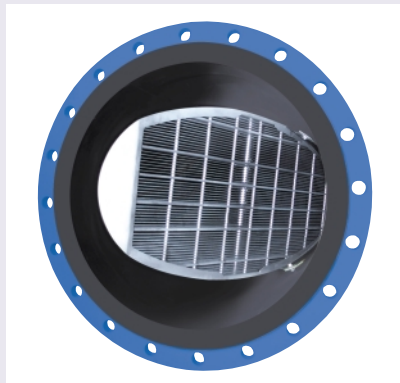
#### Ball Injection



##### Features:

- Place of installation can flexibly be adapted to space conditions
- Multiple ball injection with larger cooling water pipes

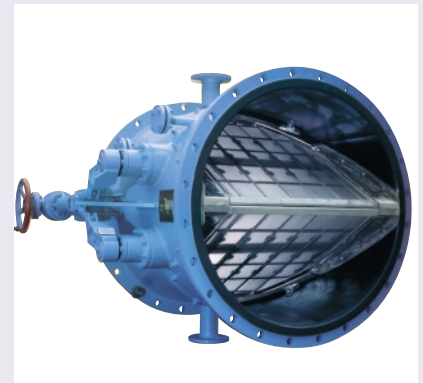
#### Strainer Section



Type: E1  
Nominal diameter: DN 150 - DN 750  
Screens: 1 elliptical screen

##### Features:

- patented vortex vane, thereby:
  - lowest pressure losses by avoidance of outdated suction points located in the flow centre
  - induction of a secondary flow in parallel to the screen surface by which a self-cleaning effect of the screens is reached; the screens remain free from macro fouling in the main areas
- screens without welding as bracing construction to avoid crevice corrosion
- screen design with edgewise bars to avoid matting caused by fibrous debris



Type: D2  
Nominal diameter: DN 800 and bigger  
Screens: 2 semi-elliptical screens in "roof shape"



## TAPROGGE System comprises 3 Components:

### Recirculating Unit (incl. Control System)



Type: C3  
Application: for small heat exchangers / ball charges



Type: C13  
Application: for medium-size heat exchangers / ball charges



Type: C40  
Application: for large heat exchangers / ball charges

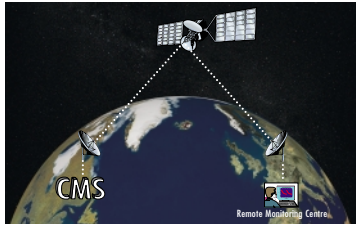


Type: C55  
Application: for large heat exchangers / ball charges

### Features:

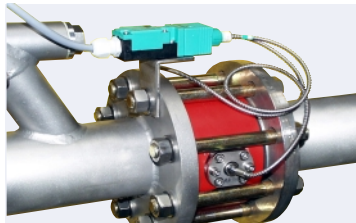
- TAPROGGE Recirculating Units include:
  - ball recirculating pump
  - ball collector
  - control panel
  - ball monitors BRM and BEM (optional)
- TAPROGGE Recirculating Units are:  
Functional units in Plug & Work standard, i.e. mounted and cabled ready for work. The operator is thus saved costly installation work on site.
- Designed as single-line system (1 recirculating unit per strainer section) or combined system (1 recirculating unit per 2 strainer sections).

## Optional Extensions of the Construction Kit.



- **Remote Monitoring**

By the optional installation of a data logging function and relevant evaluation software, the TAPROGGE System can be remotely monitored. By Remote Monitoring the operator has the immediate benefit of TAPROGGE's application know-how without incurring travel expenditure.



- **BRM**

The Ball Recirculating Monitor (BRM) is an optional monitoring function by which the undisturbed ball circulation can be supervised.

The BRM device with display and evaluation function is mounted on the recirculating unit in the control panel. It is recommended for large plants.



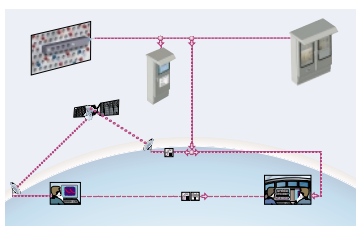
- **BEM**

The Ball Effectiveness Monitor (BEM) monitors both, the ball oversize and the effectiveness of the circulating cleaning balls. The BEM device with display and evaluation function is mounted on the recirculating unit in the control panel. It is recommended for large plants.



- **Ball Sorter**

By the Ball Sorter cleaning balls can be measured as to their oversize, automatically and with high precision. Balls without oversize are automatically extracted.



- **CMS**

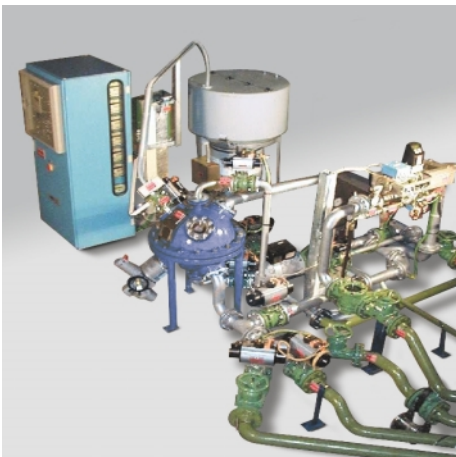
By the patented Condenser Monitoring System (CMS) highly accurate statements can be made on the thermal condition of a heat exchanger. This is effected via patented probes for individual tube measuring. Much earlier than other methods, the data gained by CMS provides evidence of altered condenser conditions (early warning system) which enables immediate countermeasures.

## TACSY®: the most comfortable Way of Cleaning.

TACSY® stands for TAPROGGE Autonomous Cleaning System. It complements TAPROGGE Systems to autonomous, comprehensive solutions. With TACSY® all functions of tube cleaning are effected automatically, in addition to the mere cleaning operation also comprising the entire logistic chain, such as storage, portioning, charging and discharging procedures, as well as the re-utilization of employed industrial waters. Manual interference is not required, the system works fully autonomously.

TACSY® is recommendable in particular for plants with several parallel condensers, for example in nuclear power plants or power stations with large turbines. For such applications, TACSY® enables

- plant operation without expenditure in terms of personnel
- no contact of operating staff with cooling medium in the case of contaminated cooling water
- optimal operational results by current remote monitoring



TACSY® installation in a nuclear power plant

Function	Conventional Tube Cleaning System	TACSY® Autonomous Tube Cleaning System
Management of new balls:		●
- storage of new balls		●
- portioning of ball charges		●
- in an independent watering circuit		●
Cleaning operation	●	●
Monitoring	●	●
Management of worn balls		●
Management of industrial water		●

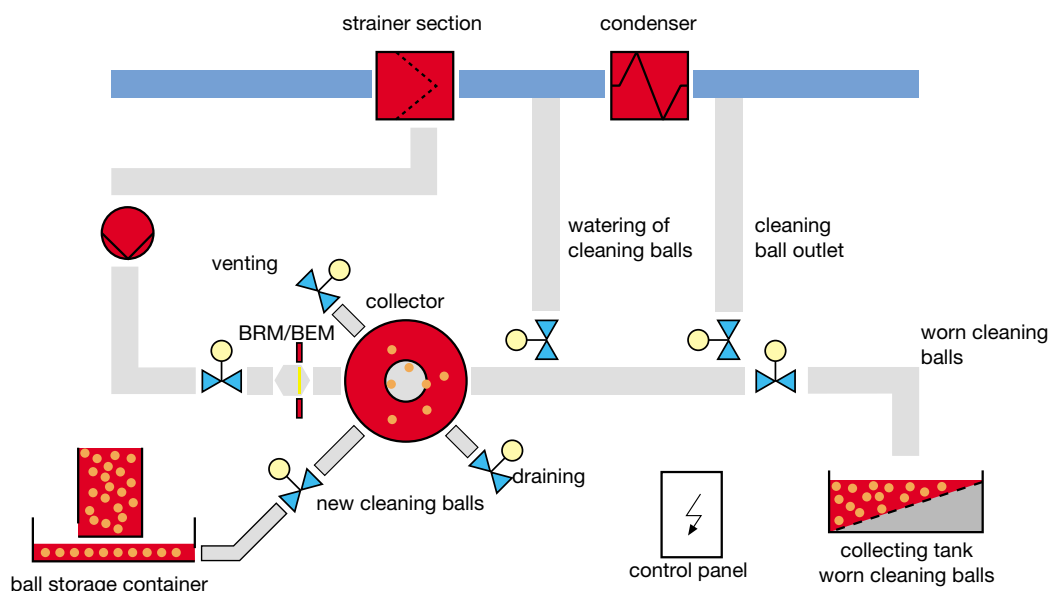
## Quite easy: that's the Way TACSY® works.

### Design and Installation

The TACSY® concept has been provided in such a way that

- it can be operated as a new system, or as a retrofit compatible with existing TAPROGGE Systems
- it is applicable with one or several parallel TAPROGGE Systems
- it can be operated with a separate controller for the TACSY® functions (in particular for the retrofit case), or with an integrated controller (integration of the control functions of the classical tube cleaning system with the additional TACSY® functions).

In the case of a single tube cleaning system, all additional TACSY® functions with regard to the recirculating unit are completed. With several parallel TAPROGGE Systems, a central arrangement of the additional TACSY® functions is recommended.



### Function

#### Management of new Balls

##### • Stock in Store

The cleaning balls are stocked in a storage container whose volume is governed by the intended storage time, for instance one year. The balls are stocked in dry condition.

##### • Portioning of Charges

Once a filling procedure with a fresh ball charge is requested via the TACSY® controller, the required number of balls are portioned in dry condition by the portioning device arranged below the ball storage container. Subsequently the ball charge is fed to the ball collector.



ball storage container

### • Watering of Balls

New cleaning balls can rise to the surface due to air absorbed during dry storage. To avoid this, the balls are first drenched with water prior to the actual cleaning operation. For this purpose a shortened recirculation path is selected for the balls to ensure that the balls are fully “watered” before introduction into the full cooling water circuit. This is effected by either a recirculation pipe arranged at the recirculation unit, or injection of the balls into the strainer section immediately downstream of the condenser (see graph). The operation in the watering circuit causes a degasifying of the cleaning balls.

### Cleaning Operation

After the watering phase the balls are fed to the continuous cleaning operation via the ball injection. The subsequent cleaning operation corresponds to that of a normal cleaning system.

### Monitoring

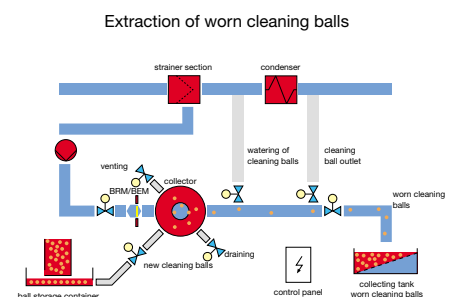
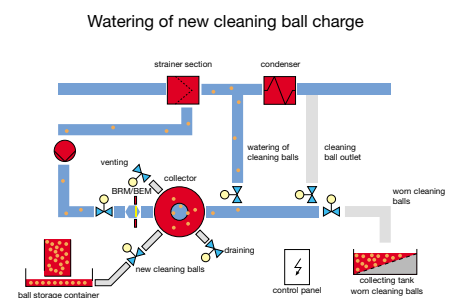
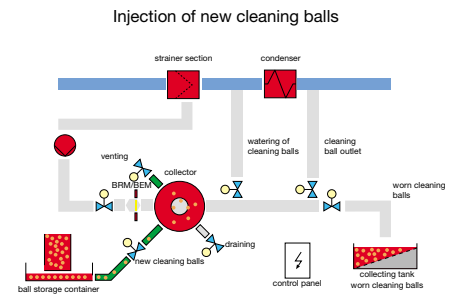
The integrated measuring technology supervises the ball recirculation (BRM) and the ball effectiveness (BEM). All measuring and controlling data can be utilized for the optimization of the cleaning process by way of remote data monitoring.

### Management of worn Balls

Balls with insufficient effectiveness are automatically separated from the system and transported to a collector for simplified disposal.

### Management of industrial Water

The water extracted from the circuit for transporting the balls into the ball collector is automatically collected in a separate tank and re-fed without loss to the cooling circuit.



storage container for worn balls

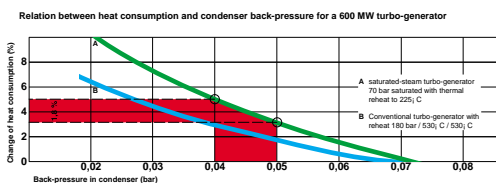


recirculation of process water

## TAPROGGE Systems are Systems with added Value.

By TAPROGGE Systems you obtain:

- efficiency and availability by permanently constant heat transfer of your heat exchangers and condensers
- reduction of your primary energy cost, increase of your turbine output
- relief of environmental burden by saved fuel (reduction of  $\text{SO}_2$ ,  $\text{NO}_x$ ,  $\text{CO}_2$ )
- longer lifetime of your thermal equipment
- reduced corrosion in heat exchangers
- avoidance of unscheduled shutdowns due to tube leakage



TAPROGGE - the cost effective investment

- By TAPROGGE Systems the heat consumption of a turbine unit is reduced by 1 - 2 % or more
- The thermal capacity gains alone, TAPROGGE Systems give payback times of 0.5 - 2 years
- Additional financial benefit is created by reduced emission (reduction of  $\text{SO}_2$ ,  $\text{NO}_x$ ,  $\text{CO}_2$ ) due to fuel saving

And TAPROGGE provides even more:

- Support in application technology at the planning stage.  
Prior to investment, tube examinations can provide valuable knowledge in view of the feasibility and the extent of the future cleaning success. This assists the operator to make his investment decision wisely.
- Access to the most comprehensive ball assortment the world over. With the system the operator is provided only with a mechanism for the transport of the cleaning balls in the cooling water circuit. This alone does not yield a benefit. Benefit is created by the application-technological know-how of the relations among cooling water chemistry and biology (micro fouling), tube material and cleaning balls.  
The availability and optimal choice of ball type and cleaning mode are the key to effective tube cleaning. That's why TAPROGGE supports its customers with an unparalleled range of special cleaning balls. The quality standard and the variety of ball types are an essential contribution to the success of our aftersales care.
- Expert know-how by IN-TA-S®. More than 50 TAPROGGE Service experts at 10 international service bases provide the operators with maximum availability. More than 10,000 TAPROGGE Systems in over 100 countries of the world are proof of the know-how and experience of our international service team. In fact it can be proven that by making use of IN-TA-S® the yearly benefits exceed the investment value of the TAPROGGE System by far.



## **TAPROGGE Care & Comfort Package**

### **Quality right from the Start**

- Performance by TAPROGGE as per DIN EN ISO 9001
- Safety of design by fulfilling the requirements of the European Pressure Equipment Directive 97/23/EC
- Application of a management system for safety, health and environmental protection (SCC)
- Standard documentation; documentation upon customer's request, respectively
- The use of extremely corrosion-resistant materials with long lifetimes safeguards the preservation of the value of investment.

### **Compatibility by IN-TA-CT® Modules**

- The TAPROGGE System is a modular element of IN-TA-CT®, our integral principle for the optimization of cooling water circuits.
- By combination with a TAPROGGE prescreening system and a TAPROGGE debris filter of our PR-BW series upstream, an effective overall solution presents itself for the protection from micro and macro fouling, from the intake to the heat exchanger or condenser. A complete solution - without interfaces - and inclusive of the TAPROGGE-Systemguarantee.

### **Competence and Experience out of one Hand**

- Application consultancy, project management, fabrication, installation and commissioning of TAPROGGE Systems are available from TAPROGGE out of one source.
- With more than 12,000 successful applications, TAPROGGE can make use of its application-technological experience in its special field that stands unparalleled the world over. This competence is indispensable for difficult media and unknown cleaning behaviour.
- In addition to that, the cooling water test circuits of TAPROGGE's Technological Centre allow a particularly reliable and cost-effective simulation of site conditions.

### **Comprehensive Operator Support by IN-TA-S®**

- By the installation and commissioning of the TAPROGGE System, operators have immediate access to IN-TA-S®.
- By IN-TA-S®, TAPROGGE takes care of the operator in all questions of operation and maintenance. Scope, duration and frequency of the care can be determined by the operator.
- Particularly quick support is available to the users of our Remote Monitoring Service.





Postal address:

**TAPROGGE Gesellschaft mbH**  
58292 Wetter  
Germany

Company address:

**TAPROGGE Gesellschaft mbH**  
Schliemannstraße 2-14  
58300 Wetter  
Germany

Tel.: +49 (0)2335 / 762-0

Fax: +49 (0)2335 / 762-245

E-Mail: [info@taprogge.de](mailto:info@taprogge.de)

Homepage: <http://www.taprogge.de>

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