



# SMART CANNON

Removing Slag Formation with Water





A Surface Cleaned with SMART Cannon

## SMART Cannon: The Most Effective Way to Remove Slag Formation with Water

## Factors of Success for Cleaning with Water

### Water: An Alternative has Proved Itself

As a specialist for the boiler cleaning, we early recognised the benefits of cleaning with water and developed it ready for market launch.

World wide SMART Cannon has proved itself as an effective system for cleaning of combustion chambers and empty passes. The prevailing high temperatures as well as the immediate combustion processes result in deposits and sometimes in difficult to remove clinkers on the membrane walls. The cleaning effect of water is the ideal solution for removing slagging. SMART Cannon has been particularly successful in the removal of severe and/or high volume deposits. Its design considers the technical demand, high reliability and particular features needed in combustion chambers and empty passes.

### A Broad Area of Application

The following table shows all application features of SMART Cannon.

Range of applications SMART Cannon		
Boiler area	Fuel	Slagging characteristics
<ul style="list-style-type: none"> <li>• furnace</li> <li>• empty pass</li> <li>• flue gas recirculation pass</li> <li>• lateral gas passes</li> <li>• hopper</li> <li>• centre wall</li> </ul>	<ul style="list-style-type: none"> <li>• lignite coal</li> <li>• hard coal</li> <li>• biomass</li> <li>• biomass co-gasification</li> <li>• waste/substitute fuel</li> <li>• fuel of these sources of energy</li> </ul>	<ul style="list-style-type: none"> <li>• solid, difficult to remove</li> <li>• partially melted</li> <li>• tenacious</li> <li>• voluminous</li> <li>• liquid slag</li> <li>• cornice build</li> </ul>

### ⚙️ Your Benefits:

- Targeted use of water to remove slagging
- Concentrated water jet quality
- Precise, reproducible and flexibly adaptable cleaning patterns
- Even difficult areas can be cleaned e.g. funnels, central sections
- High-duty cleaning system
- Compact design with integrated easy maintenance

### Water jet quality is vital

To achieve the water jet quality required for successful on-load boiler cleaning, several parameters must be perfectly aligned with each other and to slagging and fouling.

Nozzle geometry and nozzle diameter, as well as the blowing pressure, are essential factors that determine the water jet quality. In the cleaning operation, the water impact angle, the water volume and the size of the covered area must match the intensity and characteristics of the deposit. By varying the water jet speed, the impact time is adjusted to the fouling intensity.

### Effective cleaning without thermal impact on tubes

We have been successfully using water as a cleaning media in combustion chambers for more than 40 years. Several studies conducted e. g. by Electric Power Research Institute (EPRI, USA) have shown that the use of water does not reduce the lifetime of tubes in the combustion chamber. A prerequisite for this is that the boiler cleaning system is properly designed and configured as well as that it is appropriately operated.

We therefore attach great importance to the configuration of SMART Cannon for specific boiler types and fuels so that the drop in tube surface temperature is

below 30° C during the cleaning process. The combined use of SMART Cannon with SMART Furnace ensures that the cleaning action is performed demand driven. The cleaning operation adjusts according to the actual level of contamination. This flexibility can be increased to a maximum when the cleaning parameters and cleaning patterns are adjusted dynamically, depending on the distribution of actual cleanliness situation in the furnace.



**Cleaning Principle:** Water enters the pores of the deposits, evaporates and causes a sudden expansion of volume. Deposits break off.





## Smart Design

### Compact and resistant

The design is based on two linear drives and a cardanic ball suspension for holding the blowing lance. The compact and robust design is made for the challenging conditions in the power plant. By the use of aluminium for the linear drives the total weight is low.

Each of the horizontal and vertical linear drives is subjected to quality inspection with a 100 kg weight before delivery. Every linear drive has successfully held 2,5 times over the actual load of power plants. Load resistance of the drives and uninterrupted current intake of the motor are recorded and ensure the quality.

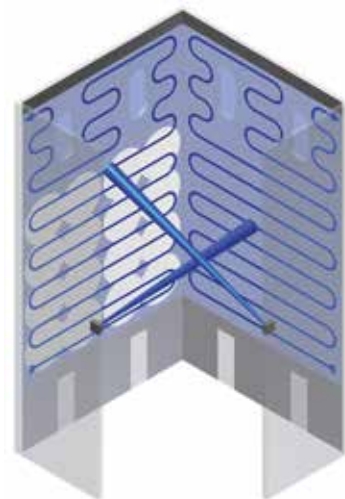
### Operation principle

Due to its specially developed control technology, the water jet creates a meander shaped pattern on the side and opposite wall. With its horizontal and vertical blowing arc each of 90°, a single cannon can clean a large area of the furnace.

The cleaning configurations can be determined precisely and repeated consistently. The lance movements are directly and continuously monitored. We do not rely on monitoring the drive alone, therefore preventing uncontrolled water application into the furnace.

### Unbeatably efficient

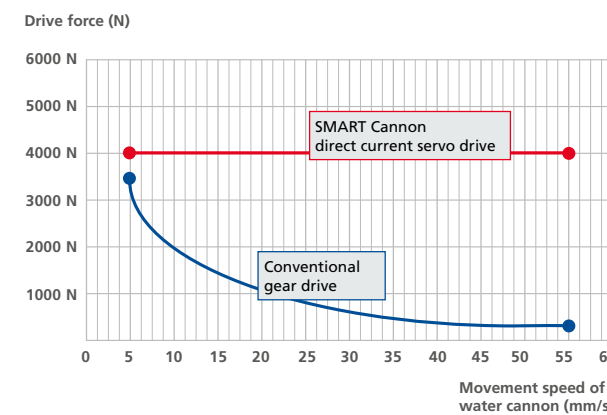
A single SMART Cannon cleans a much larger area - coloured blue in the above figure - than several conventional wall blowers together - cleaning areas coloured white in the above figures.



## High Performance, Compact Design

### ⚙️ Your benefits:

- Heavy-duty cleaning system suited for the high furnace temperatures
- Compact design
- Cleans areas difficult to access, e.g. hopper, centre wall
- Cleaning figures can be individually adjusted to boiler geometry – simple change on demand
- Precise, repeatable water jet positioning
- Open system to connect different control systems



SMART Cannon uses a gear with constant drive force

### Technical highlights

#### Water-jet quality:

A specifically developed high-performance nozzle creates a concentrated water jet. A rectifier calms the water jet at the lance entry. A very precisely designed nozzle end prevents the water jet from expanding.

#### Flexible blowing figures:

The control programme enables precise adjustment of the blowing configuration to match the geometry of the area to be cleaned. Different monitoring functions ensure blowing figure repeatability.

#### Protection of critical areas:

The control system can ensure certain areas are excluded from water jet application.

#### Large cleaning area and reliable flue gas sealing:

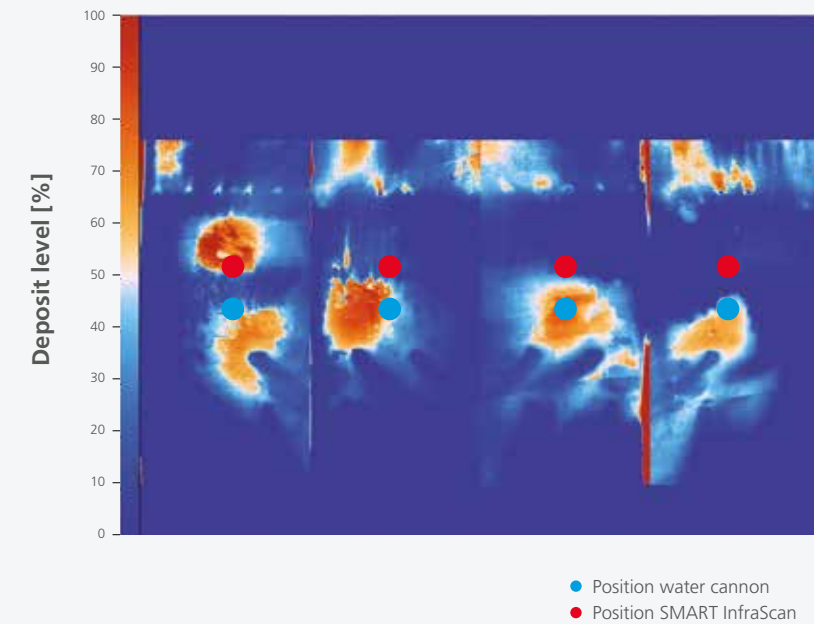
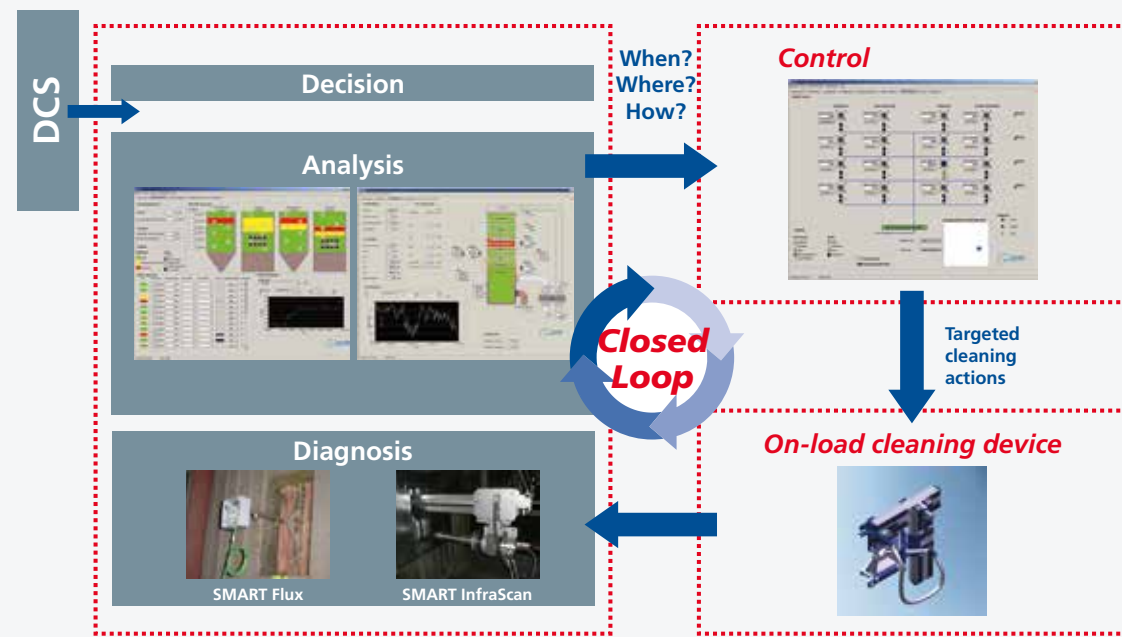
The blowing lance is mounted in a ball-shaped suspension that gives the SMART Cannon its large cleaning range while also securely sealing it against the flue gas outlet.

#### High-performance motor:

Moving parts can be blocked by deposits at any time. The direct current servo drive used also works at a constant drive force at this resistance, ensuring reliable operation of the SMART Cannon.

#### Low and easy maintenance:

Robustly designed assembly consisting of a vertical and horizontal linear drive. An individual can perform replacement without using any pulleys.



## Intelligent Cleaning of the Combustion Chamber with SMART Furnace

## Dynamic Calculation of Cleaning Figures and Cleaning Parameters

### Maximum effect with minimum effort

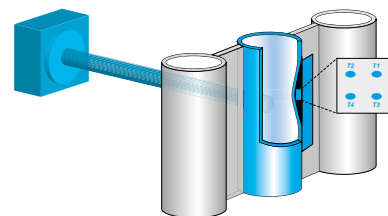
SMART Furnace supports and optimises the use of SMART Cannon. SMART Furnace continuously monitors and evaluates the levels of contamination in the combustion chamber. Sensors deliver this information.

SMART Furnace derives the necessary type of cleaning action for the combustion chamber from the sensor readings and also determines the appropriate parameter with regards to:

- WHERE is the deposit located
- HOW intensive the cleaning should be to remove the deposits
- WHEN it is the best moment to start the cleaning operation

SMART Furnace complements SMART Cannon and provides intelligent cleaning of the combustion chamber, only carried out if it is really necessary. On top of that, cleaning operations are carried out according to demands ensuring maximum effect with minimum influence on the general boiler process.

### Principle of heat flux measurement:



Heat flux measurement based on tailor-made thermoelements

### SMART Cannon combined with direct measurement of heat flow

SMART Flux Sensors continuously measure heat flux at representative places in the combustion chamber. Changed frequency readings are clear indicators that the boiler needs to be cleaned before efficiency declines.

SMART Furnace calculates the cleanliness level for each zone which is represented by SMART Flux sensors. The measured heat flux is converted into co-ordinates, which show the position and intensity of the contamination.

SMART Furnace is transferring this information into cleaning parameters, to operate only those SMART Cannons that actually reach the zone that requires cleaning. The cleaning pattern carried out thereby corresponds to the requirements of the contaminated zone.



Built-in SMART Flux Sensor for measuring heat flow

### SMART Cannon combined with infrared measurement

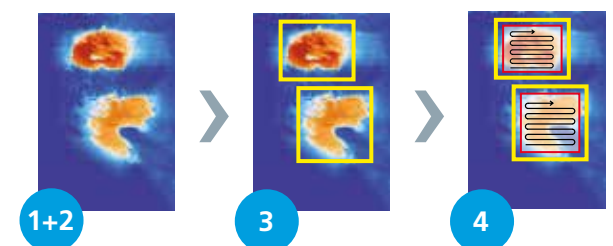
SMART InfraScan measures the surface temperature on the membrane walls in the combustion chamber with infrared sensors and shows the temperature distribution. Here the surface temperature rises with increasing thickness of the deposits, so that high temperatures indicate main points of contamination.

The measurements are carried out with 320x240 measuring points at especially high resolution. SMART Furnace receives these measurement data and calculates the cleaning patterns dynamically depending on the contamination level. Each individual cleaning pattern is always allocated individual cleaning parameters.

This highest level of flexible combustion room decontamination avoids thermal overload of pipe walls and results in optimum cleaning performance. Cleaning action by SMART Cannon is carried out automatically and on demand.

### Exemplary functional processes

- 1 SMART InfraScan directly measures the surface temperature of the membrane walls.
- 2 SMART Furnace converts the measuring values to a false colour image of the deposit distribution.
- 3 Rectangular cleaning zones are formed for different areas of the membrane walls. The most heavily contaminated spots are the starting point. Cleaning zones always end where the deposit level falls below a specific threshold.
- 4 SMART Furnace calculates the cleaning figures and cleaning parameters based on the coordinates of the cleaning zones. By doing this, SMART Furnace considers the relevant boiler and system parameters. Following that, the cleaning devices are activated with the dynamically calculated cleaning figures by the control system.







# Control, Fittings and Pumps for a Coordinated Boiler Cleaning System

## Competent independent control

It is important for the optimum operation of each boiler cleaning system that it has coordinated control equipment which responds to the specific demands of each installation. For this reason we develop and design specific automation solutions. Our solutions give particular value to the accurate monitoring of control systems. It is not enough to just control the function of the motor for the identification of the operating process. Our standardized built-in monitoring functions ascertain whether the cleaning system actually carries out the cleaning actions.

Comprehensive functions are built in as standard to recognise and evaluate fault signals. Downloaded emergency programmes ensure swift reaction and avoid unnecessary consequential damage.

## Careful layout of fittings and pumps

The quality of the water jet is crucial to successfully cleaning the boiler with water. Correspondingly, the careful layout of fittings and pumps is an important factor in achieving cleaning success. Apart from jet geometry, jet size and air pressure, we compensate prepare for possible loss of pressure because of height difference. We go back to a redundant pump station design in such instances, where an urgent boiler decontamination is absolutely necessary.

## Extracts from our references

Plant	Fuel	Capacity
AEB Amsterdam, Netherlands	Waste	1.370.000 t/J
Boxberg, Germany	Lignite coal	910 MW
Colbun, Chile	Hard coal	350 MW
Belchatow, Poland	Lignite coal	350 MW
Moorburg, Germany	Hard coal	830 MW
Rodenhuize, Netherlands	Biomass	180 MW
Ugljevik, Bosnia and Herzegovina	Lignite coal	300 MW
Mae Moh, Thailand	Lignite coal	300 MW
Avedorevaerket, Denmark	Biomass	355 MW
Loy Yang A, Australia	Lignite coal	4 x 525 MW
Yunghung, Korea	Hard coal	800 MW



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