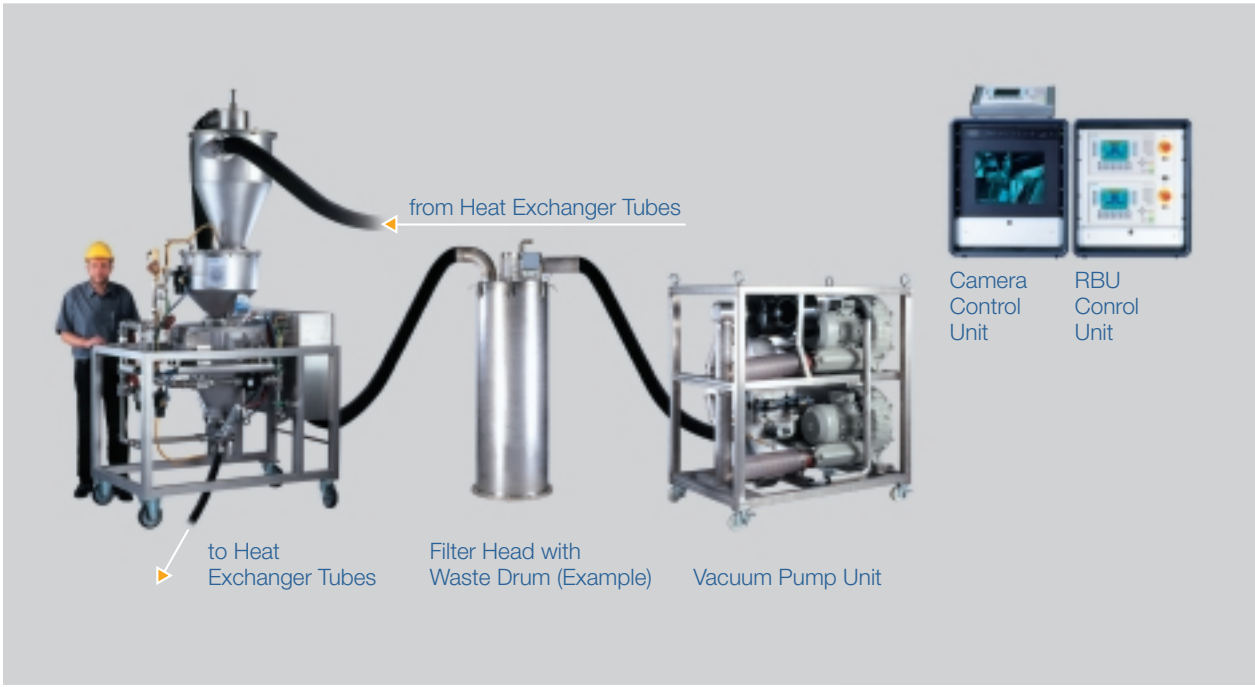
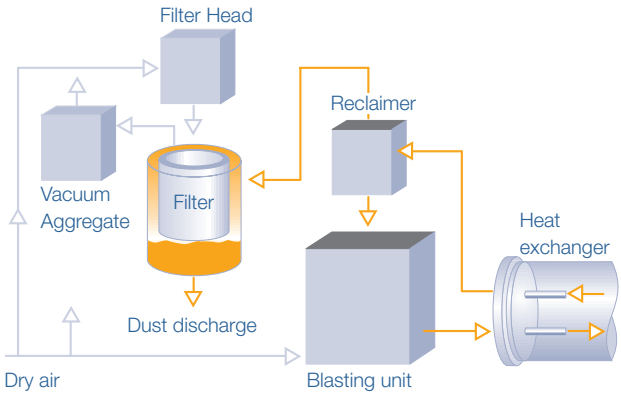
SIVABLAST®
Mechanical Cleaning Technology

An AREVA and Siemens Company

FRAMATOME ANP



Equipment for mechanical cleaning of Steam Generators



Schematic of the SIVABLAST mechanical cleaning system

Description of Method and Equipment

Basically the SIVABLAST method is a closed loop mechanical cleaning system. The blasting material (i.e. glass, stainless steel and corundum) is injected into the heat exchanger tubes under controlled pressure and flow rate. After passing and cleaning the tube surface the blasting grit is returned under vacuum to the blasting equipment. In the blasting unit dust and destroyed blasting material is separated into a filter unit. The remaining blasting material is recycled and is feed back into the blasting loop.

Main Characteristics

This cleaning process can be applied in any type of heat exchangers with vertical/horizontal tube arrangements, with either straight tubes or U bend tubes, independent of the tube material. Only pre-requisite is the tube surface must be previously dried. The process has been applied in a number of cases, resulting in:

- high cleaning efficiency
- negligible base metal losses
- significant increase of the heat exchange capacity
- short application time

Equipment for mechanical cleaning of Steam Generators

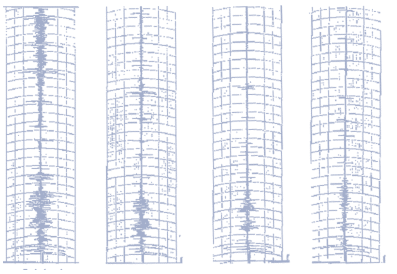
Material Compatibility

Material compatibility test shows that the process can be adjusted to the given requirements.
Depending on the blasting material used, the initial roughness can be kept nearly unchanged. Using adequate material and blasting conditions the materials wear can easily be kept in the region of 1 µm.
The SIVABLAST process can basically be adapted to all types of tube material.

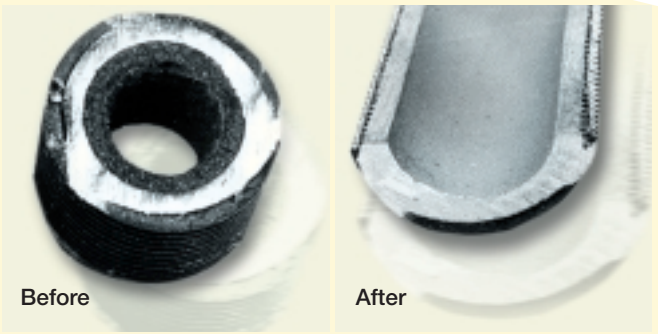
Cleaning Efficiency

Depending on the given precondition and the expected results the cleaning process can be adapted to the required conditions for example low base material attack or high cleaning efficiency. Metallic shiny surfaces can be achieved even if thick layers have to be removed.
Besides improvement of the heat exchange rates the SIVABLAST process enhances significantly testability of tube material with none destructive test methods.

Eddy Current Testing Results before and after treatment with SIVABLAST



Eddy current plots showing improvement of background noise with increasing cleaning time.



Carbon steel preheater tube before and after treatment with SIVABLAST.

Field Experience

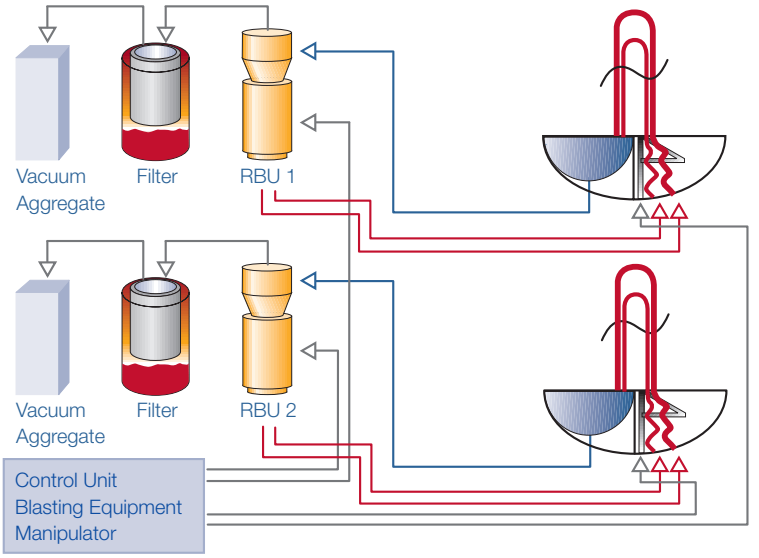
SIVABLAST has been frequently applied in fossile fired and nuclear power plants. In the latter ones heat exchangers in the nuclear island (steam generators primary side) and the balance of plant systems (preheaters) were successfully cleaned with the SIVABLAST cleaning system.

Reason for cleaning:

- Severe fouling with hard magnetite deposits, not removable by water jet lancing and consequently loss of heat transfer

Typical results of a preheater cleaning are:

- More than 90% of deposit removed
- Final surface condition (fiberscope): metallic, bright aspect
- Negligible base metal losses (average: ≈ 0,2 µm; max.: ≈ 1 µm)
- Improvement of heat exchange rates



Schematic flow chart of cleaning SIVABLAST system for cleaning two tubes at a time in two steam generators parallel.

The SIVABLAST cleaning has also successfully been applied for the cleaning of the primary side of steam Generators in nuclear power plants.

Typical data for a primary side steam generator cleaning in CANDU reactors are:

- Complete automation, remote control
- Nearly 100% deposit removed
- Low ratio of waste, effective waste volume: 1.1 ltr. per kg of removed deposit
- Radiation fields around the outside of SG were reduced
- High amount of radioactivity removed
- ECT inspection in comparison of the result of cleaned and “dirty” tubes confirmed the high effectiveness and excellent material compatibility

The main benefit for the CANDU Plants are:

- Decrease of reactor header inlet temperatur
- Improvement of core flow
- Decrease of feeder thinning rate

Whereas heat exchanger B was cleaning with SIVABLAST, the heat exchanger A was cleaned only with water jet lancing.

The thermodynamic parameters after plant start-up were following:

	Heat Exchanger A (water jet)	Heat Exchanger B (SIVABLAST)
Feedwater rate [t/h]	2300.0	2444.0
Heat exchange rate, steam zone [106 kcal/h]	79.8	98.7
Heat exchange rate, condensate zone [10^6 kcal/h]	14.6	1.3

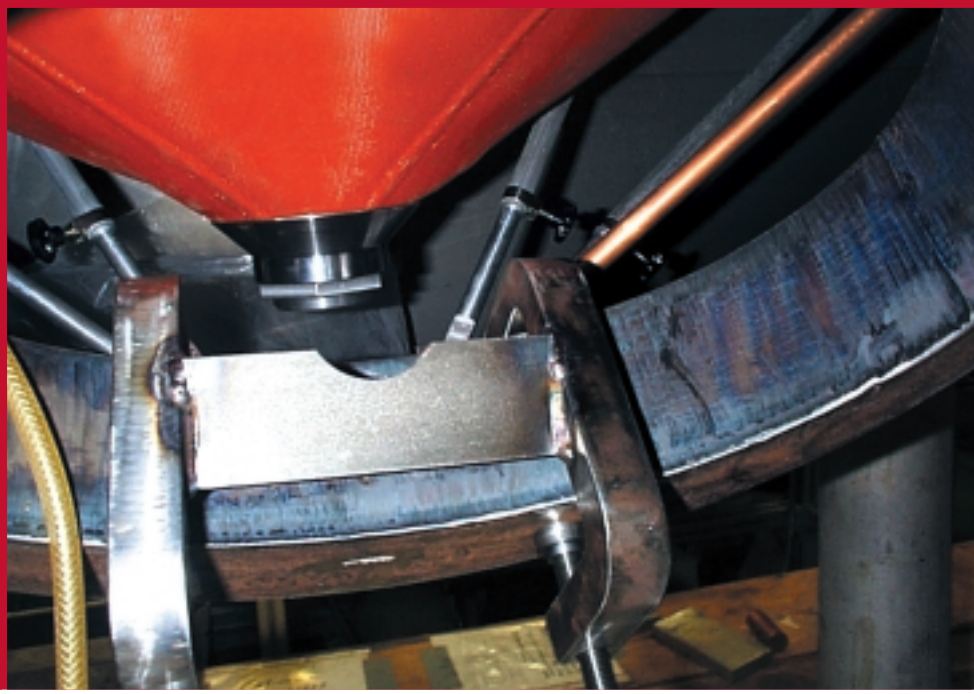
Improvement by increasing the flow rate and heat exchange rate is stated

General

The SIVABLAST recirculation blasting method for heat exchanger cleaning offers a very efficient alternative tool to:

- **improve heat exchange capacity**
- **avoid or counteract corrosion phenomena**
- **enable or facilitate the performance of non destructive analysis (ECT)**
- **reduce radiation fields**

even where other methods like brushing, water jet lancing, chemical cleaning, etc. cannot be applied efficiently.

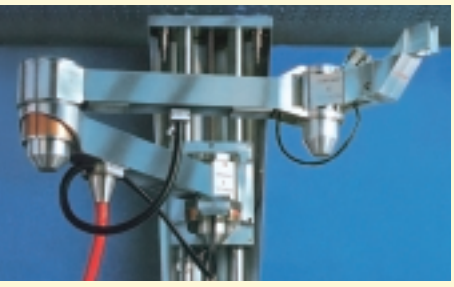


Suction header for collection of magnetite and blasting material in the SG channel head

Conclusion

- The SIVABLAST recirculation blasting method for heat exchanger tube cleaning proved to be a very useful and highly efficient tool to solve ID fouling problems in all kind of heat exchangers
- The automation and use of robotics makes it adequate for the cleaning of radioactive heat exchangers
- The application experience in steam generators and feedwater heaters shows clearly the convenience of its application
- The SIVABLAST technology with its high cleaning efficiency can be excellently adjusted to the given requirements
- Safe collection and handling of radioactive waste, if applied in a nuclear heat exchanger, the waste volume is extremely low

Robot for SIVABLAST application



AREVA, the world leader in nuclear power and components, is present in more than 30 countries. The group's employees provide customers with a full range of products and services for electricity generation and develop connectivity systems mainly for the telecommunications and computer sectors.

AREVA brings expertise and technologies for better living to meet the challenges of the 21st century: generalized access to energy and information, preservation of the planet, and responsible stewardship of resources for future generations.

www.arevagroup.com

For further information please contact:

Framatome ANP GmbH
Chemistry Products & Services

Freyeslebenstrasse 1
91058 Erlangen, Germany

Phone: (+49) 91 31/18 92 676
Fax: (+49) 91 31/18 92 821
E-Mail: chemistry@framatome-anp.de
www.framatome-anp.com

P.O.Box 32 20
91050 Erlangen, Germany

Published by and copyright (2001):
Framatome ANP GmbH
Freyeslebenstrasse 1
91058 Erlangen, Germany

Order-No. ANP: G-105-V1-01-ENG
Printed in Germany
440119T WS 07021.
K.No. 312

TH 069-010728

SIVABLAST® Technology References

Plant	Application Date	Component	Number of Tubes	Removed Scales [kg]
Many Plants in Germany	Before 1995	Various	–	–
Mihama 3	03/95	1 HP-HTR	2112	496
Point Lepreau	08–09/95	4 SG	8209	789
Tsuruga 2	12/95	2 HP-HTR	5870	876
Mihama 3	09/96	1 HP-HTR	2110	553
GKN 2	08/97	2 WAZÜ	8228	202
Ohi 1	11/97	3 HP-HTR	6293	342
Takahama 4	01/98	2 HP-HTR	4494	307
Mihama 3	01/98	2 HP-HTR	4166	158
Ohi 3	03/98	1 HP-HTR	3088	29
Ohi 4	05/98	1 HP-HTR	3088	24
Mihama 2	06/98	1 HP-HTR	1080	48
Genkai 1	06/98	2 HP-HTR	2555	81
Genkai 1	06/98	4 CCW	6372	95
Takahama 2	07/98	2 HP-HTR	4112	22
Mihama 1	08/98	1 HP-HTR	1124	24
Ohi 2	09/98	1 HP-HTR	2033	177
Genkai 2	10/98	2 HP-HTR	2842	92
Takahama 3	12/98	1 HP-HTR	2247	104
Takahama 1	02/99	1 HP-HTR	2079	10
Ohi 1	03/99	1 HP-HTR	1993	25
Gentilly 2	04–05/99	4 SG	13007	3045
Mihama 3	05/99	1 HP-HTR	2079	30
Embalse	09-10/00	4 SG	13183	2603
Genelba	02/01	Condenser	30043	1350