



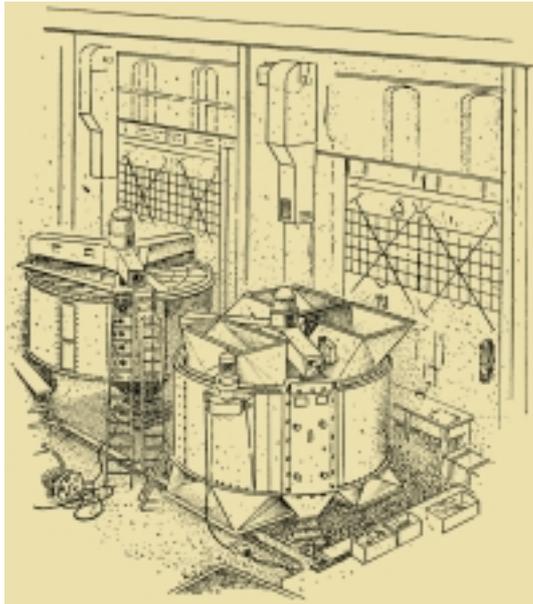
Ljungström[®] **Air Preheaters**

for Power Stations

ALSTOM

Power
Boiler Products

Know-How and Experience



APH design in 1934

The Ljungström® Air Preheater A Historically Significant Landmark

Throughout the history of boilers there have been many advancements in order to obtain a better performance and lower fuel consumption. However, few inventions have been as successful in saving fuel as the Ljungström® Air Preheater (APH) invented by Fredrik Ljungström. The first installation in a commercial boiler saved as much as 25% of the fuel consumption. In a modern utility boiler the Ljungström® Air Preheater provides up to 20% of the total heat transfer in the boiler process while representing only 2% of the total investment.

Up to now more than 20,000 Ljungström® air preheaters have been supplied to all corners of the globe.



The inventor Fredrik Ljungström from the Ljungström Medal

Introduction of ALSTOM Power Air Preheater GmbH (AGT)

Our company, previously known to our clients as Kraftanlagen Abgastechnik GmbH, since 1995 named ABB (later ABB ALSTOM POWER) Abgastechnik GmbH and now an independent company within the ALSTOM Power Group, is one of the world's leading suppliers of Ljungström® heat exchangers for the power station industry.

Our heat exchangers are accepted worldwide and we are one of the leading companies for the reheat technology in FGD plants. In this field, AGT has supplied the world's largest vertical and horizontal shaft regenerative heat exchangers. More than 100 specialists offer their assistance in the fields of engineering, manufacturing, erection, commissioning and service based on our extensive know-how and experience.

Rotary regenerative APHs are extremely compact and comparatively easy to clean and are thus still the favourite reheating component for the power industry.



Rotor diameters up to 24 m!

Maximum Flexibility and Reliability

The Ljungström® Air Preheater

General

Basically, the Ljungström® APH is a regenerative heat exchanger through which flue gas and combustion air pass in a counter-current flow. The waste heat of the flue gas is thus recovered and used for heating the combustion air.

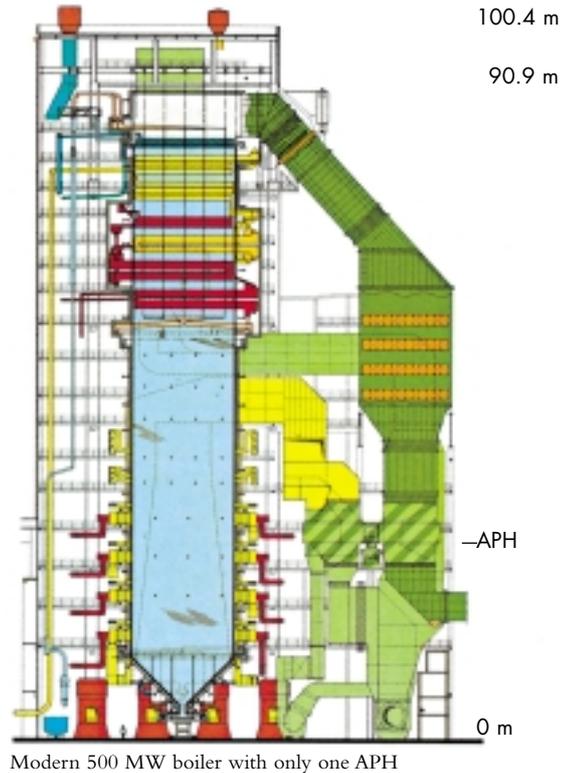
AGT has developed a specific Ljungström® design creating a modern and reliable APH to suit the demands of today's power industry.

Arrangement

Depending on the arrangement preferred by the boiler manufacturer, ALSTOM Power Air Preheater GmbH is able to supply air preheaters with vertical or horizontal shafts.

In order to cover all possible applications and offer the boiler designer maximum flexibility, AGT developed three designs of integrated regenerative mill APH based on the traditional bi-sector type:

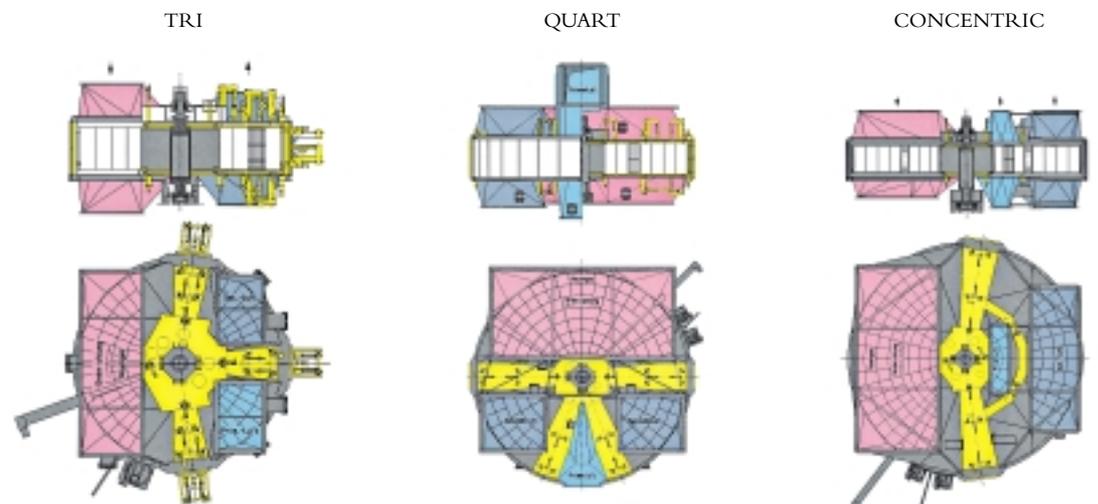
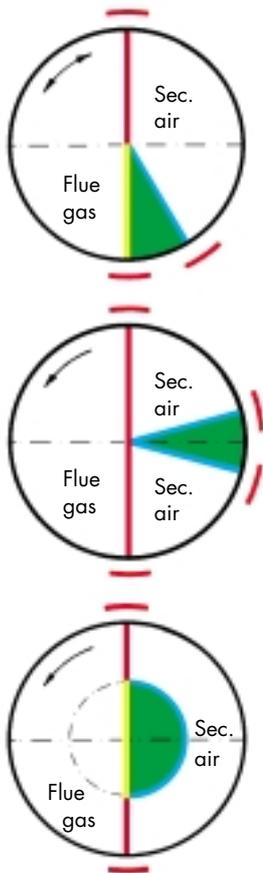
- Tri-Sector Air Preheaters
- Quart-Sector Air Preheaters
- Concentric Air Preheaters.



Modern 500 MW boiler with only one APH

The tri-sector design has the lowest cost while the quart-sector yields lower leakage rates and has a lower ash content in the primary air.

The concentric type is a very flexible design for operation with a wide range of coal since it may be adapted to different operating conditions by using different heating surfaces in the primary and secondary sections.



Proven Air Preheater Design



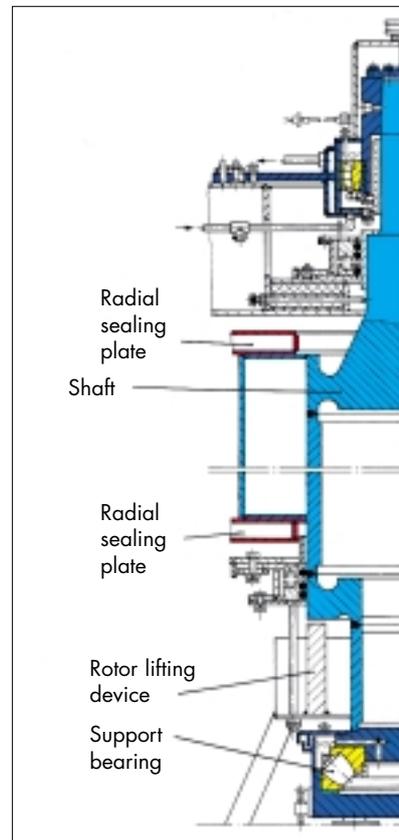
Rotor bearing and lifting device

Rotor Bearing

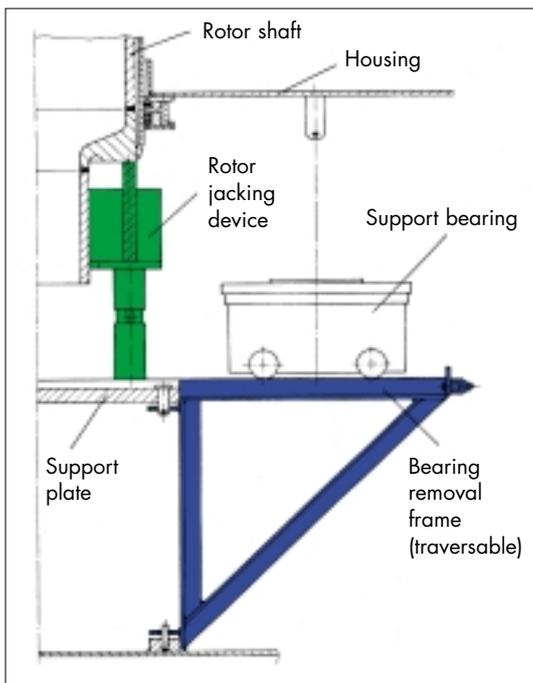
In a vertical-type air preheater the rotor shaft transmits the load forces to the support bearing which is arranged at the bottom and supported on the center pillar of the structural steelwork. A guide bearing is located at the top of the shaft and fixed to the housing.

ALSTOM Power Air Preheater GmbH uses self-aligning roller bearing assemblies with oil bath lubrication, and the bearing at the hot side is generally water-cooled.

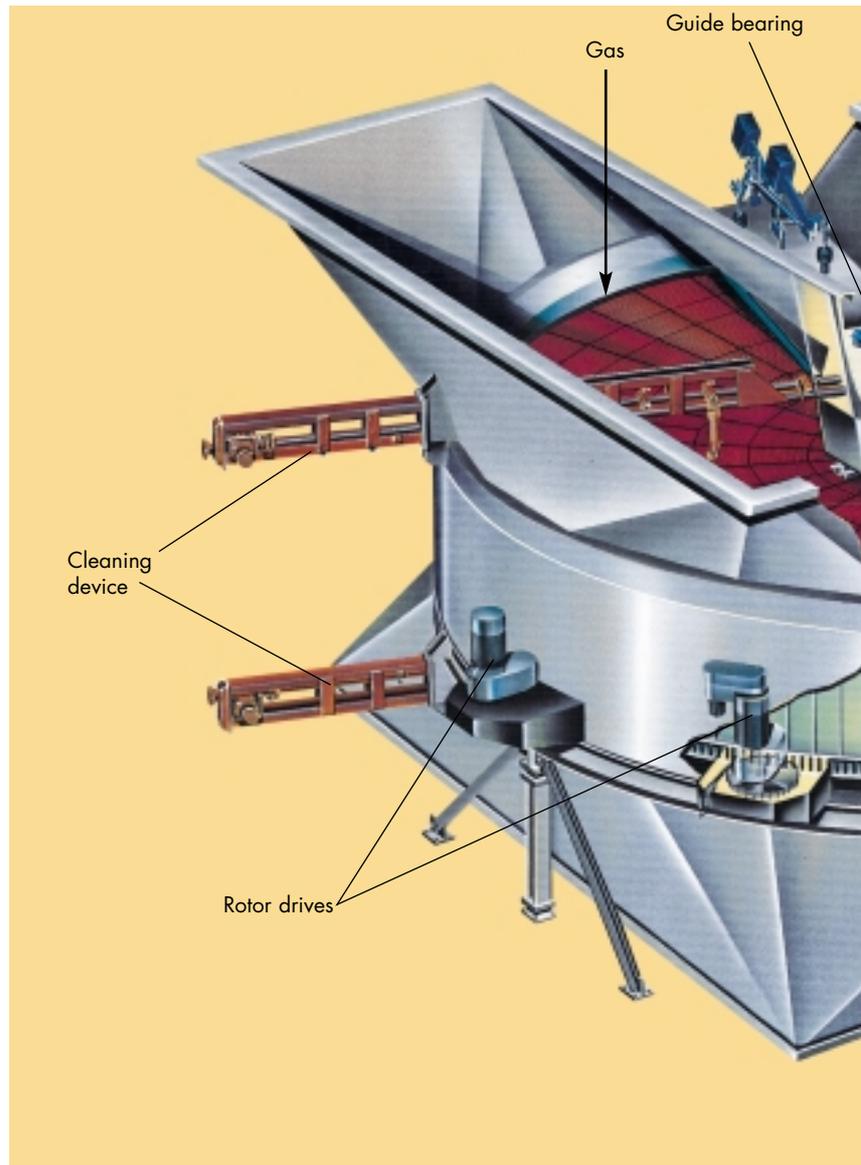
For easy maintenance a rotor lifting device is installed for inspection or removal of the support bearing.

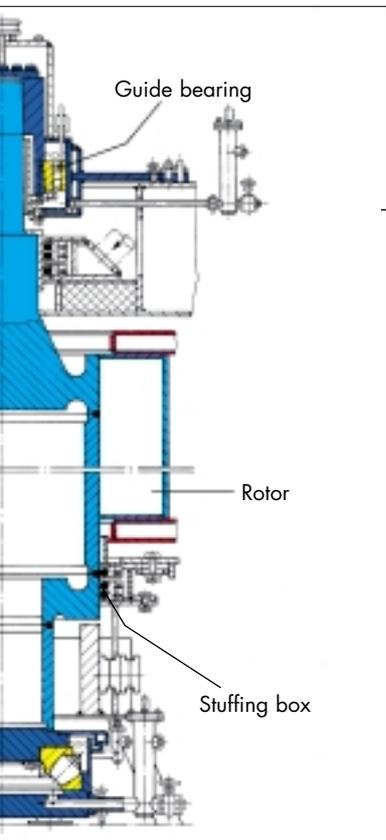


Center Part of APH



Rotor lifting device for bearing inspection





Rotor Drive System

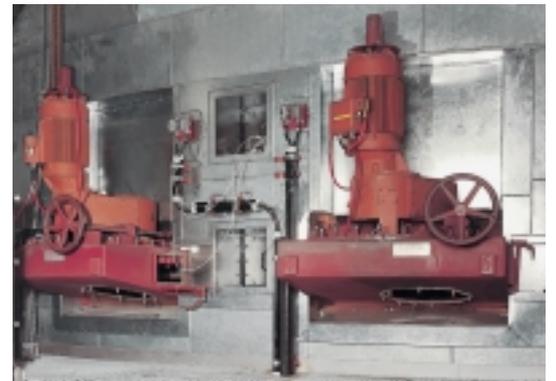
The rotor drive system of a Ljungström® APH is one of the most important parts in order to guarantee a safe operation of the power plant.

ALSTOM Power Air Preheater GmbH developed a drive system consisting of two pole-changeable AC electric motors with a gear reducer and drive sprocket which engages on a pin-rack attached to the rotor shell.

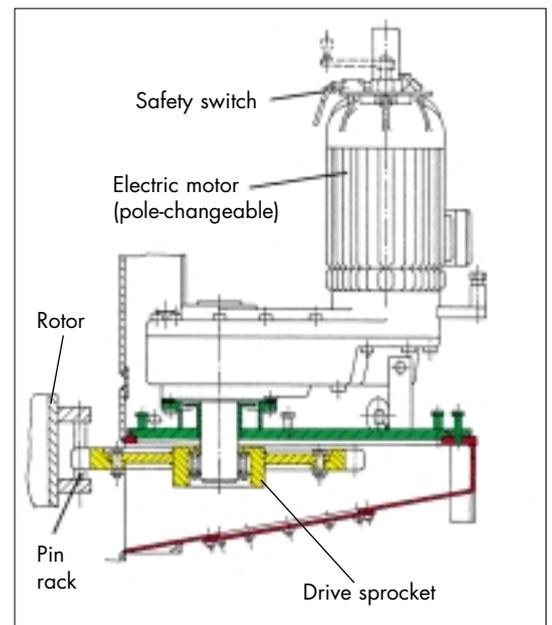
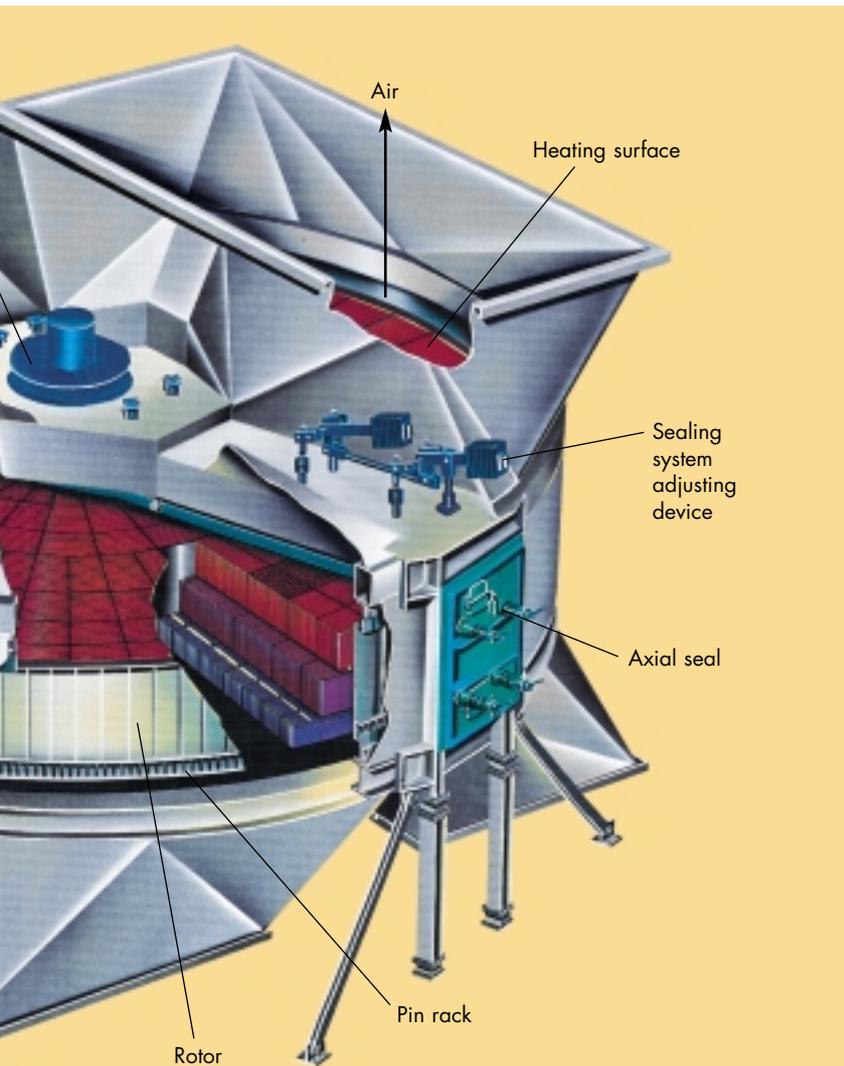
According to AGT's standard each air preheater is driven by two main drives, each one able to operate the rotor at design speed. The redundant design ensures the availability of both the drive system and the air preheater. Nevertheless, one of the electric motors should be connected to a

safe mains supply with the low speed to make sure that the air preheater can continue operation even in case of a blackout.

As a safety measure, a rotation monitor is also standard on our APH.



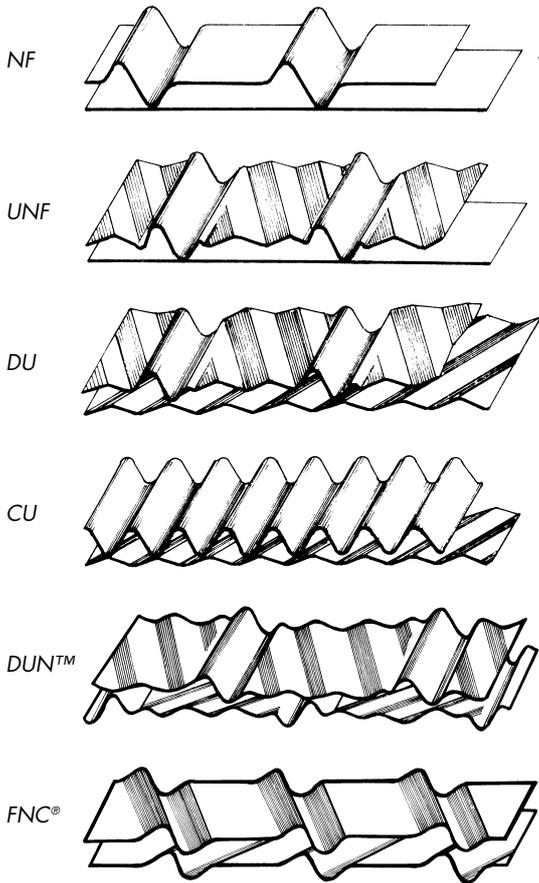
Two 100% rotor drive units



Main rotor drive unit

Advanced Profiles

Heat Transfer Surface



Typical heating element profiles

The heat transfer surface of the Ljungström® air preheater consists of thin profiled steel plates, packed in frame baskets and installed in the rotor. During each revolution of the rotor, heat is absorbed by the heating surface passing through the hot gas stream and transferred to the combustion air stream.

ALSTOM Power Air Preheater GmbH utilises several different types of profile and surface material based on ample operating experience and an ongoing development program.

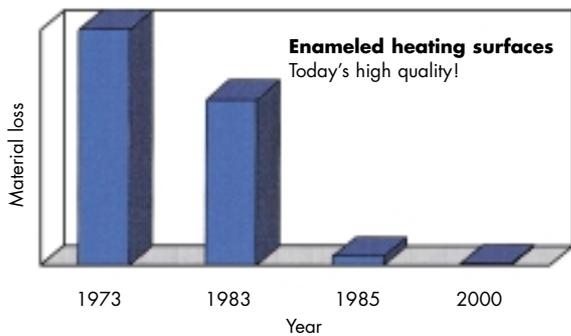
Our know-how enables us to offer our clients the correct choice for any particular application taking into account the respective operating conditions of the APH.

Typically, the materials used for the heating surface are mild steel at the hot end and low-alloy corrosion-resistant steel (corten) or enamel for the cold end.

In particular if the heating surface is exposed to severe corrosive operating conditions, the special enamel coatings developed by AGT will extend the heating surface lifetime considerably.



Packing of heating element baskets



Manufacturing of heating elements



Availability Assured

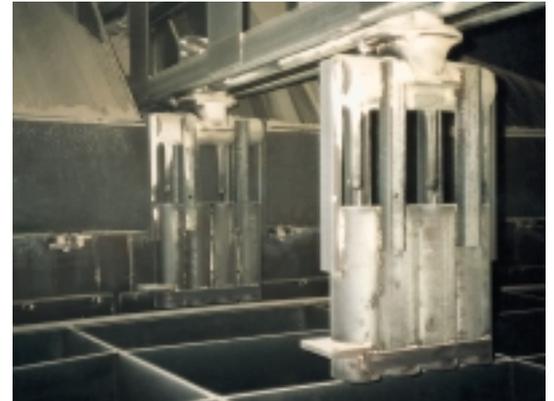
Cleaning Device

To assure the availability of the air preheater and avoid uncontrolled fouling of the heating surface, AGT air preheaters are equipped with a standard cleaning device. The special sootblowers installed at the gas inlet and/or outlet side allow sootblowing with steam during boiler operation. To ensure the efficiency of the cleaning device, superheated steam must be used for sootblowing. AGT's requirements are $>320\text{ }^{\circ}\text{C}$ and 8 bar at the sootblower nozzles.

Depending on the operating conditions and size of the air preheater, different sootblower designs are available. For small-size air preheaters swivel type sootblowers are normally used. Large air preheaters are equipped with a retractable type sootblower with injector nozzles at the hot side and multi-nozzles at the cold side.

The retractable sootblowers are designed to operate with steam or air during normal boiler operation but also allow for washing of the APH with low-pressure water during a shut-down of the unit.

To remove hard and insoluble deposits, additional nozzles for off-line high pressure water washing (up to 400 bar) may be installed on the retractable lances.

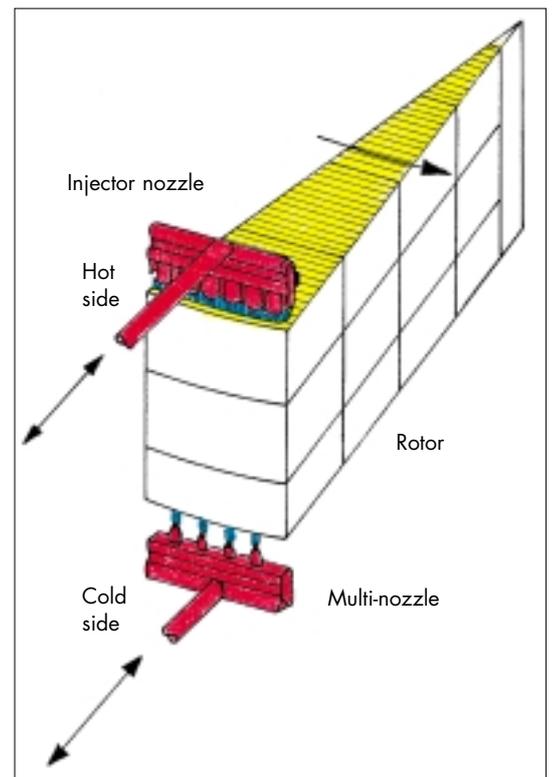
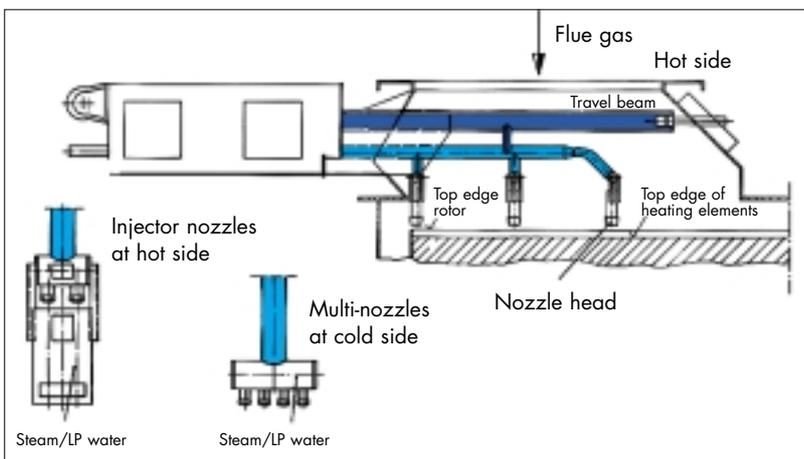


Retractable sootblower with injector headers



Erection of multi-nozzle cleaning device

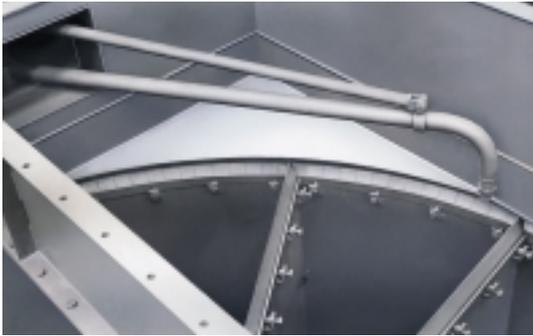
Retractable sootblower for steam and LP water washing



AGT's cleaning philosophy

Low Maintenance Cost ...

Sealing System



Package APH with leaf seals and swivel type sootblower

The pressure differential between the air and flue gas streams requires that the Ljunström® APH be equipped with a sealing system to keep the flows separate. The sealing system comprises radial and axial seals that define the air and gas sections and also minimise the air-to-gas leakage to an acceptable level. A circumferential throttle ring prevents the flue gas and air flows from by-passing the rotor.



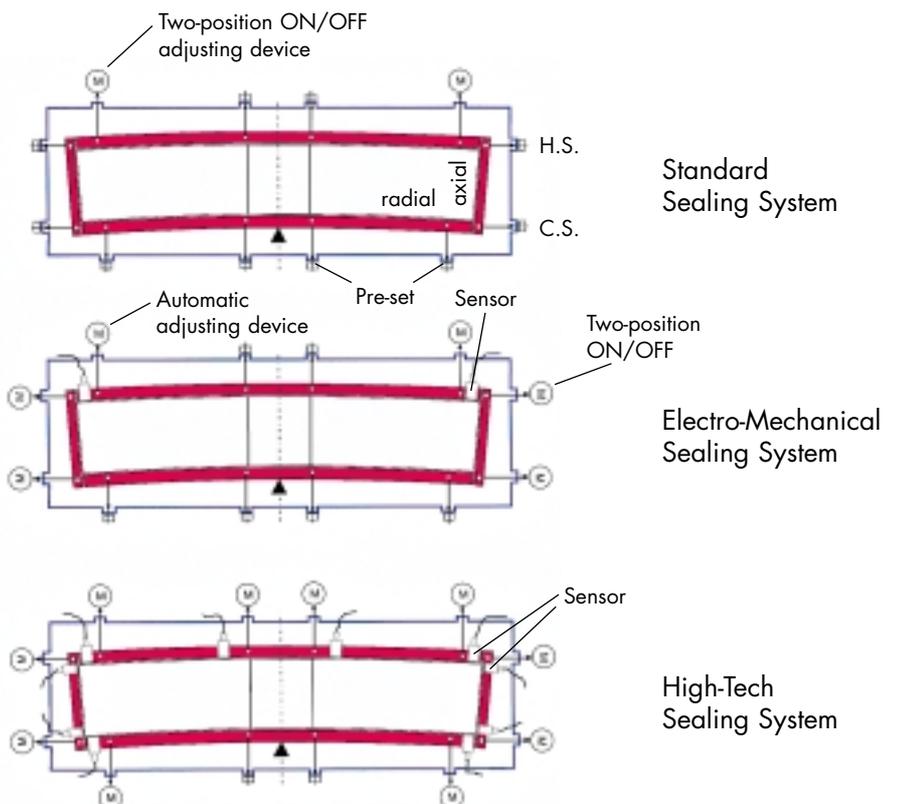
Lower radial sealing plate

For small APH sizes, up to 8 m diameter, the most economical solution is a package-type design with fixed radial sealing plates attached to the casing structure and leaf seals bolted to the edges of the radial walls of the rotor. The package radial sealing system cannot be adjusted from outside during operation.

Depending on the application and the customer's requirements, an adjustable axial sealing system can also be installed.



Radial seal adjusting device



Sketches of the available sealing systems

... and Low Leakage Rates not only at the Beginning

Our large APHs always have adjustable radial and axial sealing plates. All seals can be adjusted from outside during operation. Semi- and fully automatic control systems are available for adjusting the radial and axial seals directly to the rotor diaphragm without any contact. Basically, three variants are available:

Standard sealing system

e.g. for oil- and brown coal-fired (bi-sector) units, with manually pre-set sealing plates and – for larger air preheaters – with an ON/OFF automatic adjustment at the hot side.

Electromechanical sealing system

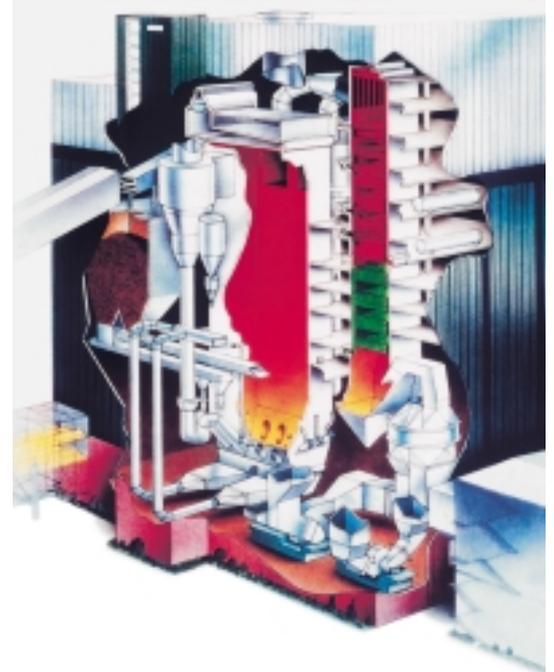
e.g. for hard coal (mill APH) units which have an ON/OFF automatic adjustment at the hot side or a sensor control system for large rotor diameters.

High-tech sealing system

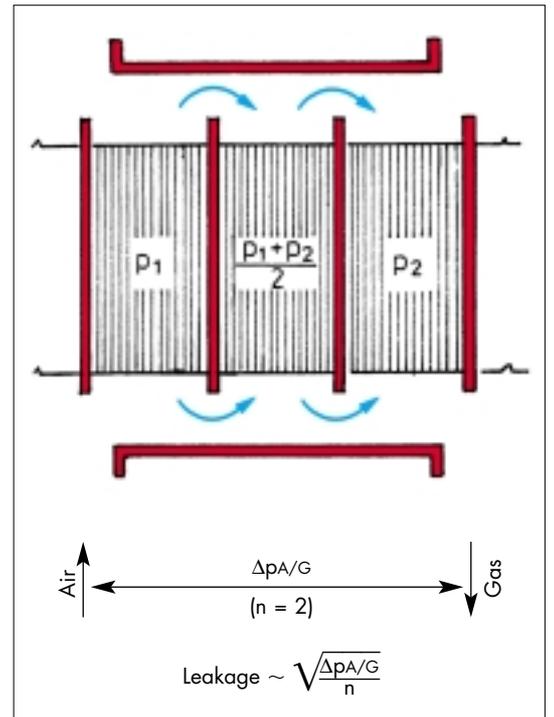
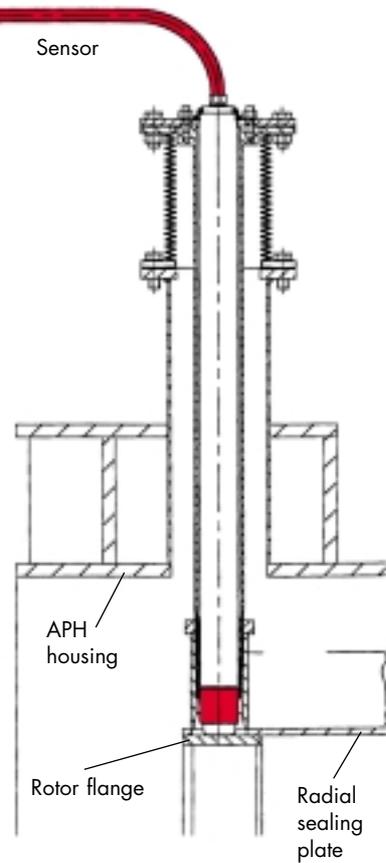
e.g. for fluidised bed boilers, where all sector plates automatically follow the thermal deformation of the rotor by using our proven sensor technology for gap measurements. By increasing the number of diaphragms under the sealing plates (labyrinth) we can obtain very low leakage rates ($\Delta O_2 < 1\%$) irrespective of the high pressure differential which is characteristic for FBC plants.

The selection of the sealing system is made taking into consideration the rotor diameter and the operating conditions of the boiler.

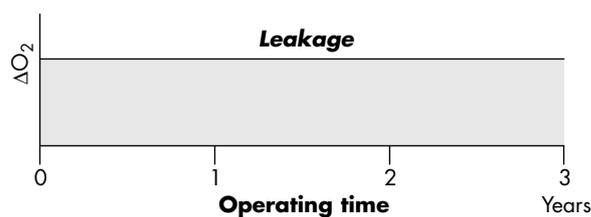
Based on AGT's concept of a controlled and wear-resistant sealing system we can assure you that our low leakage rate will not increase between two boiler maintenance periods.



CFBC with AGT air preheater



Labyrinth design



Constant low leakage rates

Manufacturing at Highest Quality Standards

Manufacturing



Bi-Sector APH: Manufacturing of the casing top cover



Tri-Sector APH: Workshop assembly of connecting ducts



Quart-Sector APH: Workshop assembly of sealing plates



Concentric APH: Manufacturing of connecting ducts



Inner rotor for a large APH before shipping

Complete Erection or Supervision

Erection

AGT can supply either full-scale erection services or – as an alternative – offer the assistance of a qualified and experienced AGT supervisor for erection carried out with local personnel, according to the customer's requirements.



Erection of top cover with pre-assembled sealing plates



Support bearing and rotor lifting device



Erection of rotor



Installation of inner rotor



All heavy APH parts lifted up

Commissioning

Our experienced staff of qualified commissioning engineers are available for cold and hot commissioning work through to carrying out the heat exchanger performance tests.

After-Sales Service - ... Flexible, Reliable, Competent!

Excellence Service

Our clients benefit from AGT's experienced After-Sales Team who are available to assist with any question concerning safe and economical equipment operation.

Modernisation and rehabilitation of existing power plants is becoming increasingly important with regard to both increasing the thermal efficiency of the plant and reducing the environmental impact. AGT offers concepts for the modification of the most important APH parts, such as heating surface, sealing system, cleaning device and rotor drives, which allow the existing equipment to be upgraded to today's state of the art.

ALSTOM Power Air Preheater GmbH has access to all original documentation for units supplied by Kraftanlagen, as well as our sister companies ALSTOM Power KK (Gadelius) and ALSTOM Power Air Preheater Co. (Air Preheater Co.) This allows us to not only supply spare parts, but also to offer any upgrades that are required to enhance the performance of the air preheaters under modified operating conditions.

ALSTOM Power Air Preheater GmbH's know-how will support you in increasing the efficiency and reliability of your plant by reducing energy losses and cutting the operating costs.



High-pressure water washing with up to 400 bar



Replacement of heating elements with our hydraulic equipment



Replacement of rotor

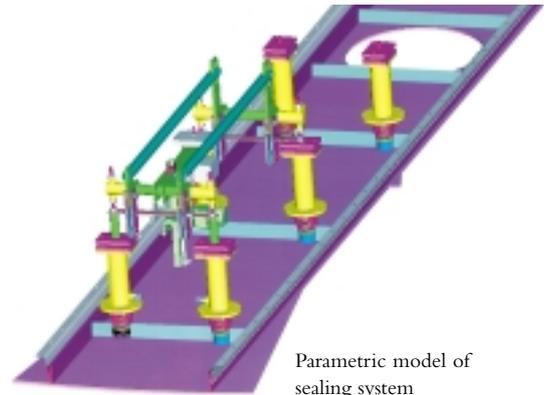


Rehabilitation work with our automatic welding machine

Quality: Made in Germany!

Parametric Modeling

For the past 3 years AGT has used Parametric Modeling for the engineering and design of new air preheaters. This systems allows for reduced engineering cycle time and costs, while eliminating sources of errors.



Parametric model of sealing system

Total Quality Management

The Total Quality Management Program of ALSTOM Power Air Preheater GmbH is a guarantee that our customers receive components with the highest quality standards: from engineering to material supply and manufacturing, up to the final quality control inspection. In 1993, AGT was awarded certification to the International Quality System Standard EN ISO 9001 by the German TÜV and in 1998 for the first time carried out the environmental management system audit according to EN ISO 14001.

ALSTOM Power Air Preheater GmbH guarantees highest quality standards not only within the company itself: But by carrying out supplier audits and manufacturing controls we make sure that all purchased parts and services are in accordance with the required standards.

A photograph of a TÜV CERT certification certificate. The certificate is white with a blue and red border. It features the TÜV CERT logo at the top. The text on the certificate reads: "The TÜV CERT Certification Body of TÜV Management Service GmbH certifies in accordance with TÜV CERT procedures that ABB Abgastechnik GmbH Industriestraße 57-61 D-69245 Bammental has established and applies a quality system for engineering, manufacturing, supply and after-sales of regenerative and recuperative heat exchangers. An audit was performed; Report No. QM-M-971519. Proof has been furnished that the requirements according to DIN EN ISO 9001 are fulfilled. The certificate is valid until May 2000. First Certification: May 1994. Certificate Registration No. 70 105 M 510." There is a signature at the bottom right and a date "München, July 26, 1997" at the bottom left.

TÜV CERT
CERTIFICATE
The TÜV CERT Certification Body
of TÜV Management Service GmbH
certifies in accordance
with TÜV CERT procedures that
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Certification of the
International Quality
System Standard
EN ISO 9001

Our Scope of Supply and Services:

- Regenerative Air Preheaters (APH)
- Regenerative Gas-Gas Heaters (GGH)
- PFA Duct Lining
- Heating Elements
- APH + GGH Rehabilitation and upgrades

We give your expert advice, offer qualified erection personnel and first-class service.

**ALSTOM Power Air Preheater
Your Competent Partner
for Heat Recovery!**

ALSTOM