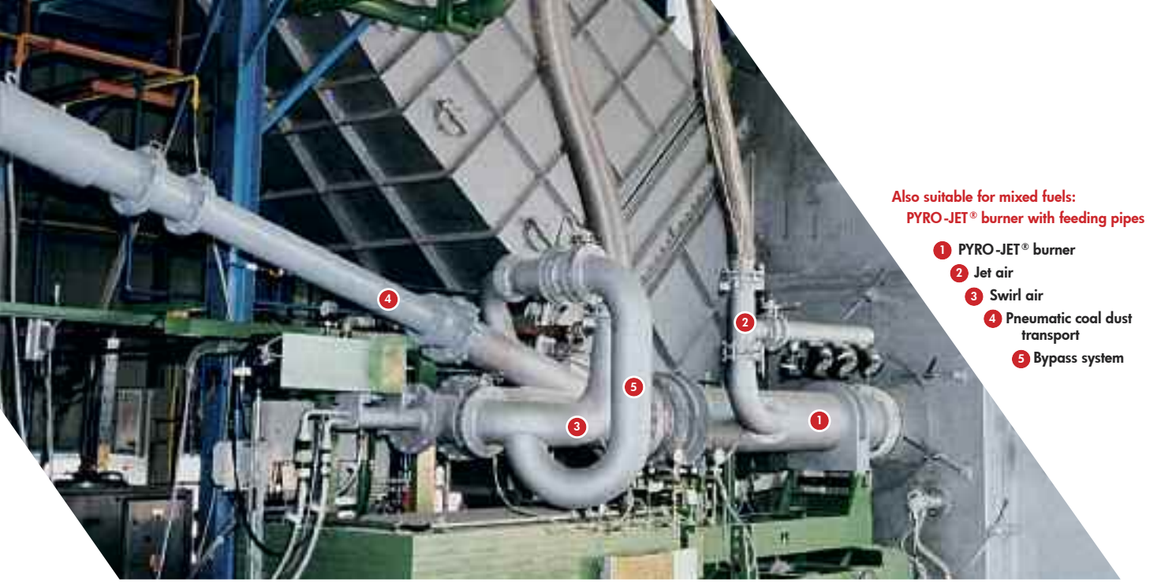


Also suitable for mixed fuels:
PYRO-JET® burner with feeding pipes

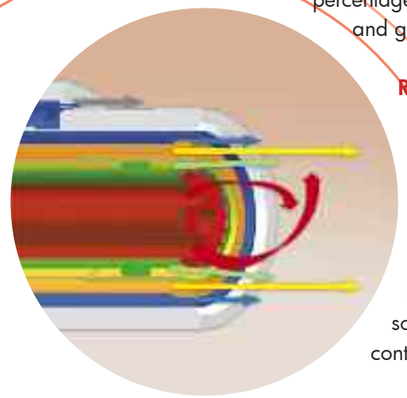
1. PYRO-JET® burner
2. Jet air
3. Swirl air
4. Pneumatic coal dust transport
5. Bypass system

KHD burner experience

Thirty years of experience in the operation of KHD **PYRO-JET®** burners in more than 700 rotary kilns has resulted in safe and reliably designed burners operating in a number of various conditions.

How it works

The axial air exits the **PYRO-JET®** burner at high speed via several separate jet nozzles arranged on the perimeter of the burner. This substantially reduces the amount of primary air required when compared with conventional burners while also reducing fuel consumption. The jets produce a flame with even heat build-up. Measurements show that the early ignition of the fuel at the outlet of the **PYRO-JET®** substantially reduces NO_x emissions. Because of its outstanding combustion properties, the burner is not only suitable for coal, but also for difficult solid fuels with low percentages of volatile components, such as anthracite, pet coke, mixed fuels with oil and gas and various alternative fuels.



Recent improvements

Additional cooling of the nozzle system is accomplished in the new generation of **PYRO-JET®** burners by refractory tubes. This increases the working life of the burner and also permits the simple replacement of the refractory tubes in the event of damage to the refractory material.

Additional components

In addition to the proven **PYRO-JET®** burner, KHD supplies engineered solutions for the entire combustion process: from burner trolleys through control systems to complete fuel storage and dosing technology.

Nozzle system of the PYRO-JET® burner

- Shock blower to remove deposite
- Cooling air, 15 m/s, 1%*
- Jet air, 300 m/s, 1.6%*
- Coal dust, 25 m/s, 2-4%*
- Swirl air, 150 m/s, 2.4-4.4%*

*Of total combustion air at λ 1.1 Σ: 7-11%

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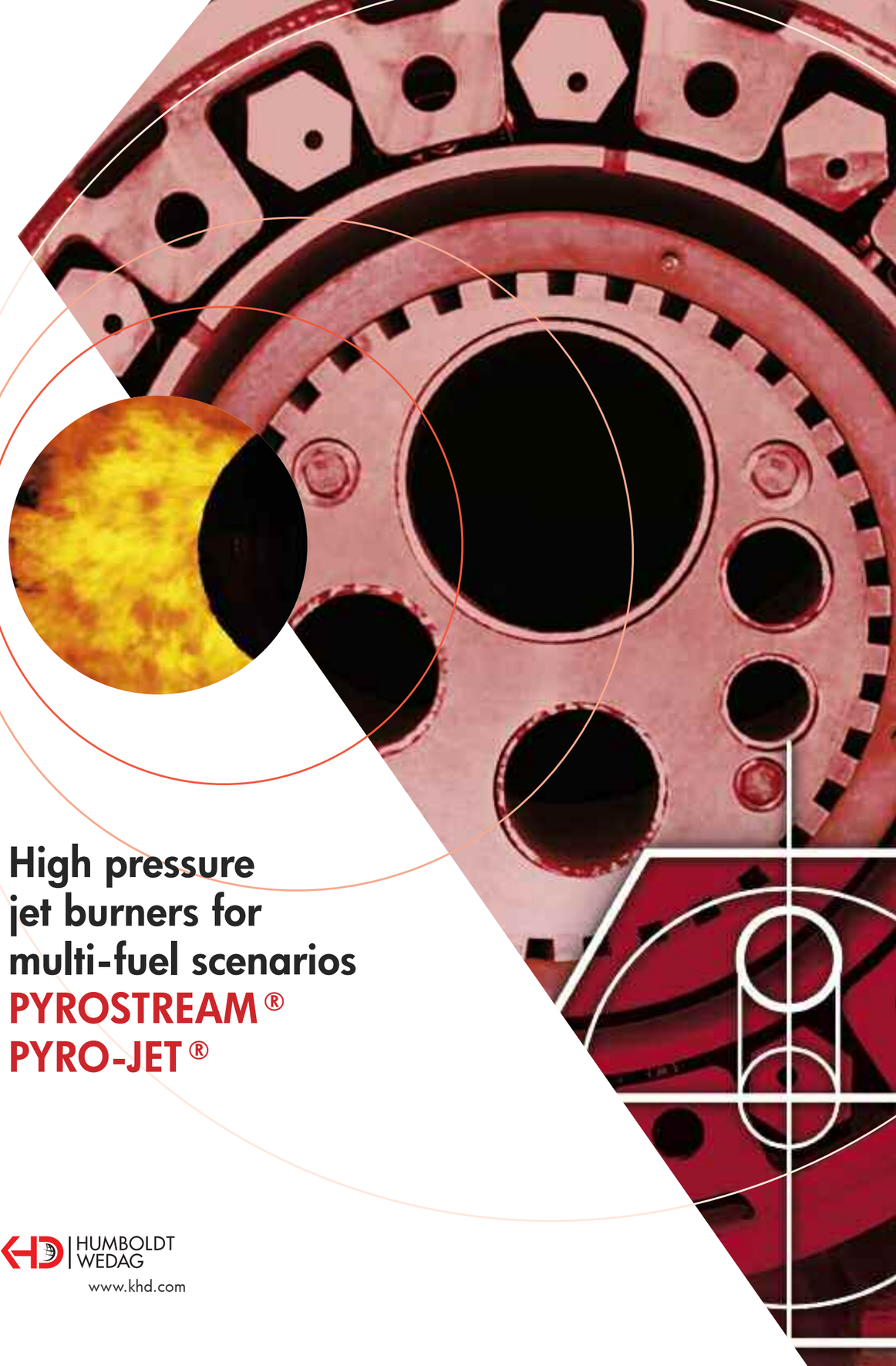

High pressure jet burners for multi-fuel scenarios

PYROSTREAM®
PYRO-JET®

KHD | HUMBOLDT WEDAG

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KHD's burner development

When focusing on new developments, it's always worthwhile to take a look at past achievements: the first high pressure burners invented by KHD's engineers were actually gas burners. Developed back in 1975, these burners worked with natural gas at a pressure of 3 bar and very high nozzle velocity. The advantage of this configuration was a strong suction effect, which mixed clinker dust into the flame cone together with the fuel rich flame base creating a strong radiant flame. The result was superior heat transfer compared to low pressure gas burners. Since this development, the jet nozzle concept has been the most outstanding feature of all KHD kiln burners.

NEW
The PYROSTREAM® burner

With the goal of reducing production costs, plant operators are focusing on alternative fuels. These have the advantage of low prices, but compared to fossil fuels, the efficiency of the process is reduced. Now, with all the experience gathered over the years, KHD has developed the **PYROSTREAM®** high performance burner. The **PYROSTREAM®** burner is designed to allow the highest possible alternative fuel substitution rates. Sharing the double-pressure primary air system and the sandwich flame concept,the main design feature is the adjustable jet nozzle system. Each of the 12 angular nozzles is bolted to an independent jet air tube which can be rotated through 360° (Fig. 1). Each tube ends in a distributor and all tubes are synchronized with an internal ring gear. At the cold end of the burner, all tubes are equipped with sturdy hexagonal ends to allow either single or synchronized adjustment. When turning the nozzles the jet streams can be set either in the main swirl direction or at counter flow, divergent or convergent. It's like turning the reflector head of a flashlight: the beam can be focused to a spotlight or set broad to illuminate a larger area. This adjustment allows a more precise flame setting than conventional burners without adjustable nozzles. In addition to the influence of the primary air pressures it is now possible to set the flame shape with the position of the jet streams. The different nozzle positions can be described with the flame characteristics shown in figure 2.

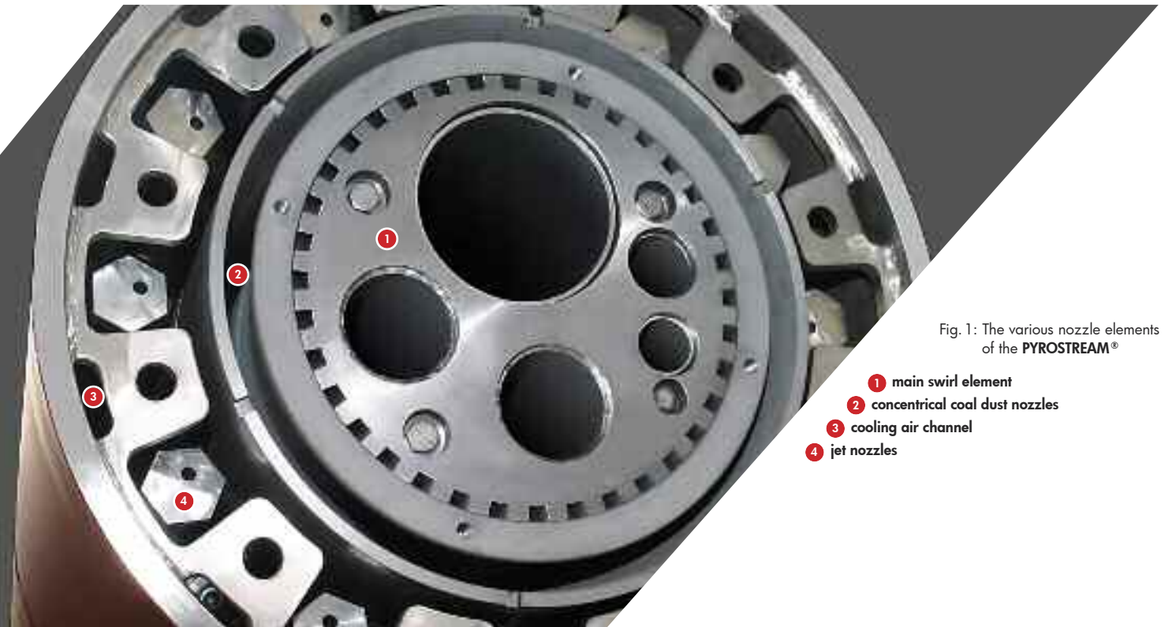
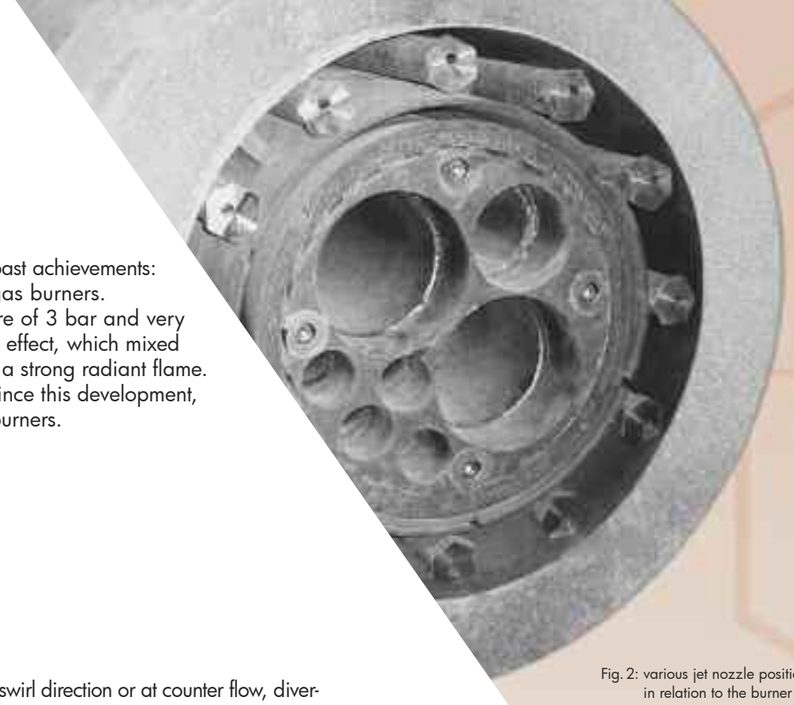


Fig. 1: The various nozzle elements of the **PYROSTREAM®**

1. **main swirl element**
2. **concentrical coal dust nozzles**
3. **cooling air channel**
4. **jet nozzles**



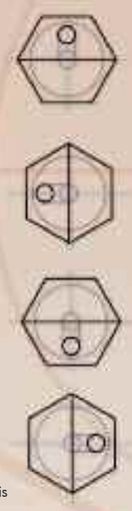


Fig. 2: various jet nozzle positions in relation to the burner axis

A Nozzle angle 0°:
Divergent setting, the influence of the jet air is small in this position, the flame is long and the energy output is stretched over a long area in the kiln.

B Nozzle angle 90°:
In this position, the effect of the main swirl air stream in the center of the burner is amplified through the jet streams. The flame becomes broad and short, with maximum recirculation to the flame root, which is advantageous for fuels with bad ignition characteristics.

C Nozzle angle 180°:
The nozzles are directed toward the center of the flame. The jet streams can distribute solid fuel particles which are fired through the central channels in the flame to shorten the burnout time of these particles.

D Nozzle angle 270°:
This position creates a strong turbulence field in the area of the angular gap with intense mixing of secondary air and can be compared with the 90° position.

The nozzles can be adjusted to all intermediate positions between 0-360° to allow, together with the pressure setting of jet air and swirl air, the most accurate flame shape adjustment. As an example, KHD's **PYROSTREAM®** burner, in operation in a French cement plant, fires a mixture of about 4t/h animal meal and sewage sludge, 2t/h fluff, 2.5t/h coal and various small fractions of liquid wastes of about 0.5t/h (Fig. 3).

Focus on maintenance and service time

Besides the advantageous features to the process, KHD's engineers took special care to improve the service time and make maintenance as easy as possible. The space around the jet air tubes, between the outer coal dust tube and the support tube, is cooled with a low pressure air stream, either from the swirl air fan, or, more efficiently, from a small fan which can be connected to the emergency power system of the plant. This configuration provides maximum protection for the burner in case of power outages. The flange between the hot end of the support tube and the first hanger allows an easy exchange of the refractory tube, when used in connection with KHD's suspended carriage with crane. Especially when in operation with new, efficient coolers providing very hot secondary air, like KHD's **PYROFLOOR®** clinker cooler, proper cooling and easy maintenance are crucial to maintain high overall operation time. Designed with special alloys, the lifetime of the nozzle system is expected to be more than two years per set. The interior parts of the burner are protected by a ceramic liner system and different metallic coatings depending on the conveyed material, the operation temperature and the possibilities for on-site maintenance.

KHD's **PYROSTREAM®** and **PYRO-JET®** kiln burners as well as KHD's combustion chamber burners (HCB) are available with different amounts of primary air, taking into consideration different fuel scenarios or plant operator philosophies. The standard design features low primary air amounts of 1.6% jet air, 2.4-4.4% swirl air and 1% cooling air, resulting in a flame momentum of 4.5-5.5N/MW. However, upon customer request, these burners can also be tailored to flame momentums up to 11N/MW. Due to the high impulse of the jet air, the amount of primary air is still low compared with other burners on the market.

Fig. 3: Flame during heating of the kiln, jet nozzles turned into 90°-position resulting in a swirl in clockwise direction