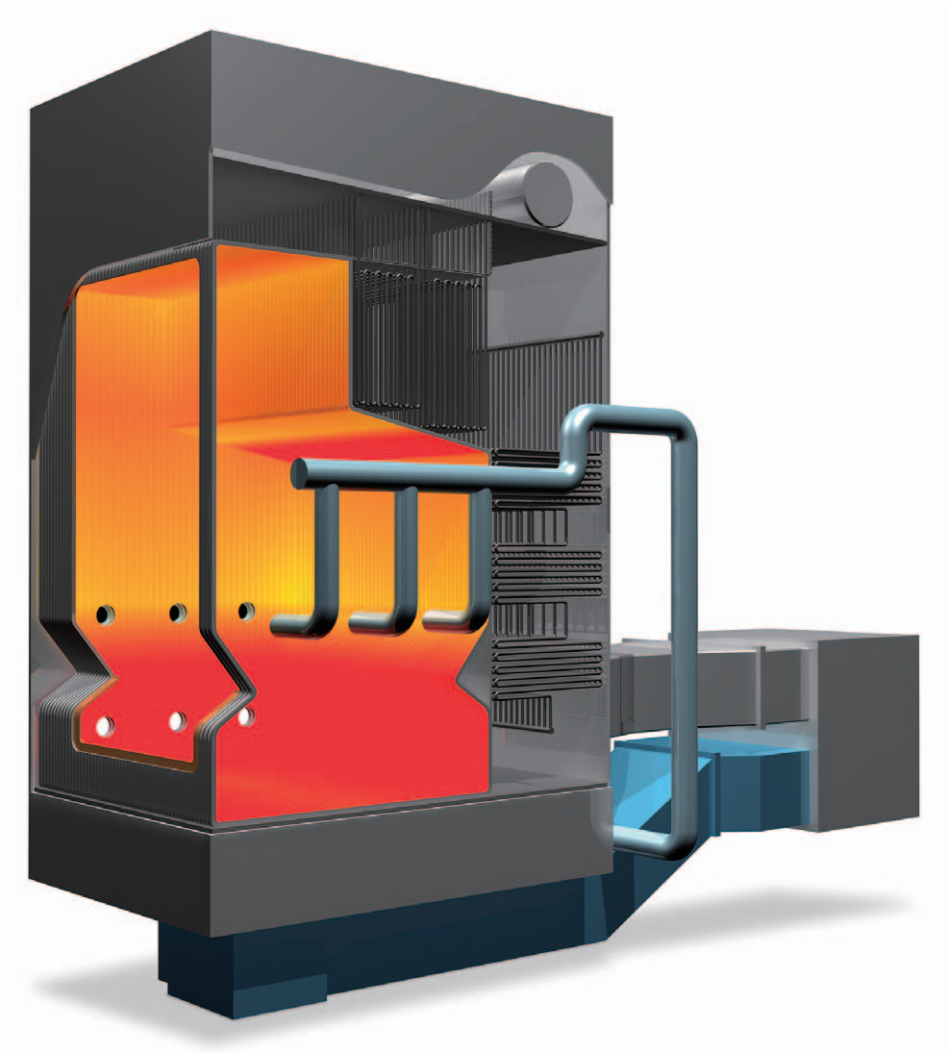
Kawasaki
KAWASAKI HEAVY INDUSTRIES, LTD.

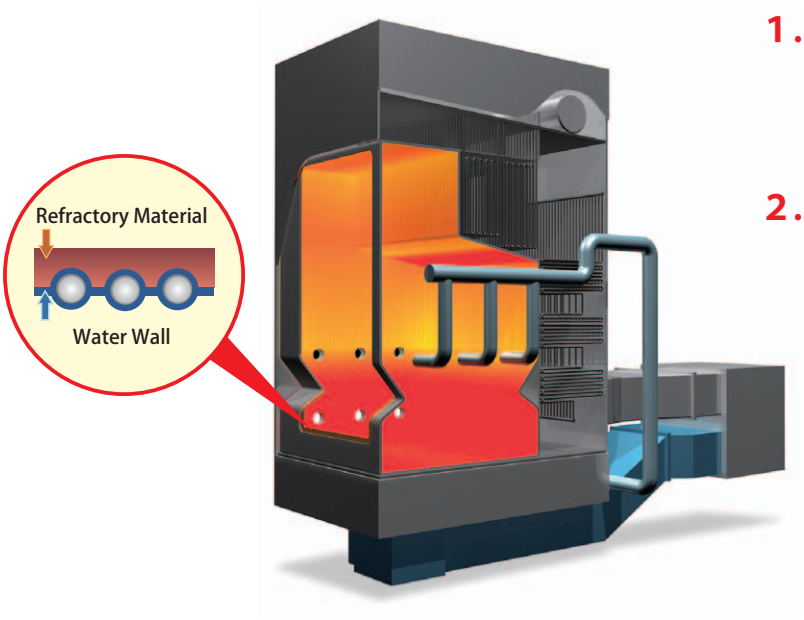
KACC & U-KACC Boiler

Kawasaki Advanced Clean Combustion
&
Upgraded KACC Boiler for Petroleum Cokes Firing



More than 120 years have passed since Kawasaki produced and delivered its first boiler in 1880.
In 1998, Kawasaki developed the KACC (Kawasaki Advanced Clean Combustion) Technology for residual fuel oil combustion.
This technology has succeeded in reducing NOx gases and dust generated in flue gas substantially compared to conventional boilers.
This enables the total elimination of both dust collection and de-NOx equipment for certain emission levels mandated by regulations in Japan.
In 1999, we installed a KACC boiler that uses asphalt as fuel, and this boiler is still operating smoothly today.
Later, in 2008, we developed the U-KACC boiler, which burns solid petroleum coke, while also offering extremely low NOx and dust emissions.

KACC & U-KACC Features



1 . Low NOx and Low Dust in Flue Gas even when Low-Grade Oil is used

- REDUCES FUEL COSTS
- ENVIRONMENT-CONSCIOUS

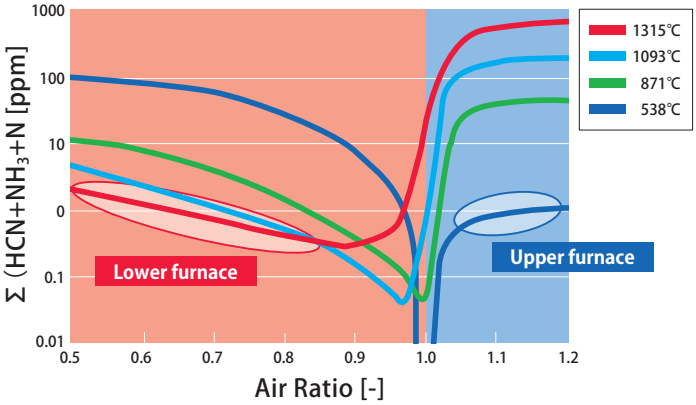
2 . Minimizes Capital Investment in Dust Collection and De-NOx Equipment

- REDUCES CAPITAL REQUIREMENTS

In KACC boiler, residual fuel oil is gasified through high-temperature deoxidization combustion in the lower furnace. Following this process, the gas is burned off completely under low-temperature oxidization combustion conditions in the upper furnace.

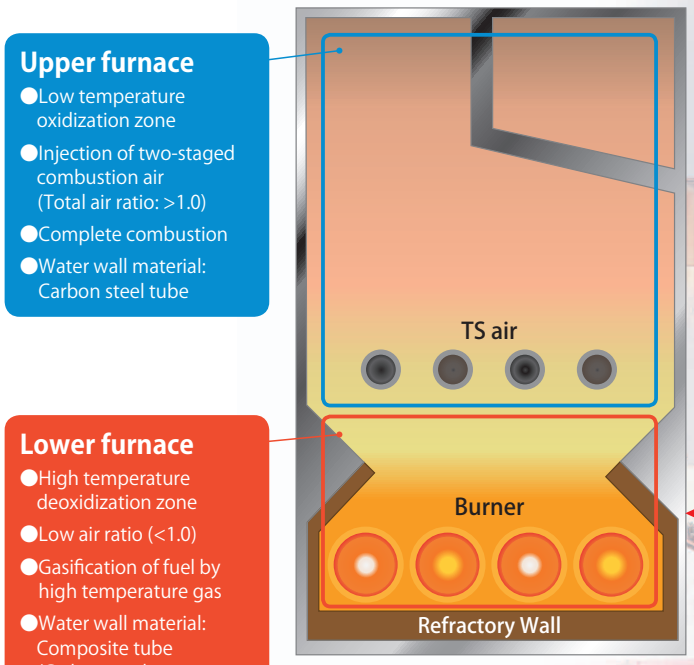
Principle for Reducing NOx

The KACC NOx reduction system is based on the principle shown in this graph. It illustrates the relationship between NOx and burner air ratio at different combustion temperatures. As the graph shows, in a deoxidization atmosphere, NOx emissions fall as the gas temperature rises, while in an oxidization atmosphere, NOx emissions fall as the gas temperature falls. The KACC system, which combines high-temperature deoxidization combustion in a lower furnace and low-temperature oxidization combustion in an upper furnace.



Data source;(EPA/EPRI Primary Source NOx Symposium 1985)

KACC

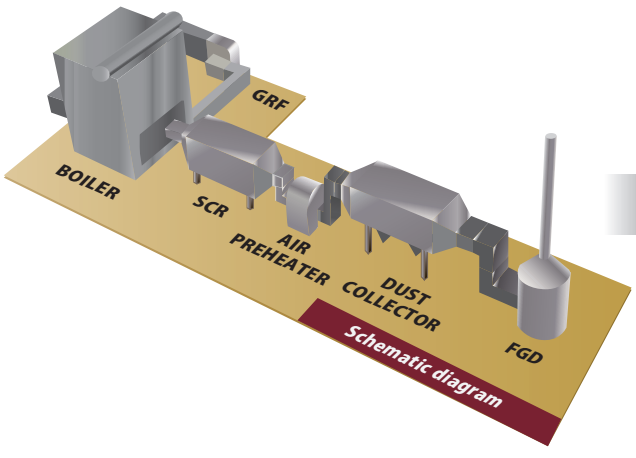


Expected Performance of KACC & U-KACC

Expected performance (Boiler outlet)

		Conventional boiler	KACC / U-KACC
Bunker-C O_2=4%, dry	NOx [ppm]	150	≦ 100
	Dust [mg/Nm^3]	300	≦ 100
Asphalt, VR O_2=4%, dry	NOx [ppm]	240	≦ 120
	Dust [mg/Nm^3]	700	≦ 300
Pet. cokes O_2=6%, dry	NOx [ppm]	300～700	≦ 250

Advantage of KACC & U-KACC on Flue Gas Treatment



Simplif

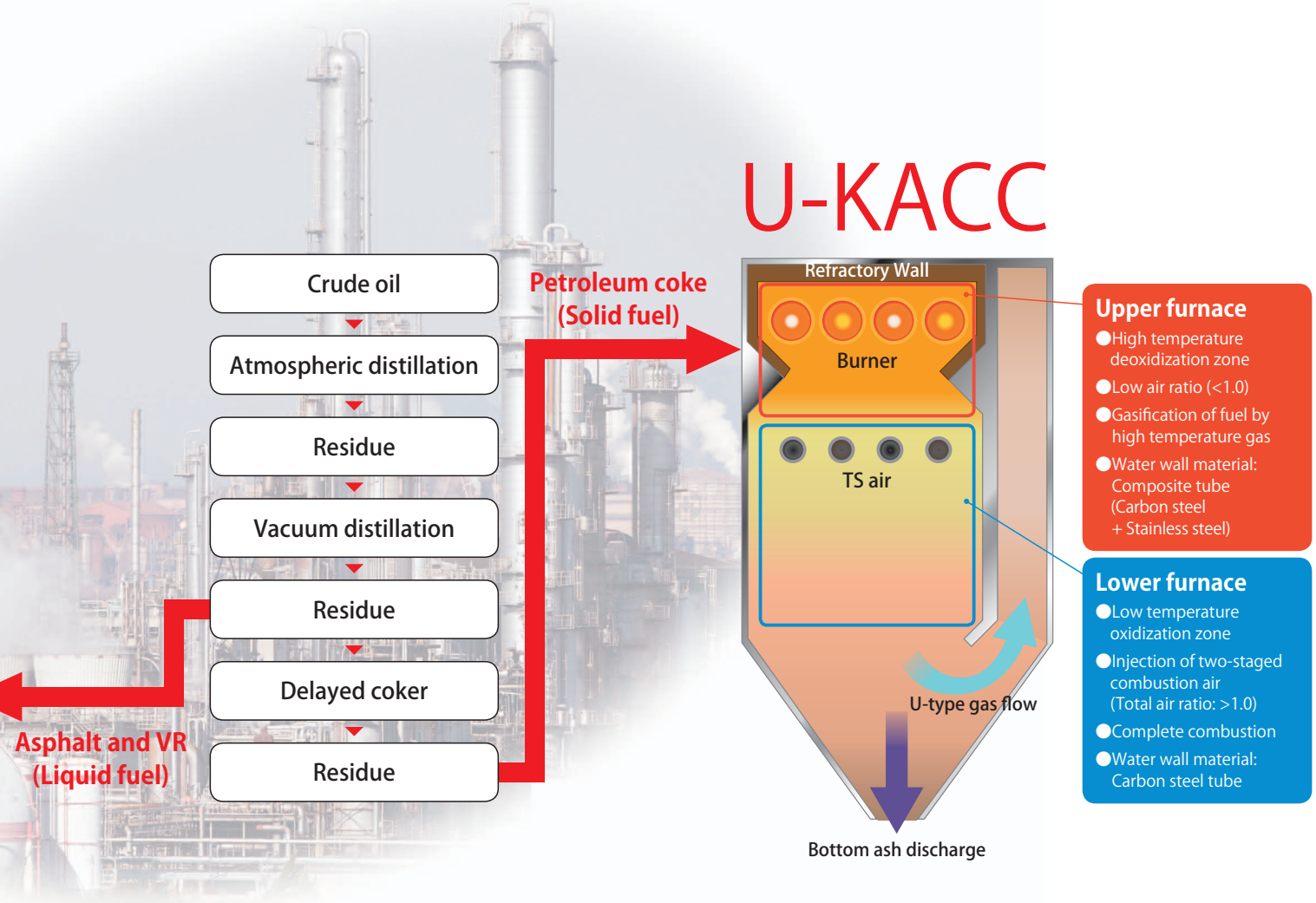
Applicable Fuels

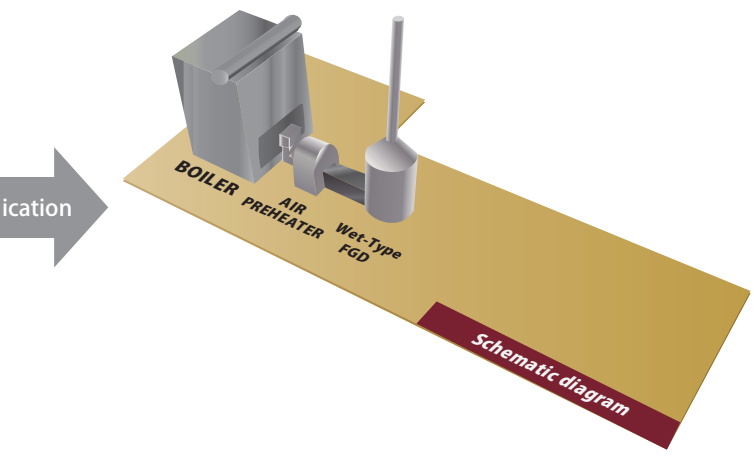
Residual oil products, such as asphalt and VR (vacuum residue), are characterized by high viscosity and high sulfur, nitrogen, residual carbon, and vanadium content. Petroleum coke is poorer quality, with factors such as its solid state and high ash content making it more difficult to burn than asphalt and VR.

Residual oil products and bitumen are burned in the KACC boiler, while petroleum coke is burned in the U-KACC boiler in a stable and clean fashion.

Applicable fuel

Fuel characteristics		Bunker-C	Asphalt, VR	Pet. coke
Sulfur	wt %	≦ 3	4～6	4～7
Nitrogen	wt %	≦ 0.2	0.5～0.7	1～3
Residual carbon	wt %	≦ 12	25～30	87～90
Vanadium	wt ppm	≦ 60	200～300	≦ 1500
Ash	wt %	-	0.03	0.2～1.0
Boiler type		KACC	KACC	U-KACC





- There is no need for a GRF (gas re-circulation fan) because the KACC & U-KACC alone can deliver low NOx emissions.
- The SCR (de-nox equipment) can be downsized or even eliminated completely, depending on the maximum permissible NOx-emission values.
- There is no need for a dust collector, if wet-type desulfurization equipment is installed.

Hokuetsu Kishu Paper Co., Ltd. (Mie, Japan in 1998)

Boiler Spec.	Capacity	t/h	130
	Steam press.	MPa	10.3
	Steam temp.	℃	533
Design Fuel	Kind		High viscosity bunker C
	Sulfur content	%	3.0 (max.)
	Nitrogen content	%	0.35 (max.)
	Residual carbon	%	-
NOx (Design / Actual)	Boiler outlet	ppm	120 / 98
	SCR outlet	ppm	-
SOx (Design / Actual)	FGD outlet	ppm	75 / 16
Dust (Design / Actual)	Boiler outlet	mg/Nm^3	300 / 100
	Stack	mg/Nm^3	50 / 10

JX Nippon Oil & Energy Corporation (Aichi, Japan in 1999)

Boiler Spec.	Capacity	t/h	200
	Steam press.	MPa	11.4
	Steam temp.	℃	515
Design Fuel	Kind		Asphalt
	Sulfur content	%	6.0 (max.)
	Nitrogen content	%	0.7 (max.)
	Residual carbon	%	28 (max.)
NOx (Design / Actual)	Boiler outlet	ppm	120 / 110
	SCR outlet	ppm	35 /26
SOx (Design / Actual)	FGD outlet	ppm	60 / 7
Dust (Design / Actual)	Boiler outlet	mg/Nm^3	300 / 250
	Stack	mg/Nm^3	38 / 7

Nippon Daishowa Paperboard Co., Ltd. (Hiroshima, Japan in 2001)

Boiler Spec.	Capacity	t/h	100
	Steam press.	MPa	10.3
	Steam temp.	℃	533
Design Fuel	Kind		Bunker C
	Sulfur content	%	3.0 (max.)
	Nitrogen content	%	0.27 (max.)
	Residual carbon	%	15 (max.)
NOx (Design / Actual)	Boiler outlet	ppm	90 / 83
	SCR outlet	ppm	-
SOx (Design / Actual)	FGD outlet	ppm	50 / 38
Dust (Design / Actual)	Boiler outlet	mg/Nm^3	200 / 152
	Stack	mg/Nm^3	50 / 24

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