X-DF by WinGD

Green Propulsion

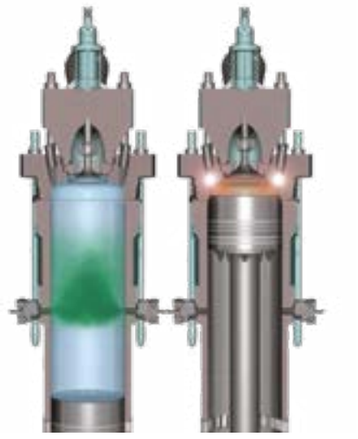
WinGD is a leading developer of low-speed gas and diesel engines for marine propulsion. Its X-DF engines are designed to meet emission requirements far below the International Maritime Organization (IMO) Tier III limits, utilising a low cost, highly efficient and reliable low-pressure gas admission system. In fact, as the only solution that is specifically made for LNG, it is designed to run efficiently – at all loads – from port to port.

AET - Eagle Bintulu LNG dual fuelled Aframax vessel

WIN GD

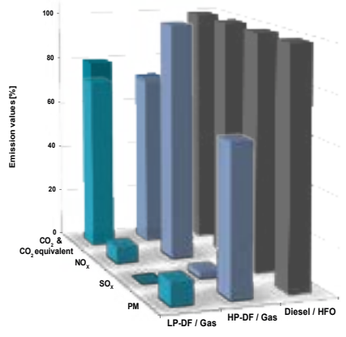
X-DF

X-DF engines offer new marine engine standards with low-pressure gas technology. Engineered for efficiency – improving operational control, compliance and costs.



The X-DF principle with gas admission (left) and ignition (right)

Gas admission valve (GAV)



Emission values

Pilot injector

Low-pressure X-DF technology: the industry standard

The launch of dual-fuel engines using LNG admitted at low pressure and ignited by a low volume of liquid pilot fuel was a breakthrough in the marine industry.

WinGD has applied a depth of gas engine expertise and experience to its low-speed engines – a move that extends the benefits of dual-fuel (DF) technology across the broader marine industry.

The low-pressure X-DF technology concept

Low-pressure X-DF technology is based on the lean-burn principle (Otto cycle), in which fuel and air are premixed and burned at a relatively high air-to-fuel ratio – a concept already used widely on medium-speed engines.

This concept on the X-DF engines provides the following benefits:

- Low-pressure gas supply means maximum simplicity, low investment costs and low power consumption
- Extremely small pilot fuel quantity, below 1% of total heat release
- X-DF engines can be operated on gas down to very low loads
- Low NO_x emissions, close to zero SO_x emissions and IMO Tier III compliant without exhaust-gas after-treatment
- Particulate matter emissions significantly reduced.

Reducing system complexity

X-DF technology requires a simple gas supply system, reducing system complexity and auxiliary power consumption. Since LNG is mixed with the scavenge air before compression, the required gas pressure is maximum 13 bar or lower when operating at lower loads. As a result, the fuel supply system is relatively simple, safe, reliable and well-proven.

Applications

X-DF technology is applicable on a variety of vessel types, including LNG carriers, chemical tankers, container ships and vessels operating worldwide including in Emission Control Areas (ECAs - Baltic Sea, coasts of North America, Gulf of Mexico). In the marine business, the low-pressure X-DF solution is an attractive alternative for companies looking for environmentally sustainable propulsion solutions.

The X-DF-ready concept, available on WinGD portfolio engines, makes the conversion of low-speed diesel to LNG possible. Retrofitting can be combined with planned maintenance, during a standard docking period.

Better operational flexibility

The pre-chamber technology and design for the gas admission valve in X-DF engines offers the highest level of combustion stability and reduced emissions, well below IMO Tier III requirements.

This stability in dual-fuel operation allows for greater load flexibility while improving port-to-port operations and maneuverability at low speeds, ensuring operational control at all times.

Ensured future compliance

WinGD offers a better alternative in a world of stringent emission targets. The use of benchmark, low-pressure technology offers compliance capabilities and viable solutions for new regulations.

Smokeless gas operation at all running speeds.

Achieving this, without additional exhaust gas after treatment systems, reduces engineering complexity, costs and emissions across the board.

Improved cost efficiencies

WinGD developed smarter, efficient engine designs with the X-DF dual-fuel technology for low investment costs and lower operating costs.

Featuring the most economic low-pressure supply system and the fewest components, the space required and fuel costs are kept low.

IMO 2050 Greenhouse Gas (GHG) reduction targets

The IMO, at its April 2018 meeting, adopted the target to halve GHG emissions from international shipping by 2050 compared to 2008.

How to reach this target in an environment of increasing global seaborne trade is open for debate. One clear measure is to strengthen the energy efficiency design index (EEDI) which was introduced in 2013 to reduce the carbon intensity per transport work. Increasing vessel efficiency by introducing new technologies like hybridisation of the propulsion system and adding sustainable assisting energy sources like wind and solar energy will be one option. Another is to change the fuel used for ship propulsion.

Moving away from today's high carbon fossil liquid residual fuels to carbon-lighter LNG can reduce CO_2 emissions by about 30% using WinGD X-DF engines.

Approaching 2050, fossil LNG will need to be replaced gradually by non-fossil, Bio-LNG (already available now in small quantities) and LNG produced in big volumes through CO_2 neutral "power to energy" factories using surplus power from solar and wind.

In future, more potential solutions may arise but the internal combustion engine as the main source of propulsion power for merchant shipping will continue to play a major role beyond 2050.

Today, X-DF low-pressure gas engines deliver the lowest overall emission level of any available technology for merchant ship propulsion. It is certain that X-DF technology will play a major role in the transition towards a carbon-free future.

GHG emissions reduction through X-DF engines

When comparing the GHG performance of X-DF engines running on LNG with propulsion systems running on residual fuels two aspects must be considered: LNG emits 30% less CO_2 during combustion while methane (CH_4) also forms part of the total hydrocarbon (THC) emissions and is a significant GHG.

Every combustion engine has unburned THC emissions, regardless of the process and the size of the engine. Unburned methane (CH_4), from the gas supply to the engine, forms part of the THC or methane emissions which is often referred to as "methane slip". The weighted average THC emission from an X-DF engine is very low at 2.0 g/kWh to 3.0 g/kWh (based on engine size with cylinder bore 72cm to 50cm) making it the best in its class. Of the total THC emissions measured, methane (CH_4) typically comprises 80%. The "methane slip" of X-DF engines is between 1.6 g/kWh and 2.4 g/kWh.

Despite that, the total GHG balance is still a reduction of 15-20%, a clear improvement over conventional diesel engines. WinGD's R&D department continues to be heavily invested in innovative technologies to reduce all emissions towards a carbon-neutral future for merchant shipping.

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X-DF

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WinGD X40DF

	IMO Tier III in gas mode
Cylinder bore	400 mm
Piston stroke	1770 mm
Speed	104–146 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.45

Rated power, principal dimensions and weights

Cyl.	Output in kW at 146 rpm		104 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
5	4 675	3 900	3 325	2 775	4 512	109
6	5 610	4 680	3 990	3 330	5 212	125
7	6 545	5 460	4 655	3 885	5 912	144
8	7 480	6 240	5 320	4 440	6 612	153

Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 310	7073	7410	7173
BSGC (gas)	g/kWh	145.0	140.0	147.0	142.0
BSPC (pilot fuel)	g/kWh	1.4	1.7	1.4	1.7

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	189.8	187.8	189.8	187.8

WinGD X52DF

	IMO Tier III in gas mode
Cylinder bore	520 mm
Piston stroke	2315 mm
Speed	82–105 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.45

Rated power, principal dimensions and weights

Cyl.	Output in kW at 105 rpm		82 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
5	7 450	6 200	5 825	4 850	5 950	217
6	8 940	7 440	6 990	5 820	6 900	251
7	10 430	8 680	8 155	6 790	7 850	288
8	11 920	9 920	9 320	7 760	8 800	323

Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 199	6 962	7 299	7 062
BSGC (gas)	g/kWh	142.7	137.7	144.7	139.7
BSPC (pilot fuel)	g/kWh	1.5	1.8	1.5	1.8

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	184.3	182.3	184.3	182.3

WinGD RT-flex50DF

	IMO Tier III in gas mode
Cylinder bore	500mm
Piston stroke	2050mm
Speed	99–124rpm
Mean effective pressure at R1	17.3 bar
Stroke/bore	4.10

Rated power, principal dimensions and weights

Cyl.	Output in kW at 124 rpm	124 rpm	99 rpm	99 rpm	Length A mm	Length A* mm	Weight tonnes
	R1	R2	R3	R4			
5	7 200	6 000	5 750	4 775	5 576	6 793	200
6	8 640	7 200	6 900	5 730	6 456	7 670	225
7	10 080	8 400	8 050	6 685	7 336		255
8	11 520	9 600	9 200	7 640	8 216		280

Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 199	6 962	7 299	7 062
BSGC (gas)	g/kWh	142.7	137.7	144.7	139.7
BSPC (pilot fuel)	g/kWh	1.5	1.8	1.5	1.8

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	184.3	182.3	184.3	182.3

WinGD X62DF

	IMO Tier III in gas mode
Cylinder bore	620 mm
Piston stroke	2658 mm
Speed	80–103 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.29

Rated power, principal dimensions and weights

Cyl.	Output in kW at 103 rpm		80 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
5	11 925	9 925	9 250	7 700	7 000	325
6	14 310	11 910	11 100	9 240	8 110	377
7	16 695	13 895	12 950	10 780	9 215	435
8	19 080	15 880	14 800	12 320	10 320	482

Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 166	6 927	7 269	7 025
BSGC (gas)	g/kWh	142.5	137.5	144.5	139.5
BSPC (pilot fuel)	g/kWh	1.0	1.2	1.0	1.2

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	182.2	180.2	182.2	180.2

WinGD X72DF

	IMO Tier III in gas mode
Cylinder bore	720 mm
Piston stroke	3086 mm
Speed	69–89 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.29

Rated power, principal dimensions and weights

Cyl.	Output in kW at 89 rpm		69 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
5	16 125	13 425	12 500	10 400	8 085	481
6	19 350	16 110	15 000	12 480	9 375	561
7	22 575	18 795	17 500	14 560	10 665	642
8	25 800	21 480	20 000	16 640	11 960	716

Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 149	6 906	7 247	7 004
BSGC (gas)	g/kWh	142.3	137.3	144.3	139.3
BSPC (pilot fuel)	g/kWh	0.8	1.0	0.8	1.0

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	182.2	180.2	182.2	180.2

WinGD X92DF

	IMO Tier III in gas mode
Cylinder bore	920 mm
Piston stroke	3468 mm
Speed	70–80 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	3.77

Rated power, principal dimensions and weights

Cyl.	Output in kW at 80 rpm		70 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
6	31 920	26 580	27 930	23 250	11 630	1 120
7	37 240	31 010	32 585	27 125	13 210	1 260
8	42 560	35 440	37 240	31 000	16 350	1 460
9	47 880	39 870	41 895	34 875	17 850	1 630
10	53 200	44 300	46 550	38 750	19 520	1 790
11	58 520	48 730	51 205	42 625	21 280	1 960
12	63 840	53 160	55 860	46 500	22 870	2 140

Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 089	6 846	7 192	6 944
BSGC (gas)	g/kWh	141.2	136.2	143.2	138.2
BSPC (pilot fuel)	g/kWh	0.7	0.8	0.7	0.8

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	181.1	179.1	181.1	179.1

WinGD X82DF

	IMO Tier III in gas mode
Cylinder bore	820 mm
Piston stroke	3375 mm
Speed	58–84 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.12

Rated power, principal dimensions and weights

Cyl.	Output in kW at 84 rpm		58 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
6	25 920	21 600	17 880	14 940	10 554	805
7	30 240	25 200	20 860	17 430	11 994	910
8	34 560	28 800	23 840	19 920	13 434	1 020
9	38 880	32 400	26 820	22 410	14 874	1 160

Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 116	6 871	7 215	6 971
BSGC (gas)	g/kWh	141.8	136.8	143.8	138.8
BSPC (pilot fuel)	g/kWh	0.6	0.7	0.6	0.7

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	181.1	179.1	181.1	179.1

All data provided in this brochure is for information purposes only, explicitly nonbinding and subject to changes without further notice. WinGD's General Technical Data (GTD) program provides up-to-date information on the complete portfolio of low-speed engines.

WinGD (Winterthur Gas & Diesel Ltd.) is a leading developer of two-stroke low-speed gas and diesel engines used for propulsion power in merchant shipping.

WinGD sets the industry standard for safety, reliability, efficiency and environmental sustainability. WinGD provides designs, training and technical support to engine manufacturers, ship builders, ship operators and owners worldwide.

WinGD is headquartered in Winterthur, Switzerland, where, as one of the earliest developers of diesel technology, it started the design of large internal combustion engines in 1893 under the "Sulzer" name.

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