Wärtsilä low-speed low-pressure dual-fuel engines – the industry standard

The global merchant marine industry is in the midst of a revolutionary transformation, with increasing pressure from new laws, higher environmental requirements and ever-tighter profit margins. Winterthur Gas & Diesel Ltd. (WinGD) is a leading developer of two-stroke low-speed gas and diesel engines used for propulsion power in merchant shipping. The low-speed dual-fuel (DF) engines, which are sold under the Wärtsilä brand name, are designed to lower this pressure – on your investment, on the environment, and on your operating costs. In fact, as the only solution that is specifically made for gas, it is designed to run efficiently – at all loads – from port to port.

Key benefits

- The lowest emissions that meet Tier III without additional exhaust after-treatment.
- Simple, reliable and most economical low-pressure gas supply system, with the fewest components.
- Stable operation on gas over the entire load for port-to-port operation and manoeuvring.

WIN GD
Winterthur Gas & Diesel

Low-pressure gas technology – The industry standard

Wärtsilä's first modern gas engines were developed as high pressure gas-diesel engines, based on the well-known diesel combustion process. The breakthrough in the marine market, however, came with the launch of dual-fuel engines using gas admitted at low pressure and ignited by a low volume of liquid fuel pilot, due to their clear advantages. In the meanwhile Wärtsilä has already delivered more than 1,300 of its "DF" dual-fuel engines, which have accumulated more than 13 million operational running hours in both land-based and marine applications. As a result, low-pressure gas admission technology has been adopted by the marine market as an industry standard.

WinGD is following this industry standard and has now applied Wärtsilä's depth of gas engine expertise and experience to its low speed 2-stroke engines – a move that extends the benefits of DF technology across the broader marine industry. To date, this technology has been received with great enthusiasm and numerous orders have been placed for a variety of vessel types, including large and small LNG Carriers, container feeder vessels and tankers.

The low-pressure dual-fuel (DF) technology concept

Low-pressure 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.

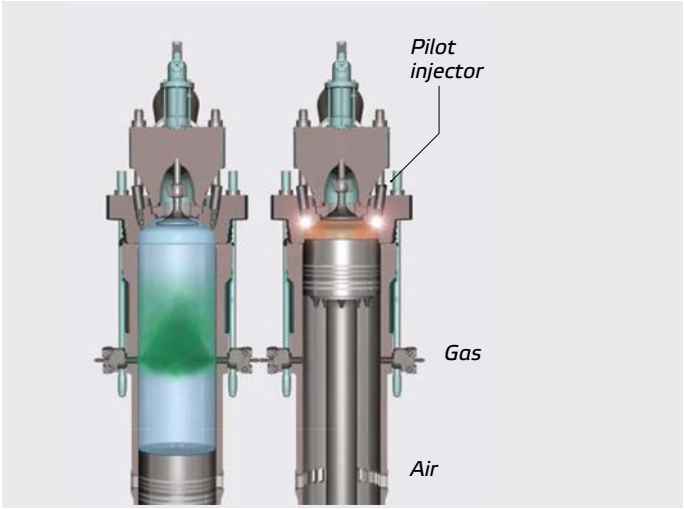
Such a concept on the 2-stroke DF engines provides following benefits:

- Low-pressure gas supply means low investment costs and low power consumption
- Pilot fuel quantity below 1% of total heat release
- DF engine can be operated on gas from idle
- Low NO_X emissions, Tier III compliant in ECAs without after treatment
- Particulate matter emissions reduced to almost zero

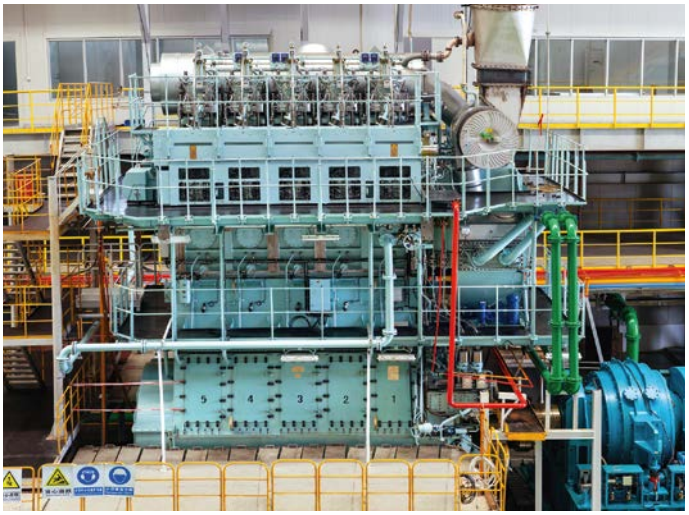
Applications

Low-pressure DF technology is applicable on a variety of vessel types, i.e. LNG carriers, chemical tankers, container ships and holds excellent potential for vessels operating in Emission Control Areas (Baltic, coasts of North America, Gulf of Mexico). In the marine business, the low-pressure 2-stroke DF solution is an increasingly attractive alternative for companies looking for environmentally friendly propulsion solutions. As the lifespan of a vessel is usually measured in decades, retrofitting an engine to DF operation is often highly cost-effective, since it "future proofs" your investment.The LNG-ready concept, available on all Wärtsilä X-engines, makes the conversion of low-speed diesel to DF a matter of course, as retrofitting can be combined with planned maintenance, during a standard docking period, for example.

Wärtsilä 6X72DF engine.

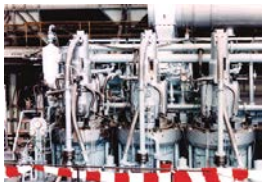


The 2-stroke DF principle with gas admission (left) and ignition (right).



Wärtsilä 5RT-flex50DF with Turbocharger at the aft end.

History of gas technology development



1986
Testing high-pressure DF engine

1987
High-pressure gas diesel engine

1992
Low-pressure spark-ignited engine

1995
Low-pressure dual-fuel engine break through in marine segment

2013
2-Stroke low-pressure dual-fuel engine

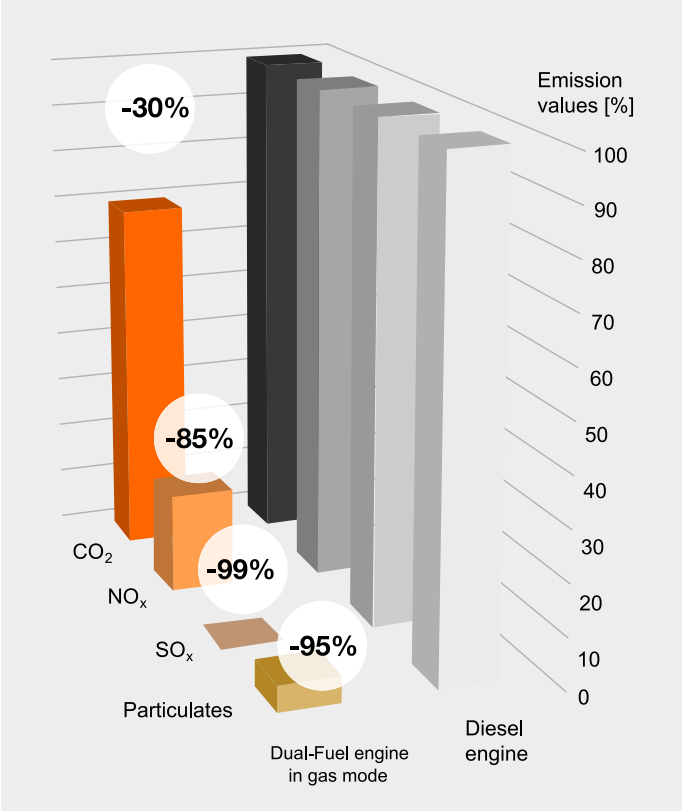
The future is low pressure

Simple gas supply system

Low-pressure DF technology requires a simple gas supply system, reducing system complexity and auxiliary power consumption. Since the fuel gas is mixed with the scavenge air before compression, the required gas pressure is below 16 bar at any operating point. As a result, the fuel supply system is relatively simple, reliable and well-proven.

Fully compliant with IMO Tier III

Due to its lean-burn combustion process, this technology has an inherent potential to reduce the formation of NO_X – by up to 90% compared to diffusion combustion of diesel or high-pressure direct-injected gas-diesel engines (GD). Thus, with lean-burn Wärtsilä DF engines, no additional exhaust gas treatment system is needed to meet the IMO Tier III NO_X limits in coastal regions. The low-pressure DF solution also reduces the vessel's total CO_2 footprint compared to HFO.



Example of emission reduction obtained by switching to gas.

Low CAPEX and competitive OPEX

The low-pressure concept offers the possibility of applying the most cost-effective low-pressure gas supply system – one that requires no large compression equipment with its high power consumption. Compared to competing GD technology, this translates into

- Considerable reduction in investment due to:
  - No high-pressure compressor and high-pressure gas system needed
  - No additional costs required for compliance with IMO Tier III in ECAs
  - Lower electrical power demand allows installation of less auxiliary engine power
  - Widest selection of ancillary component suppliers
- Competitive overall operating costs due to:
  - High overall efficiency (Low parasitic load)
  - Low maintenance costs for the entire machinery plant i.e. main engine, auxiliary engines, and fuel gas supply systems due to low amount of equipment on board and components in low pressure execution.

Safe and reliable operation

Wärtsilä's extensive operational experience with the numerous medium-speed DF engines running in the field has been incorporated into the 2-stroke DF engine design, making the concept robust and reliable. The same goes for the gas supply system which is largely identical to the standard systems installed today and is thus backed up by a large supply base of component makers.

The low-pressure DF concept ensures full redundancy by having the backup diesel fuel mode available at any time. In fact, it only takes one engine revolution to change from gas to diesel mode without any interruption of power or speed, at any load. This will keep your vessel running under all circumstances.

Wärtsilä 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				Length (mm)	Weight tonnes
	124 rpm	124 rpm	99 rpm	99 rpm		
	R1	R2	R3	R4		
5	7 200	6 000	5 750	4 775	5 576	200
6	8 640	7 200	6 900	5 730	6 456	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	7 125	7 177	7 122	7 178
BSGC (Gas)	g/kWh	140.8	141.5	140.3	141.0
BSPC (pilot fuel)	g/kWh	2.0	2.4	2.5	3.0

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	182.1	182.1	182.1	182.1

Wärtsilä 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				Length mm	Weight tonnes
	105 rpm		82 rpm			
	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	7 125	7 198	7 122	7 178
BSGC (gas)	g/kWh	140.8	141.5	140.3	141.0
BSPC (pilot fuel)	g/kWh	2.0	2.4	2.5	3.0

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	182.1	182.1	182.1	182.1

Wärtsilä 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				Length mm	Weight tonnes
	103 rpm		80 rpm			
	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	7 028	7 091	7 030	7 092
BSGC (gas)	g/kWh	139.2	140.2	138.8	139.7
BSPC (pilot fuel)	g/kWh	1.6	1.9	2.1	2.5

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	180.0	180.0	180.0	180.0

Wärtsilä 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				Length mm	Weight tonnes
	89 rpm		69 rpm			
	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	7 030	7 093	7 027	7 089
BSGC (gas)	g/kWh	139.4	140.4	139.0	139.9
BSPC (pilot fuel)	g/kWh	1.4	1.7	1.8	2.2

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	180.0	180.0	180.0	180.0

Wärtsilä X82DF — IMO Tier III in gas mode

Cylinder bore	820 mm
Piston stroke	3375 mm
Speed	65-84 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.12

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length mm	Weight tonnes
	84 rpm		65 rpm			
	R1	R2	R3	R4		
6	25 920	21 600	20 070	16 710	11 045	805
7	30 240	25 200	23 415	19 495	12 550	910
8	34 560	28 800	26 760	22 280	14 055	1 020
9	38 880	32 400	30 105	25 065	16 500	1 160

Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	6 991	7 051	6 991	7 051
BSGC (gas)	g/kWh	138.7	139.7	138.4	139.3
BSPC (pilot fuel)	g/kWh	1.3	1.6	1.7	2.0

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	178.9	178.9	178.9	178.9

Wärtsilä 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				Length mm	Weight tonnes
	80 rpm		70 rpm			
	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	6 983	7 042	6 983	7 043
BSGC (gas)	g/kWh	138.5	139.5	138.4	139.3
BSPC (pilot fuel)	g/kWh	1.3	1.6	1.5	1.8

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	178.9	178.9	178.9	178.9

We recommend you to contact us to ensure you have the most recent product information.

www.wingd.com

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