

ENERGY
ENVIRONMENT
ECONOMY



The Wärtsilä dual-fuel engine is the ultimate 'fuel flexibility' solution. It is a four-stroke engine that runs on light fuel oil (LFO) or heavy fuel oil (HFO), and can switch over from gas to LFO/HFO and vice versa smoothly during engine operation. The Wärtsilä dual-fuel engines are available in power range from 0.9–18.3 MW having speed range from 500–1200 rpm.

KEY BENEFITS OF WÄRTSILÄ DF-ENGINES:

- Fuel flexibility
- Application flexibility
- Proven and reliable dual-fuel technology
- Long overhaul intervals
- Low exhaust gas emissions
- Fuel economy over the entire engine operation range
- Low gas feed pressure
- Embedded automation system

DUAL-FUEL ENGINES – WÄRTSILÄ 20DF, 34DF, 46DF AND 50DF

TECHNOLOGY AND OPERATION ADVANTAGES

The Wärtsilä dual-fuel engines are four-stroke power converters that can be run on natural gas, marine diesel oil (MDO) or heavy fuel oil (HFO). One of the main features of the proven and reliable dual-fuel technology is that the engine can be switched from fuel oil to gas operation and vice versa smoothly during engine operation. During switchover the fuel oil is gradually substituted by gas. In the event of for instance a gas supply interruption, the engine converts from gas to fuel oil operation at any load instantaneously and automatically. Furthermore, the separate liquid fuel system makes it possible to switch over from MDO to HFO and vice versa

without power interruption. The pilot fuel is in operation during HFO operation to ensure nozzle cooling.

The fuel switch from liquid to gas operation mode can be made on operator's command. This operation flexibility is a real advantage with the dual-fuel system. The natural gas is supplied to the engine through a gas valve unit, where the gas is filtered and gas pressure is controlled. The system includes



the necessary shut-off and venting valves to ensure safe and trouble free low pressure gas supply. On the engine, the gas is supplied through a large common-rail pipe running along the engine. Each cylinder then has an individual feed pipe to the gas admission valve on the cylinder head. Gas piping is of double wall design as standard.

When running the engine in gas mode, the air / gas mixture is ignited with a small quantity of MDO pilot fuel, less than 1% of full-load fuel consumption. The amount of pilot fuel is optimised for best combustion by the embedded engine speed & load control and monitoring system. The advanced automation system provides complete engine safety system and local monitoring. Thanks to built-on complete automation integration the external control system is significantly reduced which obviously saves space in the engine control room.

ENVIRONMENTAL COMPLIANCE

The dual-fuel technology brings outstanding benefits to ship owners and operators. The Wärtsilä dual-fuel engine operates on the lean burn principle: the mixture of air and gas in the cylinder contains more air than is needed for complete combustion. Lean combustion reduces peak temperatures

and therefore NO_x emissions. In gas mode, the engine is already compliant with IMO Tier III regulations without any secondary exhaust gas purification systems. Dual-fuel technology offers reduced SO_x and CO₂ emissions as well as smokeless operation in gas operation mode. In liquid fuel oil mode, the Wärtsilä dual-fuel engines are fully compliant with the IMO Tier II exhaust emissions regulations set out in Annex VI of the MARPOL 73/78 convention.

APPLICATION FLEXIBILITY

Wärtsilä dual-fuel engines are suitable for a wide range of applications. Thanks to fuel flexibility and wide power range coverage the engine can be perfectly installed and optimised for constant speed generating sets as well as variable speed mechanical drives for main engine applications. Furthermore, compact and modular design of the Wärtsilä dual-fuel engines gives perfect space saving opportunity especially in smaller applications, such as small cargo vessels, ferries or tug boat installations. The multi-fuel operation capability offers new machinery opportunities for various vessel applications. For example, the Wärtsilä 20DF can be installed to complete the multi-fuel engine room concept as generating set next to Wärtsilä 34DF,

Wärtsilä 46DF or Wärtsilä 50DF main propulsion machinery. Typical installation examples are RoPax or LNG carriers.

To date, Wärtsilä's DF technology has accumulated more than 12,000,000 running hours, with more than 1,300 engines installed and in operation in the field.

WÄRTSILÄ 20DF

The Wärtsilä 20DF design is based on the well proven and reliable Wärtsilä 20 diesel engine which was introduced on the market in the early 1990s. Wärtsilä 20DF covers the lower power range in the dual-fuel Wärtsilä engine family. Available cylinder configurations are in-line 6, 8 and 9 configurations covering the power range from 0.9 MW to 1.6 MW. Speed range is 1000–1200rpm for use with 50 or 60 Hz applications.

Wärtsilä 20DF is optimal for a wide range of vessel types mounted as generating set. The Wärtsilä 20DF fits perfectly also as mechanical drive prime mover for smaller applications, such as small cargo vessel, ferries or tug boat installations.

WÄRTSILÄ 34DF

The Wärtsilä 34DF design is based on the well proven and reliable Wärtsilä 32 diesel engine which was introduced on the market



in the mid of 1990s. Wärtsilä 34DF covers the middle part of the power range in the dual-fuel Wärtsilä engine family. Available cylinder configurations are 6, 8 and 9 in-line, and 12 and 16 Vee- configurations covering the power range from 2.8 MW to 8.0 MW. Speed range is 720–750 rpm for use with 50 or 60 Hz applications.

Thanks to very wide power range the Wärtsilä 34DF fits for a various different vessel types mounted as prime mover in mechanical propulsion as well as generating set applications.

WÄRTSILÄ 46DF

The Wärtsilä 46DF is a four-stroke dual-fuel engine that can be run on natural gas, heavy fuel oil (HFO) or marine diesel oil (MDO). The engine can smoothly switch from gas fuel to HFO/MDO operation and vice versa without loss of power or speed. The Wärtsilä 46DF design is based on the well proven and reliable Wärtsilä 46F and Wärtsilä 50DF engine families, which have operated successfully on the market since the early 2000s. Both engines have an outstanding track record, with more than 700 engines in operation and over 9 million running hours experience using Wärtsilä's leading DF technology. The Wärtsilä 46DF extends Wärtsilä's dual-



fuel engine family by covering the power range from 6.2 MW to 18.3 MW at 600 rpm.

WÄRTSILÄ 50DF

The Wärtsilä 50DF design is based on the well proven and reliable Wärtsilä 46 diesel engine which was originally designed to operate reliably with the poorest quality heavy fuel oil, makes the Wärtsilä 50DF ultimate in reliable performing product.

Wärtsilä 50DF covers the top part of the power range in the dual-fuel Wärtsilä engine family. Available cylinder configurations are

6, 8 and 9 in-line, and 12, 16 and 18 Vee-configurations covering the power range from 5.7 MW to 17.5 MW. Speed range is 500–514 rpm for use with 50 or 60 Hz applications.

Wärtsilä 50DF is suitable for a wide range of applications in various respects. Utmost power-to-weight and power-to-space ratios of the Wärtsilä 50DF offer various machinery opportunities for different vessel applications. The Wärtsilä 50DF can be installed as mechanical drive prime mover for large LNG carriers, RoPax and various offshore applications.

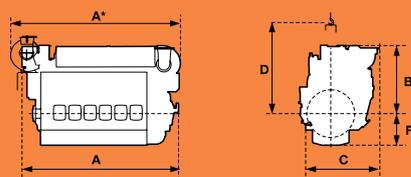


MAIN TECHNICAL DATA

Wärtsilä 20DF		IMO Tier III	
Cylinder bore	200 mm	Fuel specification: Fuel oil	
Piston stroke	280 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	185 kW/cyl	ISO 8217, category ISO-F-DMX, DMA and DMB	
Speed	1200 rpm		
Mean effective pressure	21.0 bar	BSEC 7700 kJ/kWh at ISO cond.	
Piston speed	11.2 m/s		

Rated power		kW
Engine type		
6L20DF		1 110
8L20DF		1 480
9L20DF		1 665

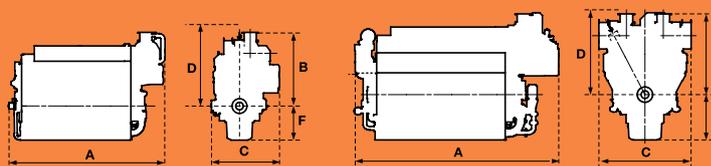
Engine dimensions (mm) and weights (tonnes)							
Engine type	A*	A	B	C	D	F	Weight
6L20DF	3 254	3 108	1 705	1 690	1 800	624	9.4
8L20DF	3 973	3 783	1 705	1 824	1 800	624	11.1
9L20DF	4 261	4 076	1 705	1 824	1 800	624	11.7



Wärtsilä 34DF		IMO Tier III, EPA T2/T3	
Cylinder bore	340 mm	Fuel specification: Fuel oil	
Piston stroke	400 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	500 kW/cyl	ISO 8217, category ISO-F-DMX, DMA and DMB	
Speed	750 rpm		
Mean effective pressure	22.0 bar	BSEC 7280 kJ/kWh at ISO cond.	
Piston speed	10.0 m/s		

Rated power		kW
Engine type		
6L34DF		3 000
8L34DF		4 000
9L34DF		4 500
12V34DF		6 000
16V34DF		8 000

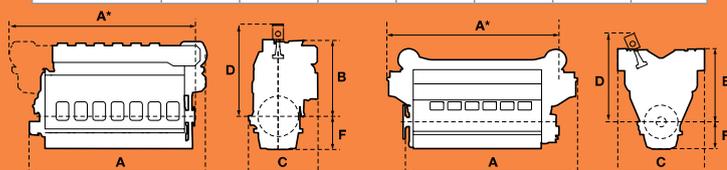
Engine dimensions (mm) and weights (tonnes)							
Engine type	A	B	C	D	F	Weight	
6L34DF	5 325	2 550	2 380	2 345	1 155	35	
8L34DF	5 960	2 550	2 610	2 345	1 155	44	
9L34DF	6 870	2 550	2 610	2 345	1 155	49	
12V34DF	6 865	2 435	2 900	2 120	1 210	61	
16V34DF	7 905	2 570	3 325	2 120	1 210	77	



Wärtsilä 46DF		IMO Tier III, EPA T2/T3	
Cylinder bore	460 mm	Fuel specification: Fuel oil	
Piston stroke	580 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	1045, 1145 kW/cyl	ISO 8217, category ISO-F-DMX, DMA & DMB	
Speed	600 rpm		
Mean effective pressure	21.7, 23.8 bar	BSEC 7060 kJ/kWh at ISO cond.	
Piston speed	11.6 m/s		

Rated power			
Engine type	High output 1145 kW/cyl	High efficiency 1045 kW/cyl	
6L46DF	6 870	6 270	
7L46DF	8 015	7 315	
8L46DF	9 160	8 360	
9L46DF	10 305	9 405	
12V46DF	13 740	12 540	
14V46DF	16 030	14 630	
16V46DF	18 320	16 720	

Dimensions (mm) and weights (tonnes)							
Engine type	A*	A	B	C	D	F	Weight
6L46DF	8 670	8 833	3 255	3 185	3 750	1 430	102
7L46DF	9 350	9 513	3 255	3 185	3 750	1 430	118
8L46DF	10 310	10 830	3 445	3 185	3 750	1 430	130
9L46DF	10 990	11 510	3 445	3 185	3 750	1 430	146
12V46DF	11 120	10 350	3 670	4 555	3 800	1 620	184
14V46DF	12 170	11 400	3 670	4 555	3 800	1 620	223
16V46DF	13 450	12 780	3 860	5 174	3 800	1 620	235



Wärtsilä 50DF		IMO Tier III, EPA T2/T3	
Cylinder bore	500 mm	Fuel specification: Fuel oil	
Piston stroke	580 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	950, 975 kW/cyl	ISO 8217, category ISO-F-DMX, DMA and DMB	
Speed	500, 514 rpm		
Mean effective pressure	20.0 bar	BSEC 7110 kJ/kWh at ISO cond.	
Piston speed	9.7, 9.9 m/s		

Rated power				
Engine type	50 Hz		60 Hz	
	Engine kW	Gen. kW	Engine kW	Gen. kW
6L50DF	5 700	5 500	5 850	5 650
8L50DF	7 600	7 330	7 800	7 530
9L50DF	8 550	8 250	8 775	8 470
12V50DF	11 400	11 000	11 700	11 290
16V50DF	15 200	14 670	15 600	15 050
18V50DF	17 100	16 500	17 550	16 940

Generator output based on a generator efficiency of 96.5%.

Engine dimensions (mm) and weights (tonnes)							
Engine type	A	B	C	D	F	Weight	
6L50DF	8 115	3 580	3 270	4 000	1 455	96	
8L50DF	10 230	3 920	3 360	4 000	1 455	128	
9L50DF	11 140	3 920	3 505	4 000	1 455	148	
12V50DF	10 410	4 055	3 810	3 600	1 500	175	
16V50DF	13 085	4 400	4 730	3 600	1 500	220	
18V50DF	14 180	4 400	4 730	3 600	1 500	240	

