# WinGD X-DF: the leading solution for LNG propulsion

Wuxi, October 11, 2019 Marcel Ott, Winterthur Gas & Diesel (Shanghai) Co. Ltd.



# A long heritage in diesel and gas engine design

**WinGD** has its headquarter in Winterthur Switzerland, one of the earliest exponents of the Diesel engine technology.

It started with the development of internal combustion engine in 1898 under the **"Sulzer"** name and continues to develop power solutions



WIN GD



### Content

**1)** Market update

2) X-DF Technology & emissions3) X-DF engines in service



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### X-DF engines reference list (August 2019)

X-DF engine type	Vessel type		Orders
X40DF	9'500 cu.m. LNGC		1 engine
RT-flex50DF	15K dwt Product Tankers 1-2K TEU Feeder CVs 14-20K cu.m. LNG Carriers 3'600 vehicles PCC 5'800 Iane m Ro-Ro		27 engines
X52DF	125K dwt Shuttle Tanker 7'000 vehicles PCC		6 engines
X62DF	115K dwt Crude Oil Tankers 180K cu.m. LNGC/twin screw 174K cu.m. LNGC/twin screw		35 engines
X72DF	174k cu.m. LNGC/twin screw 180K dwt Bulk Carriers		182 engines
X92DF	22K TEU Post-Panamax CVs 15K TEU Neo-Panamax CVs		14 engines
TOTAL	265 DF engines (ca	. 4.7 GW)	

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# LNG as fuel approaching 3.000 MW/annum

About 27% of 2-stroke engines ordered in 2019 are DF engines! X-DF holds >90% share of this!



Source: Clarksons Research Services, WinGD internal data



# The largest gas engines ever built!

#### Series of 12X92DF being delivered from CSSC-MES Diesel Co., Shanghai



- 63'840 kW at 80 rpm
- Powering the most environmentally-friendly ultralarge container vessels
- The nine 22'000 TEU vessels will run on natural gas during the entire Asia-Europe roundtrip
- Making all the commercial and environmental benefits of LNG as a fuel available to the large container vessel segment
- 5 more 10-cylinder engines contracted



# **Development of fuel price**

#### LNG as most competitive fuel

- Development of LNG pricing is supporting business cases to go for LNG as fuel
- Worldwide LNG production capacities are growing quickly
- → LNG price expected to remain very competitive
- What about liquid fuel prices post 2020??
- LNG bunkering infrastructure is developing quickly
- No other fuel is commercially more attractive







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# X-DF Technology & emissions

# Low-pressure technology sets the standard

#### **Maximum simplicity**



#### The Principle

- Engine operating according to Otto process
- Pre-mixed 'Lean-burn' combustion technology
- Low-pressure gas admission at 'mid-stroke' location
- Ignition by pilot-fuel into pre-chambers

#### The main merits with low gas pressure < 13bar

- Simple and reliable gas supply system
- Simple gas sealing
- Wide selection of proven compressors / cryogenic pumps

#### Lean Burn 'Otto' combustion means

#### **IMO Tier III compliance:**

- Without additional equipment (EGR/SCR)
- Without additional fuel consumption
- Without compromised component reliability



# **Gas Admission & Pilot fuel Injection**







# WinGD engines go on line with 'WiDE'

"WinGD integrated Digital Expert" to improve performance, reliability, service



### Lowest emission footprint in the industry

#### **"Ultra-low" NOx emissions**

IMO weighted avg. <1 g/kWh



<u>'Ultra-low' NOx emissions during 100% of gas operation time !</u>				
E.g. 180k LNGC:	regular Tier II	~2300 t/year		
(7'500 h at sea at CSR)	X-DF on gas	~150 t/year		

#### Low CH<sub>4</sub> emissions

Methane emissions confirmed to be low, also in part load operation





#### $CH_4$ emissions in the range of 1.5% of gas consumption

Even if considering GHG potential of methane slip, total GHG footprint is positive in comparison to conventional diesel engine



### **Methane emissions**

#### Why methane emissions of X-DF are not significant

- Global Warming Potential of methane is about 30 times stronger than of  $\rm CO_2$
- Overall, Methane accounts for 15 to 18% of global GHG emissions
- 50% of that is related to agriculture activities with livestock / meat production the predominate source.
- All LNG-fuelled ships in the world in 2022 (based on X-DF engines) would emit as much Methane emissions in a year as the livestock in New Zealand in 1 day !



# GHG emission comparison: X-DF vs. ME-GI

Example with X72DF, comparison of main engine only



Fig. 3: GHG comparison: X-DF vs. ME-GI

- Diesel engine on HFO Tier II set as a reference (100 %) 1
- Diesel engine on MDO Tier II emits slightly less CO<sub>2</sub> due to lower carbon intensity of MDO compared to HFO
- Significant reduction in CO<sub>2</sub> emissions with gas as a fuel (approx. 25 % 30 % less compared to HFO) Benefit is partly reduced by CH<sub>4</sub> emissions
- As a net effect, GHG emissions of X-DF are still 18% lower compared to a diesel engine on HFO
- Solely considering main engines, ME-GI results in slightly lower GHG emissions. Including auxiliary power for gas compressors and Tier III compliance of the ME-GI, GHG emissions of X-DF and ME-GI are typically similar (see following pages)



(2)

3

4

#### Ship emissions: 174k LNGC machinery GHG footprint

#### **Comparison of 2 LNGC's, with the 2 different main engine machinery concepts**



	Machinery concept with	Machinery concept with	Difference	
	2 x 5X72DF engine	2 x 5G70ME-C-GI engine	Difference	
Power [%]	GHG emission [t/day]	GHG emission [t/day]	GHG emission [t/day]	
100	271.1	279.1	-8.0	
95	258.5	267.1	-8.6	
90	246.5	255.3	-8.9	
85	234.9	244.1	-9.2	
80	223.2	232.5	-9.2	
75	211.7	221.2	-9.5	
70	201.3	210.3	-9.0	
65	190.7	200.4	-9.7	
60	180.0	190.6	-10.5	
55	169.4	180.6	-11.2	
50	158.9	170.6	-11.8	
45	148.1	160.4	-12.2	
40	137.3	150.0	-12.7	
35	126.2	139.4	-13.2	
30	114.7	128.8	-14.1	
25	103.0	118.0	-15.0	

#### With methane emissions considered, X-DF machinery results in lowest GHG emissions !

Calculation of GHG emissions with following conditions:

- TIER III operation
- ISO conditions
- BSFC and BSGC are without tolerances
- Main fuel (LNG) and pilot fuel (MDO)
- Global Warming Potential according to the IPCC report 'Climate Change 2014: GWP100=28



# What about non-GHG emissions/air quality?

**Toxic emission components with different engine technologies** 



NO<sub>X</sub> and Particulate Matter (PM) are a serious hazard to human health and can be most effectively reduced with X-DF propulsion!

Extract from the latest WHO report, 02.05.2018:

"In 2016, 91% of the world population was living in places where the WHO air quality guidelines levels were not met.

Ambient (outdoor air pollution) in both cities and rural areas was estimated to cause 4.2 million premature deaths worldwide in 2016."

http://www.who.int/en/news-room/factsheets/detail/ambient-(outdoor)-air-quality-and-health



### The difference between Diesel and Otto-cycle

#### No visible soot and NOx in gas mode!

Diesel mode (Diesel-cycle)



Gas mode (Otto-cycle)





### **Comprehensive study on GHG**

#### Published on April 11

- Latest study by independent consultancy firm 'Thinkstep'
- Assessing the environmental impact of LNG as a fuel compared to conventional fuels
- Complete well-to-wake chain has been reviewed
- Focus on GHG emissions and air quality impact by using LNG as a fuel
- Concludes that LNG contributes to reduction of GHG
  emissions from shipping industry
- Download: <a href="https://info.thinkstep.com/LNG-GHG-Study">https://info.thinkstep.com/LNG-GHG-Study</a>





# **X-DF engines in service**



### **X-DF shop tests and sea trials**

#### **Production and delivery becoming standard procedures**

- More than 86 engines have been delivered from different engine builders, in the 50 to 92cm bore range
- Type approval testing (TAT) successfully completed on RT-flex50DF, X52DF, X62DF and X72DF
- 32 vessels of different type have been sea trialled and are in service, number of vessels growing quickly
- All major yards working with X-DF propulsion systems









# Findings on low pressure concept

#### **Experience from X-DF engines in operation**

#### Low-pressure gas concept works well

- Stable combustion process
- Stable engine operation on gas in rough sea
- Very low load operation on LNG gas down to 5% proven

#### Excellent operation of Gas admission system

- No malfunction or gas leakages experienced
- Single cases of sticking GAV pilot valve during testbed commissioning (particle contamination rail valve), resulting in gas trip → safety system worked as designed.
- → Design update (adding lube oil filter) implemented, standard on new engines







# **Seagoing experience**

#### Proven and reliable engines with maximized operation in gas mode

- >18.000rhs on "Ternsund" 15K chemical tanker in the Baltic sea. 90 % operation on LNG
- "SK Audace" first LNG carrier with X-DF more then 15.000rhs. 98% operation on Gas
- Total accumulated running hours of X-DF fleet: >260'000
- Several issue have been rectified, non of them being major

#### X-DF inherent benefits:

- Tier III compliance in Gas-mode
- Simple, reliable and low-pressure gas supply system for max 13bar (engine @ 100% full load)
- Lowest CAPEX for any LNG as fuel capable propulsion system in the market







# Why WinGD Low-Pressure ?

#### 1) THE MOST ENVIRONMENTLY FRIENDLY SOLUTION AVAILABLE

- Meets IMO TIER III requirements without exhaust gas after-treatment due to lean-burn Otto combustion process
- Lowest overall emission footprint
- 2) LOW CAPEX Due to low-pressure gas supply system
  - Simple low-pressure equipment (pumps, compressor, evaporator, piping, sensors)
  - No exhaust gas after treatment required
- 3) LOW OPEX Due to high overall efficiency
  - Minimized electrical power demand
  - Low maintenance cost

#### 4) LOW-PRESSURE - THE INDUSTRY STANDARD

- Maximum safety
- Widely applied by medium-speed majors for good reasons
- Various brands: Wärtsilä, MAN, Cat/MAK, Rolls Royce, MTU, Mitsubishi







# X-DF 2.0 – introduction

Improved performance, reduced emissions in the planning

 Reduced gas consumption in gas mode by - 3 g/kWh resp. 2%

 Reduced liquid fuel consumption in diesel mode by 8 g/kWh resp. 4 -5%

• CH4 emission (methane slip) reduced by 40-50%



### **X-DF 2.0 - Development Schedule**





### **X-DF 2.0 - Customer Benefits**



Lower operating costs



#### **Reduced Methane slip and CO<sub>2</sub> emissions**



#### Proven low-pressure dual-fuel engine technology with high reliability and safety record



LNG as fuel with X-DF engines is the key towards a cleaner and more sustainable future of shipping

### Thank you

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