WinGD Low-speed Engines
Licensees Conference 2015

Concepts, Testing and First Service Experience with the Generation X-Engines (35 to 92 cm bore)

ABSTRACT

This paper describes, how the concept of the so-called Generation X-engines, namely

- X-tra efficiency
- X-tra manufacturing-friendly
- X-tra reliability
- X-tra environmentally-friendly

has been realised on the different models of this engine family i.e. the W-X35 and 40, the W-X52, the W-X62 and 72, the W-X82 and the largest engine, the W-X92. Further it is explained why there are some differences in the realisation of the Generation X concept, whether due to the need for different solutions based on engine size, due to different requirements from the shipyards or due to the availability of technical concepts.

Additionally, a short update is given on the upgraded versions of the W-X35 and 40 and the W-X82 – the so-called B versions – as well as a preview of the newest X-engine model, the W-X52.

Several Generation X-engines are already in service – these are the W-X35 and 40, the W-X62 and 72 and the W-X82. Field experience with these engines is described in the second part of this paper.

INTRODUCTION

As the expectations of major players in the market for large low-speed diesel engines, i.e. the engine builders; the shipyards and the design institutes; the ship owners and operators; and the legislative authorities, have not changed, but they have become particularly tough. The requirements for highly cost-efficient and environmentally-friendly solutions for the transportation of goods were never higher than today. It is easily shown that shipping is environmentally sound when calculating the emissions per unit of cargo transported. Yet when a single vessel can consume between 50 to 60 tonnes of fuel per day, the resulting level of pollution is high in absolute terms. Environmental concerns and the price of fuel have been driving shipping to become more cost conscious. The official term for the latest and most efficient vessels is the so-called “eco-ship”, which claims efficiency gains of up to 30% compared with previous generations of ships. These gains can be achieved by various means, including alternative energy sources (renewables, biofuels, LNG), design measures (bulbous bow, lightweight construction, design speed reduction), hydrodynamic measures like propeller modifications and hull coatings, and machinery measures such as main engine design, tuning, rating and hybrid shaft generators.

The market has evolved and is more seriously considering the condition and performance of ships at sea. For example, the largest shipping banks are much more interested in the quality and the value of assets today than back in 2010. After the global economic crisis and the introduction of stricter banking regulation, financial institutions have much less enthusiasm for risk-taking. Banks are looking for ships that can maximise asset utilisation, ensuring that owners and operators remain compliant with their loan conditions. Furthermore, in the case of bankruptcy or liquidation, a good quality asset will have a higher resale value.

Then, another important aspect is the charterer vs. owner debate. In times of high spot rates, as currently seen in the tanker market, operators are looking into accepting spot rates as they come. In more tumultuous and volatile markets, owners will be opting for the stability of long term charters, transferring the fuel cost responsibility to the charterer. The charterer is therefore deliberately looking at environmentally sound, more efficient ships. Consequently, the industry is experiencing the emergence of companies rating ships depending on their emissions and performance levels.

To summarise, the higher the rating, the more efficient the ship, which then allows more attractive bank loan terms, a better charter contract (possibly even with a premium) and a higher resale value.

As mentioned above, machinery is one key element in the design of an “eco-ship”. The new Generation X-engines are the first in Winterthur Gas & Diesel Ltd’s (WinGD) two-stroke marine diesel portfolio which are specifically developed with the aforementioned increased focus on low operating costs combined with optimised first costs, on actual and forthcoming environmental legislation and, finally, on compact design for the highest possible cargo capacity (payload).

To highlight the new generation of engines, an updated type designation was introduced in May 2011, namely W-X35 and W-X40, W-X62 and W-X72, and W-X92, where “W” stands for Wärtsilä and “X” for cross-head engine, extra low speed and flexible fuel injection technology.

THE TECHNICAL REALISATION OF THE X CONCEPT

X-tra environmentally-friendly

A newly developed engine needs to be prepared for the coming enactment of the International Maritime Organization’s (IMO) limits on emissions of oxides of nitrogen (NO_X) emissions legislation. The Tier III limits will become effective from 1st January 2016 and, in addition to NO_X limitation, limits will be introduced for fuel sulphur content for the first time, in order to limit emissions of oxides of sulphur (SO_X).

The strategies and the technologies WinGD is following to meet the upcoming emissions legislation are described in detail in two separate papers.

The Tier III NO_X legislation can be fulfilled by using so-called Dual-Fuel (DF) technology, which produces NO_X emissions are well below the given limits during operation on gas. Two other technologies which can be applied to reduce NO_X emissions to the required low level are Selective Catalytic Reduction (SCR) and Exhaust Gas Recirculation (EGR).

Among emissions, carbon dioxide (CO2) is currently receiving great attention. CO2 is the direct product of hydrocarbon fuel combustion in thermal engines, is directly proportional to their fuel consumption and contributes to the greenhouse effect. CO_2 has also become a new focus in the marine industry since IMO introduced the Energy Efficiency Design Index (EEDI). The EEDI is a method used to quantify the CO_2 emissions of merchant vessels by benchmarking them, and transport work, against a limit imposed by the IMO. Several measures can be taken to reach an EEDI below the limit, such as optimisation of the cargo capacity and hull efficiency of the ship, engine and propulsion efficiency or the application of a Power-Take-Off (PTO) generator. The following paragraph describes in which ways an engine developer can contribute to an optimised EEDI.

X-tra efficiency

The optimisation of engine efficiency – or, equivalently, Brake Specific Fuel Consumption (BSFC) – has always been one of the most important targets of an engine developer. One of the biggest steps on low-speed two-strokes was the introduction of the electronic control of fuel injection and exhaust valve actuation. While on mechanical engines it was only possible to optimise these aspects at one single operating point, a BSFC optimisation at all loads became possible with the introduction of fully flexible electronic control. As the IMO NO_X legislation weights the emissions for different load steps to define the total NO_X emissions of an engine, it is possible to use the flexibility of electronically-controlled engines to offer different tuning options to optimise the total fuel consumption of a vessel depending on its operating profile. The four tuning options which are available for the RT-flex and the X-engines are:

- Standard Tuning
- Delta Tuning
- Delta Bypass Tuning
- Low-load Tuning

The Figure 1 shows BSFC depending on the engine load for the four tuning options.

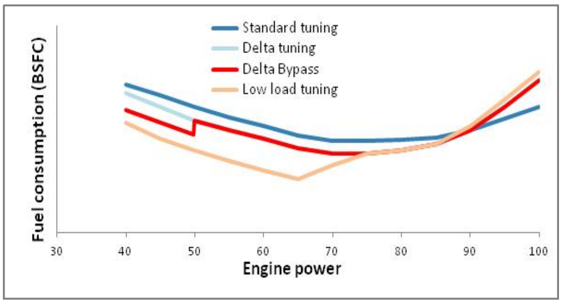


Figure 1: Typical BSFC curves to illustrate Standard, Delta, Delta Bypass and Low Load Tuning

Striving for more efficient propulsion systems leads to lower speed engines and thus to larger propellers, since reduced engine speed improves the propulsion efficiency of the propeller, and higher stroke-to-bore ratios lead to better internal efficiency of the engine. In the mid 1990s Wärtsilä introduced engine models with a stroke-to-bore ratio of over 4.0, namely the very successful RT flex48T, RT flex58T and RT flex68. All the X-engines have a stroke-to-bore ratio in the range of 4.1 to 4.5 with the exception of the W-X92. On such a large engine the stroke is limited due to machining limitations at the crankshaft manufacturers.

Why WinGD was seeking a compromise between a long stroke and engine height for some of the X-engines is described in the following Chapter.

X-tra manufacturing-friendly

As described above, the goal of highest total efficiency for the vessel propulsion system leads to engines with higher stroke-to-bore ratios. This automatically leads to engines which are considerably higher than predecessor models, with consequences for engine room design as well as component and engine weights and cost. For the W-X52, W-X62, W-X72 and W-X82 models, a bore diameter has been selected which is 2 cm bigger than for the respective competitor's engines. As a consequence, the requested cylinder power can be achieved with a stroke which is about 5% shorter, leading to a considerably lower engine room height (piston dismantling height) and also to a lower engine weight.

As mentioned above, the stroke of the W-X92 has been limited to 3468 mm to give the major crankshaft manufacturers the possibility of producing the crankshaft without major investment in new machining facilities. For the small W-X35 and W-X40, the stroke and bore have been selected at the same length as well-established competitors' models to limit engine room re-design work at the shipyards and design institutes to a minimum.

During all development work, close and continuous attention is paid to optimising designs for manufacturing. Simplified manufacturing processes lead to both high quality production and competitive manufacturing costs. Apart from shortened assembly time during production, simplified assembly leads to improved serviceability during engine operation. Since cost competitiveness can only be achieved by industrialisation that takes into account local production standards and requirements, co-operations with major engine builders in Asia were established for the development of X-engine. With the strong support of its Asian partners, WinGD's "Manufacturing Engineering" experts continuously drive this process throughout the whole development project, according to the "Winterthur Gas & Diesel Ltd design-to-cost process" (see Figure 2).

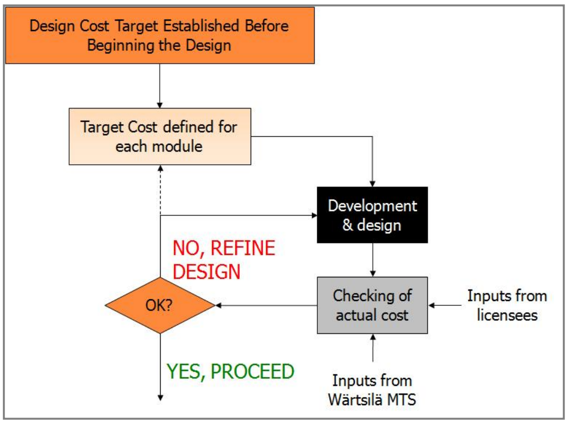


Figure 2: Winterthur Gas & Diesel Ltd design-to-cost process

Wherever possible, the X-engines follow an identical design concept. In some cases, e.g. for the engine control system, identical components are even being used. Besides the cost reduction from increased production volumes, this modular approach leads to optimisation in manufacturing and assembly since the accumulated knowledge from one engine type can be readily transferred to another type.

X-tra reliability

To ensure indisputable reliability, most of the design concepts of the X-engines were derived from the very popular RT-flex50 and RT-flex82C/T engines. As of June 2015, some 418 RT-flex50 and 129 RT-flex82C/T engines have been ordered and around 400 of these engines are already in service, accumulating a total of approximately 6 million running hours.

The new time-controlled “flex” fuel injection system is derived from Wärtsilä’s four-stroke medium speed diesel engine designs. Before its implementation on large two-stroke engines, it was tested extensively under typical operating conditions on dedicated test rigs and on an RT-flex60C engine in vessel operation.

The proven concepts then have to be customised for the respective engine type and size. The use of state-of-the-art simulation tools like the Finite Element Method (FEM) for stress and temperature calculation, vibration, hydraulic or bearing calculations, ensures that all relevant parameters and loads stay within proven design limits, without unnecessary margins which would lead to excessively high manufacturing cost.

“Same, same – but different!”

As far as possible, the same technical concepts or even identical components are being applied on all the X-engines. However, in several cases some adaptations were necessary to the respective engine types. One of the main reasons for such adaptations is the huge ranges of powers and dimensions the X-engines cover. A W4X35 has a power output of 4,350 kW whereas the biggest X-engine, the W12X92 produces 73,560 kW. Also, the weight range of 74 to 2140 tons for these two extremes in the X-engine family is impressive. It is self-evident, then, that technical concepts might differ over such huge ranges, for example due to limitations in manufacturing.

Another reason for adapted solutions is different engine room designs, depending on the vessel types in which the X-engines can be installed. In larger vessels, the typical turbocharger location is laterally on the engine’s long side, whereas in smaller vessels with very compact engine rooms, the most suitable turbocharger location is often at the engine’s driving end. Other typical causes for engine size-dependent solutions are the applicability of simpler concepts on smaller engines only – the oil-cooled piston is such an example – or weight and size limitations in workshops – the biggest crankshafts can only be produced in two parts.

The availability of technical solutions can also be a limitation to their application. It is possible that a certain technology is not yet developed to the required level of maturity for the whole engine range and therefore “older”, proven technology has to be applied until the end of the validation process. Such an example is the fuel injection system. The new time-controlled injectors were validated up to the W-X72. For the bigger W-X82 and W-X92 engines the technology is currently still in the validation phase. This is why the proven ICU (Injection Control Unit) technology can be found on these two engine types. Table 1 gives an overview of the main engine components.

Components		**W-X35/X40**	**W-X52/X62/X72**	**W-X82**	**W-X92**
Running gear	Crankshaft	Single piece; different executions		Single or double piece; different executions	Single or double piece; different executions; dual cylinder distance
	Crosshead	Straight crosshead pin, single piece guide shoe with white metal lining			
	Main bearings	Thin shell, alu. lining	Thin shell, white-metal lining		
	Crosshead bearings	Wide shell, white-metal lining; white-metal lining in cover			
	Piston cooling	Knee lever			
	Piston rod gland box	Four oil scraper, two dirt scraper and two gas-tight rings; hardened piston rod			
Engine structure & scavenge system	Bedplate	Single wall, double tie rod, integrated thrust bearing	Single wall, single tie rod with Ikea nut, integrated thrust bearing (X82 with double wall bedplate)		
	Column	Single wall, integrated gear housing	Double wall, separate gear housing		
	Cylinder jacket	Cast cylinder jacket with inspection door to piston underside			
	Turbo charger location	Aft end	Lateral side (or aft end)	Lateral side	
	Water separation	Charging unit with underslung design, 3-nose water separator			
Fuel injection, valve drive & automation	Fuel injection	Time controlled electronic Injectors		Injection Control Unit	
	Fuel pumps	Multi-element pumps	Single element, cam-shaft driven fuel pumps		
	Servo oil system	300 bar servo oil pressure, cast VCU		200 bar SO pressure, machined VCU	200 bar SO pressure, cast VCU
	Drive of supply unit	Direct gear drive from crankshaft			
	Control system	UNIC-flex		WECS	
Combustion chamber & piston running	Cylinder liner	Self-supported slim type liner	Self-supported liner with bore cooled collar (X52 with slim type liner)		
	Cylinder cover	Forged or cast execution, 6 elastic studs		Forged or cast execution, 8 elastic studs	Forged or cast execution, 10 elastic studs
	Piston	Through-flow oil cooling	Jet-shaker oil cooling		
	Piston rings	Three chromium-ceramic plated, pre-profiled piston rings			
	Exhaust valve	Electronically controlled operation, hydraulically actuated, pneumatically closed			
	Cylinder lubrication	Electronically controlled Pulse Lubricating System (PLS)			

Table 1: Concept overview of the main engine components on the X-engines

THE B VERSIONS OF W-X35 & 40 AND W-X82

W-X82-B

The design of the W-X82 is very much based on the successful RT-flex82T and the RT-flex82C. Some 130 RT-flex82T&C engines are in operation today, the earliest ones since 2008.

In 2011 the RT-flex82T became a member of the Generation X family and it was renamed the W-X82. But not only was the name changed in order to indicate that the RT-flex82 was already a very modern engine. A number of updates was also implemented. The most significant change for the market was the considerably bigger rating field, which required a number of modifications. In addition, some improvements were implemented, of which two were the introduction of the Pulse Jet cylinder lubricating system and the FAST (Fuel Actuated Sacless Technology) fuel injection valves.

Due to requirements from the market for even lower engine speeds and further de-rating possibilities, WinGD recently decided to upgrade the W-X82 to the B version, with an even larger rating field.

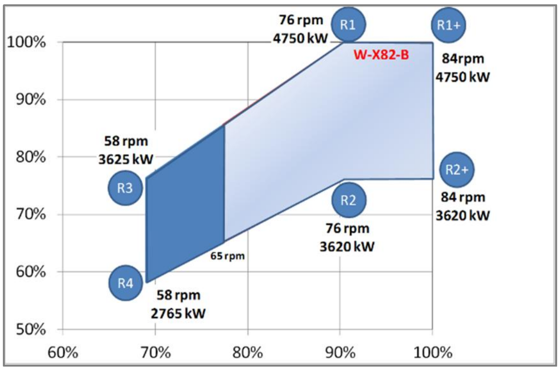


Figure 3: Extended rating field of W-X82-B (dark blue)

The only change which is needed due to the larger rating field is the introduction of crosshead booster pumps. An increase in oil-feed pressure is needed for the reliable operation of the crosshead and crankpin bearings at lower engine speeds with today's high maximum firing pressures. Thanks to the higher oil pressure, the oil film thickness is increased and the maximum oil film pressure is reduced, while additionally the bearings benefit from improved oil refreshment (cooling).

The introduction of the B-version is also used to implement two proven features from other engine types. The first is the bypass cooling of the cylinder liner and the second is the latest crank angle sensor technology, known as "Angela". The bypass cooling system was introduced on the W-X62 & 72 engines as a measure against low temperature corrosion on the cylinder liner running surface and the piston rings. The liner temperatures are increased by a combination of reduced cooling water flow and increased inlet temperature of the liner cooling water, as shown schematically in Figure 4.

Crank angle detection was implemented on all the RT-flex engines by means of a sensor located at the free end of the crankshaft. The new "Angela" system fulfils the same function, which is to give at all times the exact position and speed of the crankshaft, in order to the control system. Four standard proximity sensors "count" the teeth of the intermediate gear wheel and twice per crankshaft revolution two additional sensors are used to detect the Top Dead Centre (TDC) and Bottom Dead Centre (BDC) positions of cylinder no. 1. The rationale for the introduction of "Angela" was improved cost efficiency. "Angela" was first introduced on the RT-flex48T-D in 2012.

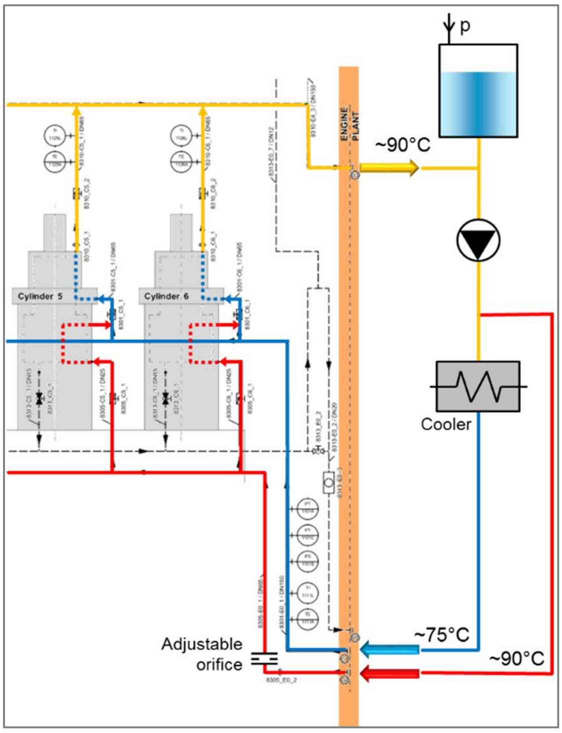


Figure 4: Diagram of the bypass cylinder liner cooling system

W-X35-B & W-X40-B

As with the W-X82, there was also increasing demand for enlarged rating fields for the smaller W-X35 and W-X40 engines. Shown in Figure 5, the relative increase in the rating field is slightly bigger since this is the first time that it has been adapted to the latest market trends.

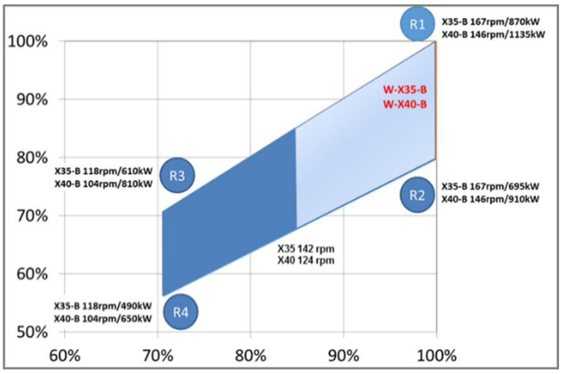


Figure 5: Extended rating field of W-X35-B and W-X40-B (dark blue)

As with the X82-B, crosshead booster pumps are also needed for the extension of the rating field. To have sufficient space for the additional piping on the exhaust side of the engine and to keep stress levels within prescribed limits, the oil supply to the main bearings has been re-designed.

In addition, the W-X35-B and W-X40-B will also benefit from a number of improvements compared to their predecessors. Some of the improvements are adopted from the W-X62 and 72, namely:

- Fuel injection nozzles with FAST technology, leading to cleaner combustion and reduced fuel consumption
- Pilot valve in the fuel injection nozzles with increased clearance
- Optimised fuel drain from the Pressure Control Valve
- Improved design of the Valve Control Unit (VCU) with integrated Parker control valve
- Hardware and base software of the UNIC control system identical to W-X62/72
- Integration of the control system power supply into the rail unit, leading to a simplification for shipyards and reduced cost
- Offering the Integrated Injection Control (ICC) as an option.

The cylinder block, liner and cover will receive a re-design as a measure against repeated issues with leakages from the combustion chamber. With the updated design it will also be possible in future to increase the maximum firing pressures for further reduced BSFC. The exhaust valve cage will be equipped with optimised cooling, as some issues were reported with the insulation applied in the current solution. The regulation of the fuel and servo-oil pumps will be optimised to improve stability and the conditioning tank for the cylinder lubricating system will be omitted. This measure and other re-design work will lead to simpler and more service-friendly pipework and cabling around the engines.

THE NEW W-X52

The W-X52 is the latest member of the X-engine family and is currently under development. Although it has a slightly increased stroke-to-bore ratio of 4.45 compared to 4.29 on the W-X62, the W-X52 is mostly scaled down from the bigger 62 cm bore engine. Due to its smaller size, there are three changes which are worth mentioning:

- For bore sizes below 580 mm, typically only two instead of three fuel injection valves are being used.
- The already well-established supply unit from the RT-flex50 fits perfectly on the W-X52. The only change is the increase in servo oil pressure from 200 to 300 bar.
- While the bigger engines need a bore-cooled collar on the cylinder liner to ensure efficient cooling and the required rigidity, smaller engines can be equipped with a simpler, slim type cylinder liner, as show in Figure 6

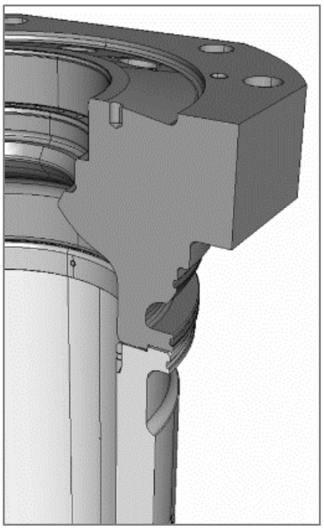


Figure 6: Slim type cylinder liner, shown using the example of RT-flex50

According to the project schedule, the delivery of the first W-X52 from the engine builder is due by the end of June 2016. Of the engines currently on order, the first W5X52 will be delivered from the engine builder in September 2016.

PROTOTYPE TESTING AND SERVICE EXPERIENCE

Before the very first engine of a new type is delivered from the engine builder to the shipyard, it undergoes an extensive testing programme. The first target of this prototype testing is the optimisation of all the relevant parameters to achieve optimum engine performance. Even in times when almost everything can be simulated, it is still necessary to carry out fine tuning on the real engine. The second important reason for testing is to verify the simulation results. As described earlier in this paper, WinGD is applying the latest simulation technologies, but verifying the results on the engine it is still an unavoidable part of the process and also confirms the correctness of all the boundary conditions. Typical measurements and tests during prototype testing are:

- Fuel consumption
- Emissions (NO_X)
- Stress & strain
- Temperatures
- Pressures
- Vibrations
- Flows
- Starting behaviour and air consumption

In some cases it is possible that on one of the following engines, additional tests have to be performed, based on the findings from prototype testing. The Type Approval Test (TAT) with all relevant Classification Societies is typically done on the third or fourth engine produced, to ensure smooth operation during this important event.

Service experience – W-X82

The first 82 cm bore engines entered service operation in the year 2008 and since then the population has increased to 165 engines (RTA and RT-flex versions). Another 60 engines are currently on order. In total, the 82 cm bore engines have accumulated about 3 million running hours with very positive service experience. In particular, all the white metal bearings (see Figure 7) have close to a zero failure rate over the whole engine population, which is a great achievement when considering past issues, especially on the main bearing.

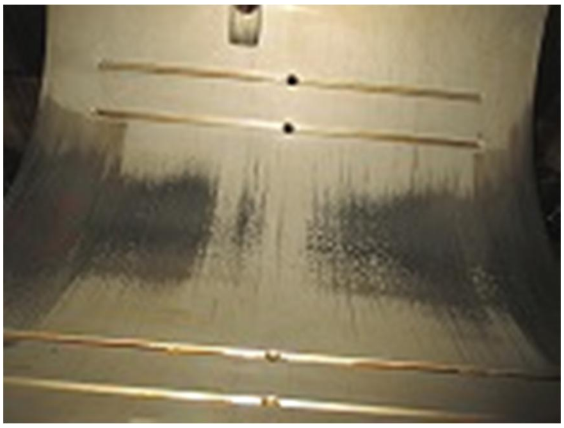
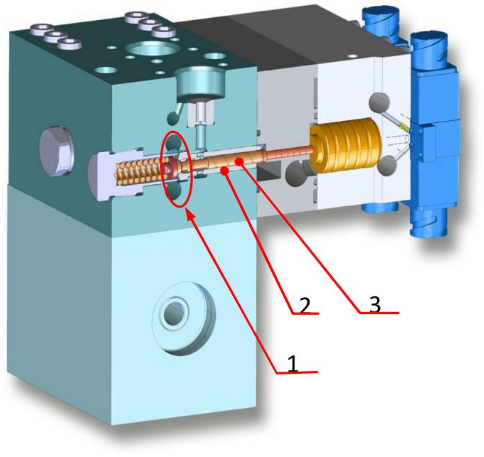


Figure 7: Crosshead bearing from a RT-flex82C engine after 29'008 running hours

The good bearing performance is a result of long experience in development and design, assisted by very accurate calculation methods. However, shaft alignment calculation methods have also been further improved since they have an extremely strong impact on bearing load and, thus, lifetime. Unfortunately, even today it is still difficult, in some cases, to convince some shipyards to follow our alignment specification.

The Injection Control Unit (ICU) for the RT-flex82T/C was launched with a new design (see Figure 8) which differs from the RT-flex84T-D and RT-flex96C-B. The injection control valve had been completely redesigned with a new housing, which is integrated into the main block and enables the use of smaller parts and easier maintenance.



1. Valve seat
2. Valve sleeve
3. Valve spindle

ICV
(injection control valve)

Figure 8: Injection Control Unit (ICU) W-X82

Initially, the new design led to some new challenges with stress factors and material selection in combination with particles in the Heavy Fuel Oil (HFO). Via minor design and material changes at the injection control valve, it was possible to drastically improve both lifetime and performance.

Since 2012, service experience has been outstanding, with components showing much less sensitivity to HFO impurities. Today, maintenance on board by the crew is possible, offering higher flexibility and lower Operational Expenditures (OPEX). For details see the relevant Technical Bulletin.

FAST fuel injectors are standard on all new W-X82 deliveries. Service experience gathered over the past three years indicates an effective lifetime of up to 18,000 running hours for components such as the nozzle tip, which is more than double that achieved with the previous design. WinGD's field testing experts observe that the fuel injection components show almost no sensitivity to fuel quality. On field testing vessels, no cavitation and no wear could be found after 12,600 hours in operation.

The core part of the FAST injection valve and the needle with needle seat showed no wear at all (see Figure 9).

Figure 9: Needle and needle seat without wear after 12,600 running hours

On the nozzle tip, neither erosion on the spray holes nor hot corrosion could be seen (see Figure 10).

Figure 10: FAST nozzle tip of RT-flex82T after 12,600 running hours

Service experience with piston running is the source of high levels of satisfaction among engine owners and operators since the introduction of the Pulse Jet lubricating system; gas-tight top piston rings and lower piston rings with a chromium ceramic layer; increased liner wall temperature; plus zig-zag and umbrella lubricating oil distribution grooves. Those ship owners who strictly follow the fuel sulphur-dependent cylinder lubrication feed-rate and use the respective Base Number of the cylinder oil, as recommended in our Technical Bulletins RT-138 and 161, will benefit from the best piston running performance. On W-X82 engines a specific cylinder liner wear as low as 0.04 mm/1000 is readily achievable, as proven on several engines.

Today the W-X82 engine – and its RT-flex82T predecessor – is a reliable workhorse with very good service experience, fulfilling the time-between-overhaul (TBO) expectations of the ship owners and offering low OPEX.

Service experience W-X35/40

At the end of 2012 the first W-X35 engine went into commercial operation. Today, ten W-X35 and two W-X40 engines are in operation and have accumulated more than 125,000 running hours (as of June 2015). The engines delivered have different cylinder numbers, Fixed Pitch and Controllable Pitch Propellers (FPP and CPP), and operate with and without shaft generators.

What has been highlighted even by the most demanding owners is the very good fuel consumption at all loads in comparison to competitors' engines of similar size.

The W-X35 and the W-X40 were the first Wärtsilä two-stroke engines with the new time-controlled fuel injection valves from L'Orange and with the new UNIC engine control system.

Generally there has been very good feedback regarding the effective lifetime and performance of the L'Orange injectors. The initial estimate of 8000 hours TBO has been confirmed and might be even increased further if current test running show no deterioration in the injector control components.

The UNIC control system, which was derived from Wärtsilä four-stroke engines, revealed a number of issues, which after several visits aboard ships are now mostly resolved.

Repeated issues are reported with leakages between cylinder liners and covers at higher loads. WinGD is working on permanent solutions for engines already on vessels. This point is also being addressed in the redesign of the B-version of the W-X35/40, see chapter "W-X35-B & W-X40-B".

Service experience W-X62/72

In mid 2014 the first W6X72 entered commercial operation and early in 2015 the first W6X62 engine. Today, eleven W-X72 and four W-X62 engines are in operation. The W-X72 population in service is set to grow to about 40 engines soon and the W-X62 to 20 engines. So far most of the sea trials and maiden voyages were attended by Wärtsilä service engineers.

General feedback

- Good piston running behaviour (see Figure 11)
- Reliable cylinder lubrication
- Good operation of fuel injection and servo systems
- Spotless condition of gear wheels
- Superb engine performance

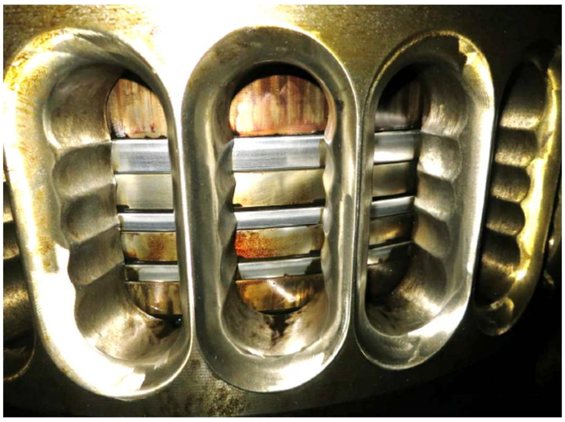


Figure 11: Good piston running behaviour W6X72

However some challenges on the new engines required the closest attention and immediate action. On a few engines the new time-controlled L'Orange fuel injection valves, basically already familiar from W-X35/40, stopped working after changing over from Heavy Fuel Oil (HFO) to Marine Diesel Oil (MDO) due to sticking pilot valves. The issues were resolved via the implementation of increased clearances in the pilot valve and by reducing injector cooling.

The UNIC engine control system required optimisations for engine start-up and crash manoeuvres. This was achieved by parameter changes in the software. Finding the solution took some time and several onboard visits by our experts were required. Another recurring defect was a pressure transmitter failure at the flex-lube cylinder lubricating pumps. To solve this issue, the sensor membrane was reinforced and the installation optimised.

A few further piston running failures occurred at the free end cylinder number 6, which with normal vessel trim stand the highest. All indications show that air was entrapped in the cylinder lubricating system and countermeasures involving improved venting are under preparation.

Cracked VCUs were found on one engine. The root cause for the crack was found to be insufficient induction hardening of the cast housing.

The W-X62 and 72 are the first engines with the combination of a double-walled column and single-wall bedplate. Both are manufacturing-friendly, allow a high quality of welding and require no heat post-treatment. Assembly experience with the new design of tie-rod with a rounded nut is positive (see Figure 12).

Figure 12: Single wall bedplate with holes for the tie rod's rounded nut

The long term advantage will be that the lower tie rod thread is located in the crankcase and not exposed to corrosion due to condensation.

The first engines in service have accumulated 6000 running hours. Only minor issues are pending and the ship owners have a good opinion of the high performance of these new members of our two-stroke engine family.

Service experience W-X92

As illustrated in Figure 13, in February and March 2015 the first W8X92 engines were shop tested at Hyundai Heavy Industries (HHI). Two further engines were tested at HHI in the summer of 2015.

Figure 13: First 8X92 engine during shop-test at Hyundai Heavy Industries (HHI)

On the first engine extensive prototype testing took place, carried out by WinGD experts.

All stress, temperature and vibration values were found to be within permissible limits. The BSFC figures were confirmed to be within the published values. The component inspection taking place after the tests on all engines showed faultless condition of the inspected parts. The Type Approval Test (TAT) was successfully passed on the fourth engine in August 2015.

The first vessel with a W8X92 engine is expected to enter commercial service in November 2015.

NOMENCLATURE

BSFC	Brake Specific Fuel Consumption
CAPEX	Capital Expenditure
DF	Dual Fuel
EEDI	Energy Efficiency Design Index
EGR	Exhaust Gas Recirculation
FAST	Fuel Actuated Sacless Technology
FEM	Finite Element Method
HFO	Heavy Fuel Oil
MDO	Marine Diesel Oil
OPEX	Operating Expenditure
SCR	Selective Catalytic Reduction
VCU	Valve Control Unit
WinGD	Winterthur Gas & Diesel

BIBLIOGRAPHY

‘THE NEW X GENERATION LOW-SPEED ENGINES FROM WÄRTSILÄ’, Marc Spahni, Andreas Kyrtatos, Ronald de Jong, CIMAC 2013, Shanghai

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