DAIHATSU
MARINE PROPULSION SYSTEM

DAIHATSU DIESEL MFG.CO., LTD.
Daihatsu Diesel R & D seeks a good balance between mother nature and the industrial sciences.

The next generation of marine propulsion system will never come into being without due consideration for the environment and the people who will be using it. Research & Development at Daihatsu Diesel continues along dual tracks that aim to boost power, save on fuel and deliver maintenance-free products, while also forging the engineering technology for drastically cutting emissions of harmful substances like NOx found in exhaust gas. It is the common love we share for all living creatures on the earth that, by and by, crystallizes new technologies in the form of better products.

DKM SERIES ENGINE
Since shipment in October 1993, Daihatsu Diesel has delivered low NOx engines numbering more than 4,300, demonstrating excellent durability.
(Conformity with NOx regulations)

* AUGUST. 2005
Power, Cost and Navigability ... Daihatsu's Geared

At Daihatsu Diesel, in order to produce geared diesel engines customers can be satisfied with, we pump a lot of effort into improving basic performance while also constructively and logically challenging new technological development. Customers turn us for most everything ... power, cost-performance, navigability, etc. Our geared diesel engines are highly respected and evaluated for being forward-looking and always one step ahead.

Adopting an exhaust gas economizer and hot effluent circulation system, waste heat energy is recovered and efficiently utilized as an onboard heat source to heat tanks, lines, living quarters, etc.

We have spared no efforts in shortening maintenance time and reducing the number of parts. As a result, maintenance and inspections are both simple and speedy for mid-speed engines.

The generator and cargo oil pump are driven by a crankshaft through the reduction gear and front engine block. This saves on space, reduces maintenance and offers other advantages.

Daihatsu's geared diesel engines were the first in the world to run on heavy fuel (H.O.7000 cSt/50°C). Moreover, they can run in the low-load region.

Propeller revolutions can also be freely set. A larger diameter propeller and multiple-input gear system greatly boosts economy, sailing speed and tow-tug force.

Customers can freely select reduction gears and gear ratio to suit vessel usage. Furthermore, with additions like Daihatsu's CRASH ASTERN system, slipping control and 2-speed slip-clutch reduction gears, vessels can go smoothly and directly from full-speed to dead-slow ahead.

6DKM-26
Diesel Engines Meet Expectation with Overall Performance.

Daihatsu Diesel has offices and dealers all over the world. We offer complete aftercare service and make every effort to communicate with customers.

Our manufacturing plants are certified by JG, NK, LR, AB and CCS, moreover the famed ISO9001 for excellence in quality assurance systems. Thanks to this, the hi-tech and high quality we stand by are known worldwide.

Years of enduring R & D has made us tough and proud of our successful record and won us the trust of many faithful customers. Our search for progress and betterment continues with strong emphasis on reducing emissions of harmful substances.

Daihatsu's geared diesel engines are employed in ferry boats, tankers, freighters, working craft and many other types vessels. Our marine engines are highly acclaimed all over as reliable propulsion systems.

Our mid-speed engines have a low vibromotive force, resonate with vessel natural vibrations and are quiet. Furthermore, dynamic load is small and torque fluctuation minimized, making them advantageous.

Both the engine and shaft drive system are no longer operated in fear of critical revolutions when shifting from idle to rated rpm. The merits are well demonstrated in fuel-saving cruising at reduced speed. Moreover, thanks to our in-house developed doughnut RD coupling, we have eliminated the problem of torsional vibration. Now, customers are free to select shafting and propeller to suit their vessel's needs.
A Wide Variation to Meet a Wide Range of Needs

Daihatsu's geared diesel engines come in a wide line-up from single-engine single-shaft systems to large multiple-input systems. Customers can choose the best system based on ship size, fuel, usage, etc.

<table>
<thead>
<tr>
<th>Model</th>
<th>Single-Engine Single-Shaft System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Power output on fuel oil A</td>
</tr>
<tr>
<td>6DKM-20</td>
<td></td>
</tr>
<tr>
<td>8DKM-20</td>
<td></td>
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<td>8DKM-28</td>
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<tr>
<td>6DKM-36</td>
<td></td>
</tr>
<tr>
<td>8DKM-36</td>
<td></td>
</tr>
</tbody>
</table>

Multiple-Geared Diesel Engines

Daihatsu's multiple-geared diesel engines are ideal for ships with twin-shaft propellers or low ceiling engine rooms. We offer a wide selection to choose including a twin-engine single-shaft system, single-engine twin-shaft system, four-engine twin-shaft system, four-engine single-shaft system and eight-engine twin-shaft system. Engine cut-off is also possible according to ship speed.

**Single-Engine Twin-Shaft System for Double-Bow Ships**

Daihatsu Diesel engines are at work onboard double-bow ships navigating narrow channels or short routes, or which operate as sightseeing boats on river cruises, etc. A single engine drives the propellers on the bow and stern. Any combination of single-engine twin-shaft system and Daihatsu's remote control system can be selected according to steering demands and guarantees improved navigation.
For an environment-friendly engine, lower fuel consumption has been accomplished with low NOx.

**NOx < 12.1 g/kW-h : IMO regulation (at 720 min⁻¹)**

Reduction of NOx (Nitrogen oxides) emitted from diesel engine has become an emergency problem worldwide. The above graph shows the standard values of international emission control that was adopted by IMO (International Maritime Organization) in September 1997.

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Environmental Conservation

- **Low noise/vibration**
- **Reduction of NOx**

- ★ Optimum combustion
- ★ Strengthening fuel injection
- ★ Increase of compression ratio
- ★ Optimizing intake/exhaust valve timing
- ★ Optimum supercharger matching
- ★ Injection timing delay
Daihatsu's Geared Diesel Engines Are a Never-Ending Pursuit of Advanced Technology, Onboard Living and Economics.

- **Noise-Vibration Isolation Systems**

In recent years, vibration-proofing and noise emission controls for onboard machinery have come under focus as a means for improving onboard living and reducing underwater noise emission. Daihatsu Diesel was quick to catch sight of these problems and has, ever since, been developing engine vibration-noise isolation systems. Since our first delivery in 1980, we have provided 43 systems to 20 ships (as of Mar. 1999) including the 6000PS for the Yokosuka support vessel of the Marine Science Technology Center's Shinaki 6500 and the 7600PS for the Hakuhomaru floating laboratory of the University of Tokyo. We have chalked up an impressive track record in this field and built ourselves a good reputation for engineering excellence.

- **Vibration Isolation Systems**

1. Horizontal vibration isolation  
2. Inclined vibration isolation  
3. Unit vibration isolation  
4. Unit inclined vibration isolation  
5. Double stage vibration isolation

- **Simulated Vibration-Isolating Effect of Horizontal Vibration-Isolating System**

The chart above illustrates the simulated vibration isolating effect of the horizontal vibration-isolating system. Different vibration-proofing rubbers are compared to show their effectiveness at various frequencies.
• Large Diameter Propeller

With the right size propeller, fuel consumption is reduced by as much as 3% in comparison with conventional propellers running at the same nautical speed, when propeller rpm is lowered by 10%. Daihatsu Diesel can set the propeller that best matches the vessel thus offering greatly improved propulsion efficiency.

• CRASH ASTERN System

With a low-rpm large-diameter propeller, engine stalling is always a problem when moving astern because of increased torque and engine overload. For this reason, Daihatsu geared diesel engines employ our own CRASH ASTERN system. It can also be effectively operated from the bridge.

• Power Take-Off & Engine Layout

With Daihatsu's geared diesel engines, generators, cargo oil pumps and other machinery can be driven using power drawn through the front engine block and reduction gear. This system greatly reduces fuel consumption. What's more, one of the generators used in conventional systems can be omitted, which enables more effective use of dead space. In addition, this kind of system reduces labor and costs in running and maintenance. Also, engine and onboard control systems can be freely designed.
DKM Series

Engines of the DKM Series are a convergence of high reliability and environmental-friendly engineering.

HIGH RELIABILITY MEDIUM SPEED DIESEL ENGINE

6DKM-28

Exhaust Manifold
- Fireproof cover
- Good gas flow figure
- DPS system

Piston
- Ductile iron monoblock type
- Chromium-plated piston rings and ring grooves

Intake Manifold
- Cast in type
- Large capacity passage

Connecting-Rod
- Marine type big-end portion

Engine Frame
- Underslung bearing
- Hydraulic tightened main bearing and side bolts

Main and Crank pin Metal
- Wear and corrosion resistant
- Alum-metal Alloy

Cylinder Head
- High stiffness construction with thicker, bore-cooled flame plate
- Secured by four hydraulically tightened studs

Intake and Exhaust Valve
- Made of heat resistant steel
- Valve rotator
- Coated seat ring type

F.O. Injection Pipe
- Mono-block forged steel
- Inserted into the cylinder head horizontally
- High reliability and easy handling

F.O. Injection Pump
- High injection pressure ensure good performance at all loads
- Cavitation free
- Oil seal system

Cam and Cam Shaft
- Large diameter camshaft
- Solid machined cam

Cylinder Liner
- Thicker wall for optimal piston performance
- High wear-resistance material
- Bore-cooled type
- With protect ring

Crankshaft
- Large diameter pins and journals are forged in one piece with continuous grainflow
- Induction hardening
- Thicker oil film thickness and lower maximum oil pressure
- High loading capacity
### DKM Series Specifications

<table>
<thead>
<tr>
<th>Engine model</th>
<th>Bore (mm)</th>
<th>Stroke (mm)</th>
<th>No. of cylinders</th>
</tr>
</thead>
<tbody>
<tr>
<td>DKM-20</td>
<td>200</td>
<td>360</td>
<td>6, 8</td>
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<tr>
<td>DKM-25</td>
<td>250</td>
<td>360</td>
<td>6</td>
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<td>385</td>
<td>6</td>
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<td>DKM-28</td>
<td>280</td>
<td>390</td>
<td>6, 8</td>
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<tr>
<td>DKM-36</td>
<td>360</td>
<td>480</td>
<td>6, 8</td>
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</table>

### Specifications

*1 : kW = PS x 0.7355

Output given for fuel oil A. Figures in () given for heavy fuel oil.

<table>
<thead>
<tr>
<th>Engine model</th>
<th>Output (kW)</th>
<th>Engine rev (rpm)</th>
<th>R/G model</th>
<th>Gear ratio</th>
<th>Popper rev. (rpm)</th>
<th>Popper dim. Z (mm)</th>
<th>Intermediate (mm)</th>
<th>Popper dim. Z+3 (mm)</th>
<th>Weight (ton)</th>
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<td>3730</td>
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<td>330</td>
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Output for only DKM-36 engine given for crank shaft end.

### Dimensions

<table>
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<th>L (mm)</th>
<th>L1 (mm)</th>
<th>L2 (mm)</th>
<th>L3 (mm)</th>
<th>L4 (mm)</th>
<th>B (mm)</th>
<th>B1 (mm)</th>
<th>H1 (mm)</th>
<th>H2 (mm)</th>
<th>H3 (mm)</th>
<th>H4 (mm)</th>
<th>D (mm)</th>
<th>H5 (mm)</th>
<th>H6 (mm)</th>
<th>H7 (mm)</th>
<th>H8 (mm)</th>
<th>H9 (mm)</th>
<th>Bx (mm)</th>
<th>Bz (mm)</th>
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<td>1200</td>
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<td>1835</td>
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</table>

![Diagram](image)
Daihatsu's Reduction Gears - One Supporting Element of Engine High Reliability

In addition to engines, Daihatsu Diesel also has a wide range of in-house developed reduction gears to match any type of vessel. We have built ourselves a good name and reputation as a gear manufacturer. Our reduction gears have a built-in main thrust bearing and wet hydraulic clutch, and can be incorporated in the CRASH ASTERN system. We also have a wide selection of speed-increasing and reduction gears for driving any type of machinery, which can be used on the engine front end block.

**2-Speed Reduction Gears**

Though low-speed and high thrust are necessary for port navigation, high-speed cruising performance is needed on the open seas. Our 2-speed reduction gear is ideal for the situation. We developed the 2-speed system (2-step ahead, 2-step astern) to maximize efficiency in normal and low-speed sailing. Because the reduction gear is suited to all kinds of vessels, from freighters to fishing trawlers, captains all over have favorably evaluated it.

**DRA-50F Reversible Reduction Gear**

- Propeller Thrust Bearing
  - White metal
  - Mitchell's system

- Shaft
  - Forged steel with precision finish
  - Highly rigid

- Gear Case
  - Cast-iron
  - Highly rigid. Lower vibration.

- Hydraulic Clutch
  - High heat-resistant lining
  - Shockless mesh because of hydraulic control

- Gears
  - Induction quenched carbon steel and alloyed steel
  - Precision ground finish
  - 25° pressure angle
  - Crowning gear

- Bearing
  - White metal
  - Precision fit
  - Long-lasting
  - Reduced maintenance costs
• **Example Application Using Daihatsu’s Reduction Gear**

**DICS (Daihatsu Slipping Clutch System)**

Clutch fluid is electronically controlled to slip the clutch. As such, propeller revolutions below idling rpm are freely controlled.

<table>
<thead>
<tr>
<th>Control Lever (Example)</th>
<th>10 knots</th>
<th>3</th>
<th>0</th>
<th>3</th>
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<tr>
<td>Astern</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dead slow</td>
<td></td>
<td></td>
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<tr>
<td>Neutral</td>
<td></td>
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<tr>
<td>Ahead</td>
<td></td>
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<tr>
<td>Dead slow</td>
<td></td>
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<td></td>
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<tr>
<td>Full</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Features
1. Enables dead-slow sailing ahead/astern with a fixed pitch propeller (FPP).
2. Enables shockless, smooth clutch meshing.
3. Propeller revolutions remain stable even under fluctuating engine revolution and propeller load.

**Constant-Speed Shaft Generator**

A compact constant-speed shaft generator is built into the reduction gear. Clutch fluid is automatically controlled by an electronic governor. By slipping the clutch, generator revolutions can be kept constant even under fluctuating engine revolution.

Features
1. An electronic governor keeps constant generator revolutions, thus ensuring a stable power supply.
2. Because of the 2-speed slipping clutch, the generator can operate a wide engine revolution range from idling to rated rpm.
3. Generator revolutions and droop can be adjusted easily during generator operation. Load switching to other generators and parallel operation can performed easily.
Monitoring Systems for Assured Safe Sailing

**Daihatsu's Maintenance Support System**

Reduces maintenance labor and helps prevent unexpected breakdowns. Ensures accurate maintenance data and swift service.

**Monitoring System**

- Crew's living quarters ... Alarm panel
- Bridge ... Console panel
- Output signal cable
- I/O signal cable
- Monitoring room ... Monitoring panel
- Potentiometer (Fuel rack)
- Pressure transmitter
- Current input (Converter)
- Pulse (Rotary/Flow)
- Thermocouples
- Temperature resisters
- Other analog input (Power/Voltage)

- Solenoid valves
  - (Fuel shutdown system, starting valve, clutch control system, etc.)
  - Actuators
  - Control motors, etc.

- Pressure switches
  - Temperature switches
  - Level switches, etc.

- Cooling water system
- Fuel oil system
- Air system
- Lubricating oil system

**Example CRT Displays**

- Diagnostic data
- Engine data
- Engine exhaust gas temperature
Daihatsu Diesel Equipment for Marine Applications

**Oil Mist Detector**

MD-SX (Sensor Type)

The Oil Mist Detector Monitors your engine to detect major engine failure. This equipment consists of two or more sensor units which carry out insertion attachment for every cylinder of diesel engine more directly than the side wall of a crankcase, and the controller which carries out integrated control of them by communication. The natural diffusion system which need neither a suction mechanism, nor the mist detection of a sensor unit, and the ease of improvement and maintenance of miniaturization and reliability is realized. With a controller, it is always the oil mist concentration in a crankcase. Since an alarm is emitted and it indicates by the state when oil mist concentration increases by bearing overheating etc. beyond a setting value while supervising and displaying the mist level, the early detection and a forecast of the serious accident of a medium- or high-speed diesel engine are attained.

**Automatic Temperature Control Valve**

A temperature sensor featuring an ultra-small wax element detects the fluid temperature and uses an oil-pressure servo function with a trigonal main valve to control the fluid temperature automatically. This unit offers easy operation as well as excellent response and sensitivity.

**Doughnut RD coupling**

This new flexible coupling combines a conventional flexible coupling with an air clutch. This design greatly reduces engine room space requirements compared to conventional installation of independent components.
Proof of Success

Daihatsu's geared diesel engines are used in ships of all classes and types, including vessels for public offices, ferries, coastal vessels, working crafts, and fishing boats. Their outstanding performance has been highly acclaimed by all customers.

**Vessels for public offices**

- **Ministry of Land, Infrastructure and Transport / Nippon Maru**
  - Training ship / 6DSMB-28NS × 2

- **Japan Coast Guard / Kajo**
  - Research vessel / 6DLM-24S (L) × 2

- **Japan Meteorological Agency / Ryoufu Maru**
  - Research vessel / 6DLM-40AL × 1

- **Fisheries Agency / Taka Maru**
  - Research vessel / 6DKM-20FL × 1

- **Hokkaido Government / Hokurin Maru**
  - Fishery Control Boat / 6DKM-28(L) × 2

- **Japan Marine Science & Technology Center / Mirai**
  - Research vessel / 6DKM-28FL(L) × 4

- **Reiyo High School / Kumamoto Maru**
  - Training ship / 6DKM-26F × 1
Ferries

Tokyo University / Hakuho Maru
Research vessel / 6DSM-28N(L)×4

Kampu Ferry Co., Ltd. / Hamayu
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Tokyo University of Mercantile Marine / Shioji Maru
Training ship / 6DLM-26SL×1

Nankai Awaji Line Co., Ltd. / Ferry Senshu
Ferry boat / 6DLM-40A(L)×2

Kobe University of Mercantile Marine / Fukae Maru
Training ship / 6DLM-26S×1

Nankai Ferry Co., Ltd. / Ferry Yoshino
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Yuge National College of Maritime Technology / Yuge Maru
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Oki Kisen K.K. / Ferry Shirahama
Ferry boat / 6DLM-40A(L)×2

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Kyusyu Yusen Co., Ltd. / Ferry Chikushi
Ferry boat / 6DLM-40A(L)×2

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RORO / 6DLM-40A(L)×2

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Passenger boat / 8DKM-32×2

Ube Shipping & Logistics, Ltd. / Saizan Maru
Cement vessel / 6DLM-40AF×1

Setonai Kisen Co., Ltd. / Furutaka
Ferry boat / 8DKM-20FL×1

Kokoku Kairi K. K. / Suzuka
PCC / 8DLM-40×1

Miyaka Ferry Co., Ltd. / Ferry Yuumutsu
Ferry boat / 6DKM-20F×1

Akiyama Zosen / Sansha Maru # 45
Gravel Carrier / 6DLM-32×1

Coastal vessels
Kansai Tech Co., Ltd. / Hikari Maru # 15
Tanker / BDKM-28F×1

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Cable Laying ship / BDK-32×4

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Crane vessel / BDKM-28L×1

Nitto Tugboat Co., Ltd. / Hoki Maru
Tug boat / BDKM-26(L)×2

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Tug boat / BDLM-28FS×2

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Daikai Marine Co. / Daiki Maru
Pusher boat / BDKM-26(L)×2

Kotobuki Kaiun Co., Ltd. / Kotobuki Maru # 3
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Fishing boats

Yoshikazu Ishikawa / Sanko Maru
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Purse Seiners / 6DKM-32×1

Norihiro Tokunura / Sensho Maru # 1
Skipjack Pole & Line Fishing boat / 6DKM-26L×1

Ohama Fishery / Teno Maru # 7
Purse Seiners / 8DLM-32×1

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Skipjack Pole & Line Fishing boat / 6DKM-28L×1

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Purse Seiners / 8DLM-32×1

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• Please refer to the separate brochure for "DAIHATSU AFTER-SERVICE NETWORK".
• All information contained in this Pamphlet is corrected at the time of printing, but will be subject to change without notice.

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