AWD-CMS-01A HFRR High-Frequency Reciprocating Rig (HFRR) for Assessment of Diesel Fuel Lubricity

ISO 12156-1 ASTM D6079 ASTM D7688 NB/SH/T 0765-2021

Main Specifications

- 1.Frequency: 50 ± 1Hz, or settable within 10~200Hz .
- 2. Stroke length: 1±0.02mm, or settable between 20μm and 2.0mm; maximum stroke: 2.0cm.
- 3. Fluid temperature: 60±2℃, and settable from the room temperature up to 150℃ .
- 4. Test mass: 200±1g, and settable within 0.1-1 KG .
- 5. Fluid volume: 2.0±0.2mL .
- 6. Reservoir surface area: 600±100 mm2 .
- 7. Test duration: 75±0.1min, and the test stops automatically when the time expires.
- 8. Wear scar measuring device: The metallographic microscope, which has an electronic imaging system, can be
- used to measure abrasions and add them to the test table. Original X \ Y axis reader with 5 megapixel camera.
- 9. Test cabinet temperature: heating control: from5 to 50℃; heating device: internal electric heater; cooling device:
- ultra-quiet compressor; temperature control precision: 1℃ per step length .
- 10. Test cabinet humidity: optionally settable from 5 to 95%RH .
- 11. laboratory air temperature: 5 to 50℃.
- 12. laboratory air humidity : 5 to 95%RH .
- 13. Test ball: diameter: 6mm; material: Grade 28 AISIE-52100 steel in conformity with ANSIB3.12; HRC: 58-66;
- surface roughness Ra<0.05μm .
- 14. Test plate: made of round steel in conformity with AISIE-52100; HV30 value: 190-210; surface roughness
- Ra<0.02μm .
- 15. In accordance with the requirements of the laboratory air conditions in the standards,ISO 12156-1, ASTM
- D6079 the control capacity of constant temperature and humidity system can maintain the followings: test cabinet
- temperature: 23℃±2℃; test cabinet humidity: 53%RH±2%RH .
- 16. The test cabinet is coated with anti-corrosive primer, and the parts and fasteners in the cabinet are made of
- corrosion-resistant stainless steel or hard aluminum alloy.

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Main Technical Parameters:

1. Vibration Stroke: 1±0.02mm, and can be set between 20μm and 2.0mm; Direct output of digital signal for stroke control, no analog conversion offset, stroke lifetime free adjustment; High frequency reciprocating stroke control shaft limit protection device.
2. Oscillation Frequency: 50±1Hz, and can be set from 10 to 200Hz;
3. Test Oil Temperature: 60±2℃, and can be set at room temperature to 150℃;
4. Test Load: 200±1g, and can be set between 0 and 1Kg;
5. Friction: 10N (Max)
6.Oil Sample Volume: 2.0±0.2mL;
7. Oil Box Surface Area :600±100mm2;
8. Test Time :75±0.1min, the test will stop automatically at the time;

- **Abrasion Measurement System:**

1. Metallographic microscope with electronic imaging system, including 2592*1944 pixel digital camera and matching color display;
2. Equipped with 1 X/Y axis reader and 1 micrometer for calibration;
3. Use the operating software to measure the wear spot and add it to the test report.

- **Constant Temperature and Humidity Control System:**

1. The test box and the constant temperature and humidity controller adopt split connection to avoid resonance; The controller is a separate instrument unit.
2. Factory setting box temperature 23±1℃, relative humidity 53±2%RH, users can set according to the test method standard requirements;
3. Within the rated temperature and humidity range, the system can automatically adjust the temperature and humidity inside the box to the set range in a short time;
4. The equipment meets the control requirements of ambient temperature and humidity in NB/SH/T0765, ISO 12156.1, ASTM D6079 test method standards.

- **Computer and Software Control Platform:**

1. Control computer: I5 processor, 8G memory, 256G solid state +1T mechanical hard disk, 24-inch display, Win10 professional operating system;
2. The test operation software is equipped with the NB/SH/T 0765-2021 standard temperature and humidity interval chart interface, and can be displayed in real time during the 75-minute test;
3. The grinding pictures after the test can be directly imported into the software system to form a complete test report with grinding pictures and various parameters.

- **Test Consumables:**

1. Test ball: diameter 6mm, Rockwell hardness HRC 58-66, surface roughness Ra <0.05 μ m, a total of 100;
2. Test sheet: diameter 10mm, thickness 3mm, Vickers hardness "HV30" is 190-210, surface roughness Ra <0.02 μ m, a total of 100 pieces;
3. Reference oil: high lubricating reference oil (A oil) and low lubricating reference oil (B oil) 150 ml each.

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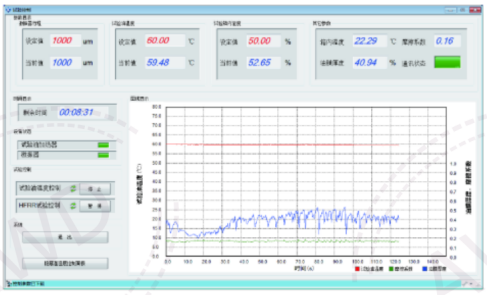
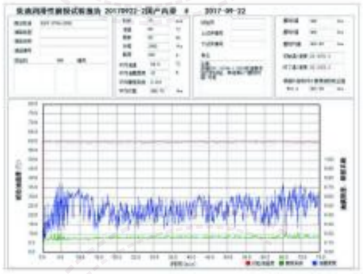
Description of AWD-CMS-01A Test Software

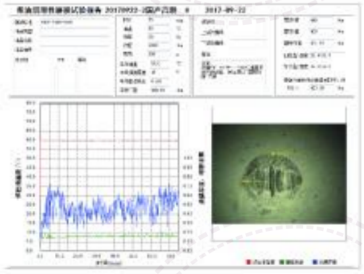
- 1. Real-time control of various parameters, and observation of data and curves during the test
- 2. Setting of static parameters of test system, and calibration of sensor reading
- 3. Storage and review of past test data
- 4. Automatic generation of test report, single curve report and combined curve and picture report



Test control panel



Test report – curve report



Test report – combined report

Environmental Requirements and Basic Specifications of AWD-CMS-01A Tester System

- 1. The voltage fluctuation range of power supply shall not be ±5% over the nominal voltage; the power supply is
- provided with ground protection.
- 2. There is no mechanical vibration, magnetic field interference or corrosive material around the tester.
- 3. The tester shall be placed on the test bench with terrazzo, marble or granite surface, and be fastened securely.
- 4. Installation space: the work bench carrying the tester shall have a length not less than 150cm and a width not less
- than 100cm; the recommended area of test site is not less than 15m2 .
- Environmental requirements of laboratory: indoor temperature 0～50°C; indoor humidity: 5～95%RH.
- 6. Power supply of equipment: 220V/50HZ± 10%.
- 7. Operating time: no special requirement; the tester can operate continuously for long period.

Installation, Commissioning and Acceptance Procedures

- 1. Instrument acceptance: use the high/low-lubricity reference fluids supplied together with the instrument to inspect the repeatability and reproducibility of the instrument; the results must meet the requirements of ASTM D 6079/ASTM D7688/IP450, IS012156-1 or other valid normative reference; the specific inspection standard will be negotiated by Party A and Party B in advance.
- 2. Acceptance of standard method: after Step 1 is completed, use the sample supplied by Party A to inspect the repeatability and reproducibility of the instrument; the results must meet the requirements of ASTM D 6079/ASTM D7688/IP450, IS012156-1:2018 or other valid normative reference; the specific inspection standard will be negotiated by Party A and Party B in advance.
- 3. When the instrument meets the above acceptance conditions, Party A and Party B shall affix their signatures on the reception form and commissioning record, and now the installation and commissioning of instrument complete. If the

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instrument does not meet the acceptance standard after installation and commissioning, Party B shall replace the substandard equipment with the equipment of same model for Party A until the acceptance standard is met.

User Training

During the installation and commissioning of instrument, Party B will appoint the technician to give the technical guidance and training on the site of Party A, including but not limited to structure, operating principle and operation of instrument, sample analysis and routine maintenance, in order to ensure that the operators of Party A can operate the instrument independently to test the sample, and master the maintenance and operation instructions; during the training period, Party B must provide the relevant operation instructions of the instrument.

After-Sales Service and Quality Assurance

1. The warranty period shall meet the customer's requirements; in the warranty period, Party B is responsible to solve all the non-man-made faults of instrument without charge.
2. The computer, printer and other auxiliary devices are served directly by the OEM's after-sales service network within the warranty period.
3. After the warranty period expires, the equipment repair service will be performed pursuant to the commercial contract.
4. After the warranty period expires, Party B can continue to provide Party A with the full-life maintenance and technical supports of equipment, and Party A shall pay the relevant service cost.
5. The technical service staff of Party B shall make follow-up feedback timely for the user, at least twice a year within 10 years via email, photo or site visit.

The AWD-CMS-01A High-frequency reciprocating rig (HFRR) for assessment of diesel fuel lubricity, standard test articles (balls and pieces) and standard reference fluid used for tester calibration are designed, researched and manufactured by the Company independently. This product has been delivered in batch to many oil refineries, quality supervision and inspection authorities, scientific research institutes and other organizations, and been well received by the users. The AWD-CMS-01A tester has improved the control accuracy of exciter stroke, and solved the periodic stroke calibration difficulty of imported tester; meanwhile, the air conditions in the test cabinet is controlled automatically in accordance with the allowable environment temperature and humidity range stipulated in the standard ASTM D 6079/ASTM D7688/IP450 or ISO 12156-1, which has solved the difficulty of imported tester that the environment temperature and humidity are hard to control accurately, and the disturbance if any cannot be intervened at real time. Moreover, many other features have been improved technically, including tester base structure, connecting mode of exciter shaft lever, installation mode of lower test piece(test plate), clamp structure of upper test piece(test ball), control system, software operation interface, oil temperature control strategy, test parameter online monitoring, test data real-time storage and digital microscope measuring system so this product is much easier, convenient and efficient to operate.

This tester has obtained the utility model patent certificate at No. ZL2008 2 0127486.5 issued by the State Intellectual Property Office, and been tested by the national analytical instrument quality supervision and inspection center and appraised by the Expert Team of China Instruments Manufacturers Association. To ensure the accuracy and validity of data, the metering instrument needing calibration is provided with the calibration certificate issued by the qualified national authority when the equipment leaves the factory.

Now, the AWD-CMS-01A High-frequency reciprocating rig (HFRR) for assessment of diesel fuel lubricity is the most advantageous version among the technical improvement and upgrade of products of same kind at home and abroad. The automatic constant temperature and humidity control system was first proposed and applied in the High-frequency reciprocating rig (HFRR) for assessment of diesel fuel lubricity by the Company, and has obtained the national patents at No. ZL201220533766.2 (semiconductor refrigeration) and No. ZL2013 20497422.5 (compressor refrigeration). This technology and other technologies such as reflective grating ruler for stroke control have represented that our technology in the field of High-frequency reciprocating rig (HFRR) for assessment of diesel fuel lubricity is ahead of domestic and foreign products of same kind.

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Test Parameters in Conformity with Various Latest Standards

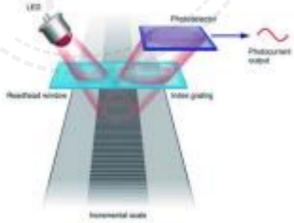
01. Stroke length(mm) 1.0 ± 0.02;
02. Frequency (Hz) 50 ±1;
03. Test mass (g) 200 ±1;
04. Fluid volume (ml) 2 ±0.2;
05. Fluid temperature (℃) 60 ±2;
06. Test duration (min) 75 ±0.1
07. Air conditions of test environment in conformity with various standards*: temperature range: 23℃±123℃; humidity range: 53%RH±2%RH.

* The air conditions of test environment stipulated in IS012156-1 and ASTM D6079are different. The first two standards stipulate the laboratory air conditionss of test environment via charts respectively; the standard ASTMD6079 just stipulates the range of relative humidity which is uniform with the standard ASTM D7688. The constant temperature and humidity control system of this equipment is designed pursuant to the test environment most close to the boundary, and meets the relevant requirements of every standard.

Configuration of AWD-CMS-01 High-frequency Reciprocating Rig (HFRR) for Assessment of Diesel Fuel Lubricity

Comparison Between the CMS-01 Tester and Other Instrument of Same Kind

- **1. Stroke Control**



Other: The linear differential transformer is used, the output signal is analog voltage, the stroke shall be calibrated periodically, and the operation is complex.

AWD-CMS-01A Tester: The reflective optical encoder can output the accurate displacement pulse directly, and does not need the periodic calibration.

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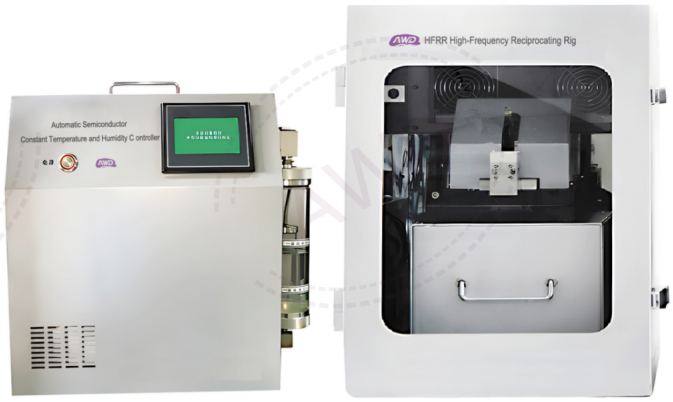
Advantages:

1. The adopted reflective optical encoder has the stable and reliable performance, and can be used for long period without calibration;
2. The stroke length precision is stable and reliable; the test result has the good repeatability and reproducibility;
3. The electronic verifying device for dynamic stroke with a resolution better than 1μm can be provided.

- **2. Environment Temperature and Humidity Control**



AWD-CMS-01A Tester:
Obtain the temperature and humidity at real time, and control and adjust the temperature and humidity automatically in accordance with the current environment conditions

Advantages: AWD-CMS-01A tester is flexible and convenient to operate, and has the stable and reliable automatic control; the user can set the allowable range (temperature and humidity) chart of test environment directly in accordance with the standard ASTM D 6079 ／ ASTM D7688/IP450, and the setting is not affected by the environment temperature or humidity change during test so the accurate test data can be obtained.

- **3. Installation and Locating Method of Lower Test Piece**

Other: The lower test pipe contacts with the bottom of fluid reservoir face to face; if the bottom is uneven, the lower test piece can be installed accurately.

CMS-01 tester: The bottom of lower test piece just contacts with the annular slot edge of bottom of fluid reservoir, which is good for the accurate installation of lower test piece.

- **4. Test software**

The computer temperature terminal that is provided as default configuration has the simple interface and rich functions, and is easy for the user to operate.

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AWD-CMS-01 High-Frequency Reciprocating Rig (HFRR) for Assessment of Diesel Fuel Lubricity Automatic Air Condition Control System

- **1. Significance of Environment Temperature and Humidity Control of Test Oil**

The assessment test of diesel fuel lubricity is a quantitative test with high precision requirement, and has the strict requirements on the temperature and humidity in the test cabinet. The standards ISO 12156-1 and ASTM D6079/ASTM D7688/IP450 stipulate a dynamic allowable environment temperature and humidity range via chart.

The accurate control on the temperature and humidity in the test cabinet affects the test result obviously.Meanwhile, for the calculation of mean value of corrected abrasion spot WS1.4, the different temperature and humidity changes affect the repeatability and reproducibility of test result directly due to the existence of temperature and humidity correction factor HCF.

The revised standard ISO 12156-1has updated evaluation method of diesel fuel lubricity, and reduced the allowable temperature and humidity range of test environment obviously compared with the standard before revision. Meanwhile, the mean diameter of abrasion spot, not the mean diameter of abrasion spot corrected as per temperature and humidity, is used as the final test result. Therefore, in order to meet the revised standard, the test method has the stricter requirement on the temperature and humidity of test environment so it is necessary to use the Automatic Air Condition Control System to control the test environment.

- **2. Perfect Basic Configuration**

The Automatic Air Condition Control System, as one of basic configurations of AWD-CMS-01A High-frequency reciprocating rig (HFRR) for assessment of diesel fuel lubricity, consists of AWD-CMS- 01 temperature and humidity controller and constant temperature and humidity test cabinet. The basic temperature and humidity control system has the perfect environment control functions including but not limited to heating, cooling, humidifying and drying. During test, the computer can adjust the temperature and humidity control system automatically in accordance with the user's setting to meet the routine test requirements of the user having the good laboratory environment.

In need of outstanding environment temperature and humidity control capacity, the user is recommended to select the enhanced Automatic Air Condition Control System designed by the Company for the ordinary worksite; this system uses the compressor as the independent air regulator, and has the stronger and more effective control ability on the environment in the test cabinet; Even if on the work site that cannot meet the perfect laboratory environment control requirements, this device can maintain the stable and reliable temperature and humidity in the test cabinet.

- **3. Proprietary Innovative Technology**

The Automatic Air Condition Control System was first proposed and applied in the High-frequency reciprocating rig (HFRR) for assessment of diesel fuel lubricity , and has obtained the national patents at No. ZL2012 20533766.2 (basic type: semiconductor refrigeration) and No. ZL2013 20497422.5 (enhanced type: compressor refrigeration).

Comparison between the Automatic Air Condition Control System matching the AWD-CMS-01A tester and the conventional temperature and humidity control mode .

- **1. Temperature Control**

The other testers have the heating function only, not the cooling function. In summer when the air temperature increases, even if in the room with air conditioner, the heating elements in the test cabinet will increase the temperature in the cabinet continuously so the test cabinet without cooling function cannot maintain the temperature within the allowable range required by the rest method; however, the Automatic Air Condition Control System matching the AWD-CMS-01A tester has both heating and cooling functions, and can control the temperature in the test cabinet rapidly within the allowable range stipulated by the test method.

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- **2. Humidity Control**

The other testers use the different saturated saline solutions to control the humidity in the test cabinet, and this operation is complex and need a long preparation time; in case of damp weather, it is more difficult to use the saturated saline solution for dehumidification, and the relative humidity in the test cabinet cannot be maintained in the allowable range required by the test method in a short period so that the test is delayed and cannot be performed normally. The Automatic Air Condition Control System matching the AWD-CMS-01A tester controls the environment temperature and humidity automatically, is not affected by time, location and seasonal climate, and can operate stably and reliably. The control units in the test cabinet, including but not limited to heading, cooling, humidifying and drying, adjust the environment in the test cabinet by the safe physical method, and have no bad effect on any device in the cabinet. When preparing for test, this system can adjust and control the temperature and humidity in the test cabinet within the allowable range required by the test method in about 10 minutes so the test convenience and accuracy are fully guaranteed.

- **3. Adaptability to Environmental Disturbance**

During the other testers, the user cannot take measures to stabilize the test environment in case of change of external environment so it is impossible to ensure that the temperature and humidity indexes during the whole test are within the allowable range required by the test method; the calculation of corrected value of test result just uses the temperature and humidity when the test starts and ends, and does not consider the effect of temperature and humidity change on the test result during the test so even if the above two sampling values are within the allowable range, the actual test result is affected by the environment change. Obviously, the use of conventional temperature and humidity control method increases the uncertainty of test result. The Automatic Air Condition Control System matching the AWD-CMS-01A tester ensures that the actual temperature and humidity are within the allowable range required by the test method, has the strong adaptability to the environment disturbance, guarantees the conformity of environment temperature and humidity with the method requirement during the whole test, and reduces the uncertainty of test result obviously.

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