Oil Steel Dust Checker
SDM-73
Instruction Manual

- Keep this manual for easy reference.
- Carefully read this manual prior to use.

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NEW COSMOS ELECTRIC CO.,LTD.

Table of Contents

1. Introduction

Thank you for purchasing the SDM-73 oil steel dust checker (“meter”).
Prior to use, please carefully read this manual to ensure correct use. This product is suitable for preventive maintenance of bearings and gears of rotating machinery such as motors, pumps, industrial robots, vessel engines, wind turbines, and elevators.

2. Features of this Product

This product is a portable analyzer designed to measure the steel dust concentration in lubricating oil on-site. It is useful when checking the wear condition of bearings and gears.
It is also very easy to use. Simply sample a small amount of oil waste discharged from the machinery at the time of oil lubrication, and set it in the meter.

- Highly sensitive
  The meter is able to identify the initial bearing wear because it employs a magnetic balance-type electromagnetic induction method as its measuring principle.
- High precision
  The meter is able to find an abnormality in the ultra-slow speed rotation, which is difficult to detect by the vibration analysis technique.
- User-friendly
  Just fill a syringe with the oil specimen and insert it into the meter. Within a few seconds the meter gives you a readout of the ferromagnetic particles in the oil as a percentage of the total weight.
- Compact and portable
  There is no longer any need to send your sample to a laboratory for analysis, making on-site measurement possible.

3. Safety Precautions

Symbols Used in this Manual

This manual uses Warning, Caution and Note symbols to draw attention to procedures, materials, methods, and processes, which require particular attention.

⚠ **WARNING**	Indicates a potentially hazardous situation that may result in death or serious injury.
⚠ **CAUTION**	Indicates a hazardous situation that may result in minor injury or property damage.
NOTE	Provides information on product handling.

Safety Precautions

To ensure safe operation, follow the precautions below.

⚠ CAUTION

- This product is not explosion-proof and should not be used in explosive atmospheres.
- Avoid any strong mechanical shock or impact to the product as a result of dropping or bumping against a surface. Failure to do so may impair the performance of the product.
- Do not leave the product in a high-temperature/humidity environment for an extended period of time. Doing so may cause device failure.
- Do not expose the product to rapid temperature/humidity changes. Doing so may cause device failure.
- The product is not drip-proof. Keep the product away from water. Failure to do so may cause device failure.
- If this product is to be left unused for an extended period of time, remove the batteries from the unit. Failure to do so may cause device failure.
- This product is a precision instrument. Do not disassemble, modify, or alter the structure of the product or its electrical circuits. Doing so may compromise the performance of the product.
- This product employs the electromagnetic induction method as its measuring principle, and should not be used in the vicinity of devices emitting a strong electromagnetic wave. Electromagnetic waves may cause a drift in the reading.
- Keep the product away from wireless devices (e.g., walkie-talkies, cellphones) while in use.
- The sampling port is equipped with an optical sensor. Keep the sampling port and optical sensor clean, as correct measurement is not possible if they are contaminated with iron particles, etc. If contaminated, wipe them with a cotton swab or cloth.
- If the product is dirty, wipe it with a soft, dry cloth. Do not use alcohol, detergent, benzene, thinner, or a wet cloth.

4. Package Contents

A standard package consists of the following items. If any items are missing or damaged, please contact New Cosmos or its authorized representative for replacement.

Item	Model/Part No.	Quantity
SDM-73 oil steel dust checker	SDM-73	1
2 ml syringe, with cap	SMC-2	5
Syringe nozzle	SMC-2Z	2
Syringe holder	CLH-3	1
AA battery		4
Carry case, with shoulder strap		1
Instruction manual (this document)		1
Inspection certificate		1

5. Consumables (sold separately)

Item	Model/Part No.
2 ml syringe with cap (10 pcs)	SMC-2-10
Syringe nozzle (5 pcs)	SMC-2Z-5
Syringe holder	CLH-3

6. Component Names and Functions

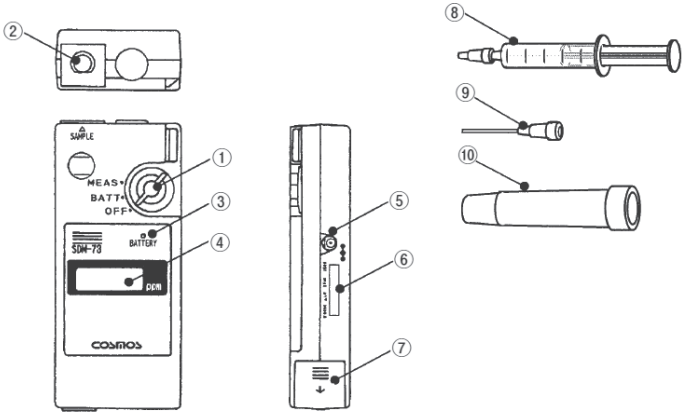

Figure 1. Exterior Appearance

Item	Component	Function and Description
①	Selector switch	· Set the switch to **MEAS** to enter measurement mode; set to **MEAS** before inserting the syringe into the meter · Set the switch to **BATT** to check the battery voltage · Set the switch to **OFF** to turn off the unit
②	Sampling port	Insert a syringe with syringe holder here for measurement
③	Battery alarm LED	Turns red when the battery voltage decreases and reaches the discharge-cutoff voltage (3.6 V); notifies users to replace the batteries; starts blinking when the battery voltage decreases to 3.2 V or lower
④	LCD	Displays the steel dust concentration value, battery voltage, or error code
⑤	DC jack	(For use in Japan only. Used to connect the AC adaptor.)
⑥	Calibration date label	Indicates the calibration date; do not remove the label
⑦	Battery compartment	Houses four AA batteries
⑧	Syringe	2 ml syringe to collect an oil sample
⑨	Syringe nozzle	Used with the syringe to collect an oil sample
⑩	Syringe holder	Needs to be attached to a syringe before the syringe is inserted into the meter

7. Operation

7-1. Battery Installation

Open the battery lid. Insert four AA batteries in the correct orientation (polarity +/-).

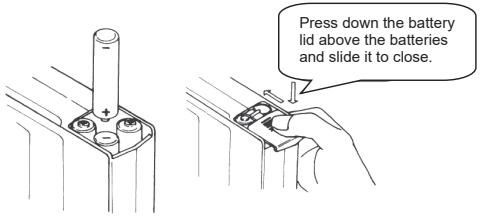

Figure 2. Battery Installation

7-2. Battery Check

Set the selector switch to **BATT**. "– – – –" will be displayed on the LCD for a few seconds, and then it will be replaced by the battery voltage.

b 5. 6	Battery voltage is 5.6 V.
b 3. 6	When the battery voltage exceeds 3.6 V, the unit is ready for use. When the voltage decreases to 3.6 V or lower, the battery alarm LED will turn red, indicating that the batteries need to be replaced with new ones.
b 3. 2	When the battery voltage decreases to 3.2 V or lower, the battery alarm LED will start blinking and the unit will start beeping indicating that the batteries need to be immediately replaced with new ones. If you continue to use the unit without battery replacement, P. OFF (power off) will be displayed, then the unit will be shut down.

⚠ CAUTION

- Accurate measurement is not possible if the battery alarm LED is lit or blinks. Replace the batteries with new ones.
- Replace all the four batteries at the same time.

NOTE

If the battery voltage decreases to 3.6 V or lower while the selector switch is in the **MEAS** position, the battery alarm LED will turn red. If the battery voltage decreases to 3.2 V or lower while the selector switch is in the **MEAS** position, the battery alarm LED will start blinking and the unit will start beeping in the same way as when the switch is in the **BATT** position.

7-3. Taking Measurements

(1) Set the selector switch to **MEAS** to enter measurement mode.
(2) Ensure that “0" appears on the LCD with no syringe installed in the meter.
(3) Attach the syringe holder to the syringe filled with the oil sample. Insert the syringe into the sampling port of the meter.
For the oil sampling method, refer to page 8.
(4) Within a few seconds, the measurement is complete with a short beep. The reading is displayed on the LCD. Record the reading.
(5) Remove the syringe and syringe holder from the sampling port. The reading will return to “0”.
Note: Remove the syringe holder and syringe together.
(6) Return the selector switch to **OFF** to end the measurement.

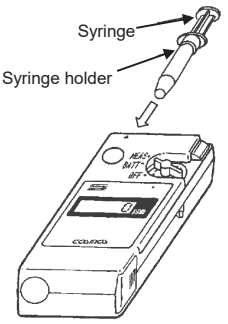

Figure 3. Syringe Insertion

⚠ CAUTION

- After blending the sampled oil well, draw the oil sample into the syringe right away, and then take the measurement immediately. It is not recommended to store the oil sample in the syringe. However, if you need to store the oil sample in the syringe, keep the syringe horizontally. Leaving the syringe vertically with the tip facing downward will cause iron particles to concentrate at the tip of the syringe, resulting in a drift in the reading or a negative reading.

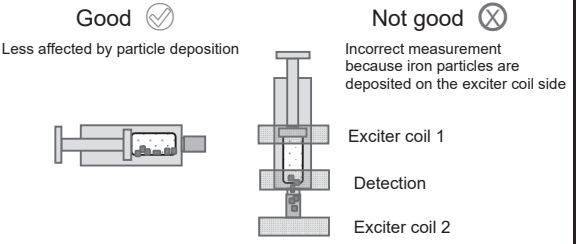

Figure 4. Effect of Particle Deposition

⚠ CAUTION

- Accurate measurement is not possible if an empty sample syringe or syringe holder is inserted.
- Insert/remove the syringe holder and syringe together in/from the meter.
- Avoid causing any impact and carefully insert the syringe into the sampling port. Failure to do so may cause the reading to drift. Inserting the syringe too slowly may also cause the reading to drift. If a drift occurs, remove the syringe and syringe holder from the meter, and then reinsert them.
- Once you insert the syringe in the sampling port, do not move it until the unit gives a short beep indicating measurement completion. Impact during measurement may cause a drift in the reading.
- Larger particles tend to deposit faster. As a result, the reading varies as they deposit. Complete measurements quickly to mitigate the effect of deposition. Placing the meter horizontally while in measurement can also mitigate the effect of the deposition of particles.
- The reading is normally stable during normal wear period. However, as the wear progresses, flaked abrasion powders are generated. These have a large diameter. The reading may vary as a result.
- Repeat the cycle of insertion and measurement three or four times (for the same oil sample in the same syringe) to obtain an average or majority value. The reading may drift or become negative when the syringe is inserted for the first time due to the difference in temperature between the syringe and the built-in sensor. If the first reading (1st measurement value) is significantly different from other measurement values, it should not be used.

7-4. Oil Sampling

It is necessary to take an oil sample expelled from the rotating machinery at the time of oil lubrication, etc., and to fill the syringe with it in the following manner.

(1) Sample 10–30 ml oil expelled from the rotating machinery and put it in a sample bottle.
Note: Iron particles in oil are likely to settle down at the bottom. Take an oil sample from the bottom to pour it into a sample bottle.
(2) Shake the bottle to blend the sampled oil well. When the sampled oil has a high viscosity, stir it well with a stirrer, etc.
(3) After blending well, **immediately** collect 1.5 ml of oil sample by using a syringe with a syringe nozzle attached. Ensure that the syringe is filled with a slightly excessive amount. Push the piston upward to remove air bubbles, then obtain an exact volume of 1.5 ml.
(4) Remove the syringe nozzle from the syringe and wipe the tip of the syringe with a cloth, etc. Attach the cap and syringe holder to the syringe.
(5) Start the measurement **right away**.

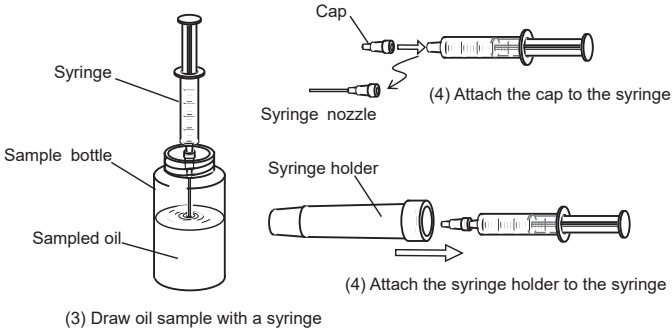

Figure 5. Oil Sampling

NOTE

Syringes are consumables. Take the following precautions.

- The graduation lines on a syringe may vanish when wiped with oil, depending on the type of oil. Prevent oil from making contact with the graduation lines as much as possible.
- When the measurement is finished, empty the syringe by releasing the oil sample back into the sample bottle. Leaving the syringe filled with oil for an extended period of time may deform the syringe depending on the oil type. A deformed syringe may not be properly housed in the syringe holder.
- When keeping the oil sample in a syringe for a while, ensure the cap faces upward. A drift in the reading or negative reading may be caused, if iron particles are deposited at or adhere to the tip of the syringe.
- A syringe can be used 5 to 10 times (as a reference). When the graduation lines fade away and are illegible, replace it with a new one.

8. Error Codes

In case of an error, the corresponding error code is displayed on the LCD. Take the necessary action according to the displayed error code, as well as measures suggested in the next section, “Troubleshooting”.

Table 1. Error Code Table

Error code on screen	Cause	Action
_ _ _ _ (Blinking)	Cannot start zero adjustment because the unit was turned on while the oil sample (syringe and syringe holder) was inserted	Remove the syringe and syringe holder from the unit and wait until “0” is displayed before using again
	Measurement error Oil sample (syringe and syringe holder) was removed from the unit before the completion of measurement	Remove the syringe and syringe holder from the unit, reinsert them, then measure again
P. OFF	Unit was forcedly turned off because the battery voltage is too low	Set the selector switch to **OFF**, and then set it to **BATT** or **MEAS**
Err. E	Device error Non-volatile memory write error	Set the selector switch to **OFF**, and then set it to **BATT** or **MEAS**. If the error code is still displayed, repair is necessary
Err. r	Device error Non-volatile memory read error	
Err. S	Device error Non-volatile memory check sum error	
Err. A	Device error No response from the AD converter	
Err. F	Device error Abnormal sensor output	

9. Troubleshooting

Before contacting us for service repairs, please perform basic troubleshooting using the table below.

Table 2. Troubleshooting

Symptom	Cause	Action
Setting the selector switch to **BATT** or **MEAS** does not turn on the LCD	・Battery depleted	・Replace the batteries with new ones (page 5)
	・Incorrect battery orientation	・Remove and reinsert batteries in the correct orientation (page 5)
Battery alarm LED is lit or blinking	・Battery is low or depleted	・Replace the batteries with new ones (page 5)
Battery alarm LED is lit or blinking even after new batteries are installed	・Incorrect battery orientation	・Remove and reinsert batteries in the correct orientation (page 5)
Reading is unstable even after the oil sample (syringe) has been inserted in the meter Repeatedly measured values (of the same sample) vary or become negative	・Oil sample is too hot to measure ・Iron particles in the oil sample deposit or adhere to the tip of the syringe	・Allow the sample to cool down before measuring ・The reading is affected by deposition of particles. Fill the syringe with well blended oil sample, and then measure right away
		・If particles adhere to the tip of the syringe, wash to clean the syringe, cap and syringe holder or replace them with new ones
"— — — —" blinks on the LCD	・Unit was turned on while oil sample (syringe and syringe holder) was inserted	・Remove the syringe and syringe holder from the unit and wait until "0" is displayed before using again
"0" is not displayed or "— — — —" blinks on the LCD even after oil sample (syringe and syringe holder) is removed	・Optical sensor at the sampling port is dirty ・Only the syringe was removed from the sampling port then reinserted while the syringe holder remained inserted	・Wipe the optical sensor with a cotton swab or cloth to remove dirt ・Remove/insert the syringe and syringe holder at the same time.
Reading does not change even when oil sample (syringe and syringe holder) is inserted		

(Continued on next page)

(Continued)

Symptom	Cause	Action
Reading does not become “0” even when there is no oil sample in the syringe	・Reading has been calibrated to “0” by using fresh oil. It is not possible to check “0” by using air	・Insert a syringe filled with fresh oil, then check that the reading becomes “0”
Error code is displayed	Refer to the Error Code Table on page 10	

10. Warranty

The warranty period is one (1) year from the date of purchase.
You are entitled to limited warranty if the product malfunctions due to a manufacturing defect during normal use, in accordance with the instruction manual, specifications and labels.

Warranty Scope
If the product fails or is found to be damaged due to a manufacturing defect during the warranty period, and used in accordance with the instruction manual and specifications, we will provide a free replacement and repair services. This warranty covers the New Cosmos product/parts only and not third-party product/parts.

Warranty Exclusions
The following will be repaired at the cost of customer even during the warranty period:

(1) Failures and damages incurred by incorrect use, deliberate acts or negligence on the part of the user
(2) Failures and damages caused by disasters such as earthquakes, storms and floods, lightning, extreme climate, abnormal power supply voltages, excessive electromagnetic interferences, or other acts of God
(3) Failures and damages resulting from repair and/or modification by non-New Cosmos certified technicians
(4) Consumables and failures and damages resulting from improper consumable replacement
(5) Other failures and damages not attributable to the manufacturer

11. Maintenance

In order to ensure the accurate operation of this product, it is vital to perform periodic maintenance and inspection. It is highly recommended that a maintenance contract with a New Cosmos local representative be made for annual maintenance and inspections.

12. Specifications

Model	SDM-73
Measuring principle	Magnetic balance-type electromagnetic induction method
Target	Steel dust concentration in oil
Measurement range	0 to 19999 ppm *Weight ratio
Concentration display	4.5 digit LCD
Resolution	1 ppm Note “0” ppm displayed for less than 5 ppm
Accuracy	± (10 %reading + 10 digits) Compared with the value measured by ICP analysis on the company standard oil sample
Zero adjustment	Automatic adjustment
Sample volume	1.5 ml
Power supply	AA batteries x 4 pcs
Continuous operating time	Approx. 30 hours
Operating temperature	0 to 40 ºC
Dimensions	Approx. W84 × H190 × D40 mm
Mass	Approx. 500 g (including batteries)
Compliance	EMC directive (2014/30/EU/SI 2016 No.1091) and RoHS directive (2011/65/EU+(EU)2015/863/SI 2012 No.3032)

・ Above specifications may be subject to change without notice for product improvement.

Appendix: Measuring Principle

A1. Magnetic Balance-Type Electromagnetic Induction Method

This product employs a magnetic balance-type electromagnetic induction method, as illustrated in the Figure A1 below, as its measuring principle.

This is a magnetic circuit sensor formed by placing a detection coil between two exciter coils, so that magnetic fields generated by the exciter coils are canceled by each other, resulting in no magnetic field around the detection coil.

The detection coil does not normally generate an induction voltage. However, when an oil sample containing iron particles is inserted into one of the exciter coils, the magnetic permeability will change, causing a magnetic imbalance, which will then cause the detection coil to generate an induction voltage. The iron particle concentration in the oil can be measured by measuring the induction voltage.

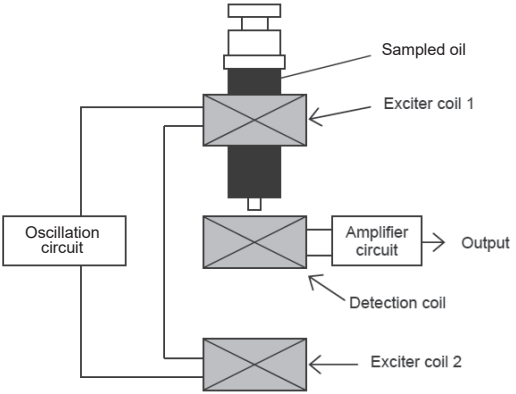

Figure A1. Magnetic Balance-Type Electromagnetic Induction Method

A2. Measurable Metals

Table A1. Measureable and Non-Measurable Metals

Metal	Magnetic property	Measurable	Remarks
Iron, nickel, cobalt	Ferromagnetic	✓	
Aluminum, chrome, manganese, titan, stainless steel (SUS-304, SUS-316)	Paramagnetic	X	
Copper, silver, lead, zinc, tin	Diamagnetic	X	
Sodium, calcium, lithium, molybdenum	Paramagnetic	X	*1
Iron oxide (α-Fe_2O_3), iron dust (hydroxide iron)	Paramagnetic	X	*2
Iron oxide (γ-Fe_2O_3, Fe_3O_4)	Ferromagnetic	✓	

*1. These are raw materials used to make oil thickeners. This product has no sensitivity to them; therefore, they have no effect on the reading of the product.

*2. There are several isomers of iron oxide. Some of them can be measured using this product while others cannot, as shown in the table above. If the specimen contains red rust or if it is measured in an environment where steel dust may easily oxidize, the reading may be especially lower than the actual concentration value.

A3. Usage

(1) Major Applications

- Trend management and simplified diagnosis of wear status of oil-lubricated bearings and gears
  This product can be used to check the lubrication of low to high speed rotating machinery. It is especially suitable when used as a simplified diagnosis of wear status of low speed rotary bears and gears, which is otherwise difficult to diagnose with the vibration analysis technique. It is possible to improve the diagnosis accuracy of middle and high speed rotating machinery by using this product along with a vibration meter.
- Preliminary diagnosis for Spectrometric Oil Analysis Program (SOAP), ferrography, etc.
  This product's usage leads to maintenance cost reduction.

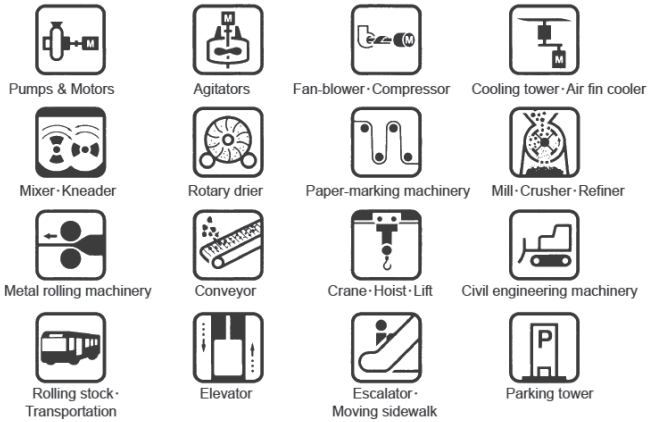

Figure A2. Typical Applications

(2) Typical Steel Dust Concentration Trend in Lubricant Oil

Figure A3 shows the 5-year data of changes in steel dust concentrations in lubricating oils of the large-sized force-feed lubrication speed reducers (Machines A to N) installed in a chemical factory. As for the speed reducers where the concentration greater than 30 ppm was observed, wears (e.g., pitting) were found on the gear tooth surface.

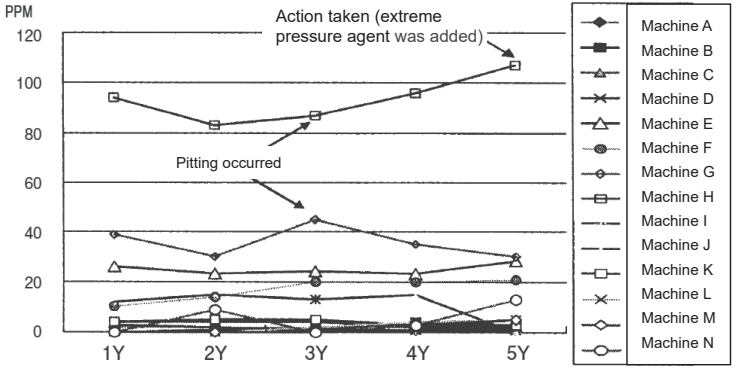

Figure A3. 5-year Steel Dust Concentration Trend in Lubricant Oil from Large-sized Speed Reducers

(3) Criteria (Reference)

The criteria for steel dust concentration in the oil sample are given in Table A2. They are set to be relatively strict so as to detect abnormalities, if any, at an early stage through trend monitoring to ensure that you take appropriate and timely corrective steps that ensure long life for your machinery.

The machinery type and condition of use vary greatly. Hence, these criteria are not suitable for all types of machinery. It is recommended that you establish suitable operating criteria through the data accumulation and trend monitoring of the steel dust concentration tendencies of your machinery.

Table A2. Typical Criteria of Steel Dust Concentration in Oil

Criteria		Judgement	Action
Large-sized machinery*	Small-sized machinery*		
Less than 30 ppm	Less than 100 ppm	Normal	Continue to monitor the steel dust concentration at a normal frequency
30–100 ppm	100–300 ppm	Of Caution	Fill the machinery with fresh oil immediately and then measure the concentration again after one month; take necessary corrective action (e.g., improvement of lubrication)
Greater than 100 ppm	Greater than 300 ppm	Abnormal	Perform a thorough examination; identify the cause of abnormality and take necessary corrective action

* Machinery is classified into large-sized or small-sized based on whether it is with or without filtering.

* A rough distinction between large-sized and small-sized machinery is the motor size. Large-sized machinery has motors of 20 kW or greater, while small-sized machinery has motors of less than 20 kW.

* For small-sized machinery, usually oil bath lubrication is used and the oil is hardly filtered. Therefore, the concentration criteria for small-sized machinery are three times more in number than those for large-sized machinery.

(4) Iron Particle Diameter and Detection Range Comparison among Measuring Methods

It is very useful to check the condition of wear particles in lubricating oil/grease as a method to diagnose and forecast the damage or wear progression of the gears and bearings.

SOAP (e.g., ICP analysis) and ferrography are commonly used for measuring the steel dust concentration in oil/grease.

Figure A4 provides a conceptual diagram of the detection range of four methods (ICP, analytical ferrography, quantitative ferrography and SDM-72/73) and the relationship between particle diameter and detected value.

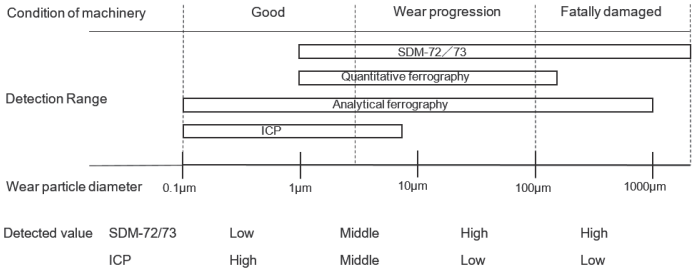

Figure A4. Iron Particle Diameter/Detection Range Comparison

Generally, SOAP (e.g., ICP analysis) is considered unsuitable for detecting large particles (5 μm or larger in diameter). On the other hand, the SDM-72/73 meter has high sensitivity for large particles, which directly lead to fatal damage. The use of the SDM-72/73 meter does not require any special knowledge. The SDM-72/73 meter enables the user to easily and quickly detect abnormal wear condition at an early stage and on site.

*SOAP: Spectrometric Oil Analysis Program
*ICP: Inductively Coupled Plasma

(5) Comparison between SDM-Measured Values and ICP-Analyzed Values

The wear particles in oil/grease sampled from actual machinery are a mixture of various ingredients of different shapes. The quantity and properties of wear particles in an oil/grease sample differ depending on the sampling location and operating conditions, which causes the reading to vary in the end.

On placing the ICP-analysis values from smallest to largest and then comparing them with the SDM-measured values (as shown in Figures A5 and A6), the SDM-measured values are well correlated with those of the ICP-analysis. Therefore, we believe that the SDM-72/73 meter is capable enough to be used as a portable analyzer for providing a simplified preliminary diagnosis on site.

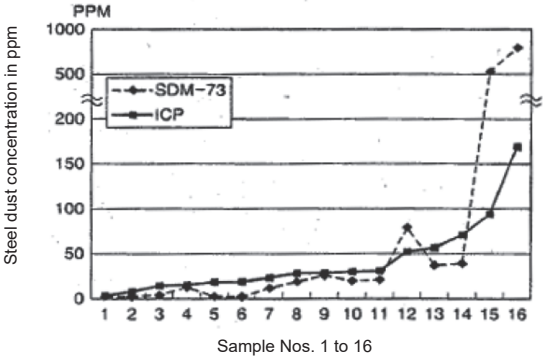

Figure A5. Concentration Comparison between SDM-73 and ICP

*1. Large-peeled wear particles are mixed in Sample Nos. 15 and 16:
In the ICP analysis of a sample containing large-peeled wear particles, a large error is likely to occur. This often results in a lower reading. This phenomenon is caused as a result of the incomplete luminescent reaction of metal particles. On the other hand, the SDM-73 meter is capable of measuring a sample containing such large particles because it is designed to detect the change in permeability. It is also reported that permeability change is affected by wear particles' size and shape, for example, if needle-shaped wear particles or flattened wear particles are longitudinally lined up, the meter gives a higher reading. Normally the particles are in a random orientation, and some particles line up longitudinally to some extent, which causes the SDM-measured value to be higher than the ICP-analyzed one. This phenomenon, however, is on the safe side from the viewpoint of detecting an abnormality at an early stage. Therefore, we conclude that the use of SDM-73 meter is practical.

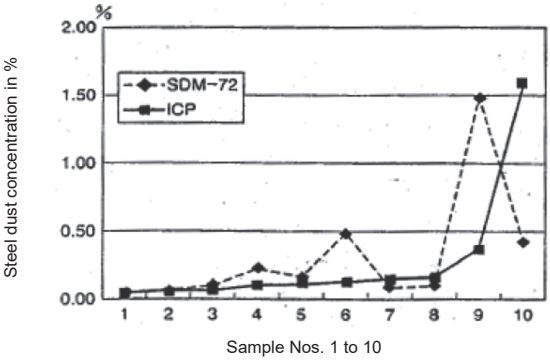

Figure A6. Concentration Comparison between SDM-72 and ICP

*2. Red rust is formed in Sample No. 10:
If water enters the lubricating oil/grease and causes formation of red rust (iron oxides), it means that the polluted (rusted) wear particles have lost their magnetic properties. In this case, the SDM-72 meter gives a lower reading. Note that it is possible to visually recognize this abnormality because the sample turns iron oxide brown-red.

*3. Fretting occurs in Sample Nos. 6 and 9:
When observed under an electron microscope, it was found that most wear particles are flattened ones having metallic luster and are large in size (250 μm max.) That's why the ICP-analyzed value is low. Fluorescent X-ray analysis did not detect any electromagnetic materials except iron (Fe). A very small amount of manganese (Mn) was detected.

Revision History

Document No.	Date	Revision
SDM-73CEET	June 2008	Initial issue
SDM-73CEET	July 2012	01
SDM-73CEET	August 2013	02
SDM-73CEET	June 2019	03
SDM-73CEET	July 2020	04
SDM-73CEET	July 2021	05
SDM-73CEET	September 2022	06

Additional copies of this instruction manual may be purchased.
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