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Introduction

The *Series 2000 Speedy* moisture tester is a portable system for measuring the moisture content of a wide range of materials including soils, aggregates, dust and powders (and liquids). The system consists of a rugged plastic case containing a low-pressure vessel fitted with a pressure gauge and an electronic scale and ancillaries.

Moisture measurements are made by mixing a weighed sample of the material with a *calcium carbide* reagent in the sealed pressure vessel. The reagent reacts chemically with water in the sample, producing acetylene gas that in turn increases the pressure within the vessel. As the pressure increase in the vessel is proportional to the amount of water in the sample, the moisture content can be read directly from the calibrated pressure gauge.

The Series 2000 Speedy is available in the models listed *Table 1* below.

Table 1: Series 2000 Speedy Models

Model	Vessel Size	Measurement Range (H_2O% W/W)	Max. Recommended Particle Size (mm)	Sample Wt. (g)
L2000C	Large	0-10	20	40
L2000D	Large	0-20	20	20
L2000G	Large	0-50	20	8
S2000C	Standard	0-10	10	12
S2000D	Standard	0-20	10	6

Safety Precautions

- The calcium carbide reagent used with the Speedy tester is a hazardous product that must be handled with care by the user and with consideration for the environment. Users must follow calcium carbide transportation, storage, handling and disposal guidelines in accordance with local regulations and/or the calcium carbide *Material Safety Data Sheet* (MSDS) in Appendix A of this manual. Users should be familiar with the hazard identification, first aid measures, fire-fighting measures, accidental release measures, personal protection measures, physical and chemical properties, stability and reactivity, toxicological information, and ecological information as given in the MSDS (see Appendix A).
- Users of the Speedy must be familiar with the Speedy *Moisture Test Procedure* detailed in this manual.

Moisture Test Procedure for Standard Size Speedy

A standard size speedy is shown in the photograph to the left. The moisture test procedure is simple to follow and takes a just few minutes for most materials. However, to ensure accurate and consistent results the procedure should be followed precisely. To test your sample, refer to the photographs below and complete the following steps:

1. **Clean the Speedy vessel:** Prior to using the Speedy tester, ensure that the inside of the Speedy cap and vessel are empty and clean. Use the bristle brush to remove any residues from previous tests.
2. **Select and prepare the sample:** Ensure that the sample to be weighed and placed in the Speedy is representative of the material that is under investigation. Some materials, such as free-flowing powders and sands, need no preparation whereas others may need to be ground prior to testing. See *Table 4* on page 6 for further information.
3. **Weigh the sample:** Place the empty measuring beaker on the electronic scale and zero the scale (refer to the electronic scale user instructions for further details). Add small amounts of material from the sample until the correct sample weight is reached. The sample weight is determined by the size and measurement range of the Speedy that is being used, as listed in *Table 2* below.

Table 2: Sample Weights - Standard Vessel

Model	Vessel Size	Range (H_2O% W/W)	Sample Wt. (g)
S2000C	Standard	0-10	12
S2000D	Standard	0-20	6

4. **Add the sample to the Speedy vessel:** Pour the sample into the chamber of the Speedy vessel.
5. **Add the reagent to the Speedy cap:** Using the metal scoop, add a minimum of two full scoops of calcium carbide reagent to the Speedy cap cavity.
6. **Seal the Speedy:** Hold the Speedy horizontally and position the cap as shown. Then swing the stirrup into position and tighten the top screw to seal.
7. **Mix the sample with the reagent:** Hold the Speedy vertically with the pressure gauge facing the ground and shake vigorously for 5 seconds. Rotate the Speedy through 180° so that the pressure gauge faces the sky, tap the sides of the Speedy to ensure the sample falls into the cap cavity and prop or hold the Speedy in this position for 1-2 minutes.
8. **Take the reading:** Hold the Speedy horizontally and at eye level and take the moisture content reading directly from the pressure gauge.
9. **Release the pressure:** Hold the Speedy vertically with the pressure gauge facing the ground. Locate the arrow on the flange of the cap and point this away from yourself and other people in your vicinity. Unscrew the top screw slowly to vent the gas that may have been generated within the Speedy.
10. **Remove the sample and reagent:** Tip the contents of the Speedy directly into a clean and dry open container and dispose of in accordance with *Section 13 of the Calcium Carbide Material Safety Data Sheet*.
11. **Clean the Speedy:** Clean the Speedy vessel, cap and measuring beaker in preparation for the next moisture measurement.

Moisture Test Procedure for Large Size Speedy

A large size speedy is shown in the photograph to the left. The moisture test procedure is simple to follow and takes a just few minutes for most materials. However, to ensure accurate and consistent results the procedure should be followed precisely. To test your sample, refer to the photographs below and complete the following steps:

1. **Clean the Speedy vessel:** Prior to using the Speedy tester, ensure that the inside of the Speedy cap and vessel are empty and clean. Use the bristle brush to remove any residues from previous tests.
2. **Select and prepare the sample:** Ensure that the sample to be weighed and placed in the Speedy is representative of the material that is under investigation. Some materials, such as free-flowing powders and sands, need no preparation whereas others may need to be ground prior to testing or pulverized during the test. See *Table 4* on page 6 for further information.
3. **Weigh the sample:** Place the empty measuring beaker on the electronic scale and zero the scale (refer to the electronic scale user instructions for further details). Add small amounts of material from the sample until the correct sample weight is reached. The sample weight is determined by the size and measurement range of the Speedy that is being used, as listed in *Table 3* below.

Table 3: Sample Weights - Large Vessel

Model	Vessel Size	Range (H_2O% W/W)	Sample Wt. (g)
L2000C	Large	0-10	40
L2000D	Large	0-20	20
L2000G	Large	0-50	8

4. **Add the sample to the Speedy vessel:** Pour the sample into the chamber of the Speedy vessel. If so indicated in the *Sample Preparation* table, place pulverizing balls into the chamber.
5. **Add the reagent to the Speedy cap:** Using the metal scoop, add a minimum of two full scoops of calcium carbide reagent to the Speedy cap cavity.
6. **Seal the Speedy:** Hold the Speedy horizontally and position the cap as shown. Then swing the stirrup into position and tighten the top screw to seal.
7. **Mix the sample with the reagent:**
   a. **Without pulverizing balls:** Hold the Speedy vertically with the pressure gauge facing the ground and shake vigorously for 5 seconds. Rotate the Speedy through 180° so that the pressure gauge faces the sky, tap the sides of the Speedy to ensure the sample falls into the cap cavity and prop or hold the Speedy in this position for 1-2 minutes.
   b. **With pulverizing balls:** Hold the Speedy horizontally and shake it in an orbital motion to make the balls spin around inside the Speedy vessel. Do this for 20 seconds and then rest for 20 seconds. Repeat this process 2or 3 times so that the spinning balls pulverize the sample to give a more reliable measurement.
8. **Take the reading:** Hold the Speedy horizontally and at eye level and take the moisture content reading directly from the pressure gauge.

Moisture Test Procedure for Large Size Speedy (cont.)

9. **Release the pressure:** Hold the Speedy vertically with the pressure gauge facing the ground. Locate the arrow on the flange of the cap and point this away from yourself and other people in your vicinity. Unscrew the top screw slowly to vent the gas that may have been generated within the Speedy.
10. **Remove the sample and reagent:** Tip the contents of the Speedy directly into a clean and dry open container and dispose of in accordance with *Section 13 of the Calcium Carbide Material Safety Data Sheet*.
11. **Clean the Speedy:** Clean the Speedy vessel, cap and measuring beaker in preparation for the next moisture measurement.

Special Considerations

Use the instructions in this section to adapt your test procedures to special measuring conditions.

Applying the Proportional Test Technique

If the moisture content of the material exceeds the measurement range of the Speedy being used, then the *Proportional Test Technique* may be used to obtain measurements. This involves halving the normal sample weight and doubling the gauge value. For example:

1. Assume an L2000D Speedy with a measurement range of 0-20 H_2O% W/W is being used to test soil with a nominal moisture content of 30%.
2. The sample is prepared as required and half the normal weight (i.e. 10 g) is placed in the Speedy.
3. The normal test procedure is followed and a gauge value of 14.7% is recorded.
4. This value is then doubled to give the actual moisture content of 29.4%.

The *Proportional Test Technique* may also be used to obtain clearer readings in very dry material by doubling the sample size and halving the gauge value.

Compensating for Non-Standard Temperature

For optimum performance the Speedy tester and sample should be at 20°C (68°F) when used. If this is not practical, take at least three tests in quick succession to equilibrate temperatures as much as possible. Ignore the first and second test results and record the later results.

Establishing Correction Factors

When compared with oven test results, Speedy readings may be low if the material under investigation contains volatile components other than water, as these may evaporate with the water at elevated temperatures. Correction factors for given materials can be established by plotting graphs of Speedy test results against oven test results.

Measuring Moisture Content in Liquids

Speedy testers may be used to measure the moisture content of certain liquids (most commonly oils) by adapting the test procedure as follows:

1. Weigh the liquid sample as in the standard procedure.
2. Place the liquid in a clean mixing vessel and add two to four scoops of dry sand. Mix the contents thoroughly and place the mixture in the Speedy vessel.
3. Continue with the test as detailed in the standard *Moisture Test Procedure*.

Converting Wet Weight to Dry Weight

The pressure gauges used with the Series 2000 Speedy testers are calibrated to give the moisture content expressed as a percentage of the sample's wet weight. If required, the measured value (M_{WW}) can be expressed as a percentage of the sample's dry weight (M_{DW}) by using the following formula:

$$M_{DW} = \frac{100 \times M_{WW}}{100 - M_{WW}}$$

Troubleshooting

Use the following procedures to troubleshoot suspected inaccurate results.

Suspected Low Reading

If the Speedy gauge readings are lower than you expect or anticipate, check the following:

- Was the test procedure followed correctly? Ensure the correct sample weight is used, the sample is placed in the Speedy vessel, and the calcium carbide reagent is placed in the Speedy cap. Also, make sure the Speedy vessel and cap are united and sealed in the horizontal plane to prevent premature contact of the reagent and sample.
- Was there was adequate cleaning of the Speedy vessel and cap between tests? Ensure all residues from previous tests have been removed from the cap and vessel before starting a new test.
- Was sufficient reagent used? Repeat the test using an additional scoop of reagent.
- Was the reagent ineffective? Ensure that the reagent is fresh.

Note: *The color of fresh reagent is dark gray; ineffective reagent that has been exposed to moisture in the air or other sources will have turned light gray in color.*

- Was sample preparation or sample-reagent mixing adequate? Consider grinding the sample prior to weighing and/or (for Large Speedy only) using pulverizing balls.
- Was the temperature too low? Low readings may be recorded if the Speedy is used in very low temperatures. Take numerous readings in quick succession to raise the operating temperature of the Speedy.
- Was there a pressure loss? Visually check the cap washer for signs of holes or leak paths. Remove the pressure gauge and visually check the pressure gauge washer. Visually check the Speedy vessel and cap for hairline cracks.
- Is the pressure gauge defective? If the needle does not sweep smoothly across the scale plate, replace the gauge or return the Speedy tester to an authorized distributor for service.

Suspected High Reading

If the Speedy gauge readings are higher than you expect or anticipate, check the following:

- Was the correct sample weight used? Ensure that the sample weight is weighed correctly.
- Was the gauge read correctly? Ensure that the Speedy is held in the horizontal plane at eye level when reading the pressure gauge.
- Was the temperature too high? High readings may be recorded if the Speedy is used in very high temperatures. If the Speedy is warm/hot to touch as a result of taking many readings in quick succession, allow time for it to cool down before taking more tests.
- Is the pressure gauge defective? If the needle does not return to zero after releasing the pressure from the Speedy, replace the gauge or return the Speedy tester to an authorized distributor for service.

Recommended Spares and Consumables

It may be wise to consider having the following spares and consumables available when using the Speedy tester, especially in remote locations:

- batteries for the electronic scale, AA/LR6 1.5V (3 required)
- Speedy cap washer
- pressure gauge washer
- pressure gauge (note the measurement range)
- cleaning brushes

Other spares parts for the Speedy vessel are available on request.

Sample Preparation Table

Refer to Table 4 below for instructions on preparing your sample for analysis.

Table 4: Sample Preparation

Material Type)	Recommended Preparation
Aggregate	Check maximum sample size. Crush if larger than maximum recommended particle size.
Dust	None required.
Liquids	Mix with dry sand (see *Measuring Moisture Content in Liquids* on page 4).
Powders	None required.
Sand	None required.
Soils	Grind with mortar and pestle prior to testing, or use pulverizing balls (for large size Speedy only).

Appendix A - Material Safety Data Sheet (According to Directive 93/112/EU)

1.1 Identification of the Product

Name: Calcium carbide
CAS-No.: 75-20-7
UN-No.: 1402
EINECS-No.: 200-848-3
EU - No.: 006-004-00-9

1.2 Identification of the Manufacturer/Supplier

Name: Carbide Industries Limited
Address: Althorpe Wharf, Keadby, Scunthorpe
UNITED KINGDOM, DN17 3DA
Telephone: +44 1724 782383

1.3 Emergency Telephone

Telephone: NCEC + 44 1865 407333

2. Composition

CAS-No.	Chemical Name	Conc. (wt. %)	Hazard Classification
75-20-7	Calcium carbide	~80	F - Highly flammable R -15: Contact with water liberates highly flammable gas.
1305-78-8	Calcium oxide	~15	C - Corrosive R -34: Causes burns.

3. Hazard Identification

Reacts with water to form $Ca(OH)_2$ and flammable acetylene, which forms explosive mixture with air. By contact with water (humidity), acetylene gas with anesthetic effect is liberated. Simultaneously, very small amounts of poisonous phosphine and hydrogen sulphide gas are set free.

Residue contains Calcium hydroxide which may cause burns.

4. First Aid Measures

Acute poisoning due to handling of calcium carbide is unlikely to occur if usual safety precautions are taken.

Skin:	Remove contaminated clothes immediately. Flush exposed skin abundantly with clean water and cover with sterile compress (do not use compress for burns).
Eyes:	Flush abundantly with clean water for at least 15 minutes forcing the eye-lids open. *Immediate transport* to hospital or eye specialist.
Inhalation:	By poisoning caused by inhalation of phosphine (and arsine) gas from moist calcium carbide: remove the victim from the source of exposure as quickly as possible. Usual first aid: rest, warmth, fresh air,.
	By unconsciousness: Loosen tight-fitting clothes, place the body in a stable, lateral position.
	By breathing difficulties: Give oxygen.
	By breathing arrest: Artificial respiration.
	By heart arrest: External heart compression.
	Immediate transport to hospital preferably under administration of oxygen.
Ingestion:	Not relevant.

5. Fire-Fighting Measures

Dry calcium carbide is not inflammable. Contact with humidity and water liberates acetylene gas which is highly inflammable and can form explosive mixtures with air. The gas is lighter than air.

Fire extinction:	*Small fires*: Dry powder, lime or dry sand.
	Large fires: Withdraw from area and let fire burn.
Do not use:	Water or foam.
Protective measures:	If staying in atmosphere containing acetylene is unavoidable, be aware of the high risk of explosion and wear self-containing breathing equipment.

6. Accidental Release Measures

Be aware of the possibility of acetylene gas formation on contact with humid atmospheres or water.

Shut off ignition sources.

Stay upwind.

Keep people and animals away from the polluted area.

Removal: Collect material in suitable containers which must not be tightly closed. Protect the spilled material from contact with water and do not allow it to enter water courses.

Water contamination: Calcium Carbide should not be let into the sea, lakes, rivers etc. By the reaction with water alkaline calcium hydroxide is formed which is harmful to fish and marine organisms. Observe possible national/international pollution regulations.

Contamination of streets and the environments: Proceed as described previously. Evacuate the polluted area. Material remaining after collection must not be dumped into the public sewer.

In case of spillage affecting the environment, consult the authorities (pollution agency etc.) according to local regulations and rules. By serious accidents, inform the authorities concerned.

See also Sections 8, 12 and 13

7.1 Handling

Keep tightly closed in a dry and cool place. Handle and open container with care.

Use spark proof tools.

Protect against humid air and water.

Keep away from sources of ignition.

No smoking.

7.2 Storage

Calcium carbide must be stored in tightly closed containers in a dry, well ventilated place without sprinkler protection.

Exclude possible sources of ignition of acetylene gas.

Even traces of humidity will cause liberation of explosive acetylene gas.

It should be stored separately from silver, mercury, copper and copper alloys.

8. Exposure Controls/Personal Protection

The working operation should be arranged in such a way that formation of dust is reduced to a minimum. Avoid moisture. Provide good ventilation.

Respiratory protection: For working operations involving *dust formation*, use approved dust mask (P2). In case of possible presence of phosphine-, (arsine-) and hydrogen sulphide gas: use combination filter or preferably fresh air mask until control measurements are done.

Hand Protection: Rubber gloves

Eye protection: Safety goggles, eye flushing facilities

Occupational Exposure Standards	Long-term Exposure ppm (mg/m^3) (8 hour TWA reference period)			Short-term Exposure Limit ppm (mg/m^3) (15 minute reference period)		
	UK[1]	USA[2]	Germ.[3]	UK	USA	Germ.
Calcium carbide	Not stated					
Acetylene-gas (C_2H_2)	Simple asphyxiant					
Phosphine-gas (PH_3)	0,3 (0,4)	0,3 (0,42)	0,1 (0,15)	1 (1)	1 (1,4)	- (-)
Arsine-gas (AsH_3)	0,05 (0,2)	0,05 (0,16)	0,05 (0,2)	- (-)	- (-)	- (-)
Hydrogen sulphide-gas (H_2S)	10 (14)	10 (14)	10 (15)	15 (21)	15 (21)	- (-)
Ammonia (NH_3)	25 (18)	25 (17)	50 (35)	35 (27)	35 (24)	- (-)
Calcium hydroxide ($Ca(OH)_2$)	- (5)					

[1] Environmental Health Series No. 40 (EH 40), The Health and Safety Executive. Occupational Exposure Limits 1984.

[2] Threshold Limit Values 1992 - 1993, American Conference of Governmental Industrial Hygienists (ACGIH).

[3] List of MAK- and BAT-values. Commission for the investigation of health hazards of chemical components in the work area. Report No. 29. Deutsche Forschungsgemeinschaft. 1993.

9. *Physical and Chemical Properties*

Appearance: Lump-formed or granular, dark gray material

Smell: Onion-like, due to presence of phosphine or arsine as impurities.

Calcium Carbide		Calcium Carbide (cont.)	
Boiling point:	NA	Relative density	2.3 g/cm^3
Melting point:	1700 - 1950°C	Bulk density	~1100 kg/m^3
Flash point:	Does not flash if dry	Acetylene	
pH - value	NA	Explosion limit in air	1.5 – 82%
Vapor pressure (20^{o}C)	<<1 mbar (in dry air)	Ignition temperature	305°C
Solubility (water)	Reacts heavily	Specific gravity (air =1)	0.91

10. *Stability and Reactivity*

Calcium carbide reacts violently with water with the liberation of flammable acetylene gas and the formation of corrosive calcium hydroxide solution. Small amounts of phosphine, arsine, hydrogen sulphide and ammonia are also released.

Even very small amounts of water will react with calcium carbide developing sufficient heat to make the acetylene gas ignite spontaneously.

Acetylene will react with copper, silver and mercury creating explosive compounds (acetylides which are shock and temperature sensitive.

11. *Toxicological Information*

Handling of dust - free, lumped-formed Calcium Carbide is not considered to be a health risk when safety precautions are taken.

Skin: Dust may irritate moist skin and can cause skin ulceration and eczema.

Eyes: Dust may damage the cornea and can in serious cases cause blindness.

Inhalation: Symptoms of acute poisoning are: nausea, vomiting, disorientation, burning sensation in the nose or throat and breathing difficulties.

12. *Ecological Information*

The decomposition products of calcium carbide, acetylene and calcium hydroxide are harmful to fish.

Acetylene: 200 mg/l lethal for trout fry
400 mg/l lethal for gold fish within 24 -48 hrs.

$Ca(OH)_2$: 20 mg/l harmful to fish.
70 mg/l lethal after 26 minutes

13. *Disposal Considerations*

Small amounts of Calcium Carbide are collected and mixed with diatomaceous earth at a safe place in the open air. Add small portions of water in a suitable, open container. Ignite the acetylene gas with a pilot flame. Let burn out, and stay for 24 hours. Decant the fluid part and transfer the solid precipitate to an approved site for deposition or burial.

Equipment etc. can be cleaned with water. Observe the possibility of acetylene gas formation and use protective equipment.

14. Transport Information

Calcium Carbide must only be packed and transported in packing according to international transport regulations. The packing must be strong and tightly closed to prevent access of humidity to the material.

UN No.:	1402
Air Transport (ICAO-TI/IATA-DGR):	Class 4.3, P.G. II, P/A: 416/15 Kg CAO: 418/50 Kg
Sea Transport (IMDG-Code, Amdt. 25-89):	Class 4.3, PG. II, Page 4335 EMS: 4.3-03 MFAG:705 Stowage Cat.: B
Road Transport (ADR):	Class 4.3, Item 17(b) Kemlercode: 423/1402
Rail Transport (RID):	Class 4.3, Item 17(b) Kemlercode: 423/1402
CEFIC - Card:	(R) - 192

For further information about the different transport classes, consult national / international transport authorities.

15. Regulatory Information

According to EU-Dir. 67/548, as amended, the product is labeled as follows:

F -	Highly flammable
R 15	Contact with water liberates highly flammable gases
S 8	Keep container dry
S 43	In case of fire, use dry sand (i.e.) dry powder. Never use water.

16. Other Information

The information given here is based on the present state of our knowledge and describes our product under the aspect of safety. It should not therefore be construed as guaranteeing specific properties.

The information contained in this manual is given in good faith. As the method of use of the instrument (and its accessories) and the interpretation of the readings are beyond the control of the manufacturers, they cannot accept responsibility for any loss, consequential or otherwise, resulting from its use.

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