

Vers. 7.0 UPDATE 2012



*Used wherever
compost is made!*

OFFICIAL SOLVITA® GUIDELINE COMPOST EMISSIONS TEST

The Solvita® kit is a widely recognized and easy-to-perform test procedure that measures evolution of carbon-dioxide (CO₂) and volatile ammonia (NH₃), the two most prominent gaseous emissions of active composts. Together these indicators are useful for evaluating stability and maturity and determining the need for aeration.

THIS MANUAL UPDATES THE FOLLOWING PROTOCOLS from Vers 6.0:

- **GAS Concentration:** the concentration of CO₂ corresponding to any Solvita color;
- **AERATION SUFFICIENCY:** the time it takes based on indicated respiration that a compost is likely to become depleted in air and require fresh aeration.
- **TROUBLESHOOTING:** adds information about VOC and N₂O interferences.

Solvita® is employed with composts and manures for the following purposes:

- 1) To comply with maturity standards (**Table 1** - Maturity Index)
- 2) To evaluate compost status (**Table 2 - 3**) and to determine aeration needs (**Table 4**).
- 3) To determine product best-use (**Table 5**) and ammonia situation (**Table 6**).

Scope of Test and Obtaining Satisfactory Results

The Solvita® test may be used to obtain several types of information regarding stability, nitrogen-loss, maturity and quantitative respiration rates. It is best to determine in advance what kind of information is sought, and then establish test procedures and the appropriate interpretation. Composts are rarely uniform and therefore special attention to proper sampling is recommended. A troubleshooting key is included in the Appendix.

QUALITY CONTROL & STORAGE OF SOLVITA KITS

Solvita® kits are pre-calibrated and packaged for highest quality prior to shipping. The sealed probes should be the "Control Color" when the foil pack is opened (see color chart). If the foil packs are damaged or the jar is cracked then the test may not work properly. The probes may be used for up to one year from date of purchase. The jars may be reused 4 times, then discarded. Shelf-life is extended by refrigeration. Do not allow gels to freeze.

For technical references see list at end of manual, or go to www.solvita.com for complete downloads

Solvita® is a trademark of Woods End Laboratories, Inc.

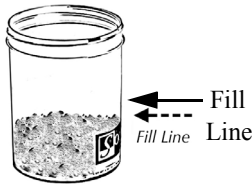
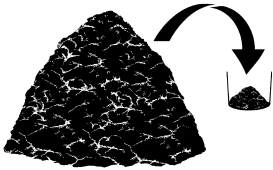
Protected by one or more of the following patents:

5,320,807 - 6,391,262 - 6,780,646 and DE4416387AI

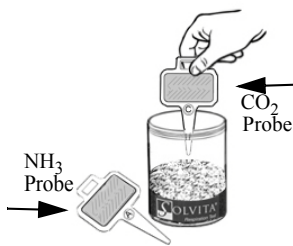


Detailed sampling instructions are available at: www.woodsend.org

SAMPLE PREPARATION



lbs/ yd ³	kg/m ³	g/ jar
500	300	30
800	475	50
1,000	600	60
1,200	700	70



1. OBTAIN and PREPARE SAMPLE: Take a grab sample or prepare a composite by mixing several sub-samples representative of the entire compost. Remove by hand wood chips and large objects before testing. A $\frac{3}{8}$ " (10mm) sieve if available may be used.

2. CHECK MOISTURE: To properly measure respiration, sample moisture should be ideal and if not, it should be adjusted. A sample that is too dry may give a false maturity test. It may be acceptable to test without moisture adjustment if as-is stability is desired (e.g. a sample being bagged). To determine ideal moisture use the squeeze test¹. If too dry, carefully add water incrementally while mixing and repeat the squeeze test until proper moisture is achieved. Then, *allow to stand overnight loosely covered* so the sample equilibrates to the new condition.

3. LOAD SAMPLE: Carefully fill the Solvita jar to the fill line. To get the proper density tap the jar gently while filling to fill line. Optionally, the proper weight in grams per jar corresponding to actual field density is found in the table at the left.

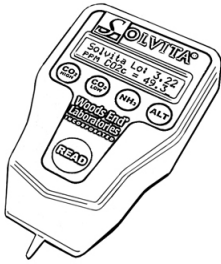
4. EQUILIBRATION STEP: Let the sample "air-out" in the jar for one-hour prior to starting the test. If the sample was taken directly from a very hot or frozen pile, it is advisable to allow it to stand for 24hrs with the lid open before starting the test.

5. START TEST: The Solvita maturity test is two tests carried out in the same 4-hour period. Open both the individual pouches marked "Compost CO₂" or "Ammonia" and carefully remove each probe. The gel in the probe is color-coded: the carbon-dioxide probe is purple and the ammonia probe is yellow. *Do not touch the gel surface, and don't allow compost to touch it.* Once the gel-pack is opened, the test should be started immediately.

6. INSERT PROBES: Both probes are pushed into the sample in the jar according to the cue marks on the jar, visible through the clear back panel. The edges of the probes can be touching in the middle at about right angles. Push the probe all the way into the compost to the bottom of the jar. Do not jostle or tip the jar which may coat the sensitive gel probes with compost!

1. Squeeze test: make a fistful of compost. Squeeze very hard. Moisture should appear between fingers but not drip out if compost is at the proper moisture content.

CTIONS



The Digital Color Reader (DCR) eliminates the subjectivity of color discrimination and notably improves the scale of readability.

7. **SCREW THE LID TIGHT**, and keep the jar at room temperature (68—77°F or 20—25°C) *out of direct sunlight* for 4 hours.
8. **READ THE GEL COLOR**. At 4 hours after the jar has been sealed, remove probes one at a time and hold next to the proper color chart or use the Digital Color Reader. Compare the gel color to the numbered color scales, finding the closest match (half shades of color may also be read). *Read the color immediately after removing from the jar*. Color matching is best in fluorescent light.
9. **THE LID LABEL** is removable and may be affixed to a notebook page as a record and official proof-of-testing.
10. **TO FIND COMPOST MATURITY INDEX**: Using the CO₂ and NH₃ test results, consult Table 1 below to find the intersection of the two values. It should be noted that with composts with no free ammonia (or compost with pH < 7.5) the Index is the same result as the CO₂ paddle.
11. **TO ESTIMATE GAS EMISSIONS**, consult later sections. For aerobic compost, *the inverse of CO₂ (from 21%) can be assumed to be the amount of oxygen consumed in 4 hours*. This can be used to estimate air needs to maintain aerobic respiration (see Table 4).

Table 1. Compost Maturity Index Calculator^a

use the Ammonia and CO₂ paddle color numbers and read across and down to where the columns meet

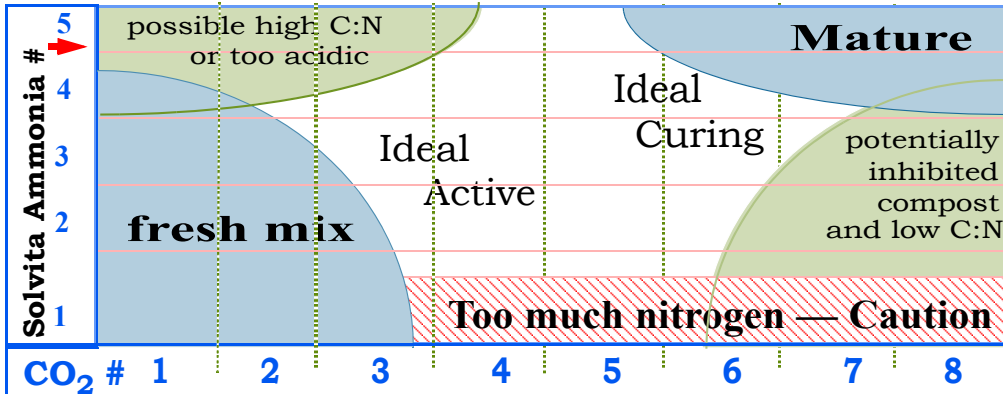
		SOLVITA Carbon Dioxide Test Result is:								
		1	2	3	4	5	6	7	8	
Solvita Ammonia Test Result is:	5	VLow / No NH ₃	1	2	3	4	5	6	7	8
	4	Low NH ₃	1	2	3	4	5	6	7	8
	3	Medium NH ₃	1	1	2	3	4	5	6	7
	2	High NH ₃	1	1	1	2	3	4	5	6
	1	Very High NH ₃	1	1	1	1	1	2	3	4

a. Example: If the NH₃ result is 2, and the CO₂ result is 6, then the Maturity Index is: 4

STATUS AND CONDITION OF COMPOST PROCESS

Using both Solvita results Table 2 indicates where in the general process compost may be. Table 3 based on the Maturity Index can be used to infer the overall condition.

Table 2 STATUS OF COMPOSTING PROCESS



Example: If the NH₃ result is 3, and the CO₂ result is 5, then the process is Active moving into Ideal Curing

Table 3 CONDITION OF COMPOST BASED ON MATURITY INDEX

8.	Inactive, highly matured compost, very well aged, possibly over-aged, like soil; no limitations for usage	"FINISHED" COMPOST
7.	Well matured, aged compost, cured; few limitations for usage	
6.	Curing; aeration requirement reduced; compost ready for piling; reduced management requirements. <i>Solvita 6 and above is commonly recognized as suitable maturity for official uses.</i>	Curing
5.	Compost is moving past the active phase of decomposition and ready for curing; reduced need for intensive handling	"ACTIVE" COMPOST
4.	Compost in medium or moderately active stage of decomposition; needs on-going management	
3.	Active compost; fresh ingredients, still needs intensive oversight and management	Very Active
2.	Very active, putrescible fresh compost; high-respiration rate; needs very intensive aeration and/or turning	"RAW" COMPOST
1.	Fresh, raw compost; typical of new mixes; extremely high rate of decomposition; putrescible or very odorous material	



MANAGING AERATION SUFFICIENCY

Solvita® shows CO₂ accumulation and O₂ depletion in a standardized jar over a specific period of time and therefore may be employed to estimate the need for aeration to maintain aerobic biodegradation. This application is most accurately used for enclosed composting systems, but may also be used as a general guideline for small-scale outdoor systems.

Table 4 OXYGEN DEPLETION AND NEED FOR AERATION

Solvita Rate†	CO ₂ produced / O ₂ consumed in Solvita test ‡	VENTILATION NEEDS FOR VARIOUS SYSTEMS	
		COL 1 -----	COL 2
		In-vessel and large pile systems including totally enclosed, fabric-sealed; piles > 2m (6.5') high; all large cure piles	Small-scale open windrows; short loosely covered piles; home compost bins §
8.	≤0.4%	Refresh air in 4-days	Essentially self-aerating unless material is very wet or very dense
7.	0.7%	Refresh air in 2-days	
6.	1.2%	Refresh air daily (every 24 hrs)	
5.	2.0%	Refresh air twice per day (every 12 hrs)	The need to turn should be determined by pile size and temperature in core; if hot it should be turned at least monthly
4.	3.0%	Refresh air 4x per day (every 6 hours)	
3.	5.0%	Refresh air 6x per day (every 4 hours)	Should be regularly turned on a scheduled basis until the pile temperature peaks and starts to decline and maturity improves.
2.	8.0%	Refresh air 10x per day (every 2.5 hours)	
1.	≥13%	Refresh air 16x per day (every 1.5 hour)	

† Numbers correspond to Solvita® Maturity Index (Table 1) or the Solvita® CO₂-probe result alone if the Solvita® ammonia color is ≥ 4

‡ Normal, ambient air is 20.9% O₂ and < 0.04% CO₂

§ Natural ventilation by air diffusion in small compost piles may be sufficient for aeration but depends on the surface:volume ratio, porosity, moisture content and temperature. Under wet, dense conditions, Col 2 samples may have to be treated as Col 1 types.



SELECTING BEST USE OF COMPOST BASED ON MATURITY

The favorable relationship of compost maturity to plant performance is well known¹. Plants tolerate and utilize compost better the more mature it is. Compost is also more hygienic and less likely to support pathogen growth, and therefore safer for food crops, when mature. There is no exact division between proper and improper use, or between maturity-sensitive vs. insensitive crops. The following table based on field experience is intended as a general aid for the range of best-use categories.

Table 5 COMPOST BEST USE GUIDELINE

SOLVITA® MATURITY INDEX	Raw Feedstock- Mushroom Compost	Landspreading on fallow soil; Mulch	Farm Row Crops, Field Cultivation	Hothouse Beds, Greenhouses	Orchards, Pastures, Hay Crops, Turf	Topsoil Substitutes; filter berms	General Gardening	Bedding Plants, Container Media	Potting Mixes, Seeding Starters	Material in this class will be similar to:
	8.					✓	✓	✓	✓	
7.				✓	✓	✓	✓	✓		Soil mixes; filter berm material
6.				✓	✓	✓	✓			Stable compost-soil blends
5.			✓	✓	✓					dried organic fertilizers
4.		✓	✓	✓						untreated organic fertilizers
3.	✓	✓	✓							dehydrated manures all types
2.	✓	✓								raw-waste and most fresh manures
1.	✓									fresh garbage, raw-waste & hot manures

Note: Other key factors that may determine how well a compost performs include nutrients level, pH, and salinity. Immature composts may contain pathogens. If in doubt, a compost should be examined by a laboratory that is experienced in compost analysis. See the web site www.woodsend.org for up-to-date information on all other aspects of compost testing.

1. Literature about Solvita® validation and field testing can be found at www.solvita.com



AMMONIA EMISSIONS OF MANURES & COMPOSTS

The Solvita® ammonia test can be conducted alone to measure the ammonia emissions potential of any material, or in conjunction with the Solvita CO₂ test for compost maturity estimation.

Volatile ammonia (NH₃) is a primary cause of odor in wastes, is noxious, and is an important loss mechanism of nitrogen during processing and handling.

The presence of ammonia indicates that the product may be high in nitrogen or low in C:N ratio; that it is unstable and possibly phytotoxic or that a potentially noxious or hazardous condition exists. If a sample persists in high ammonia values (1 - 3), it should be investigated.

Table 6 Solvita® Ammonia Gas Content, Plant-Toxicity, N-losses

Ammonia Color No:	1	2	3	4	5
Compost Condition	---- Extremely Active ----		Active	Curing	Stable
Potential Phytotoxicity is:	Very High	High	Medium	Slight	None
Noxious Hazard	Extreme	Severe	Moderate	Slight	None
ppm of Gas in 4-h test ‡	>25,000	8,000	2,500	800	<100
N-loss potential §	V. High	M High	Moderate	Low	V Low-None

‡ Concentration of ammonia gas in headspace of Solvita® test-jar. The concentration expected for an enclosed compost system will vary based on the specific ratio of the composting material to the total volume of the container.

§ Based on amount of NH₃-N absorbed in 4-hr test in Solvita® jar. The actual losses during composting will depend on aeration frequency, moisture and pH.

Technical Notes

Interferences: CO₂-Probe. Nitrous oxide and VOC emissions cause a pinkish tinge with the effect of a positive color error (lower apparent stability). Volatile Fatty Acids > 10,000 ppm cause a positive error (lower apparent stability). Volatile ammonia > 2,500ppm impedes CO₂ color development and therefore results in a negative error, which is corrected in the Maturity Index chart (Table 1). NH₃-Probe: No known interferences.

Bag-Sampling: Cumulative saturation by CO₂ of samples taken from bags may result in a positive error (more apparent CO₂ than is accounted for by biological respiration). This may be avoided by allowing samples to air out for one hour before testing.

DCR (Digital Color Reader): The DCR available to read Solvita gives the same visual color scale as expected but over a wider and more precise range 0.2 - 8.00. The DCR additionally gives quantitative CO₂ and NH₃ data.

Reprints of independent validation studies for Solvita® are available at www.solvita.com/solvita.html.

* The Solvita protocol is written into regulations in: CA, CO, ID, KS, MA, ME, MN, NJ, NM, OH, VA, TX, WA. Other states pending. In Europe Solvita® is recognized in: DK, ES, IE, IT, SE, NO, UK. Listed by EU Eco-Label.

Solvita® is a trademark of Woods End Laboratories, Inc.

Protected by one or more of the following patents:
5,320,807 - 6,391,262 - 6,780,646 and DE4416387AI



APPENDIX - Troubleshooting Guideline

Indicated Problem or Result	Possible Explanation	Possible Remedy
Compost is young but test results indicate “mature”	Compost may be very low in organic matter or depleted in needed available nutrients	Check organic content; check available-N; add fresh ingredients; check self-heating
	Compost inhibited by low or high pH; very dry or very hot prior conditions; check ammonia test	Check pH and VOA level; correct moisture; test again 1-2 days later
Compost is old but Solvita® results indicate “active” and/or high ammonia levels	Compost may have composted improperly and not advanced significantly, e.g. it is too wet or too dry, too compacted, poor mix of ingredients, not enough air	Turn pile, loosen material, add moisture or “green” materials if needed; if high in ammonia select for field rather than seedling use
Compost has given the same Solvita® colors on several tests at 1-2 weeks apart	Compost is not progressing properly— it may be too dry or too compacted, not well mixed; C:N or pH is too high or too low	If pile looks woody add green matter; add moisture if too dry; loosen if too dense
Different parts of the pile give different Solvita® colors	Pockets of poorly mixed or poorly aerated material exist	Re-mix entire pile and re-sample and test again
Core is always #1 or #2 on Maturity Scale	Core is anaerobic and/or is not composting properly	Provide coarse structural materials, mix pile or add air; pile may be too large
Solvita indicates “mature” but plants were hurt by compost	Compost is very acidic which inhibits respiration, or contains high levels of salts and VOA, which inhibit plants.	Check pH and conductivity; allow more composting; allow time in soil before planting
Color doesn't match the color chart	Package may have leaked air prior to the test or is defective	Discard paddle and request replacement product
Unexpected CO ₂ vs. ammonia paddle results	unusual or extreme conditions persist; check paddle quality	See table 2 and table 6
DCR color result is different from visual color	high emissions of VOC or nitrous oxide detected by spectrometer but not visible to eye	allow compost to air out; allow compost to mature
Solvita CO ₂ differs from a lab CO ₂ assay	Solvita test reflects <i>volumetric</i> emissions, not weight-based	convert Solvita readings to weight basis with DCR