



InstronTek[®]
Inc.

innovators in instrumentation technology

ACT[™]

Asphalt Compatibility Tester



OPERATING MANUAL

www.InstronTek.com

Important

PRECAUTIONS WHEN USING THE ACT

1. DO NOT PROBE INTO THE CONTROL BOX OR OUTLETS WITH CONDUCTIVE MATERIALS, TOOLS, OR HANDS. IF COVER MUST BE REMOVED, CONTACT INSTROTEK FIRST.
2. Do not attempt any repairs with the unit plugged into AC power or a battery installed. Maintenance on this unit must be done by trained technicians.
3. Always use your internal laboratory safety procedures when working with and around this unit.
4. Use special caution when performing the boiling procedure to prevent burns from hot water and equipment.

Important

PRECAUTIONS WHEN USING THE ACT

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1. Introduction

The Asphalt Compatibility Tester (ACT) is an innovative method to quantify the adhesion of asphalt binder to aggregate. This quick test can be used during mix design and quality control (QC) testing to determine if the mixture is susceptible to adhesion failure and moisture damage.

The results of this test allow a user to quantify a change in the color of an asphalt mixture. The change in color indicates the adhesion strength of the mixture. The ACT uses a photo detector to measure the light reflected from the surface of the asphalt mixture to automatically quantify the change in reflected light. The % Loss of the mixture is then calculated using a correlation with the change in reflected light. An increase in reflected light represents an increase in the % Loss. The % Loss is also affected by the color of the aggregate in a mixture because lighter colors reflect more light. A factory calibration has been developed based on the average response of a granite and a limestone mixture. The % Loss calibration can be fine-tuned using the calibration procedures in this manual.

The ACT method entails several steps that can be completed within an hour. 1) A sample of loose mixture is collected. It can be a mixture that is prepared in either the laboratory or during plant production. 2) The % Loss of the sample is measured before boiling. 3) The sample is boiled in water according to ASTM D3625. 4) The sample is dried using an external heat source, which is provided in the ACT system. 5) The % Loss of the sample is measured after boiling. By testing both the boiled and unboiled samples, the ACT quantifies the change in adhesive properties due to moisture, which is an evaluation of the compatibility of the binder, aggregate, and anti-strip additive.

The % Loss results of the ACT device can also be used to evaluate different anti-strip additives and determine an optimum dosage rate during mixture design. The ACT can be used during production to ensure required changes in the production process do not result in adhesion failures in the mixtures and thereby poor pavement quality.

2. ACT Equipment



3. Requirements

Electrical requirements:

ACT sensor and control box: 110VAC outlet OR 9V battery (optional)

Heat gun: 110 VAC outlet

4. Overview of Procedure

1. Obtain an unboiled sample (lab or plant) of asphalt mixture.
2. Measure the % Loss of the *unboiled* (original) sample.
3. Boil the sample (based on the requirements of ASTM D3625)
4. Dry the sample using the drying kit.
5. Measure the % Loss of the *boiled* sample.

5. Sample Preparation

1. Collect a 400-500 g sample of loose asphalt mixture. The sample can be produced in a lab or a plant.
2. Assemble testing tray by placing the ring into one of the end caps and placing the collar on the other side of the ring.
3. Pour 350-400 grams of mixture into the testing tray.
4. Using a spoon, stir the mixture **three** complete revolutions. For each stir, insert the spoon into the mixture until the spoon touches the bottom of the tray. Then, in a continuous circular motion, mix the fine and coarse particles together.
5. Smooth out the surface of the mixture with the spoon.
6. Use the tamper to compress the mixture. Drop or press on the tamper to level the mixture. DO NOT rotate or grind the tamper against the mixture because it will remove binder.
7. If the tamper does not touch the rim of the collar after



stirring and compressing, remove 1-2 spoonfulls of material. If the tamper touches the rim of the collar without pressing, add 1-2 spoonfulls of material. Then, repeat steps 2-5.

6. Measuring % Loss for the Unboiled Sample

1. At the beginning of each day or when there is a significant change in temperature, press the STD button to take a standard reading. The ACT sensor has to be in the holder touching the standard felt to work properly. The standard reading corrects for temperature differences.
2. Open the lid to the testing chamber and slide the compacted sample and testing tray in the testing tray until it touches the alignment base.
3. Press *Test*. Follow the instructions on the screen.
 - a. Place sample prepared according to Section 5 in testing tray and press *Enter*.
 - b. Press *Test* to measure the top of the sample.
 - c. Place second end cap on testing tray and remove tray from testing chamber. Flip sample over. Remove the other end cap and slide the testing tray into the testing chamber.
 - d. Press *Test* to measure the bottom of the sample.
4. When testing for a given sample is complete, record the % Loss for both the top and bottom of the sample and the SRI, which is a ranking index (see Section 10 for details).
5. If the % Loss is outside the limits of 0.0 +/- 2.0%, the unboiled sample is different from general asphalt mixtures. Follow the steps in the Calibration section to perform an *Unboiled Offset* calibration.



7. Boiling Procedure

Items included in Boil Test Kit:

- 2 L glass beaker or metal pan
- Hot plate or induction heating plate
- Metal pan
- Spatula to spread the mixture
- 500 g of mixture
- Timer

1. Heat approximately 500 mL of *distilled* water in a glass beaker or metal pan to a boil.

NOTE: According to ASTM D3625, using non-distilled water can significantly change the % loss of the mixture.

CAUTION: Burn Hazard – Hot surface.

2. While the water is heating, heat the asphalt mixture to 85-100°C in an oven.
3. Once the water is rapidly boiling and the asphalt mixture is heated, transfer the asphalt mixture into the boiling water. Immediately start a timer.
4. The water shall return to a rapid boiling within 1 minute of pouring the mixture into the water.
5. Boil the mixture in the water for 10 minutes \pm 15 seconds.
6. Remove the container from the heat source. Skim off any free asphalt from the surface of the water to prevent recoating with a paper towel or metal spatula. Pour off the water while retaining the fines of the mixture.

8. Drying Procedure

Items Included with ACT:

- Metal pan to spread loose mixture into a thin layer
- Heat Gun
- Outlet Timer
- Spatula to spread the mixture
- Testing Stand to Hold Heat Gun

1. Pour the wet boiled asphalt mixture into the metal pan.
2. Spread the mixture as thinly as possible at one end of the pan. Elevate this end of the pan to drain any remaining water in the loose mixture. The excess water can be removed using a cloth.
3. Place the heat gun in the testing stand at a height of 12 inches from heat gun nozzle to the surface of the pan.
4. Set the electrical outlet timer for 5 minutes.
 - a. Press the Left arrow to change from the clock to the countdown (CD) timer.
 - b. Set the timer to 0:05⁰⁰ minutes using the Set and arrow keys.
 - c. Press CD to begin the timer.



5. Turn on the heat gun. Switch the heat gun to Level 2 heat and HIGH fan speed.

CAUTION: Burn Hazard – Hot surface.

6. After 5 minutes, stir the loose mixture with the spatula to redistribute the water and dry loose mixture.
7. Repeat steps 4 and 5 *at least two* more times until the mixture is dry to the touch.

9. Measuring % Loss for the Boiled Sample

1. At the beginning of each day, press the STD button to take a standard reading. The ACT sensor has to be in the holder touching the standard felt to work properly.
2. Prepare the sample in the testing tray according to the instructions in Section 5.
3. Open the lid to the testing chamber and place the compacted sample and tray in the testing chamber.
4. Press *Enter* or *Test*. Follow the instructions on the screen.
5. When testing for a given sample is complete, record the % Loss for both the top and bottom of the sample and the SRI, which is a ranking index (see Section 10 for details).

10. Theory of Operation

The purpose of the ACT is to measure % Loss of asphalt binder from an asphalt mixture after a boil test. The % Loss is based on the amount of light reflected back from a stripped sample compared to an unstripped sample. Factors that can affect the amount of reflected light include the amount of stripping, texture, and color of the sample. While the amount of stripping and color of the sample are material properties, the texture of the sample is affected by both the gradation of the mix and the preparation of the sample. Because asphalt mixture can strip on the coarse and fine aggregate particles in the material, it is necessary to measure both sizes of particles. The sample preparation process includes placing the asphalt mixture sample in the testing tray, stirring several times, and compacting at room temperature using a hand tamp. The top of the compacted sample generally has more large particles and a coarser texture. The % Loss measurement is achieved by measuring the top and bottom of the compacted sample. Because the top of the compacted sample generally has a coarser texture, the top and bottom of a sample with zero % loss (i.e., unboiled) may have different baseline readings due to different textures. An offset has been incorporated into the calculation to accommodate this difference. The % Loss of asphalt coating is reported for both the top and bottom at the end of the measurements. Knowing whether the top or bottom strips more is important for determining how to address the stripping because different aggregates may require different antistrip additives. The two % Loss values are combined into an index called the Sample Ranking Index (SRI). The SRI is calculated like the magnitude of separate vector components, i.e., the square root of the sum of squares. The SRI represents the total condition of the sample because it incorporates the stripping and textures of both sides of the sample, which represents both coarse and fine particles of the asphalt mixture. It provides a method to rank the overall stripping of different mixtures against each other.

$$SRI = \sqrt{(\%LOSS_{Top})^2 + (\%LOSS_{Bottom})^2}$$

11. Interpretation of Results

The results of the ACT depend on mixture characteristics such as the aggregate and the adhesive strength of mixtures. The % Loss criterion is used to evaluate whether a mixture is likely a good or poor performing mixture but this criterion could change for different mixtures.

(a) % Loss Threshold

The % Loss threshold is a pass/fail criterion. A strong correlation exists between % Loss and the AASHTO T 283 tensile-strength ratio (TSR) because both test methods evaluate the adhesive strength of asphalt mixtures. Mixtures below the threshold are labeled as good because they have less % Loss than the criterion and thereby a higher TSR. Mixtures above the threshold are labeled “Poor” because they have excessive % Loss and thereby a lower TSR, which indicate that these mixtures will have adhesion problems, especially when moisture is present. The default % Loss pass/fail threshold is 10%, which is based on testing several North Carolina mixtures and comparing the % Loss and TSR. *This threshold may need to be adjusted for local materials.*

(b) Relative Change in Measurement (QC/QA)

The results can be used to measure relative changes in the % Loss. The procedure below is designed for tracking the relative % Loss of a mixture to correlate its behavior to a mixture with a known TSR result. The user tests a boiled asphalt mixture sample when the TSR of a given mixture is measured. This provides a reference point for subsequent measurements to provide a rapid indicator if properties that affects the adhesive strength of the mixture have changed.

Information Needed:

% Loss - measured from the same batch of mixture as the TSR specimens

1. Sample the mixture from a current production batch.

2. Prepare the sample following the steps in Sections 5.
3. Measure the % Loss at a given sampling interval to verify that a mixture is still similar to the mixture from the design/initial production.
4. Set the % AC Loss Warning to the threshold measured from the initial test.
 - a. Press *Menu*. Press (1).
 - b. Similar is defined as: +/- 2.0 percentage points of the original % Loss. For example, the original value was 7.5%, so the normal expected range is 7.5% +/- 2.0% (5.5 – 9.5%). Therefore, set the warning to the upper limit of the range (9.5%).

(c) Determining Optimum Dosage of Anti-strip Additive

In mixtures known to have problems with adhesion between the aggregate and the asphalt binder, the optimum dosage of anti-strip additive can be determined by plotting the % Loss versus the dosage (Figure 1). When insufficient antistrip is added, the % Loss will be high. Once sufficient anti-strip is added, the % Loss will decrease rapidly and then plateau. The first point below the % Loss threshold is the desired anti-strip dosage. In Figure 1, the optimum value is 0.50% anti-strip additive because it falls below the 10% threshold.

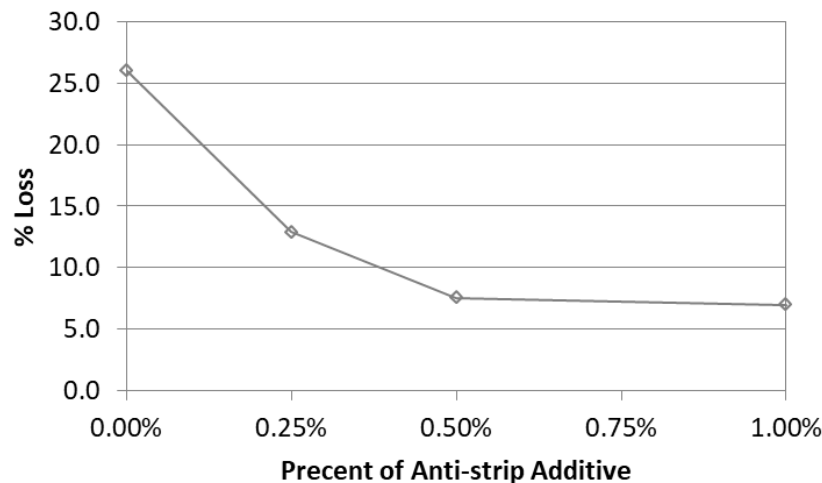


Figure 1. % Loss versus percentage of anti-strip additive

12. Calibration Procedure

The ACT comes with a factory calibration. The *factory calibration* is the **average % Loss** for a given number of counts from a granite and a limestone mixture. When the factory calibration gives undesirable results, such as a large negative % Loss, it is necessary to recalibrate the ACT. The calibration can be modified in 3 ways:

- 1) *Unboiled Offset* - Offset the average slope of the factory calibration using an unboiled sample for both the top and bottom of the sample. This procedure maintains the slope of the factory calibration but calculates new offsets for both the top and bottom such that the unboiled sample reads 0% Loss.
- 2) *Full Calibration* – Perform a full calibration with an unboiled sample and a sample of the aggregate gradation. The unboiled sample represents 0% Loss and the aggregate represents 100% Loss. A linear relationship between the % Loss and counts is calculated using this information.
- 3) *Quick Entry* – Enter the slope, intercept, and standard count for the calibration. If the slope and intercept are known from a previous calibration, they can be entered using this function. A linear relationship between % Loss and counts can be developed in Excel or other fitting software and entered using this function.

(a) Unboiled Offset Calibration

1. Press the *Menu* button. Press (2) for Calibrations. Press (3) for New. Press (1) for Unboiled Offset.
2. Select the calibration to offset.
3. Measure the Count of the unboiled asphalt mixture.
 - a. Prepare a sample based on the procedure in Section 5. Place the sample in the testing tray.
 - b. Place the sensor in the testing chamber and press *Enter*.

- c. Measure the top and bottom of the sample.
 - d. Empty the testing tray. Prepare another sample with the same mixture.
 - e. Repeat measurements 2 additional times.
- 4. Provide a name for the new calibration.
 - 5. Select the calibration.
 - a. Press the *Menu* button. Press (2) for Calibrations. Press (1) for Select.
 - b. Select the number that corresponds to the desired calibration.

(b) Full Calibration

- 1. Press the *Menu* button. Press (2) for Calibrations. Press (3) for New. Press (3) for Full Calibration
- 2. Measure the Count of the unboiled asphalt mixture. This value is 0% stripping.
 - a. Prepare a sample based on the procedure in Section 5. Place the sample in the testing chamber.
 - b. Place the sensor in the testing chamber and press *Enter*.
 - c. Measure the top and bottom of the sample.
- 3. Measure the Count of wet aggregate. This value is 100% stripping.
 - a. Prepare a sample based on the procedure in Section 5.
 - b. Spray the aggregate with water using a spray bottle. Allow the water to absorb for at least 30 seconds.
 - c. Gently blot the surface with a cloth until the coarse aggregates are saturated-surface-dry (SSD).
 - d. Place the sample in the testing tray and the sensor in the testing chamber to measure the Count.

- e. Measure the Standard Felt (in the sensor holder)
 - f. Enter a calibration name using the numeric keypad.
4. Select the calibration.
 - a. Press the *Menu* button. Press (2) for Calibrations. Press (1) for Select.
 - b. Select the number that corresponds to the desired calibration.

(c) Quick Entry

1. Select reference samples with a known % Loss.
2. Record the standard count for the day.
 - a. Press the STD button and record the count measured on the standard felt.
3. Measure the counts for the reference samples.
 - a. Press the *Menu* button. Press (4) for Diagnostics. Press (1) for Get Color Data.
 - b. Follow the instructions on the screen.
 - c. Record the counts.
4. Develop a relationship between the reference % Loss and the counts using Excel or other fitting software.
5. Determine the offset between the top and bottom of the unboiled sample.
 - a. Record the counts for the top of the unboiled sample.
 - b. Record the counts for the bottom of the unboiled sample.
 - c. Offset = bottom counts – top counts
6. Press the *Menu* button. Press (2) for Calibrations. Press (3) for New. Press (2) for Quick Entry.
7. Enter the slope, intercept, standard count, and offset.

13. Menu Items

(a) % AC Loss Warning

Adjust the threshold that states whether a mixture has good, marginal, or poor performance based on the % Loss.

(b) Calibrations Menu

1. Select – Select the calibration for predicting the % Loss.
2. Review – Review the current values of a calibration and change the slope, intercept and reference values. The access code for the factory calibration is 117.
3. New – Enter a new calibration using either Unboiled Offset or Full calibration.
4. Erase – Erase a calibration.

(c) File Storage ID

Enter a numeric ID for test data. The test data will be appended to the current data if the name is same.

(d) Data Store: On/Off

Enable/Disable data storage of test data.

(e) Set Time/Date

Enter the current date and time, which is displayed on the main screen.

(f) Diagnostics

1. Get Color Data – Measure the Counts for a given sample. This data can be used for calibration.
2. Enable Sensor – Turns on the LEDs to show the sensor is working properly.
3. Enter Serial # – Enter serial number for device.

-
4. Update Firmware – Updates the ACT to the latest version of firmware. See Section 15.
 5. Reset Memory – Resets all the calibrations to default values. Requires an access code of 117.

NOTE: Press ESC to exit a menu or menu item.

14. Trouble Shooting

ACT does not turn on –

- Make sure unit is plugged into an electrical outlet.
- Test outlet by plugging another device into the same outlet such as a lamp or fan.

Standard Reading is Outside Limit –

- Vacuum the felt to clean it
- Install a new piece of felt

Further trouble shooting can be performed using the Diagnostics menu. Contact InstroTek for further details.

15. Program Update

1. Download the firmware update file onto a USB device in the main folder (for example, E:\). The file name is "ACTUpdate.cyacd"
2. Press *Menu*. Then, press (4) *Diagnostics*.
3. Press (4) *Update Firmware*. Follow instructions on screen.

16. Warranty

InstroTek extends a 1-year warranty on the ACT to the original purchaser of this equipment. This warranty covers defects in material, workmanship and operation under the conditions of normal use and proper maintenance.

InstroTek will replace, free of charge, any part found to be defective within the warranty period.

This warranty is void if inspection shows evidence of abuse, misuse or unauthorized repair.

This warranty covers replacement of defective materials and workmanship only. It does not cover shipping charges, duties or taxes in the transport to and from the factory or authorized service center.

InstroTek's liability is in all cases limited to the replacement price of its products. InstroTek shall not be liable for any other damages, whether consequential, indirect, or incidental arising from use of its product.

If return of the product is necessary, please include return shipping directions, contact name, phone & fax number and a description of the action needed.

Call InstroTek, Inc. for shipping details at (919) 875-8371.

Notes:



Contact us for top quality, best value and superior service!

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