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Standard Guide for Measuring the Reactivity of Hydraulic Refractory Castables using Exothermic Profile[1]

This standard is issued under the fixed designation C1656; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide applies to all castables with a reactive binder system that produces a measurable heat profile during the setting and hardening process. The majority of these systems will have calcium aluminate cement as one component of the binder system.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C401 Classification of Alumina and Alumina-Silicate Castable Refractories

C71 Terminology Relating to Refractories

C862 Practice for Preparing Refractory Concrete Specimens by Casting

3. Terminology

3.1 *Definitions:*

3.1.1 *EP – exothermic profile, n*—the curve generated by plotting temperature of the embedded thermocouple versus time.

3.1.2 *LCC, n*—Low cement castable.

4. Significance and Use

4.1 The heat of hydration of a calcium aluminate based castable is liberated over a short period of time (as compared to Portland cement). This makes it easy to measure the heat profile using off-the-shelf thermocouple equipment.

4.2 The heat profile can be used to make inferences about the setting and strength gain behavior of a castable and sometimes the working time of a castable.

4.3 Factors that should be controlled when comparing two castables include: size, shape and mass of cast object, start temperature of the mix, temperature of environment, and the thermal conductivity of the environment. If these factors are held constant, then the two castables heat profiles can be compared.

4.4 The temperature increase created by the castable exothermic reaction shall be at least 2.0°C more than the normal fluctuation of the laboratory temperature so that the time of this increase is easily discernible to the user.

4.5 Varying the amount of cement in the castable, the amount of water, the type and quantity of admixtures, and so forth, will change the shape, maximum temperature and time to maximum temperature of the curve.

4.6 Following is an example of a curve generated for an LCC (see Fig. 1) that does exhibit two peaks, the first one marking the end of working time. In this curve one could also infer that the start temperature of the mix was 24°C and also that the hydraulic strength gain reaction was significantly started, but not completed by 6 h.

5. Apparatus

5.1 Mixing equipment as prescribed in C862.

5.2 Type T thermocouple (Type J, E, or K are also acceptable but not preferred due to range of sensitivity. Other types cannot be used.) Wire ends should be joined by solder or welding. Simple twisting is not recommended due to the potential for inaccurate readings.

5.3 Thermocouple sheathing (optional).

5.4 Voltmeter, data acquisition card or some other instrument to read the thermocouple mV value.

5.5 Container for storage of castable during heat profile generation and constant temperature environment in which to store the container.

5.6 Personal computer loaded with above card will make curve generation easier.

[1] This guide is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.09 on Monolithics.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

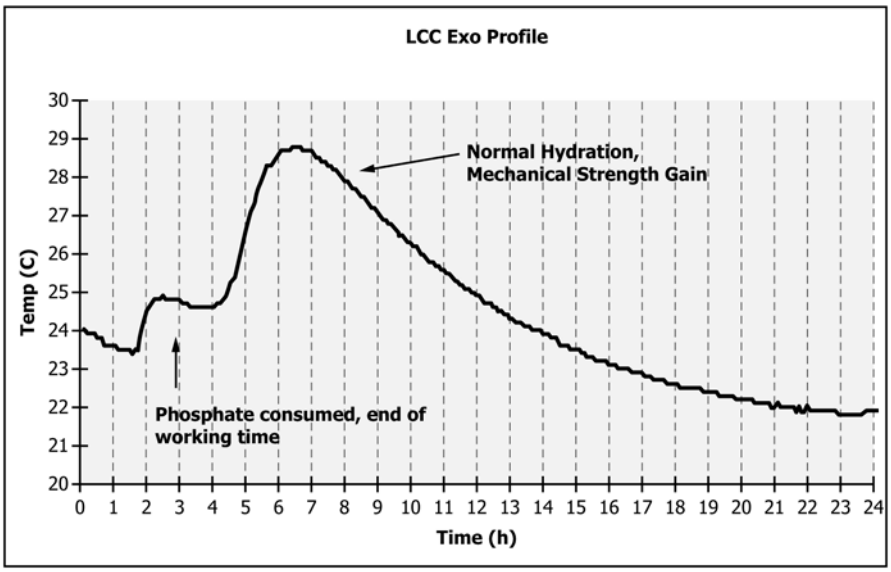

FIG. 1 Example of LCC Exo Profile

6. Hazards

6.1 There are no known hazards associated with the method. Safe practice should be used when mixing the castable. Castable MSDS should be consulted to determine if any hazards exist with the castable.

7. Procedure

7.1 Prepare the castable according to the manufacturers' mixing instructions noting the time of water addition. For comparison testing, the water addition should produce a comparable consistency of the castables.

7.2 If the entire sample will not be used for the EP generation, grab select a representative sample of required size from the mixing bowl by successive quartering when the mixer is turned off.

7.3 Place castable in a container. Place container in an environment with constant temperature.

7.4 Place thermocouple in the center of the castable in the container. Use of a sheath is not required but will allow for easier removal of the thermocouple later. Use of an insulating container will drive the final peak temperature to a higher point.

7.5 Begin taking readings within 5 minutes of placing the castable in the container. Readings can be taken either manually at desired time intervals (note the mV (or temperature) reading readjusting your time 0 from the water addition point or automatically with a PC) by using a strip recorder or automatically gathering the information with a PC outfitted with the correct hardware to read thermocouple values.

7.6 Plot temperature versus time to view the EP. This can be automated through the use of a personal computer and a data acquisition card or a strip or chart recorder.

8. Report

8.1 Record the type of castable, mixing time, and water added and consistency after mixing.

8.2 Record the temperature of the immediate surroundings.

8.3 Record the amount of castable and the type of container used during the EP generation.

8.4 Record the type and presence of any insulation used as the container or around the container.

8.5 Record the start temperature.

8.6 Generate the EP curve.

9. Keywords

9.1 castable; refractory; exothermic profile; EP; working time