Designation: C 1545 – 02

Practice for Dispersing Pigments and Other Materials into Water-Based Suspensions with a High Intensity Mixer[1]

This standard is issued under the fixed designation C 1545; 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 In preparing ceramic glazes and slurries for use, it is often necessary to add pigments to develop a desired fired color, to incorporate viscosity control agents for developing, or providing to develop the desired thickness of the glaze on the ware, to add materials which stabilize the suspension, control bacterial growth, and develop the desired hardness of the glaze on the ware to allow moving and handling before firing. While it is convenient to add these materials to the glaze or slurry in the dry form, it is often possible to use slurries where these materials are dispersed in a slurry and the slurry then added to the liquid glaze. Regardless of the state of the additions (dry or slurry), the dispersion can be done efficiently and effectively by the use of a high intensity mixer (sometimes referred to as a dissolver) and the procedure used is described here.

1.2 The values stated in SI units are to be regarded as the standard.

1.3 *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:*

C 242 Terminology of Ceramic Whitewares and Related Products[2]

3. Terminology

3.1 Standard terminology for ceramic whitewares and related products is given in Terminology C 242.

4. Significance and Use

4.1 The traditional method of preparing glazes and slurries has been to add stains (pigments), stabilizers, viscosity control agents, bactericides, and so forth, to the pebble mill batch along with normal batch materials such as clay, frit, quartz, feldspar, whiting (calcium carbonate), zinc oxide, opacifier, and so forth. This method had the disadvantage of over grinding some of the materials of the batch and under grinding other materials. While part of the disadvantage could be alleviated by double or triple batching (where the pebble mill was stopped at one or two points in the cycle and one or more materials added), the practice was labor intensive and not always well controlled. Another disadvantage of the traditional method was that it was necessary to thoroughly wash out the mill between batches of different colors. An obvious advantage, however, was that small components of the batch (such as pigments) were thoroughly dispersed in the batch and even today it is necessary to use this procedure when small quantities of strongly colored pigments are to be used.

4.2 With the advent of high speed intensive mixers using a rotating shaft-mounted impeller, it is now the usual practice to add pigments, conditioners, and so forth, to the batch from the pebble mill and accomplish the same uniform dispersion as would be the case if the pigments were milled in rather than "stirred" in. In addition, the pigments tend to yield a stronger color in the glaze because they have not been over ground in the pebble mill. It is not uncommon to make a reduction in the amount of pigment needed to develop the desired color when the pigment is stirred in rather than milled in. An even greater benefit is using the "stirred in" technique is that a single large batch of a base glaze (for example, clear) can be made by milling, and individual colors developed by stirring appropriate pigments and conditioners into small amounts of the base glaze. In this way, a large pebble mill can be dedicated to clear base glaze and cleaning the mill between batches is not needed. Glaze stains frequently are treated with proprietary materials which assist in dispersing the stain into the glaze.

5. Apparatus

5.1 There are two types of high intensity mixers (dissolvers), those designed for laboratory use, where capacity is approximately 10 to 15 litres of liquid, and those designed for production use, where capacity can be 1200 litres or more. Typical characteristics of both types of mixer are shown in Table 1.

5.2 Essential installation and operating "tips" for the mixers are:

5.2.1 The motor power must be sufficient to maintain

[1] This practice is under the jurisdiction of Committee C21 on Ceramic Whitewares and Related Products and is the direct responsibility of Subcommittee C21.03 on Methods for Whitewares and Environmental Concerns.

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[2] *Annual Book of ASTM Standards*, Vol 15.02.

TABLE 1 Characteristics of Intensive Mixers[A]

	Laboratory	Production
Capacity (litres)	10 to 15	1000 to 1500
Motor power (KW)	0.75	7.5 to 25.0
Motor speed (RPM)	0 to 16000	1800
Shaft speed (RPM)	0 to 16000	850 to 1500
Typical tank diameter (mm)	200	1200
Typical tank height (mm)	N/A	1200
Mounting	Bench	Floor
Tachometer on shaft	Yes	Yes
Hydraulic lift for drive and shaft	N/A	Yes

[A]From a Morehouse-Cowles information sheet

desired speed with specified load.

5.2.2 The floor mounted model must be rigidly secured to the floor.

5.2.3 A cylindrical container can be used for the glaze whether it is laboratory or production equipment. Production equipment must be fitted with a guide which centers and holds in place the container on the same center as the impeller. A rectangular container can be used, provided that the side and bottom corners are well-rounded to avoid "dead" areas in the mixture, just as is necessary with the bottom corner of the round tub. A rectangular container has an advantage over the round one in that there is less "spinning" of the glaze during mixing. See Fig. 1 for details of a round tub.

5.2.4 There must be a guard for the impeller (production machine) when the machine is not being used. This can be a split disk of plywood slightly larger in diameter than the impeller.

5.2.5 The drive unit must have sufficient vertical travel to clear the tub when the tub is on a pallet.

5.2.6 The impeller size is determined by the size of the container and the viscosity of the glaze. For a 1200 mm diameter tank, the impeller should have diameter of 250 to 350 mm.

5.2.7 The speed of rotation, the viscosity of the liquid, the size of the impeller, and the height of the impeller (from the bottom of the tub) determine the effectiveness of mixing the pigments into the glaze. The correct setting results in the depth of the vortex being one third of the depth of the glaze batch when at rest.

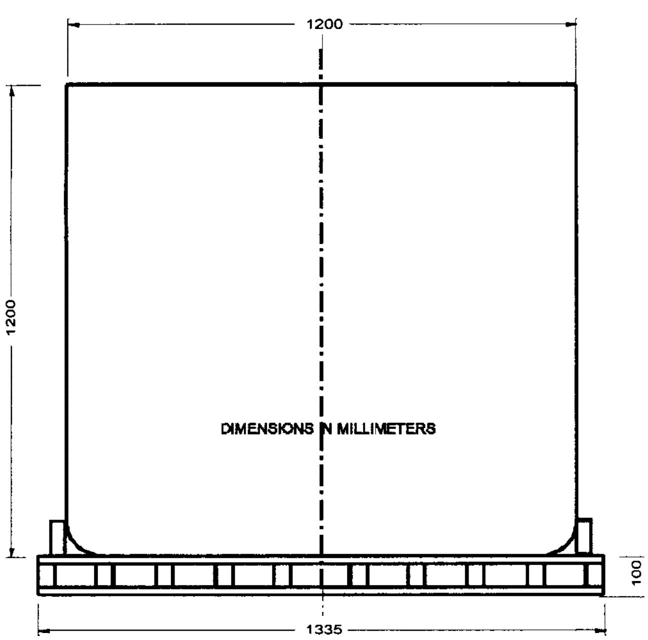

FIG. 1

5.2.8 When there is no vortex, mixing will not be thorough; when the vortex is too deep there will be considerable air entrainment and splashing if the impeller is exposed. See Fig. 1 for a view of the recommended tub, and Fig. 2 for the tub, impeller, and pattern of liquid flow.

6. Procedure

6.1 It is convenient to standardize on one size of container (for example, 1200 mm diameter × 1200 mm height).

6.2 Add the desired amount of base glaze to the container. The fill height should be no more than 80 % of the height of the container with the impeller in place. The dry weight of the base glaze in the container can be obtained by the use of a percent solids vs. specific gravity curve, the weight of base glaze in the container, and (from the curve) the percent solids in the glaze. An example of the percent solids vs. specific gravity curve is shown in Fig. 3. See 4.4 for the procedure for developing this curve.

6.3 Start the dissolver at a low speed and if necessary, adjust the height of the impeller to avoid splashing and to develop the desired vortex. Extremely fluid base glazes may require a smaller diameter impeller or a lower level of the base glaze in the container. Continue stirring for a few minutes.

6.4 Knowing the dry weight of the base glaze in the container, calculate the weight of the pigments and conditioners to be added, weigh these materials and add slowly (in the center of the vortex) to the container, increasing the speed of the dissolver if necessary to develop a good vortex. It may be necessary for better dispersion to make a slurry of the pigments and conditioners with a small amount of the base glaze and add the slurry to the container rather than the dry materials.

6.5 Mix the glaze, pigments, conditioners, and so forth, for 15 to 20 min (time depends on the types and amounts of materials being added), stop the dissolver and take the required sample for testing (viscosity, fired color, and so forth). Excessive mixing time, especially with a high viscosity glaze, will increase the temperature of the glaze in the tub, as well as shortening the life of the impeller.

6.5.1 Rules for glaze storage:

6.5.1.1 Always keep tight-fitting covers on glaze tubs.

6.5.1.2 Tubs must be washed and cleaned thoroughly after one batch is finished and before another batch (even if the same color) is added.

6.5.1.3 Leaking tubs must be repaired (epoxy/fiberglass is useful for repairing small holes or cracks) or discarded.

6.6 *Developing the Percent Solids vs. Specific Gravity Curve*

6.6.1 The dry weight of solids per millilitre of slip is calculated by Brongniant's equation:

$$W^d = (W^S - W^W) \quad (1)$$

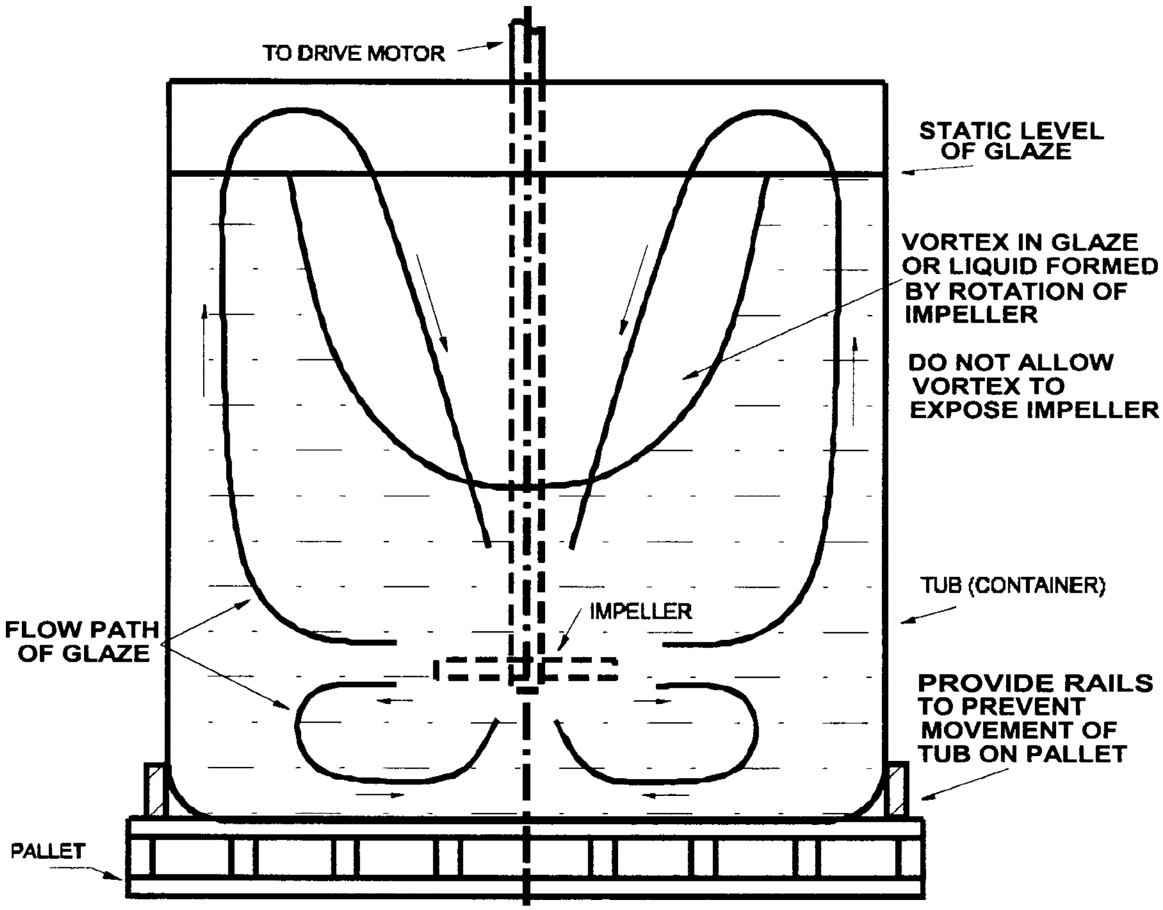

FIG. 2

where:

W_S = slip weight/millilitre (in grams),
W_W = Weight of water/millilitre (in grams),
W_d = Dry weight/millilitre (in grams), and
SG = Specific gravity of the dry material.

6.6.2 Substitute several values for W_S, calculate the percentage of solids corresponding to these values, and finally plot the several points on a percent solids vs. specific gravity curve as shown in Fig. 3.

NOTE 1—Fig. 3 does not represent actual data and is shown here for illustration only.

7. Safety and Health Precautions

7.1 The dissolver must be fitted with a guard that will ensure that a hand or paddle cannot be placed in the machine while it is in operation.

7.2 The machine must be in direct line of sight with the "start/stop" button.

7.3 The employer shall have a program to ensure that the machine cannot be energized accidentally during cleaning or repair of the machine.

7.4 The walls of the container can easily be damaged if the revolving dissolver blade contacts them.

7.5 Inspect the blade once a week to determine the amount of wear on the teeth. The more the teeth wear, the less effective will be the mixing. It is false economy to keep a blade in service with badly worn teeth.

7.6 An appropriate ventilation system should be installed to protect employees from dust exposure during dry operations. If such a system is not feasible, the employer should develop an OSHA respiratory protection program.

7.7 Electrical connections and equipment must be properly grounded, water-tight, and in compliance with all local electrical codes.

7.8 Surface dust and spills should be washed up as frequently as needed to keep the area clean. As the very minimum, the floor of the glaze preparation area must be washed daily.

7.9 Bagged materials must be stored on pallets or racks, never on the floor, and protected from water and dust.

7.10 Drums of materials, liquid or dry, are to be kept on pallets or racks and kept tightly covered and protected from water and dust.

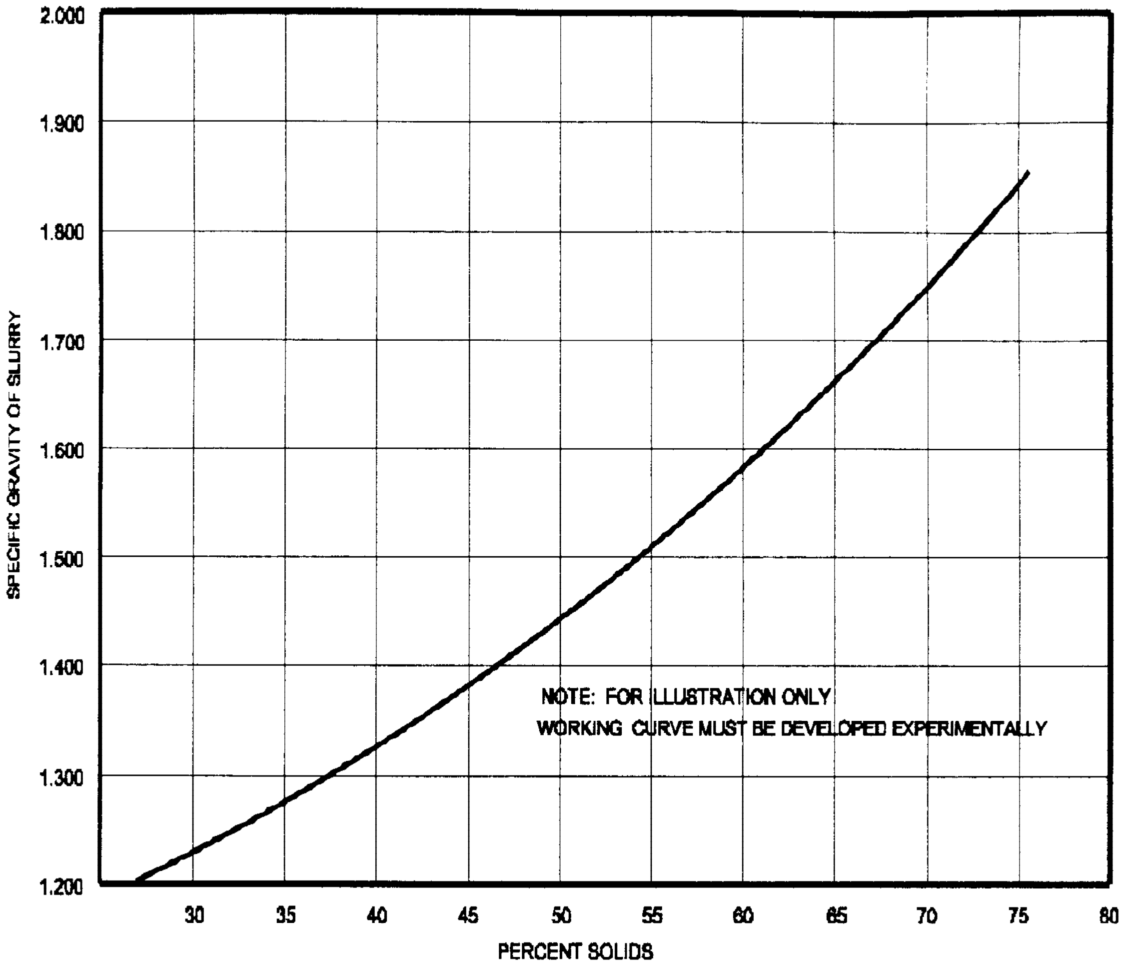
2.000
1.900
1.800
1.700
1.600
1.500
1.400
1.300
1.200
SPECIFIC GRAVITY OF SLURRY
30
35
40
45
50
55
60
65
70
75
80
PERCENT SOLIDS
NOTE: FOR ILLUSTRATION ONLY
WORKING CURVE MUST BE DEVELOPED EXPERIMENTALLY

FIG. 3