# Water Based **THICK** Tape Casting Demonstration Kit


## Polymer Innovations, Inc.

2426 Cades Way
Vista, CA, 92081, U.S.A.
760) 598-0500
PolymerInnovations.com

# Polymer Innovations, Inc. (PII)

**Founded 1996**

# WB4101 Type Binder Advantages

- Unique and highest performing WB binder available.
- Environmentally green - eliminate dangerous and expensive solvents. Non flammable.
- Equivalent performance to solvent based but with superior ceramic packing and dispersion performance - especially with Nano-size powders.
- Long history of successful use in production tape casting facilities since 1998.
- Water based but acts similar to solvent based.
- Reversible water solubility allows tape water resistance yet ability to rework old tape with pH adjustment.
- Cleans easily with water containing couple % ammonium hydroxide (window cleaner with ammonia also effective).

# The Standard Demonstration Kit

- Due to various misconceptions regarding water based binders as well as differences in processing at various facilities many customers have had difficulties trying to institute water based tape casting.
- In addition not every ceramic responds to the exact same mixture of binder ingredients.
- PII has found the supply of a complete Demonstration Kit provides a working example with a known powder and can greatly accelerate customer implementation.
- This Kit provides all the ingredients and formula to produce tape from 0.5 micron alumina powder. Customer just to supply ball mill and grinding media. The small ball mill and media shown in this report can be supplied by PII for a nominal charge if desired.
- Tape should be cast per the formula and method outlined in this report and can be compared to example tape supplied by PII (in the Kit).

# The Sample Kit Contains All Ingredients to Reproduce PII Results and Includes a Few Extra Helpful Ingredients for Other Ceramics

| Water Based Tape Casting Demonstration Kit | | |
|---|---|---|
| WB4101 | 2 liters | Most Popular PII WB Binder |
| | | |
| DF002 | 100g | All Organic Defoamer |
| PL002 | 100g | Most effective plasticizer if increased lamination or cutting performance is required |
| PL005 | 50g | Very high pH plasticizer useful for reactive ceramics and to enhance dispersants (glass bottle packed inside vermiculite powder) |
| DS001 | 100g | Dispersant compatible with WB4101 |
| DS005 | 100g | Dispersant compatible with WB4101 |
| TK004 | 8oz | Thick Casting Additives that work together to prevent cracking and ceramic settling by stabilizing thick sections of cast slurry during drying. ***Please refer to ThickTapeCastingDemo.pdf for proper usage guidelines*** |
| TK005 | 8oz | |
| | | |
| A16SG Alumina | 400g | Almatis Alumina powder used in example formula |
| | | |
| KE2-6 | .3 meter | Example Tape cast at PII |
| | | |
| SiPET Casting Film | 6 meters | Example of suitable silicone treated PET casting film (release coating on only one side) |
| | | |
| CD | 1 | CD containing SDS, Certs, Pictures of Process and other useful technical articles and resources. |

# Thick Casting Requires Optional TK Additives


•The standard kit for casting does not include TK004 and TK005.
•TK004 and TK005 are additives useful for casting tapes thicker than about 100 microns.
•However, **proper addition of the TK additives is critical** and thick casting in general is more difficult as explained in following slides.

# Thick Casting Difficulties

- Many beginners believe casting thicker tape is easy but this is not true.
- It depends on the ceramic but in general:
  - 15-60 microns green thickness is easiest with least problems
  - Under 15 microns is still relatively easy as long as the ceramic has fine enough particle size and very good dispersion.
  - Thicker than about 100 microns is the most difficult to cast. The thicker one casts the more difficult.
- Thick casting is difficult due to problems obtaining uniform drying and minimizing flow within the cast slurry.
- These problems result in cracks and poor tape thickness uniformity.
- For casting less than about 50-100 microns the standard sample kit and instructions (tapecastingdemo.pdf) are adequate and can be requested from PII.
- The rest of this presentation will focus on thick casting.

# Why is Thick Casting so Difficult?

- In thinner tape casting drying is very rapid and viscosity of the slurry during drying rises quickly locking in good thickness control.
- In thick tapes the outer surface of the tapes dries more quickly forming a semi-dry “skin” and slurry below is slow to dry due to slow diffusion.
- In thin tapes this skin is practically the thickness of the cast.
- In thick casting the liquid slurry under the drying skin is warm from drying temperatures and viscosity becomes even lower allowing easy movement of slurry due to drying stresses, convection, gravity, etc.
- Typically slurry dries faster at the edges of the cast since the atmosphere is less saturated with water or solvent in that area.
- This faster drying at the edges causes slurry movement from the center of the tape cast towards the outer edges.
- This migration of slurry toward the outer edges under the drying skin causes the drying skin to stretch even to the point where it breaks causing a large drying crack typically parallel to the casting direction.
- In addition this flow towards the edges results in the center of the tape being thinner and the edges thicker.
- It is possible to get convection drying cells under the drying skin which can cause mud cracking and other drying stresses.(con’t)

# Why is Thick Casting so Difficult (con't)?

- Drying times are much slower for thick casting: doubling the thickness may cause 4 times slower drying times.
- Due to these difficulties getting crack-free homogenous tape of uniform composition is more challenging than casting thinner.

**HOWEVER**

- Thick casting is possible by careful formula development with the use of thick casting additives TK004 and TK005.
- Tape casting thickness higher than 1000 microns can be achieved and in general is easier than using solvent based binders.
- The TK additives react together in the slurry to make a very high viscosity polymer resulting in a more thixotropic and less heat sensitive slurry rheology.
- **The TK additives are reactive with each other and the binder - so order of addition and mixing technique is very critical.**
- This presentation will focus on the proper use of TK additives.

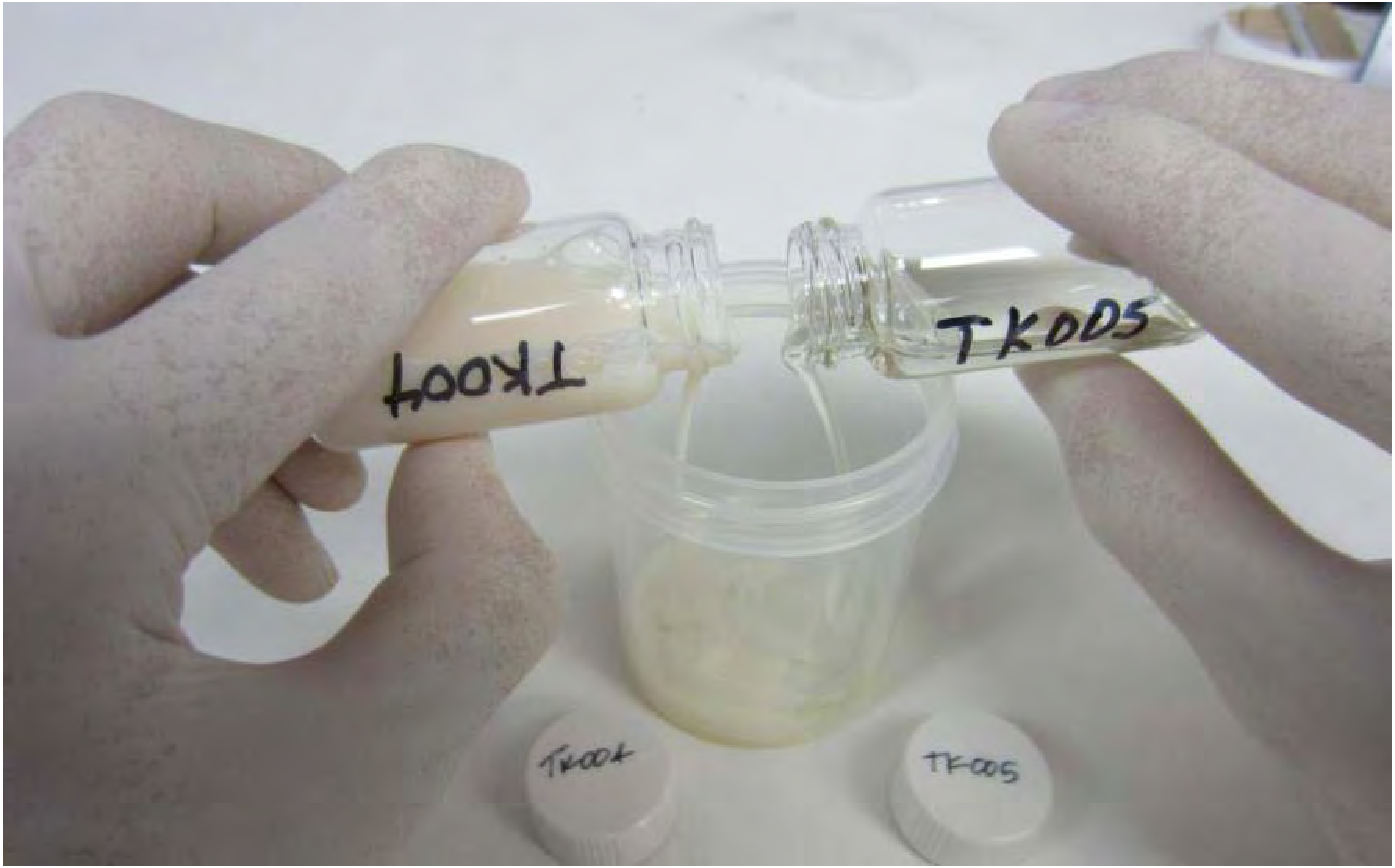
# What is the Best Strategy for Thick Casting?

- Developing a thick casting formula takes larger volumes of ceramic powder and takes considerably more time than a 15-60 micron formula.
- In addition some expected economies of casting thick are lost due to longer drying times.
- For these reasons if a customer is interested in getting thick ceramic sheet quickly for feasibility reasons the most successful path to follow is to cast 15-60 micron sheet and laminate these sheets together to yield the desired thickness final sheet or plate.
- This water based binder is easily laminated using temperatures around 70-80°C, 2000 psi or more for about 15 minutes time.
- The above cast thin and lamination approach allows for fast formula development with less powder, easier de-airing and the resulting final laminated sheet is expected to have higher thickness uniformity and homogeneity than a thick single cast sheet.
- Polymer Innovations, Inc. (PII) can provide the service of developing water based casting formulas if supplied customer ceramic powder. PII will run multiple formulas with slurry and tape testing. All data will be supplied to the customer along with the recommended formula and example tapes. Please contact PII if there is an interest in this service.

# Successful Thick Casting

- Slurry viscosities for 15-60 micron can cover a fairly wide range. A typical range might be 100-500 cps and rheology can be fairly Newtonian if desired.
- Thick casting requires the use of TK004 and TK005 and considerably higher viscosities than thin casting. Viscosity is typically over 1000 to 2000 cps and needs to be thixotropic to help lock in the slurry during drying.
- The higher and thixotropic slurry rheology will hold on to air bubbles and will require vacuum de-airing to remove bubbles.
- TK004 is acidic and when neutralized will form a very high viscosity polymer.
- TK005 is basic and is used to neutralize the TK004 but the order of mixing the TK004 and TK005 is critical.
- WB4101 binder can not tolerate an acidic environment with pH less than about 6.
- Therefore it is important to first disperse the high pH TK005 into the slurry after ceramic dispersion followed later by careful addition of the lower pH TK004.

# Incorrect Example of Mixing TK004 and TK005



# Formation of Problem Gel From Improper Mixing


- Mixing TK004 and TK005 together in an undiluted state results in a concentrated very high viscosity polymer in the form of a large gel.
- If this occurs in the slurry it will result in large or small gels which can not easily be eliminated.
- The key is to first thoroughly disperse the TK005 in the ceramic slurry followed later by addition of the TK004 with high mixing.
- In addition it is helpful to further dilute the TK004 with some water to make it easier to mix in without causing localized low pH which will cause the WB4101 to precipitate causing more gels.
- If added properly the TK005 and TK004 react after being uniformly dispersed through the ceramic slurry resulting in a higher more thixotropic rheology without gel formation.

# Example Thin and Thick Cast Alumina Formulas

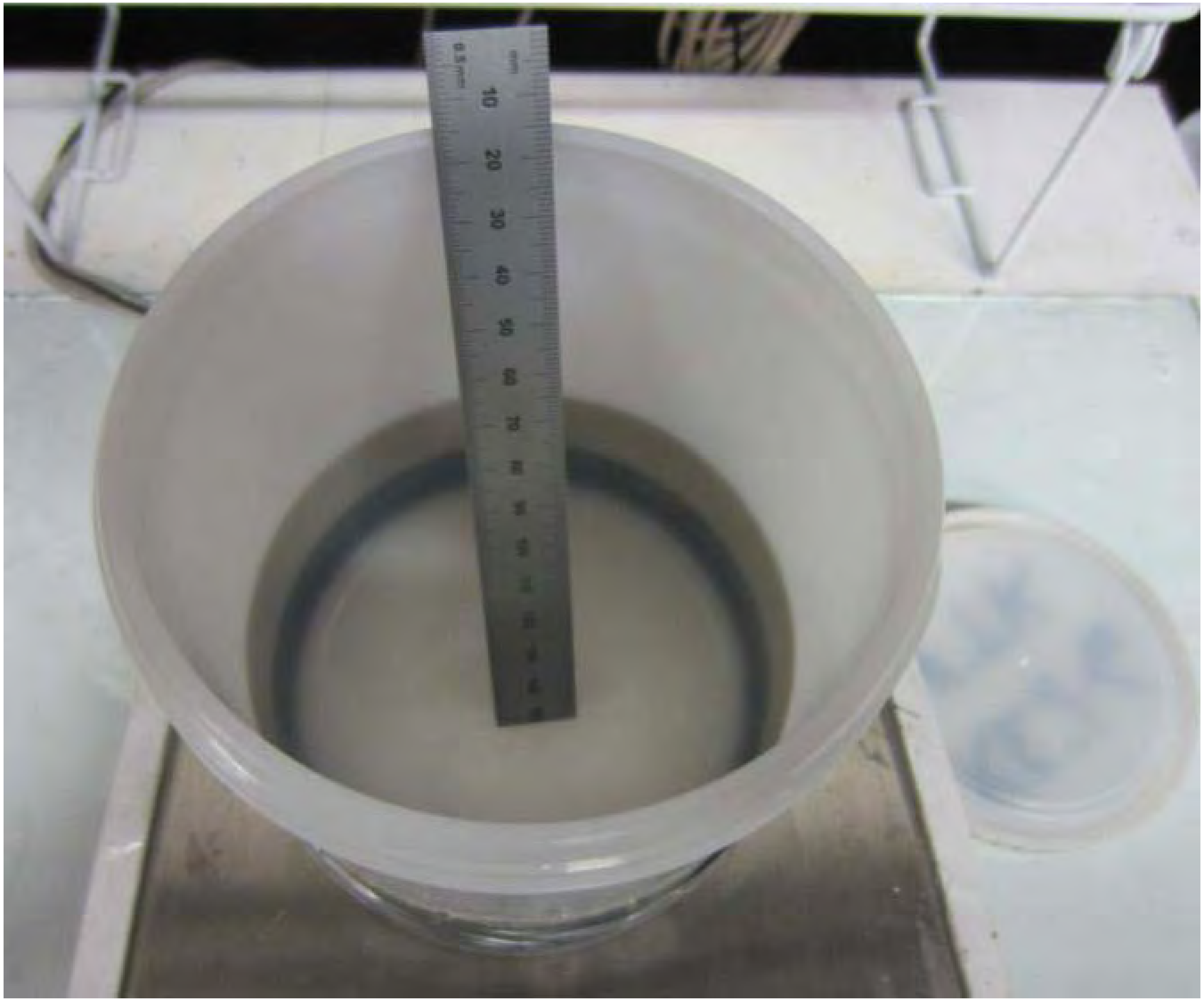
| Sample Number | KE2-6 | | KE2-6 & TK | |
|---|---|---|---|---|
| **ACTUAL FORMULA (grams):** | % | Grams | % | Grams |
| **First Stage:** | | | **Thick casting examp** | |
| Alumina A16-SG (Almatis) | 56.00 | 67.20 | 55.00 | 264.00 |
| WB4101 | 11.00 | 13.20 | 23.00 | 110.40 |
| DF002 | 0.10 | 0.12 | 0.50 | 2.40 |
| **DI water** | **21.80** | 26.16 | **18.00** | 86.40 |
| **Second Stage:** | | | | |
| WB4101 | 11.00 | 13.20 | | |
| DF002 | 0.10 | 0.12 | 0.50 | 2.40 |
| TK005 | | | 0.50 | 2.40 |
| TK004 | | | 0.50 | 2.40 |
| DI water | | | 2.00 | 9.60 |
| **Total** | 100.00 | 120.00 | 100.00 | 480.00 |
| Total organic solids | 7.90 | 9.48 | 9.70 | 46.56 |
| Ceramic density | 3.70 | 3.70 | 3.70 | 3.70 |
| Volume Ceramic Loading in Tape | 65.70 | 65.70 | 60.51 | 60.51 |
| Grams of media (3\8" cylinders) | 350g in 8oz.jars | | 1400g in 32oz.jars | |
| First stage mill time (hours) | **16 hr @ 92rpm** | | **16 hr @ 70rpm** | |
| Second Stage mill time (hours) | **4 hr @92rpm** | | **4 hr @70rpm** | |
| Stage 1 visco at 100 rpm | 0.8 | 32 | 3.5 | 140 |
| **Stage 2 Slip Properties:** | | | | |
| 25 C Viscosity HBT SC4 21/13R | reading | CPS | reading | CPS |
| 2.5 rpm | 0.0 | 0 | 1.5 | 2400 |
| 5 rpm | 0.1 | 80 | 1.9 | 1520 |
| 10 rpm | 0.1 | 40 | 2.6 | 1040 |
| **20 rpm** | **0.2** | **40** | **3.6** | **720** |
| 50 rpm | 0.6 | 48 | 5.9 | 472 |
| 100 rpm | 1.1 | 44 | 9.2 | 368 |
| Foam stage 1 | 0.8 | | 0.9 | |
| Foam stage 2 | 0.8 | | 0.6 | |
| pH | 7.05 | | 6.44 | |
| Average tape thickness (microns) | 54.00 | 25.00 | 155.00 | 306.00 |
| Weight (g) | 2.1539 | 0.9785 | 6.0086 | 11.5968 |
| Theoretical tape density (g/cc) | 2.77 | 2.77 | 2.63 | 2.63 |
| Green Density (g/cc) | 2.62 | 2.60 | 2.55 | 2.49 |
| Approximate % porosity | 5.6 | 6.3 | 3.2 | 5.6 |
| Typical puncture strength of tape (g) | 320 | 140 | 1000+ | 1000+ |
| **Average Puncture ( grams/mil)** | **141** | **134** | **0** | **0** |
| Crease Strength (~ % of crease intact) | 75 | 65 | 100 | 80 |
| Laminatioin 80C 400 psi 15 sec | | | 30 | 40 |

## KE2-6 &TK thick casting (using TK additives):

**1. Add water, Df002, WB4101 and alumina to small ball mill and mill 16 hours.**
**2. Drain as much of the slurry from the ball mill as reasonable leaving the media and residual slurry in the ball mill.**
**3. Add the amount of DF002 per the formula to the slurry in the new container and using a mixer mix the slurry until there is a noticeable vortex.**
**4. Add the TK005 slowly into the vortex as the slurry is being mixed. The slurry viscosity may begin to increase and the mixing rpm can be increased as needed to maintain a vortex.**
**5. Pre-mix TK004 and water in another container and slowly add the diluted TK004 into the vortex. As the viscosity begins to increase it maybe necessary to increase the mixing rpm to maintain a good vortex.**
**6. After TK004 addition the mixture can continue to be mixed for about 5-15 minutes and finally it is returned to the ball mill and media still containing the residual amounts of slurry from stage 1 and ball milled 2-4 hours more.**
**7. Drain final slurry, de-air by vacuum and tape cast.**

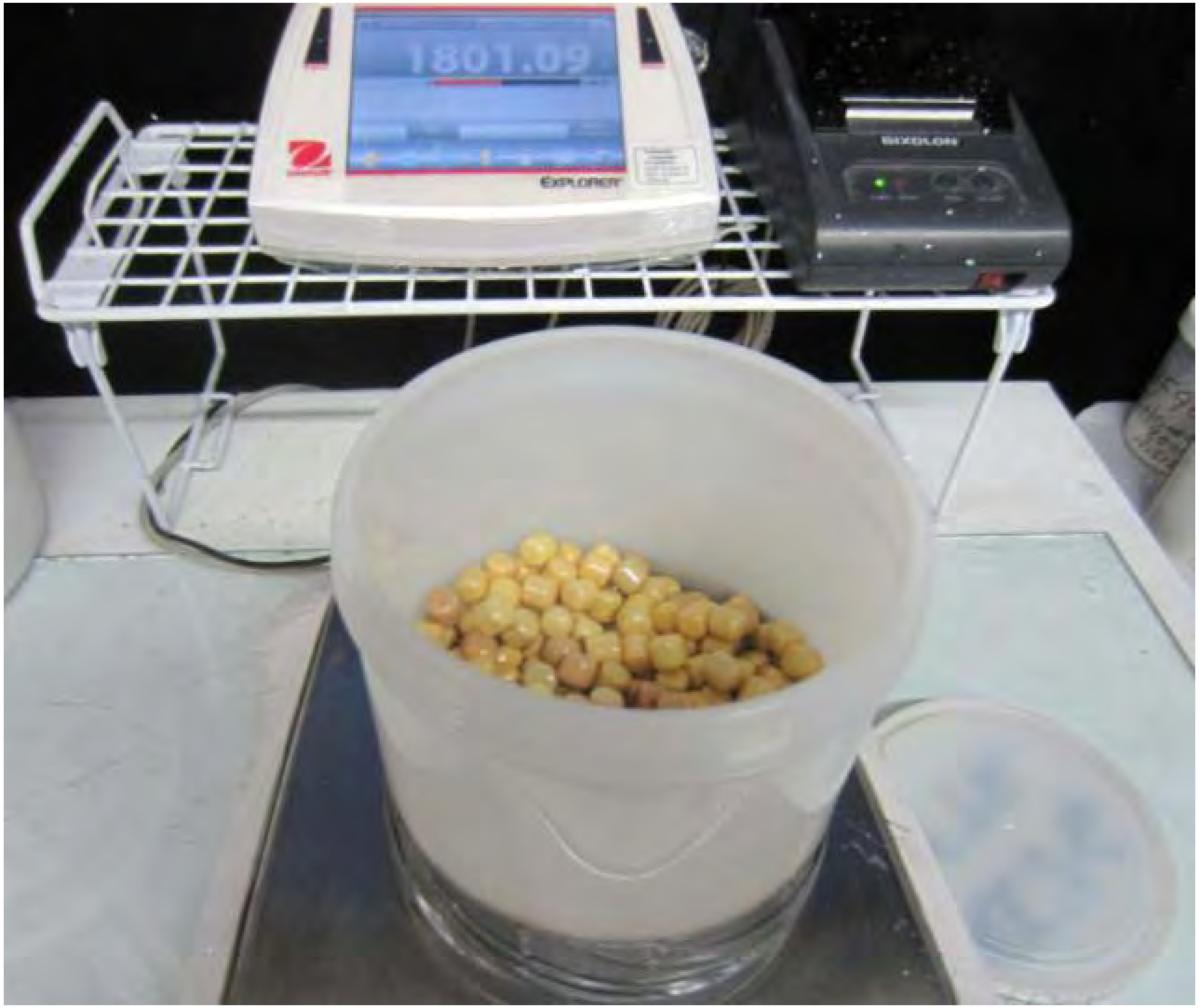
- The procedure to make standard thin cast KE2-6 is fairly easy and can be seen in the basic presentation (tapecastingdemo.pdf).
- Use of the thick casting additives is more complicated with directions above and shown in pictures in the rest of the presentation.

# Illustration of Batching Thick Cast Formula KE2-6 &TK



•For this example a Kinki Yoki 1 liter size jar is used as a ball mill.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

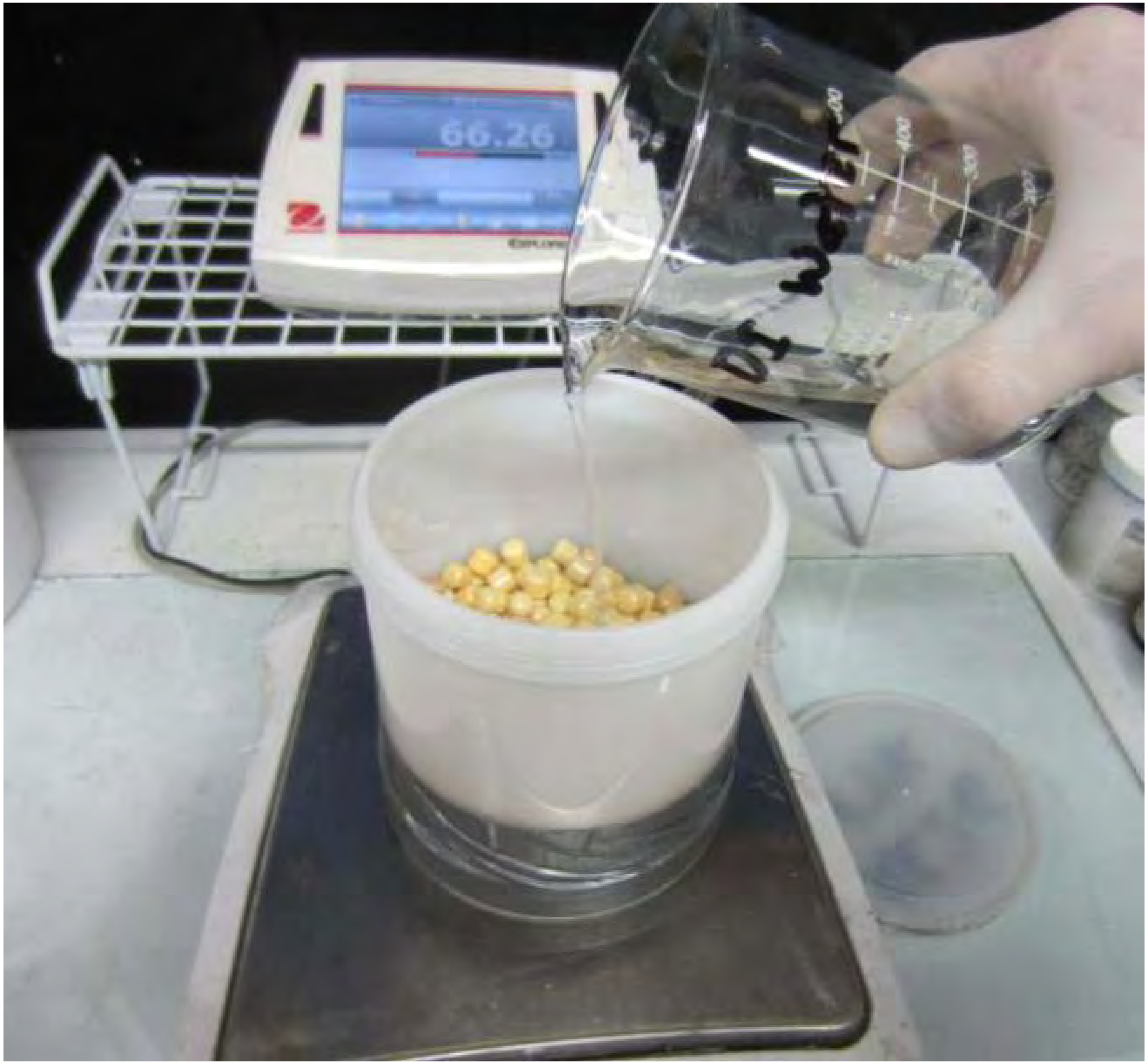



•Ball mill is filled about half full of zirconia cylinders (~1800 grams).

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•Depth of media is shown in this picture.

# Illustration of Batching Thick Cast Formula KE2-6 &TK




•DI water is added to the ball mill next.

• The formula calls for 86.4 grams.

# Illustration of Batching Thick Cast Formula KE2-6 &TK


•WB4101 Water Based Binder is then added after the water.

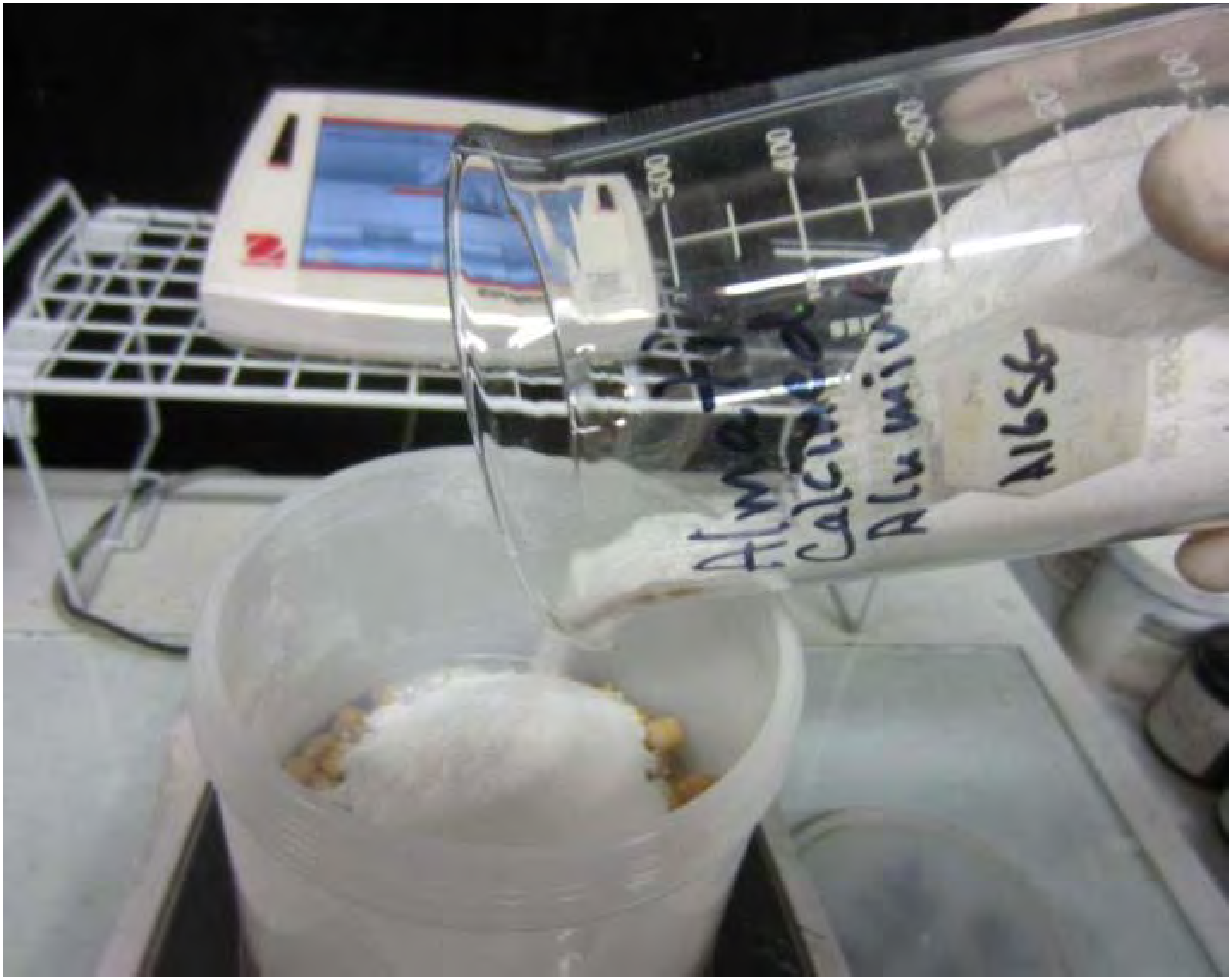
•The formula calls for 110.4 grams and all of it in the first stage milling.

# Illustration of Batching Thick Cast Formula KE2-6 &TK


- Next 2.4 grams of DF002 defoamer is added to the ball mill.

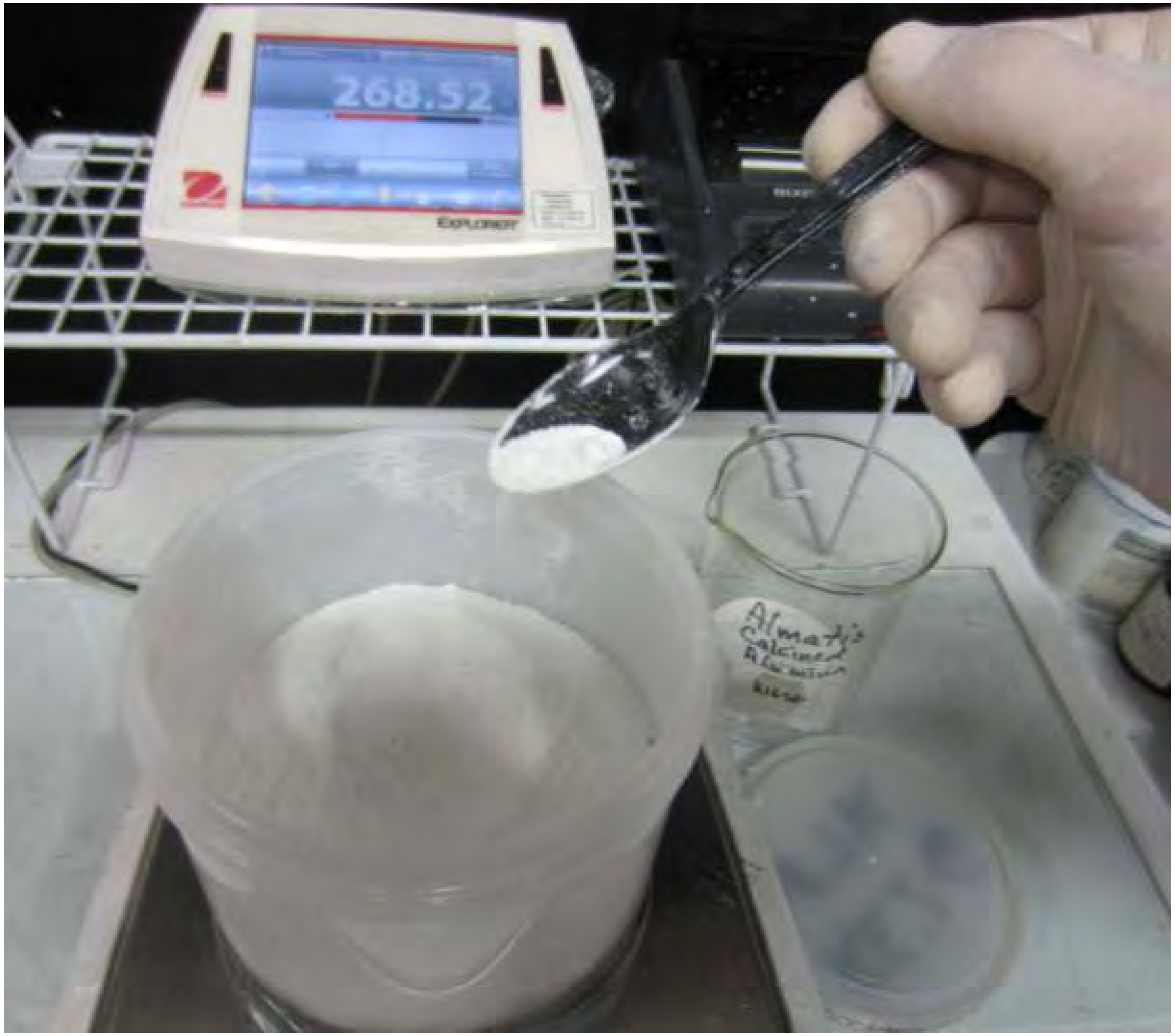
- This defoamer is a non-silicone product.

# Illustration of Batching Thick Cast Formula KE2-6 &TK



•Finally the alumina powder is added to the ball mill.

# Illustration of Batching Thick Cast Formula KE2-6 &TK




•Adding small amounts of alumina to get to the final desired amount.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•The batched ball mills have inner and outer lids installed and taped to keep them from coming loose during milling.
•The 1 liter ball mill is rotated at 70 rpm for 16 hours.
•The actual time and rotation speed used will vary on the size of ball mill used.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•Opening the ball mill after 16 hours of milling shows a typical level of slurry and foam.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

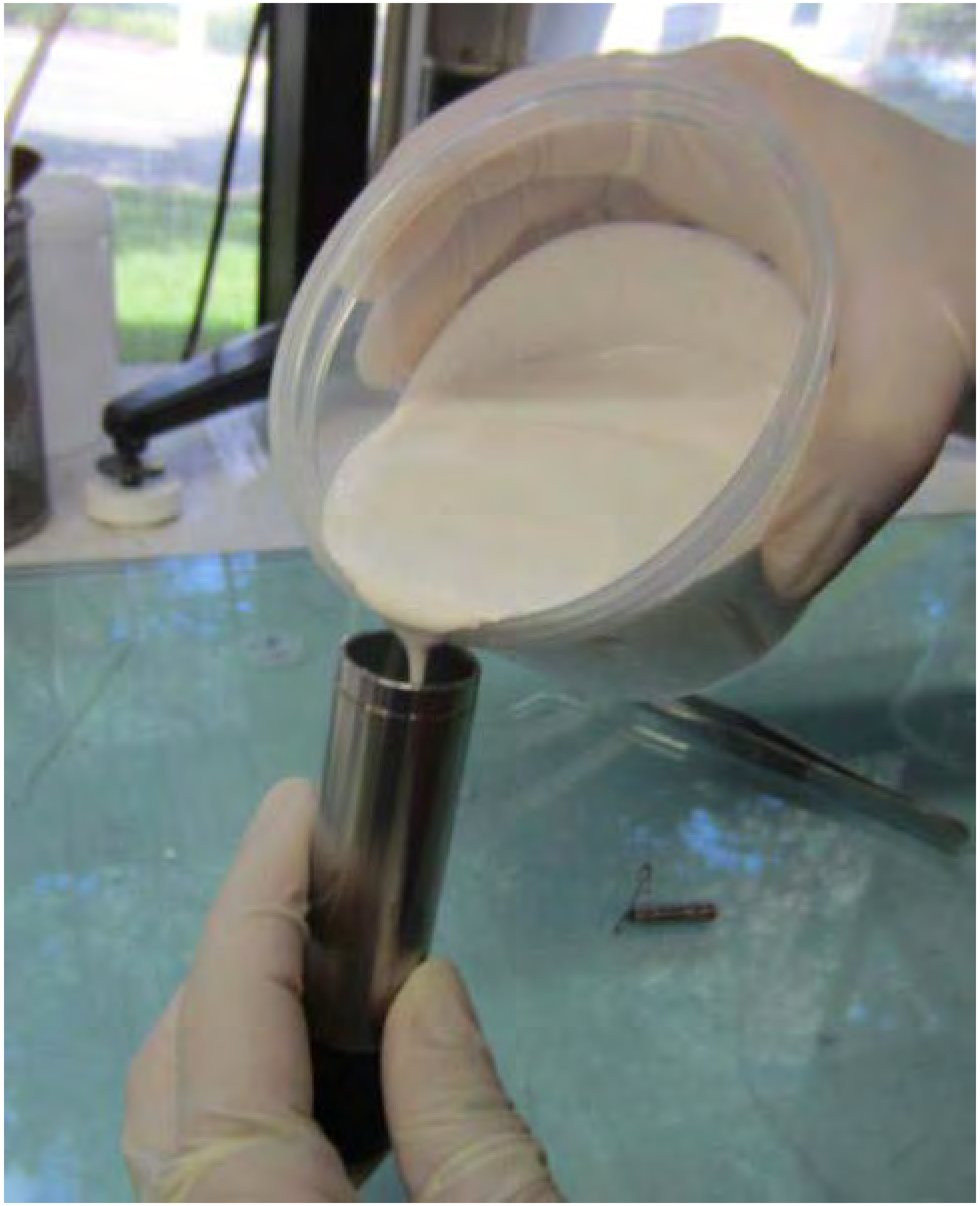
•The outer lid is removed and the inner lid is offset enough to allow draining of the slurry without allowing media to fall out.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

- Most of the slurry should be drained out but complete draining is not necessary since the slurry will be returned to the ball mill after the TK additives are mixed using a separate mixer.

- It is best to seal the ball mill up so it does not dry out during the TK mixing steps.

# Illustration of Batching Thick Cast Formula KE2-6 &TK



•As a general quality practice at PII the first stage slurry viscosity is typically measured.

•The photo shows the slurry being poured into the viscometer's small sample adapter in preparation of measurement.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

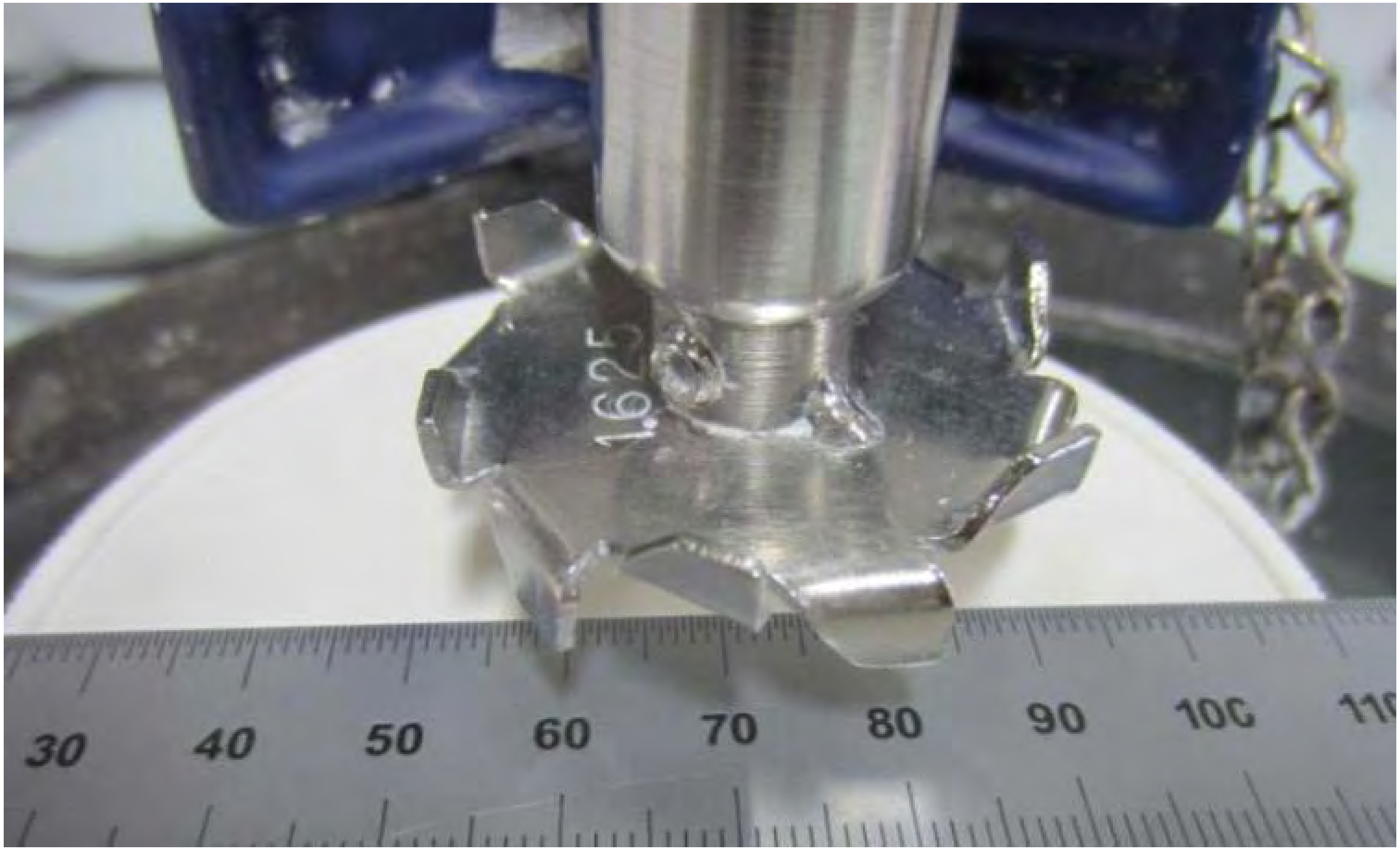

•Here the slurry is in the viscometer being measured for viscosity.

•Notice the small sample adapter is jacketed with coolant to maintain 25°C +/- 0. 5°C.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•Here the slurry is returned to the container with the rest of the first stage slurry after viscosity measurement.
•This container will hold the slurry while the second stage additives are incorporated with mechanical mixing.

# Illustration of Batching Thick Cast Formula KE2-6 &TK




•Above is an example of a small mixer suitable for a small amounts of slurry.
•It is key to have mixing good enough to have nearly instant mixing of additives to prevent localized concentration of additives which can cause local pH variation and precipitation of the WB4101.
•The above mixer is a Cowles style blade with diameter of 1.625 inches (4.1 cm).

# Illustration of Batching Thick Cast Formula KE2-6 &TK


- Here the second stage amount (2.4 grams) of DF002 defoamer is being added drop-wise to the slurry with stirring.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•At left is shown a suitable vortex for fast mixing of additives.

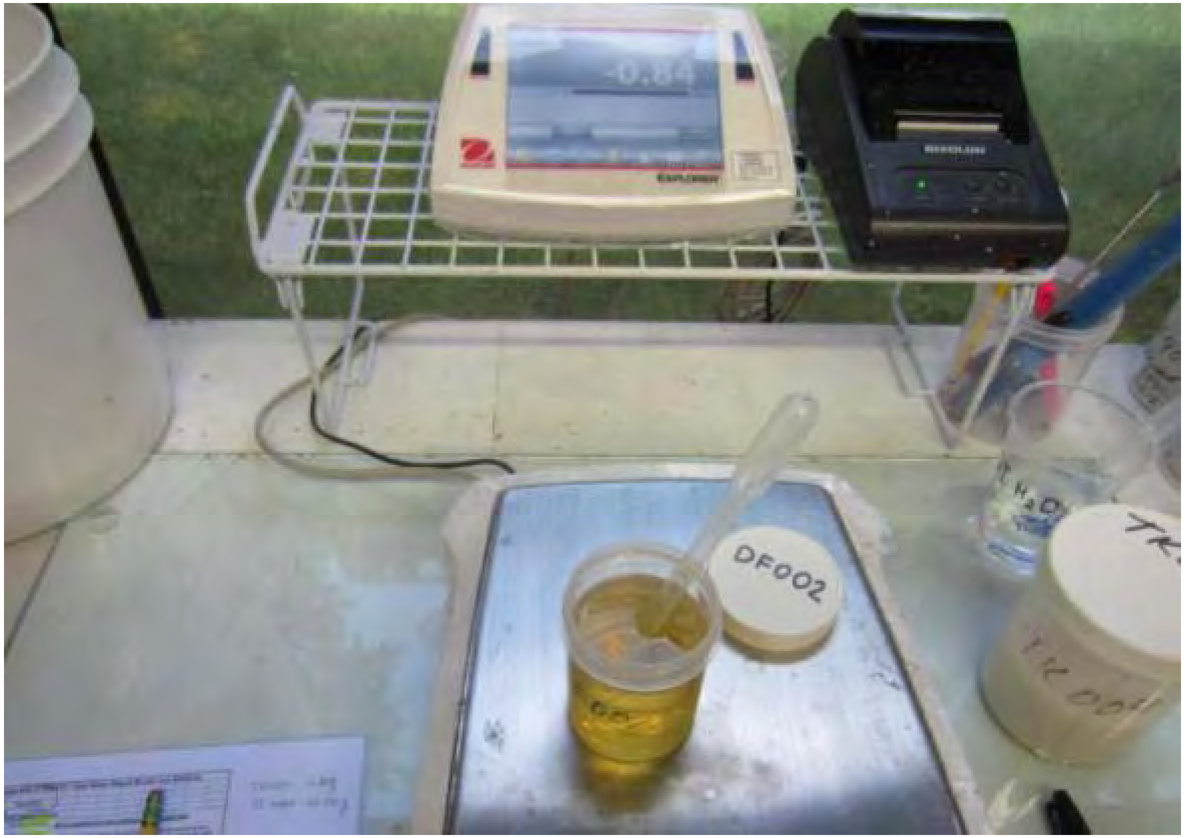
# Illustration of Batching Thick Cast Formula KE2-6 &TK

- Here is a close up showing proper additive mixing.
- The mixer speed should be fast enough to form a small vortex.
- The speed should not be so high that air is entrained causing excessive foam.
- You can see the individual drops of additive on the surface of the slurry being rapidly mixed in.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

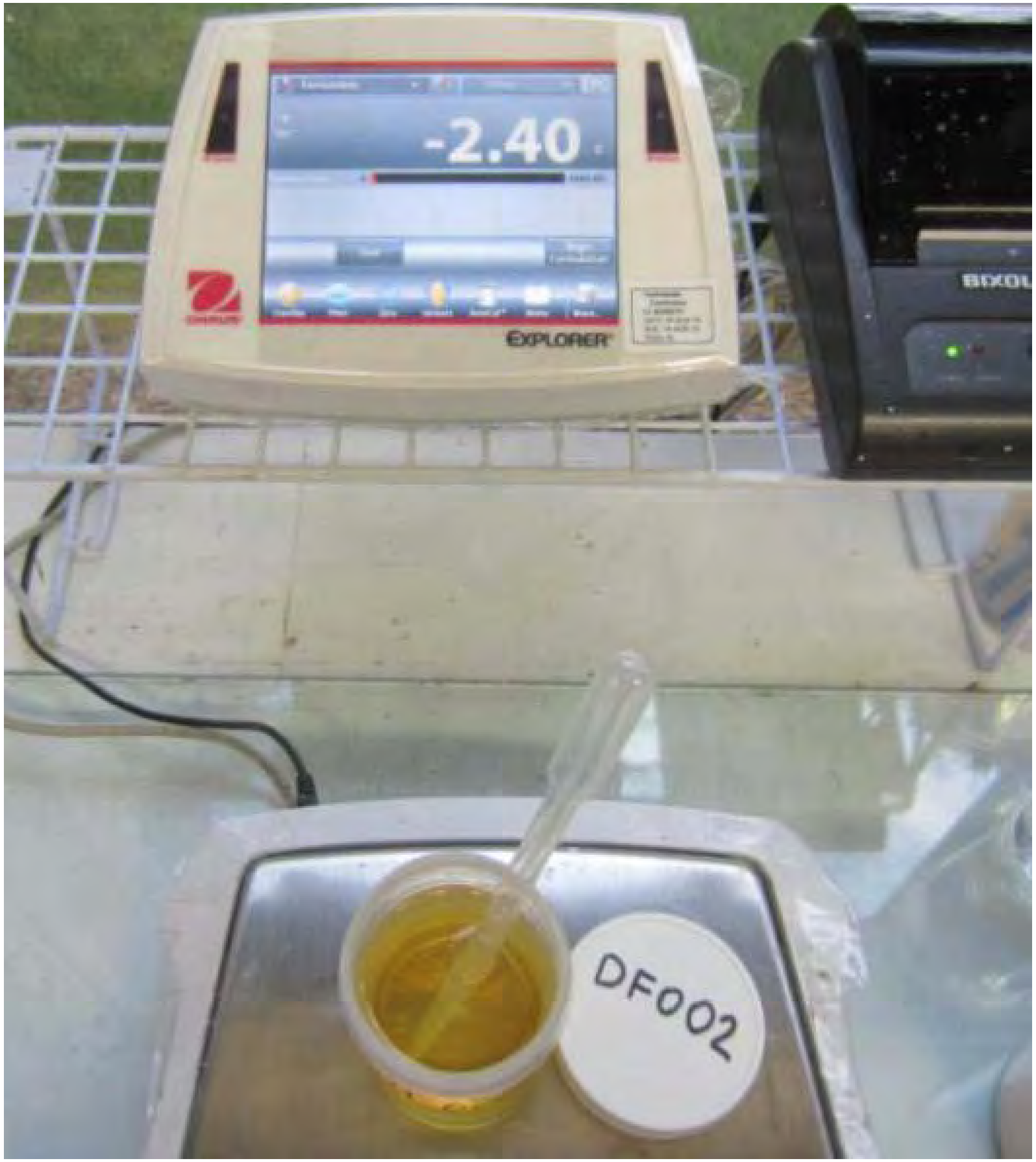

- For this particular example the proper vortex and mixing conditions were obtained at 500 rpm.
- The rpm will vary depending on the style and size of the mixer as well as the slurry viscosity.
- As the thickeners are mixed into the slurry the rpm will need to be increased to keep the correct vortex.

# Illustration of Batching Thick Cast Formula KE2-6 &TK




•With small batches as illustrated here it should be guaranteed the actual desired amount of each material is added.
•If the additive is weighed into a separate container and it is later poured out of the container there will be some material remaining in the container.
•Therefore the method at PII is to weigh a container and pipette used to add a material and it is checked frequently during addition until the correct amount of material has been added.
•In the above example the DF002 container and pipette was tared to zero and frequently reweighed during the course of addition to the slurry. As shown above .84 grams of the required 2.4 grams were added.

# Illustration of Batching Thick Cast Formula KE2-6 &TK




•Similar to the previous photo you can now see the entire required amount of second stage DF002 (2.4 grams) has been added.

# Illustration of Batching Thick Cast Formula KE2-6 &TK


- Next the TK005 should be added. This material has a high pH and is later needed to neutralize and react with the TK004.
- The method of adding this higher pH material is not as critical to add as a low pH material but still should be uniformly mixed in to yield a homogeneous solution.
- The method of weighing and addition is the same as previous additives.

# Illustration of Batching Thick Cast Formula KE2-6 &TK


•Here the drop-wise addition of TK005 is shown.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•After the TK005 addition the vortex is reduced since the viscosity of the slurry is starting to rise.

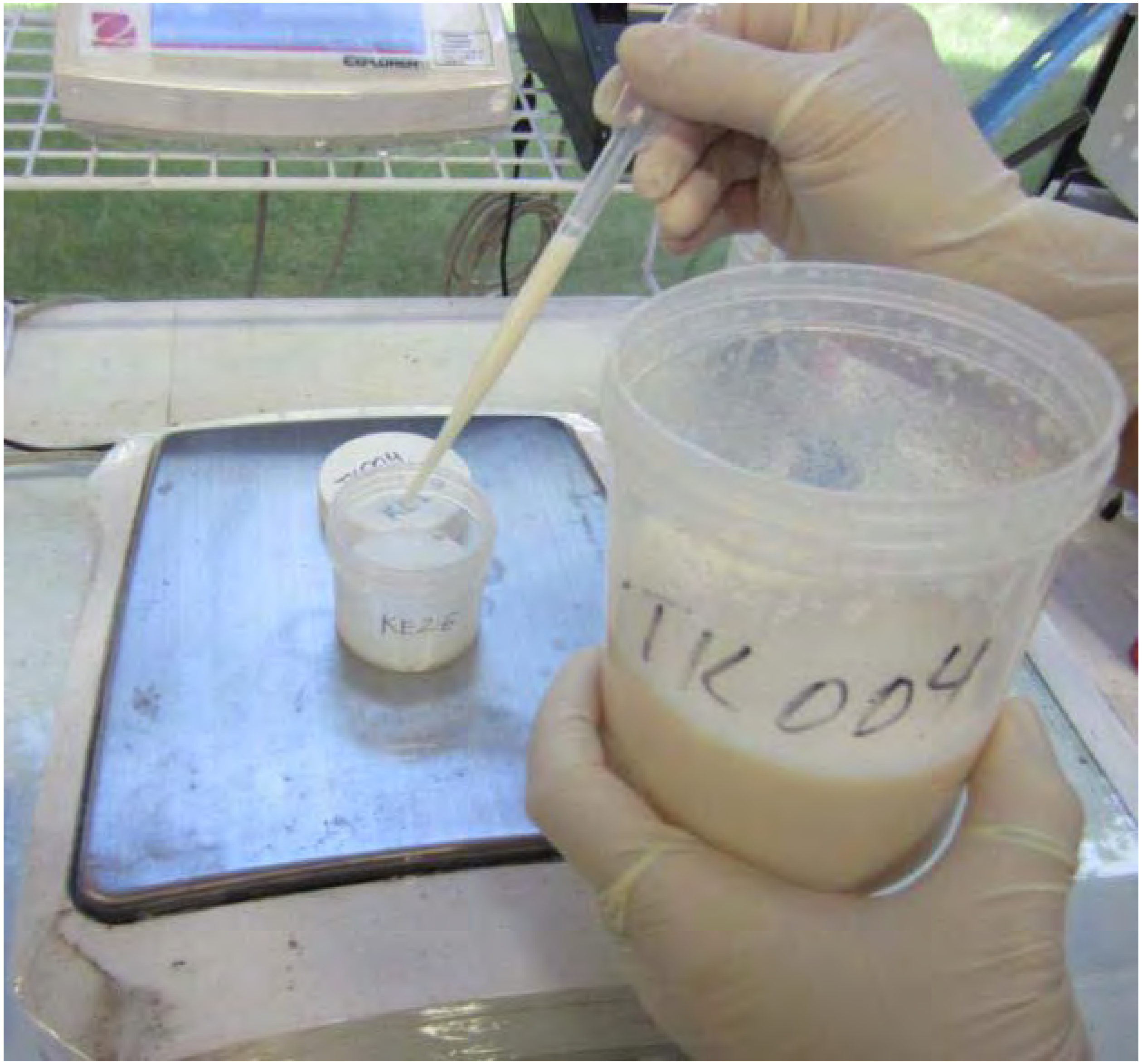
# Illustration of Batching Thick Cast Formula KE2-6 &TK


- The rpm has now been increased to 1,400 rpm to maintain good mixing of the more viscous solution.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

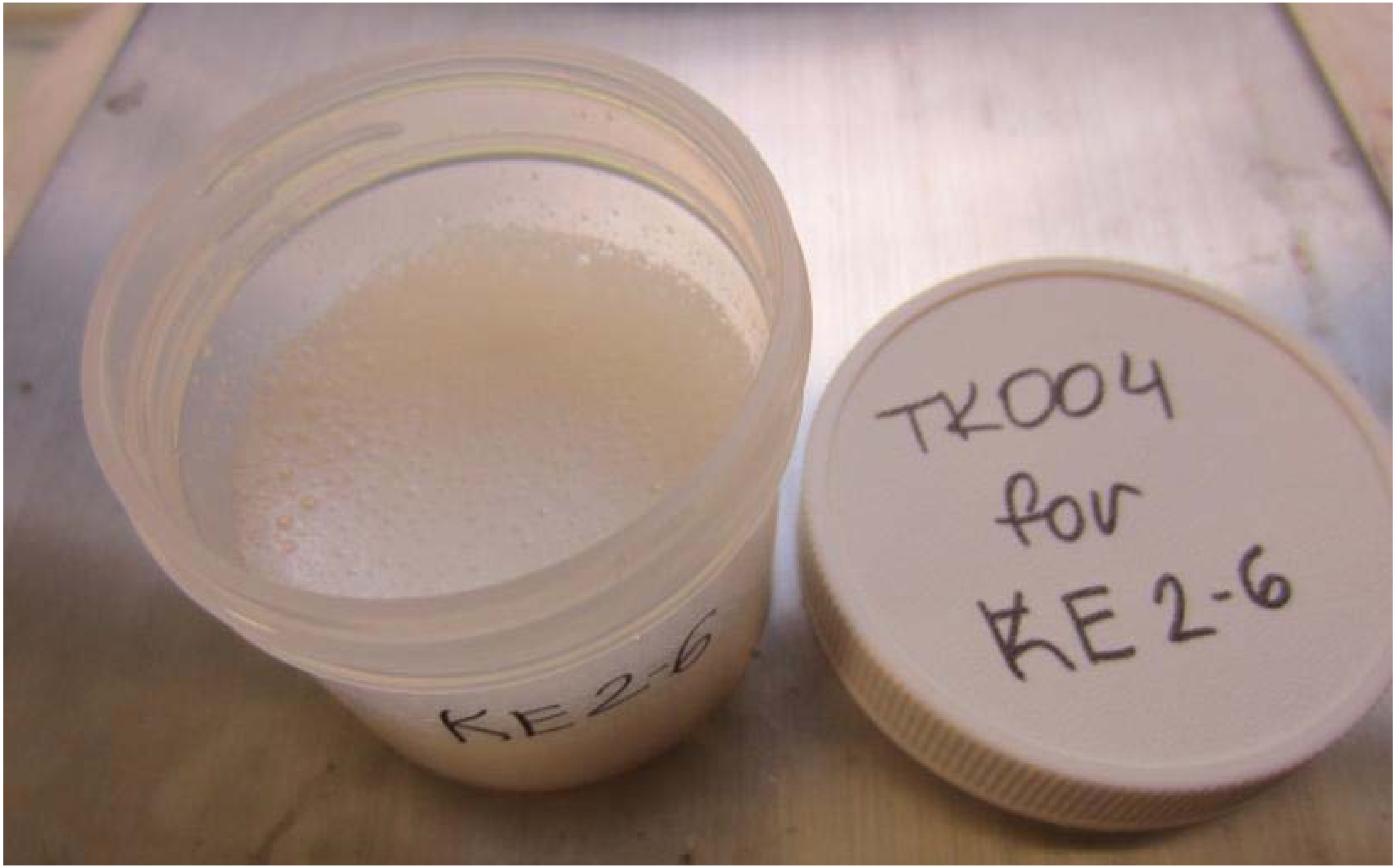

- The TK004 portion of the formula is premixed with the DI water also required in the second stage.
- Dilution of the TK004 helps it to mix into the slurry without localized low pH concentration which will cause WB4101 to precipitate.
- This photo shows adding the water to a second container.

# Illustration of Batching Thick Cast Formula KE2-6 &TK




- This photo shows adding the TK004 to the previously added water.
- This size formula calls for 2.4 grams of TK004 in 9.6 grams of water.
- However for small mills like this usually excess diluted TK004 is produced so that all the required11.8 grams of mixture is available for addition.

# Illustration of Batching Thick Cast Formula KE2-6 &TK




•The diluted TK004 solution ready for addition to the slurry is shown above.

# Illustration of Batching Thick Cast Formula KE2-6 &TK


- It is now time to add the TK004 and water mixture.
- This is the most critical ingredient since it is low pH and also since it will start to react with the TK005 already dispersed in the slurry to make a higher viscosity.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•Photo showing slow drop-wise addition of TK004 and water solution.
•The viscosity will start increasing and rpm needs increasing to maintain fast mixing.

# Illustration of Batching Thick Cast Formula KE2-6 &TK


•The rpm has increased to 1,500 after a small amount of TK004 solution.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•As more TK004 is added the viscosity will continue to rise and some more air bubbles are being formed. It is important to keep the mixing speed fast enough for good additive incorporation but not too much air.

# Illustration of Batching Thick Cast Formula KE2-6 &TK


•In this example of another formula all the required TK004 and water has been added.

•For this formula the total amount should be 11.8 g.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•The slurry is now becoming higher viscosity and rpm needs to be further increased to maintain good mixing.

# Illustration of Batching Thick Cast Formula KE2-6 &TK


•The rpm is now up to 3,000 rpm to maintain good mixing.
•The slurry with all additives should be allowed to continue mixing for some time (at least about 10 minutes) to result in a uniform mixture.
•If performed properly the slurry should not have any large gels or lumps visible.
•If some small gels are present the media in final ball milling can disperse them.
•If the gels are as large as the milling media it will be difficult to re-disperse them.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•Here is a picture showing the mixer coming out of the properly prepared slurry.

•This is an acceptable and typical level of bubbles.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•The slurry is now returned to the ball mill for the final stage of ball milling.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•The ball mill with second stage additions is returned to the roll rack and rotated at 70 rpm for 2-4 hours to finish final mixing.
•The actual time and rotation speed used will vary on the size of ball mill used.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

- The picture above shows the ball mill opened after the final ball milling.
- This shows a typical and acceptable level of foam.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•Above you can see the mill jar with the inner and outer lids to the right side and a perforated metal plate on the left which will be used to aid draining the ball mill.

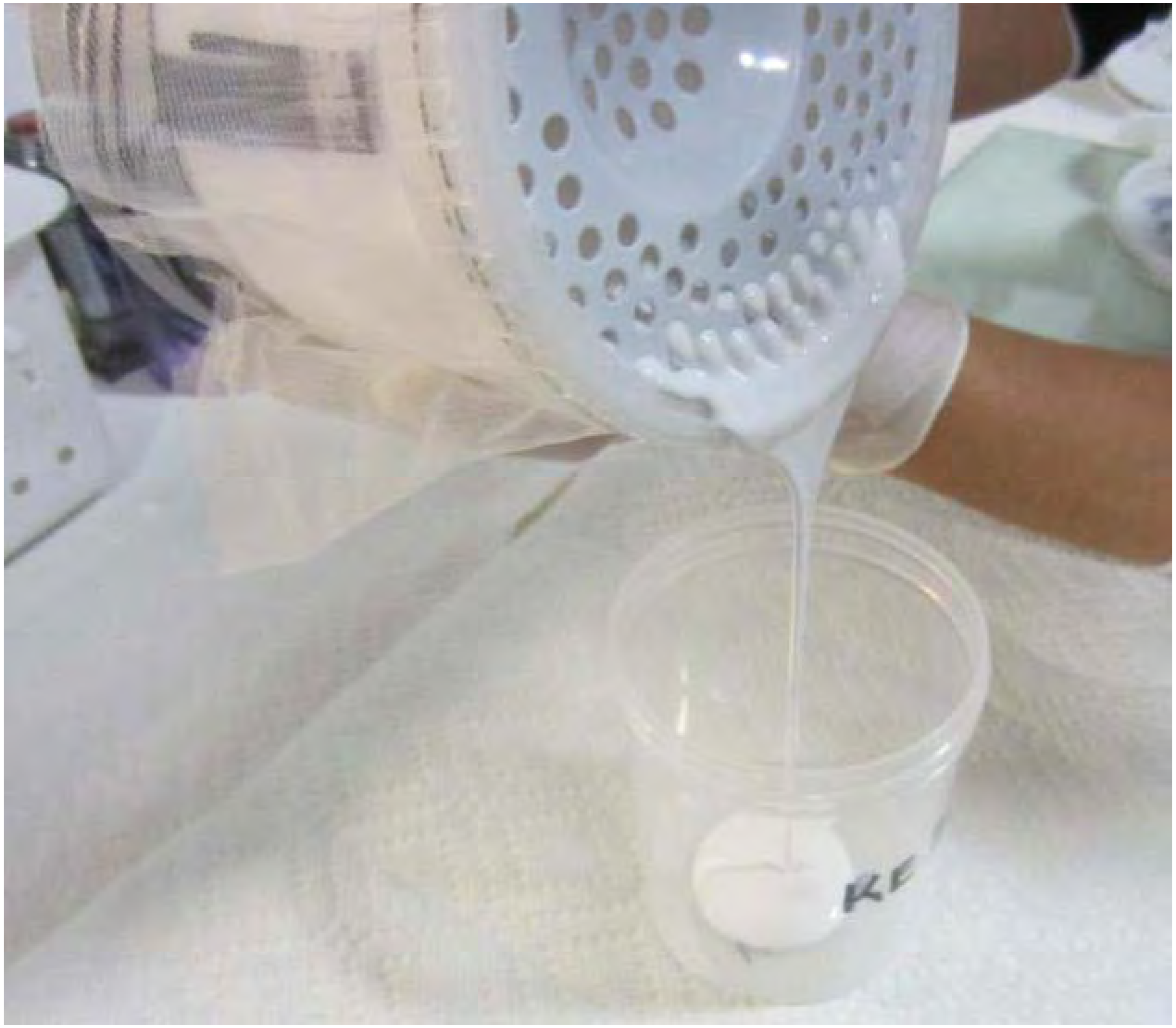
# Illustration of Batching Thick Cast Formula KE2-6 &TK

•To drain this slurry a paint filtering plastic mesh is put over the jar, covered with the draining plate.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•For convenience a mill lid was cut out and used to hold the mesh and drain plate in place.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

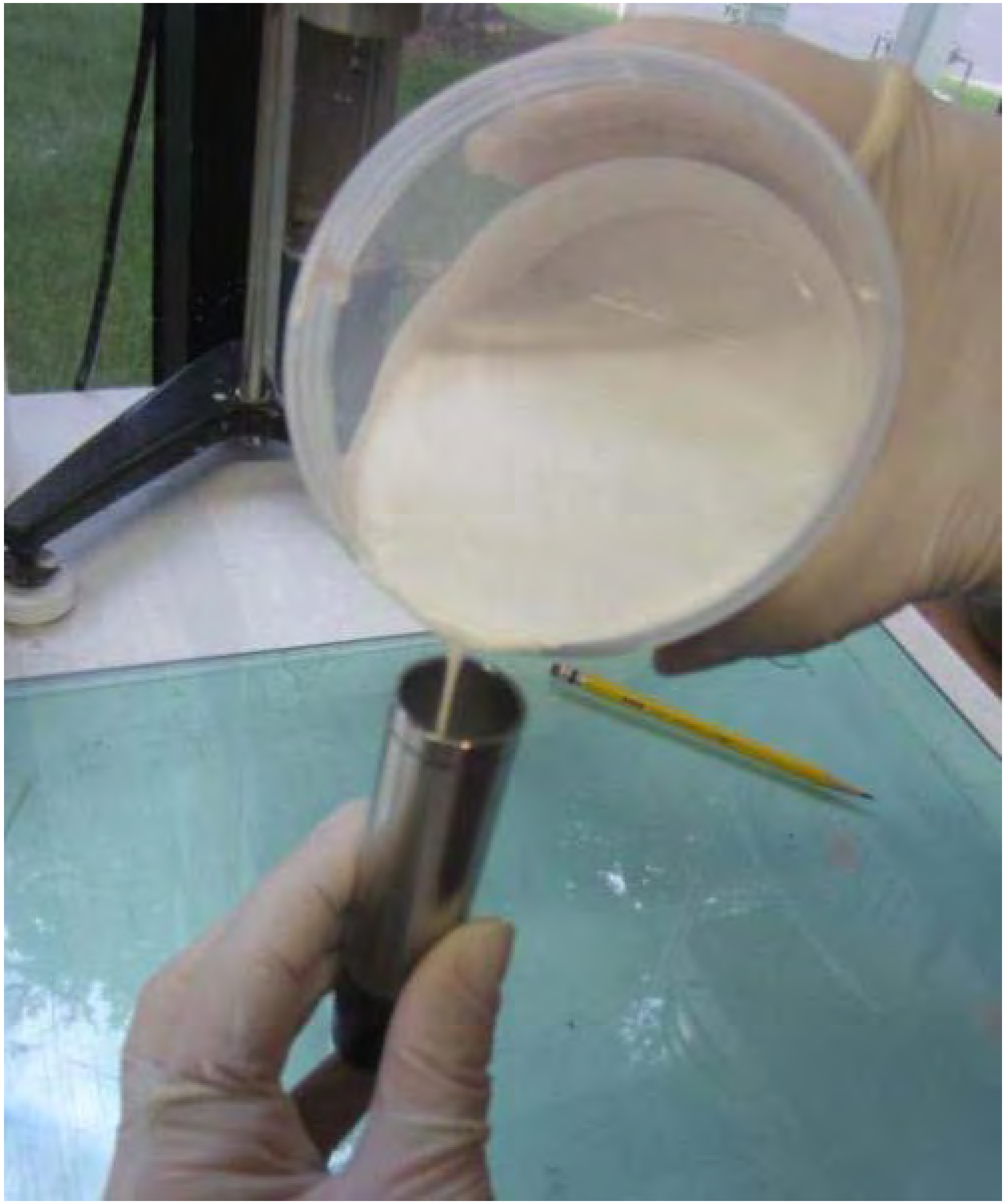


•The final slurry is drained from the ball mill.

# Illustration of Batching Thick Cast Formula KE2-6 &TK


- The material is slow to drain since the viscosity is much higher after incorporation of the TK additives.
- The mill is allowed more time to drain until the flow nearly stops.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

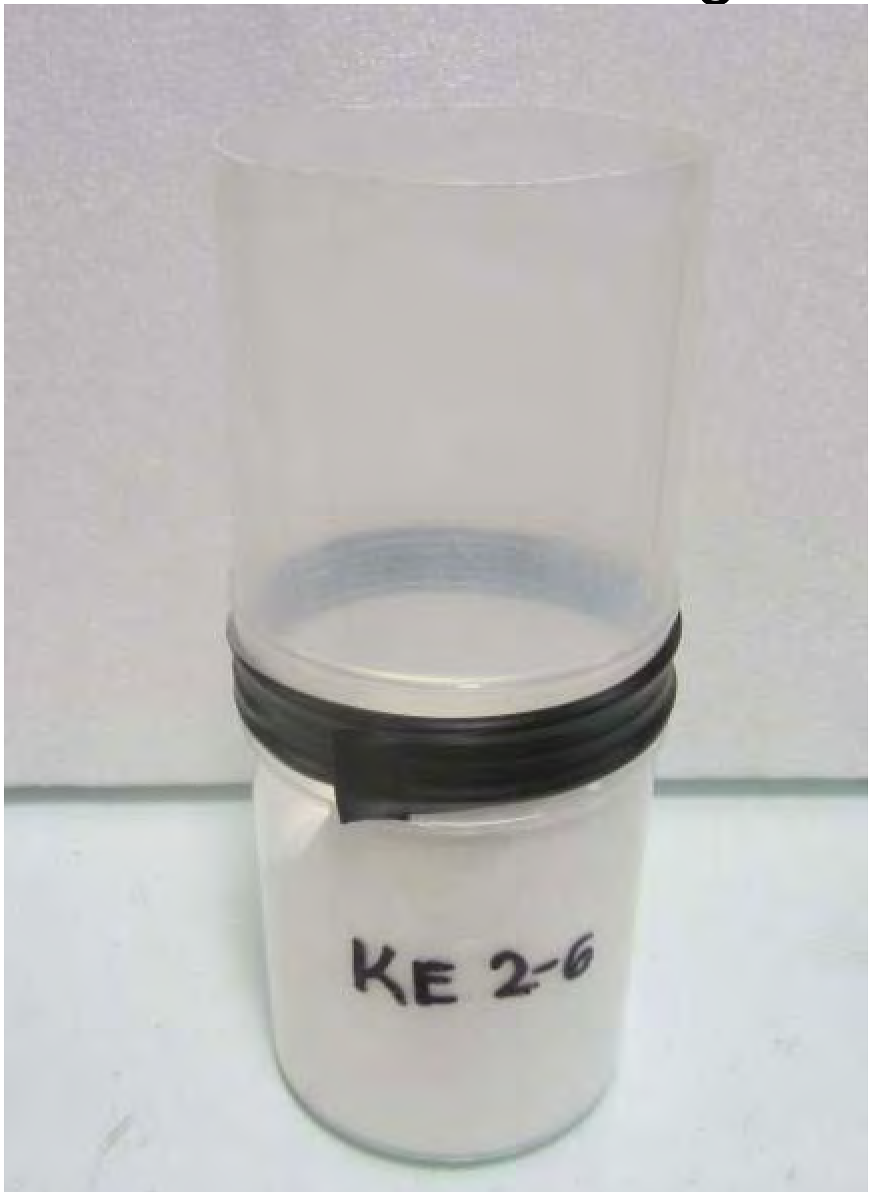


•Typically the final slurry viscosity is measured similar to how the first stage viscosity was measured.

# Illustration of Batching Thick Cast Formula KE2-6 &TK


•Typically  pH is also measured.

# Illustration of Batching Thick Cast Formula KE2-6 &TK




•De-airing the slurry requires vacuum because of the higher viscosity.

•Since the slurry will increase in volume considerably when exposed to vacuum typically one or two “collars” are taped onto the jar for de-airing.

•The picture at left shows one collar taped on but it actually took 2 to allow best de-airing.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•The slurry container is placed inside a vacuum chamber.

•In this example PII used a kitchen high pressure cooking pot as the chamber.

•The next slide shows the lid.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•The lid of this vacuum chamber is made from thick acrylic sheet with an outlet connector and O ring machined in.

•A flashlight is useful to help see the progress of the defoaming.

•The vacuum pump is just visible in the lower right side of the photo.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

•Here you can see the slurry under vacuum has expanded to the top of the collar.

•The vacuum can be temporarily blocked at this stage and the vacuum container shaken or swirled to help the foam break.

•When the foam level goes down the vacuum is again applied and the process repeated until the foam permanently breaks.

•When the foam permanently breaks the slurry will still be generating bubbles under vacuum but the height of the bubbles will stay low.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

- The vacuum chamber holding the slurry container can be lifted and dropped a short distance or swirled to help the bubbles break.
- Sometimes it is a good idea to have a weighted ring or other method to keep the slurry container from tipping over inside the vacuum chamber.
- If a vacuum mixer is available the de-airing process is much easier.
- Magnetic mixers should be avoided as they can result in agglomerates.

# Illustration of Batching Thick Cast Formula KE2-6 &TK

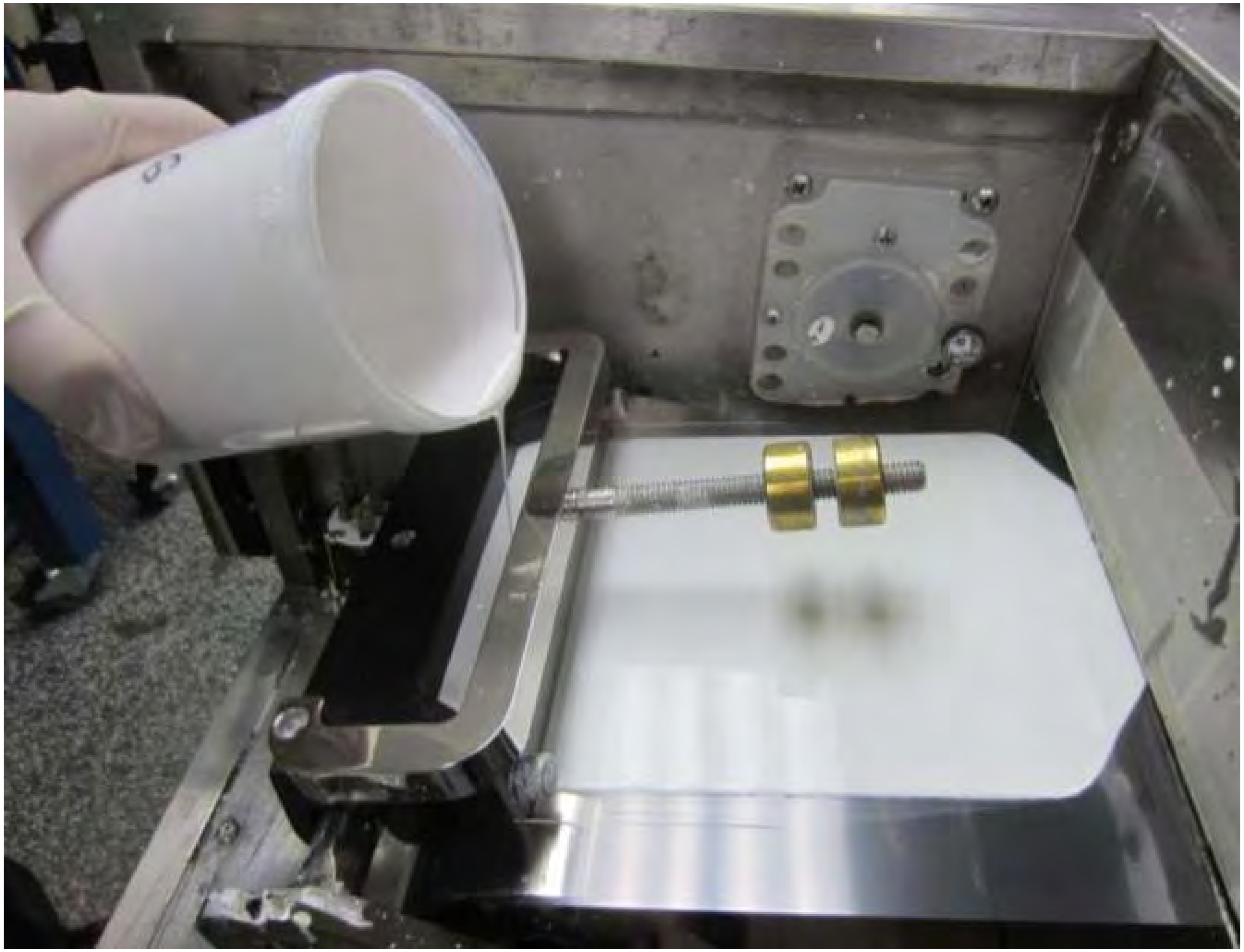
•This view of the top of the slurry inside the vacuum chamber shows how the slurry looks when the foam is broken.

•The slurry is under constant vacuum and continues to bubble slightly (usually larger bubbles than initially) as if boiling but the level does not rise substantially.

•The slurry can be swirled a little now to get the bubbles up to the surface.

•After about 5-10 minutes of this bubbling the slurry should be adequately de-aired.

# Illustration of Batching Thick Cast Formula KE2-6 &TK



•After de-airing the slurry can be cast.

•This picture shows hand pouring the slurry into the doctor blade fixture of a Dreitek tape casting machine.

•Hand pouring slurry needs to be done with care as it can generate some air bubbles.

•It is best to use pressure to feed the slurry.

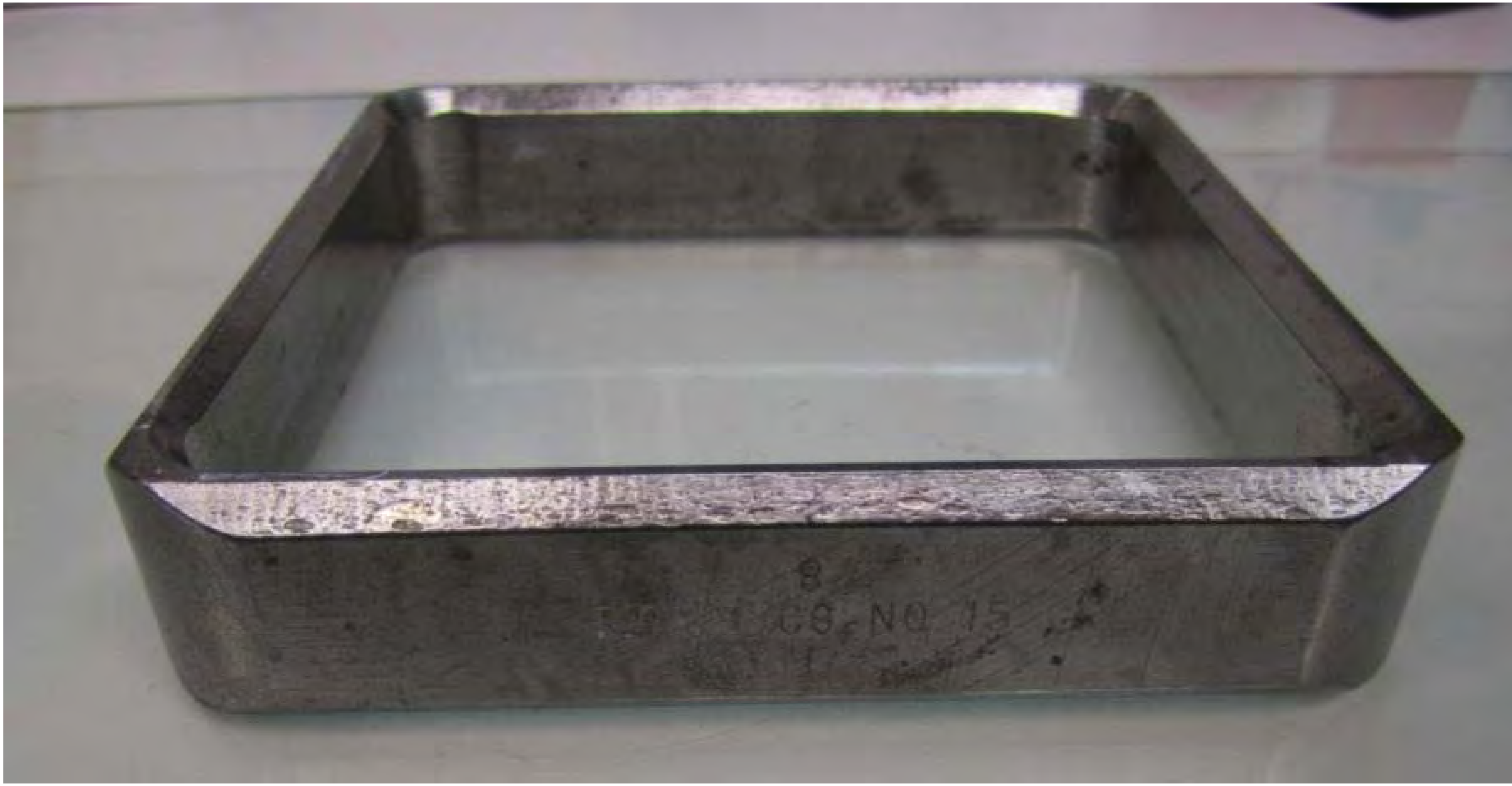
# Zone Temperatures Depend On Tape Thickness, Caster Type and Desired Casting Speed (Typical Lab Settings Provided). Adequate Air Flow Depends on Caster.

| Typical Dreitek Settings | |
|---|---|
| Heater Zone # | Temperature (°C) |
| 1 | 55 |
| 2 | 65 |
| 3 | 70 |
| 4 | 75 |
| 5 | 85 |

•Drying times and therefore casting speeds need to be much slower with thicker tape.

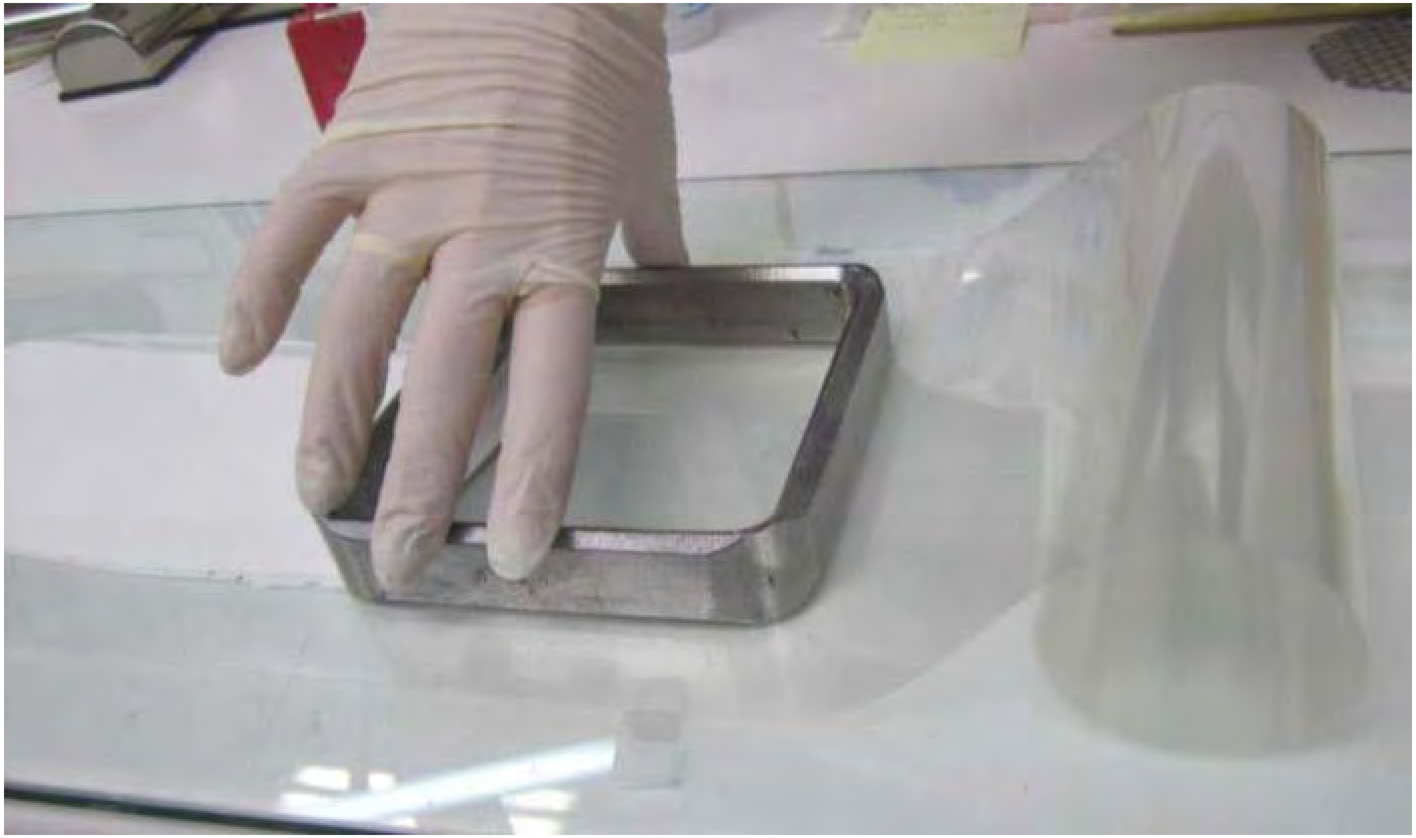
# If Slurry will not be Cast Soon it is Stored on a Slow Roller. Roll Speed is about 1-5 rpm to Keep Slurry Homogenous. PII Uses a Cell Culture Roller for this Purpose

**For Small Volume Experimental Purposes a Relatively Inexpensive Hand Doctor Blade Can be Used. Shown is an Example of 8 Side Doctor Blade.**



**SiPET Rolled Out on Flat Glass Surface and Slurry Poured Into Hand Doctor Blade. This method will create thin spots as a result of air trapped under the siPET and glass but otherwise acceptable results. Tape can be dried flat in an oven.**

# Casting Slurry with Hand Held Doctor Blade on to Release Side of siPET



•Normally casting thicker ceramic tape requires thicker siPET film otherwise the thicker ceramic tape will cause the base siPET film to distort during drying resulting in non-uniform cast tape thickness.
•The thickness of the siPET needed depends on the thickness of the ceramic tape being cast and how much tension is on the siPET to keep it from curling. The siPET film above is 75 microns thick which should be adequate to maybe 400 micron thick ceramic tape if properly tensioned.
•Due to the very high strength of thick alumina tapes it is possible to use just PET without silicone coating since the ceramic tape is so strong it can be peeled off without distortion.

# Hand Cast Example Thick Cast Formula KE2-6 &TK


•These example tapes were hand cast with a 50 mil (1250 micron) gap onto 250 mil thick PET and dried in 65°C oven for 70 minutes

## APPLICATION

### 8-PATH WET FILM APPLICATORS

For laying down wet films of materials in predetermined thicknesses. These precision wet film applicators are used in conjunction with paper charts, hiding power charts, plate glass or any other smooth, flat surfaces. They are simple, accurate experimental or quality control devices that require no adjustments.

### GENERAL INSTRUCTIONS

A small quantity (depending on length and thickness of film required) of the material to be checked is placed on the inside of the channel near the correct opening for the thickness desired. The applicator is then drawn down over the chart or other surface and a uniform thickness of film is produced for observation and test. A path with a depth or a clearance of one mil will lay down a film approximately 1/2 mil thick. A latex film will shrink considerably more, so paths of greater depths are required in order to obtain a dry film thick enough to check flexibility and toughness.

Film thicknesses deposited may vary from 40% to 80% of the actual clearance.

- Adhesives
- Board
- Ceramic Colors
- Cosmetics
- Driers
- Duplicating Inks
- Resins
- Lacquers
- Cellulose
- Oils
- Pigments
- Plastics
- Printing Inks
- Waxes & Hot Melts
- Metallic Powders
- Floor Polishes
- Varnishes
- Fillers
- Emulsions

The 8-Path applicators are available in three widths

| CAT. NO. | Overall Width | Path Width | Actual Path Depth, Mils | Approx. Wet Film Thickness | Stainless Steel |
|---|---|---|---|---|---|
| 1 | 3" | 2" | | 0.5, 1, 1.5, 2, | $476.00 |
| 14 | 4" | 3" | 1, 2, 3, 4, 5, 6, | 2.5, 3, 3.5, | 521.00 |
| 15 | 5" | 4" | 7, 8 mils | 4 mils | 581.00 |
| 2 | 3" | 2" | | 2.5, 5, 7.5 | $493.00 |
| 24 | 4" | 3" | 5, 10, 15, 20, | 10, 12.5, 15, | 535.00 |
| 25 | 5" | 4" | 25, 30, 40, 50 | 20, 25 | 598.00 |
| 3 | 3" | 2" | 0.5, 1, 1.5, | 0.25, 0.5, 0.75, | $502.00 |
| 34 | 4" | 3" | 2, 3, 4, 5, 6 | 1, 1.5, 2, 2.5, 3 | 597.00 |
| 35 | 5" | 4" | | | 470.00 |

ORDER INFORMATION: To order please use the following example.

AP - ( CAT. NO.) SS

GARDCO Paul N. Gardner Co., Inc. • www.gardco.com • (954) 946-9454 • 1-800-762-2478 1

# Example of Hand Casting Doctor Blades from Paul N. Gardner Company. These casting heads are square and have 8 different casting gaps.

http://www.gardco.com/app.cfm

- **Thicker Casting will require greater gaps to result in thicker tape.**
- **Chart at left shows gaps in mils (1 mil = 25 microns)**
- **Highest gap at left is only 50 mils which will result in about 400 micron sheet.**
- **Adjustable blades allowing higher gaps are available.**