Two New Ways to Build Shells Rapidly

(1) Slurry + Modified Stucco With An Amorphous Mineral Silicate

(2) Brush-on

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Two ways to speed up shell building for investment casting

- (1) Slurry + stucco – traditional method with modified stucco
  - Rainfall (sieve method)
  - Fluidized bed
- (2) Brush-on
  - Paint face coat on pattern
  - Paint on backup coats to achieve desired thickness
- From pattern to solid metal in < 8 hours
- Has been used for
  - Non-ferrous (aluminum, brass, bronze, copper)
  - Ferrous (cast iron, stainless steel)

Method 1 - Slurry + Modified Stucco

Video of slurry + modified stucco process

- What was done in the production run in the industrial foundry
- 7 stucco coats + seal coat
- Shells were built in 8 h
  - 2 different slurries – most schools only use 1 slurry for all coats
  - 3 different modified stuccos
- Autoclaved to remove wax
- Poured stainless steel
- For video got to www.FoundrySolutions.net – video – production run

Only modify the stucco

- **Add amorphous mineral silicate adsorbent to stucco → modified stucco**
- **Use:**
  - **With standard slurry recipes**
  - **With standard or custom stucco recipes**
  - **With rainfall and fluidized bed processes**

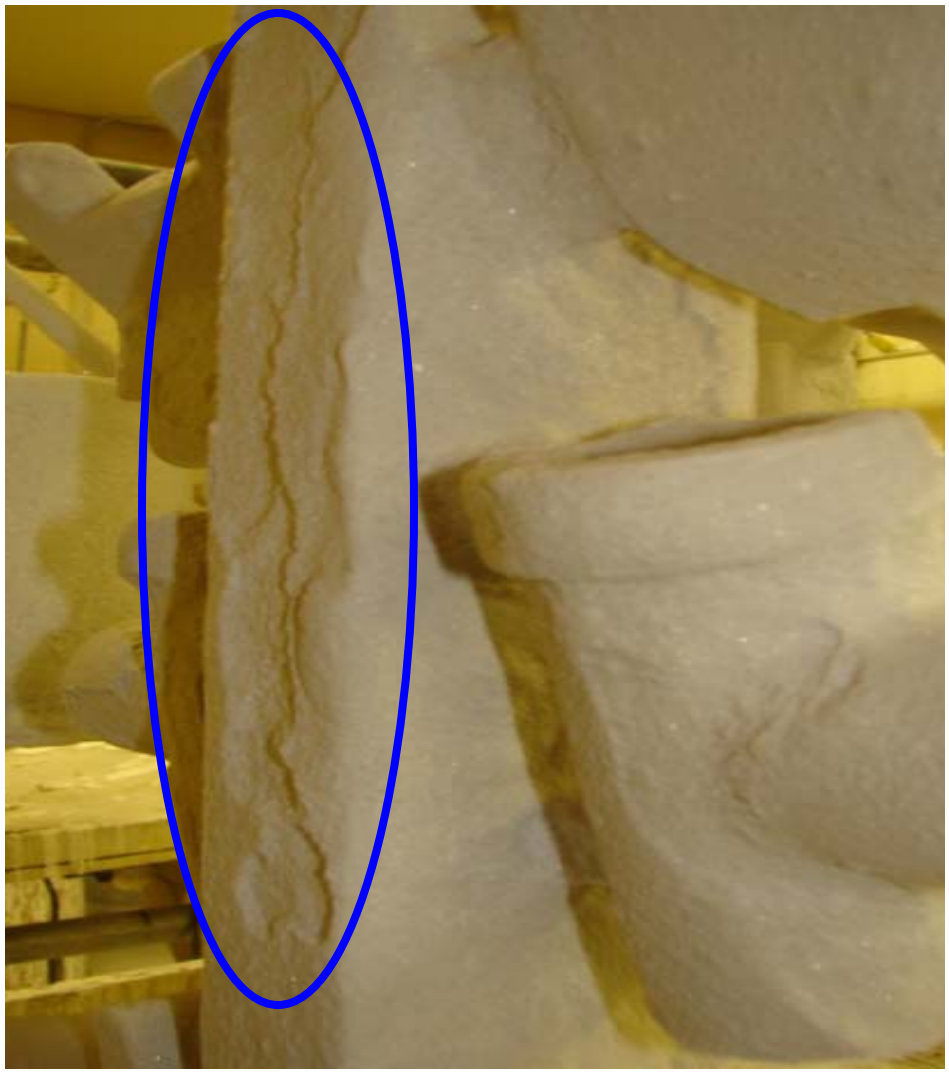
Only one minor change to standard slurry + stucco rainfall shell process

- Coat pattern with standard slurry
- Apply modified stucco
- Remove small amount of stucco after 15 to 60 min
- Repeat to build up desired shell thickness
- Time between coats can be as short as 20 min
- Note: Adsorbent is neutral – does not change slurry pH

Why remove stucco material?

- **Initially stucco is very uniform**
- **After about 5-10 minutes of drying, patches of stucco begin to shed**

Stucco begins to fall off after 5 – 10 minutes



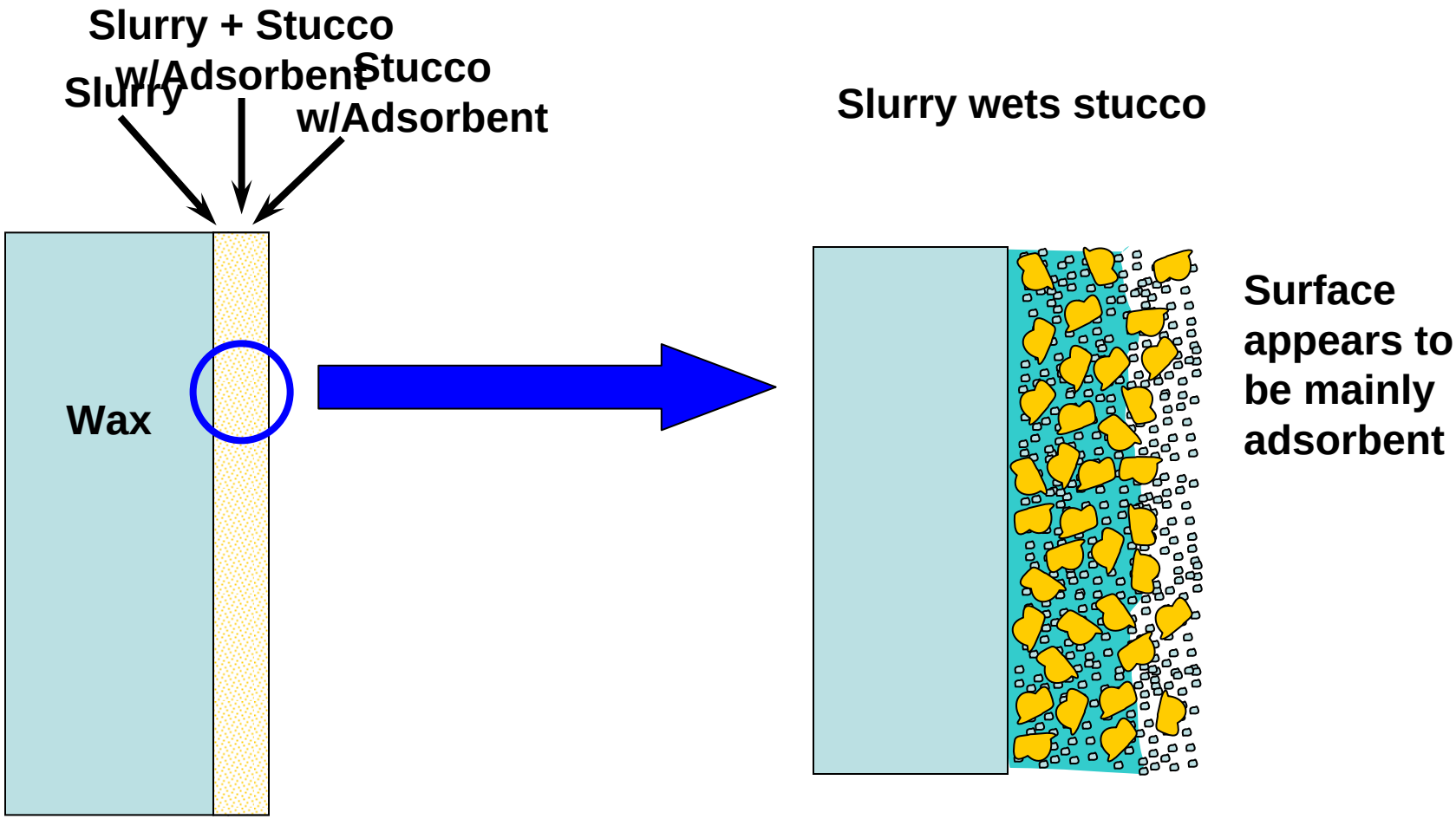
Why remove stucco material?

- Initially stucco is very uniform
- After about 5-10 minutes of drying, patches of stucco begin to shed
- **Remove stucco with air, tapping, brushing, vibration**
- **If loose stucco is not removed, rewetting peels off loose stucco causing delamination**

Remove layer of loose stucco with air or mechanical means

Surface is smooth and uniform after loose stucco is removed

Proposed mechanism how adsorbent speeds up the process



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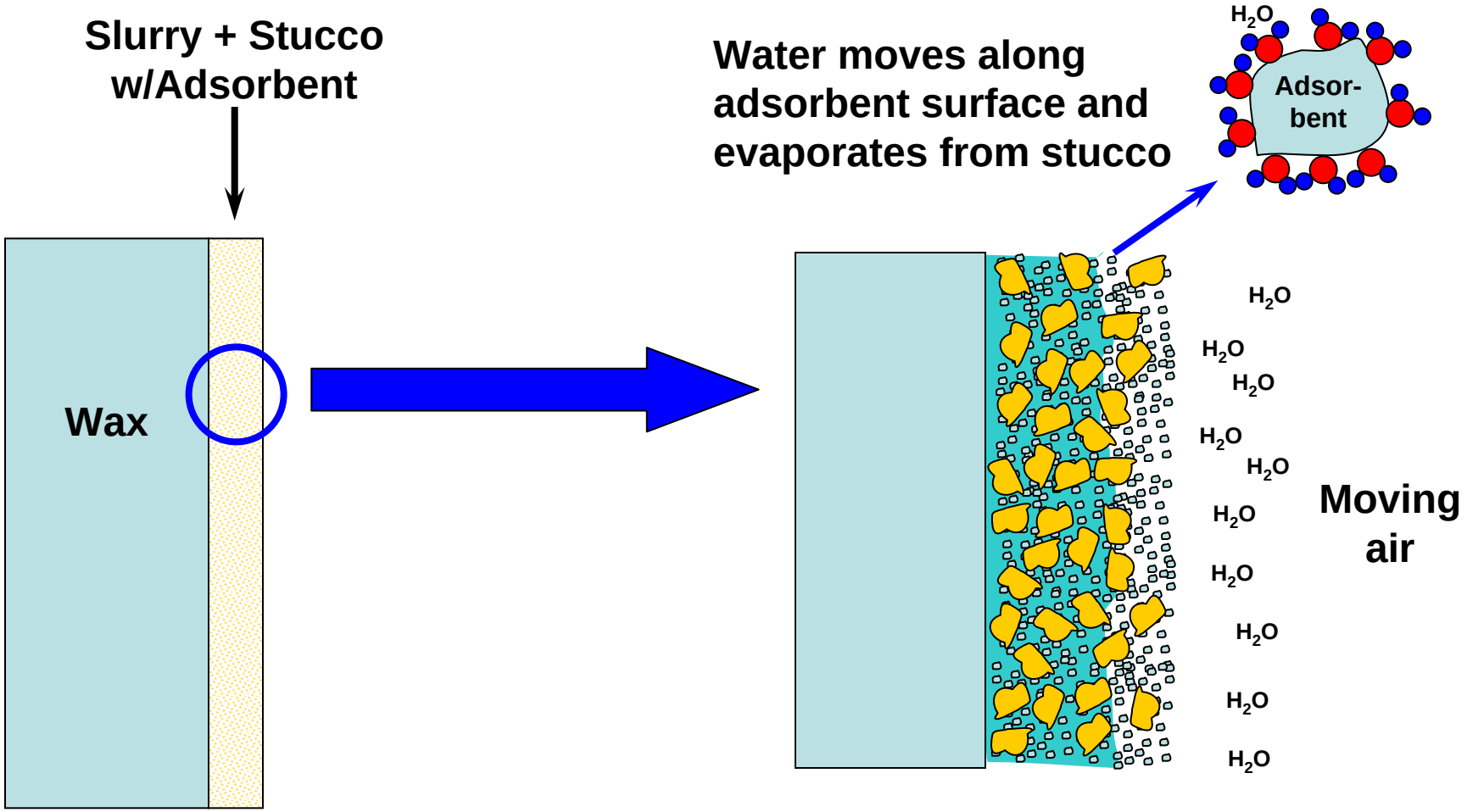
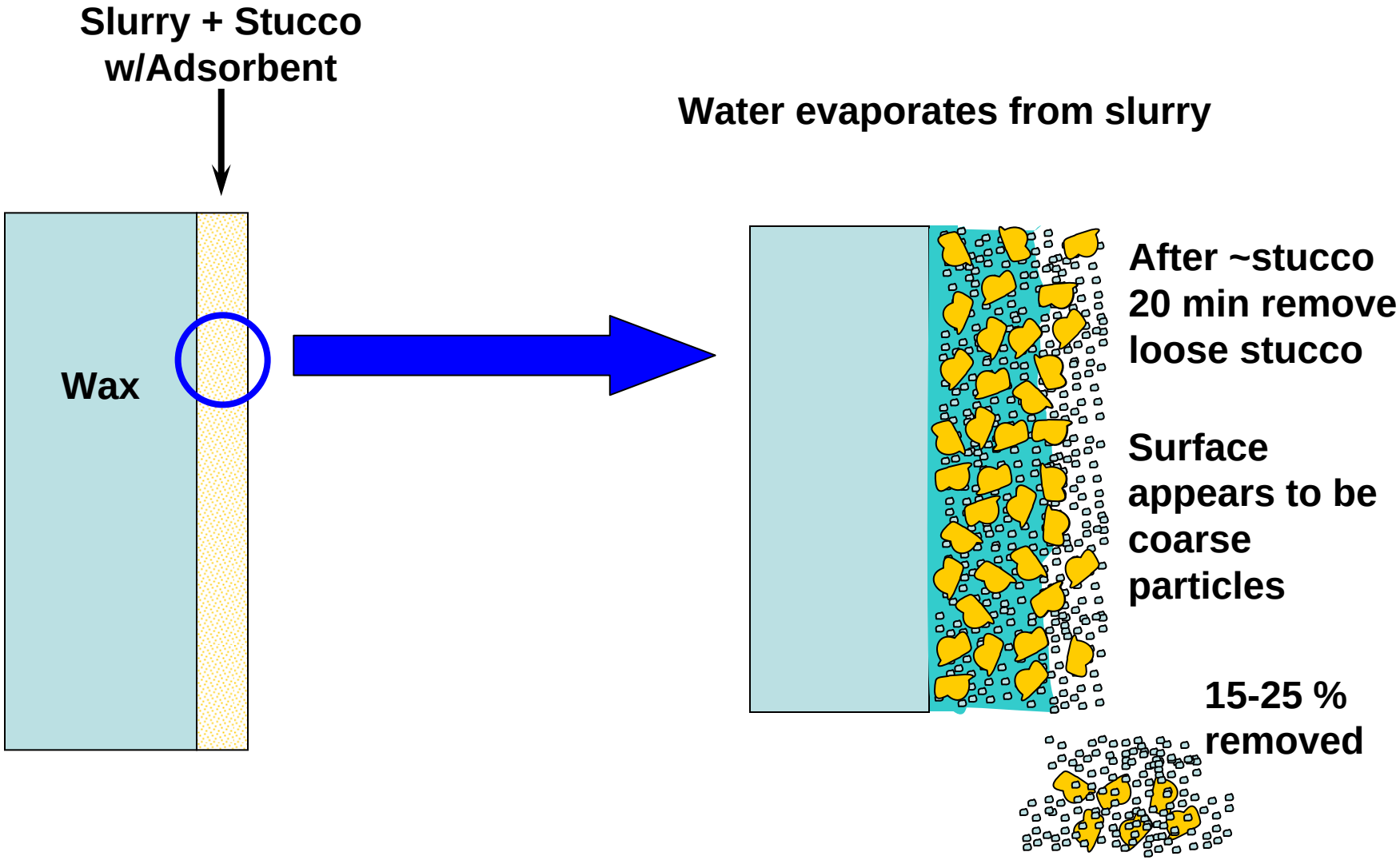


Proposed mechanism how adsorbent speeds up the process



No changes to standard slurry + stucco fluidized bed shell process

- Coat pattern with standard slurry
- Apply modified stucco
  - Fluidized bed removes loose stucco – accomplishes stucco removal that is done separately with rainfall method
- Repeat to build up desired shell thickness
- Time between coats can be as short as 20 min
- Note: Adsorbent is neutral – does not change slurry pH
- Proposed mechanism - adsorbent allows water to evaporate faster than from traditional stucco

Comments 1 – slurry + stucco

- **Apply desired number of layers; use adsorbent in all stucco layers**
- **Shell is ready to be autoclaved or flash fired when seal-coat is dry**
- **Adsorbent is neutral - does not change pH of slurry**
- **Adsorbent is non-toxic and - does not generate toxic waste**
- **Stucco + adsorbent mix has excellent shelf life**
- **May be able to reuse loose stucco that is removed**

Can be used with deep cores

Metal surface is clean (304 SS) with no burn in - excellent dimensional tolerances

Comments 2 – slurry + stucco

- Have cast Al, Cu, brass, bronze, cast iron, SS
- No permeability problems with ferrous or non-ferrous alloys
  - no $ to try gold and platinum yet
- Works with rainfall and fluidized beds
- Small amounts of Na, K, and Ca in adsorbent; they do not appear to present a problem
- Initial bowing problem when pouring - adding layers eliminated problem

Comments 3 – slurry + stucco

- **Mechanical properties of shell are comparable or better than standard slurry + stucco**

Sample	MOR (psi)	MOE (psi)
--- Green---		
Std-60	783 ± 22	100 ± 8
Mod-60	814 ± 25	70 ± 7
--- Hot wet (immediately after autoclaving) ---		
Std-60	370 ± 18	69 ± 8
Mod-60	371 ± 16	44 ± 5
--- Fired (at room temperature after 1800ºF / 2.5h) ---		
Std-60	274 ± 21	35 ± 4
Mod-60	572 ± 39	65 ± 7

Chris Whitehouse, Minco

Summary – slurry + modified stucco

- **Build a shell in 4-8 h**
- **Use standard slurry and stucco recipes**
- **Add adsorbent to stucco**
- **Remove loose stucco before rewetting (rainfall method)**
- **Use standard autoclaving, burn-out, and pouring schedules**

General information

- **Add hanger for all pieces – can hang pieces to get good air flow**
- **Need high 360°air flow for both methods**
- **Wax patterns - temperature changes expand or contract wax, which can crack the shell**

Method 2 - Brush-on

Video of brush-on process

- **What you will see in the video**
- **Prepare and apply face coat**
- **Apply 3 backup coats**
- **Burnout**
- **Ready to pour**
- **For video go to www.FoundrySolutions.net – video – Brush-on**

Brush-on process

- **Face coat and backup coats have the consistency of cake frosting**
- **Add accelerant to face coat and backup coat mixtures just before using**
- **Face coat and backup dry to touch in ~5 min**
- **Backup coat can be applied in 1 h**
- **Add backup coat each hour to achieve desired thickness – shell should be about 3/8” thick**
- **Ready for burn out 1 h after final backup coat**
- **Mechanism – accelerant changes pH, which causes gelling. Air flow removes water.**

Characteristics of brush-on

- **Face coat and backup mixtures have long shelf life – they do not settle or harden**
- **No dust**
- **Excellent surface detail**
- **Composition of backup coat improves heat retention - allows multiple metal pours**
- **Can be used for ferrous and non-ferrous alloys**
- **Excellent mechanical properties can eliminate need for core pins**
- **Easy to remove shell after pouring**
- **Shell material is non-toxic and is not hazardous – no safety or disposal problems**


Nestlé
Pure Life


Miller
HIGH LIFE

Notes and new knowledge from the Sloss workshop (1)

- **Can make shells under non-ideal conditions – had not worked in sun and wind before**
- **Ideal conditions**
  - **No direct sun (no snow or ice)**
  - **No wind when applying ceramic**
  - **Lots of air flow when drying each face coat**
  - **Air circulation is best if the piece is hung – next best is inverting piece on its pour cup**

Notes (2)

- **Properly prepared pattern surface is vital to get face coat to stick**
  - **How surface is prepared depends on pattern material (wax, paper, cloth, food)**
  - **When in doubt seal/coat surface with shellac**
- **Can adjust consistency of face and backup coats with water**
- **Can get face coat fissures if the consistency is too runny – consistency of molasses is about the runniest you should attempt**

Notes (3)

- **Apply thick enough layer of face coat to cover pattern. Face coat has a tendency to not cover pattern at first.**
- **Daub face coat and backup onto pattern and push it around (the DT technique) – minimize normal brush stroking**
- **Don’t spend too much time trying to fill small holes that appear in the face coat – touch them up a few minutes after the face coat is applied.**
- **Apply face coat to entire pattern including pour cup, sprue, vent, gates – face coat material sticks to pattern better than backup material.**

Notes (4)

- **Each backup coat should be thicker than face coat (about 2X thicker). About 1/8” thick per layer.**
- **Adjust consistency of backup for ambient conditions**
- **Daub backup coat on previous layer – use DT technique – minimize stroking**
- **Final shell thickness should be about 3/8” – measure at pour cup.**
- **The pour cup, sprues, gates, vents (etc.) need the same attention to detail as the pattern. Good pour system = good casting.**

Notes (5)

- **Inspect shell before burnout**
  - **Surface should be smooth and crackfree**
  - **Small cracks can be touched up with more backup – dry at least 30 min before burnout**
- **Cracks after burnout can be repaired with glaumo (thick consistency backup with accelerant)**

Notes (6)

- **Hybrid technique – new at Sloss workshop**
  - **Face coat - slurry + stucco**
  - **Backup coats - Brush-on**

- **DO NOT DIP BRUSH-ON INTO SLURRY TANK – IT COULD CAUSE THE TANK TO GEL**

- **Do not put anything that has come in contact with the accelerant into the container of premixed face coat or backup material. (Don’t double dip with your brush.)**

Overall summary

- **Two simple new methods to get from pattern to solid metal in <8 h**
- **Slight modification of standard slurry + stucco method**
- **Entirely new brush-on method**

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