CASTING SOLUTIONS

ASHLAND®

Reducing Environmental Impact of High Productivity Foundry Binders

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Introduction

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The production and use of environmentally responsible foundry sand binders is of critical importance and a key consideration in Ashland's chemical binder development.

Responsible Care*

Certified to
RC 14001, ISO 14001

Environmental Stewardship • Operational Excellence • Innovative Solutions • Global Team

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Evolution of Synthetic Binders

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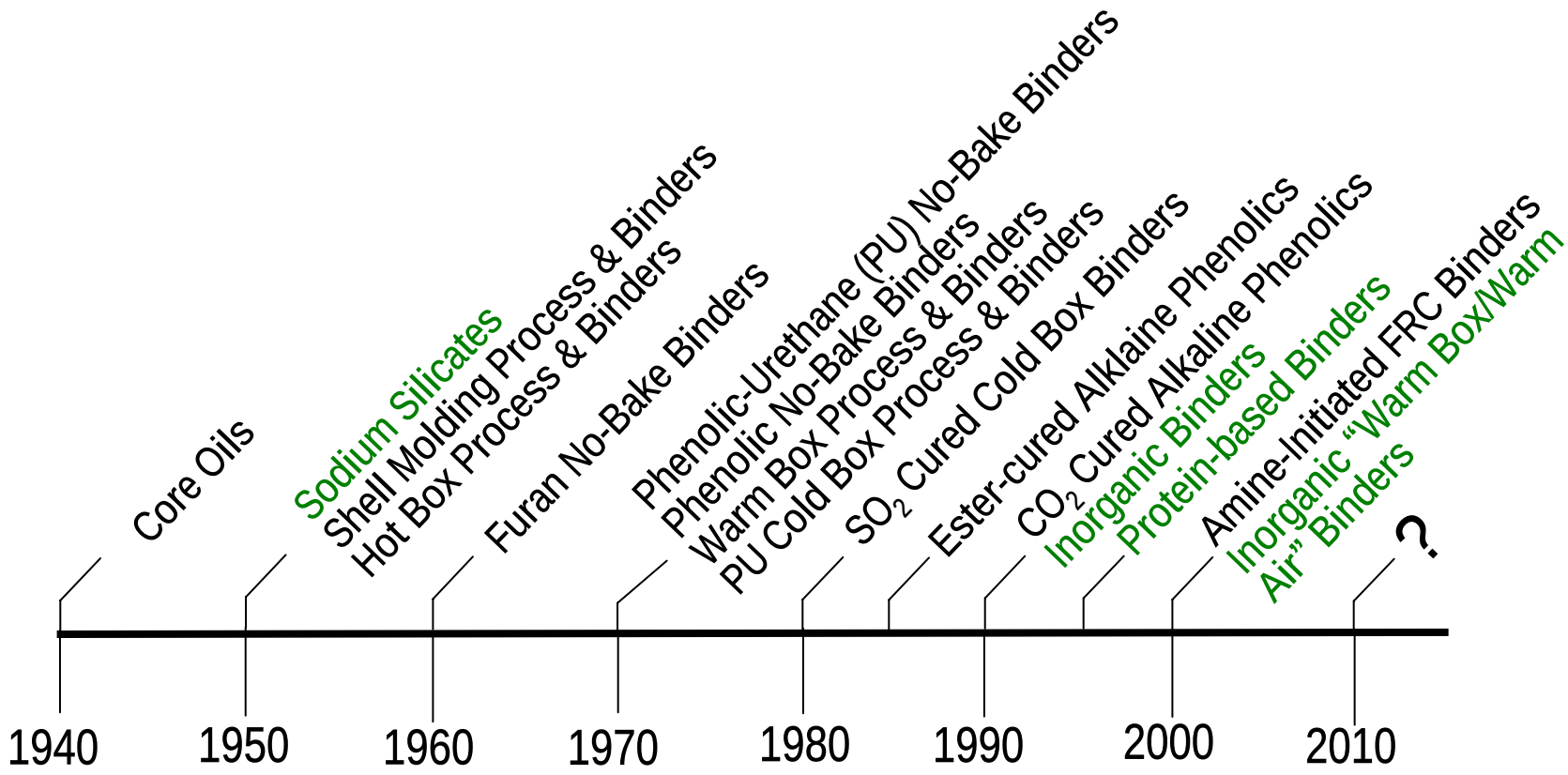


Drivers:

- Productivity
- Efficiency
- Casting Quality
- Emissions Reduction
- Waste Minimization

Scope

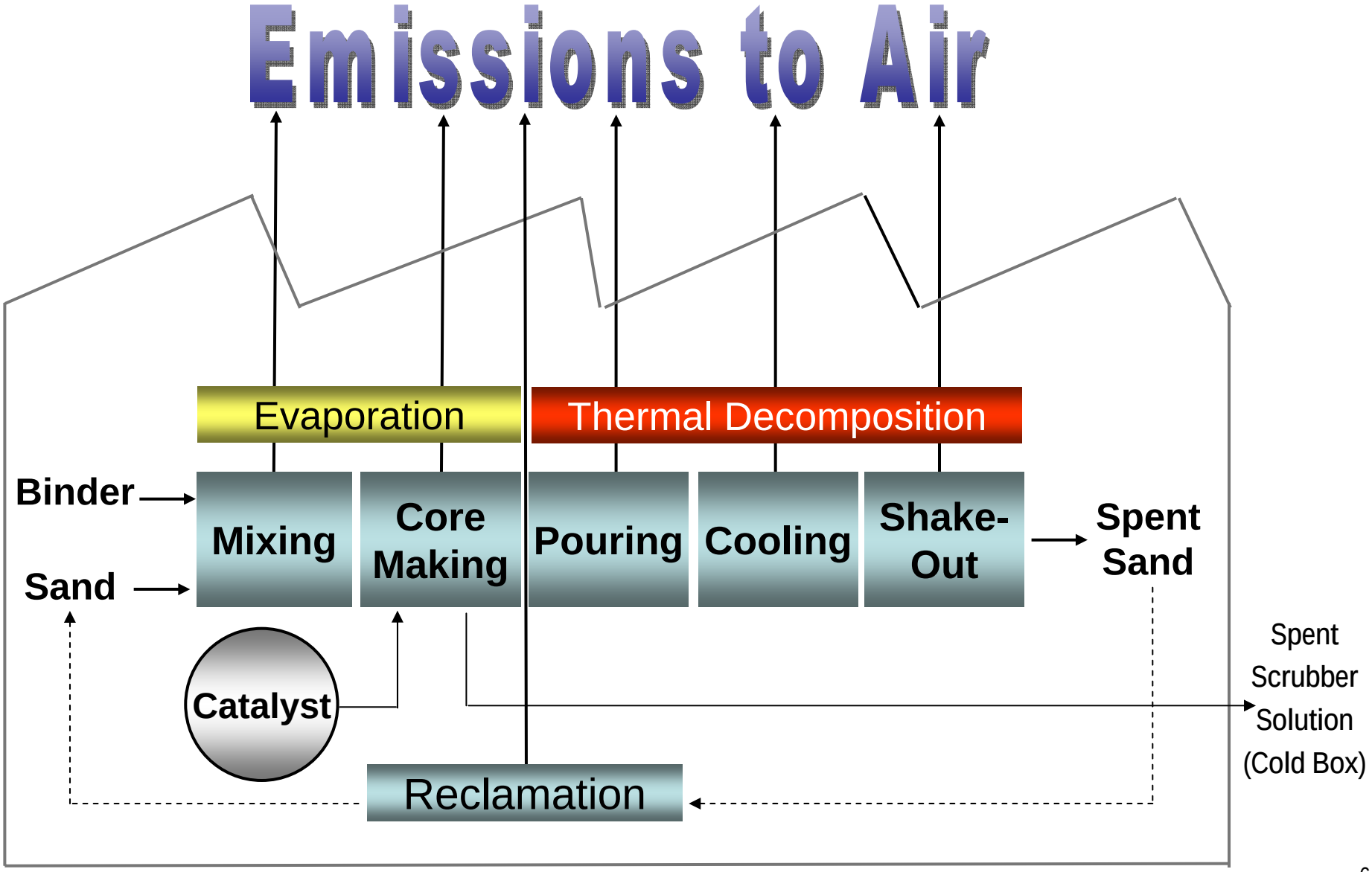
- Foundry requirements:
  - World competitive process stability
  - World competitive process robustness
  - World competitive quality consistency
  - World competitive productivity
  - Environmental compliance

Binder impact is larger than just VOC, HAP content and emissions! More complex castings pose new, unique and not easily achieved requirements for binders and processes.

Pollution Prevention

- Emissions reduction is a key driver for the development of inorganic binders
  - Reduced HAP
  - Reduced odor
  - Alternative, “natural” binders ride the wave, too
- Proven synthetic organic binder technologies exist which effectively address HAP emissions concerns

Binder-Related Foundry Emissions



Emissions Due to Evaporation

- Sand mixing
- Storage of mixed sand
- Core / mold making
- Storage of cores / molds
- Coating application and drying

Emissions Due to Thermal Decomposition

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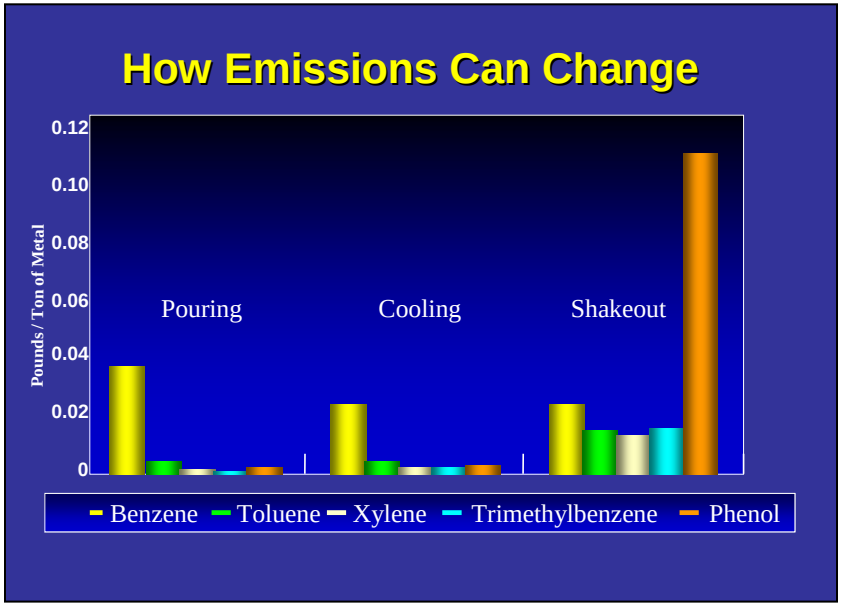
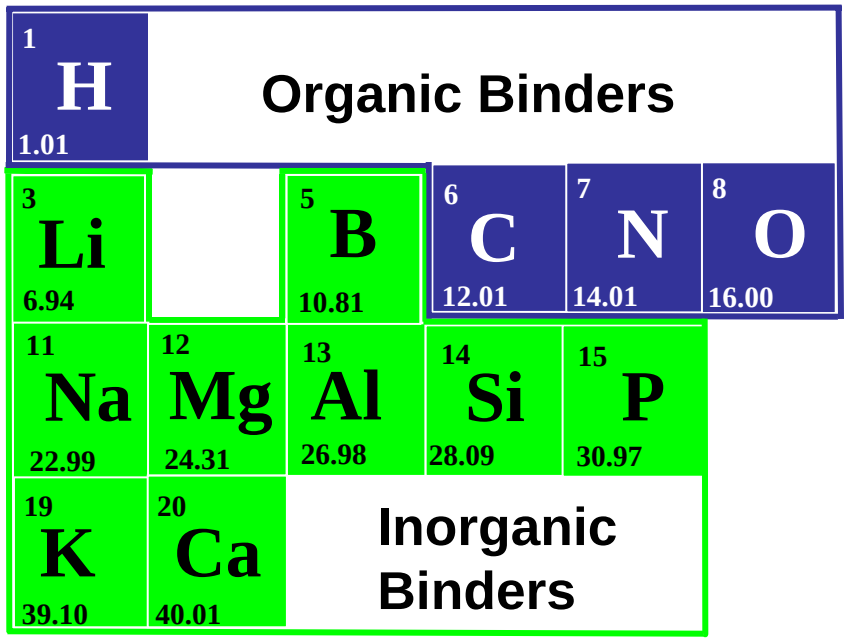
More complicated!

- Pouring
- Cooling
- Shake-out
- Sand reclamation



Distribution of species is different at various points in the process. Speciation depends on pouring temperature.

Binders – The Works



Emissions to Air	
Evaporation	Thermal Decomposition
Synthetic: VOC / HAP	VOC / HAP
Natural: Minimal	
Minimal	Minimal (CO)

Inorganic binders result in minimal emissions to air

Recent Surge in Inorganic Binders

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- Characteristics
  - "Hardening mechanism" based on dehydration
  - Reduced emissions
  - Targeting light metal applications
  - Water solubility for improved core removal and sand / binder reclamation
  - Limited humidity resistance – variable performance in normal foundry operating conditions

Alternative binders are very different products and require different processes, but inherently result in lower HAP emissions.

Conventional cold box equipment / tooling is not suited for core making with inorganic binders.

Phenolic-Urethane Binders Are Evolving

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- Continuous reduction of environmental impact:
  - Elimination of lead
  - New synthetic methods for improved phenol formaldehyde resins
    - Free phenol <5%
    - Free formaldehyde <0.1%
  - Non-photochemically reactive solvent packages
  - Naphthalene depleted aromatic hydrocarbon solvents
  - Ester solvents
  - Reduced chlorine content
  - High solids binders, less solvent content

Higher performing binders resulting in reduced EH&S impact.

PUCB Binders – Technology Evolution

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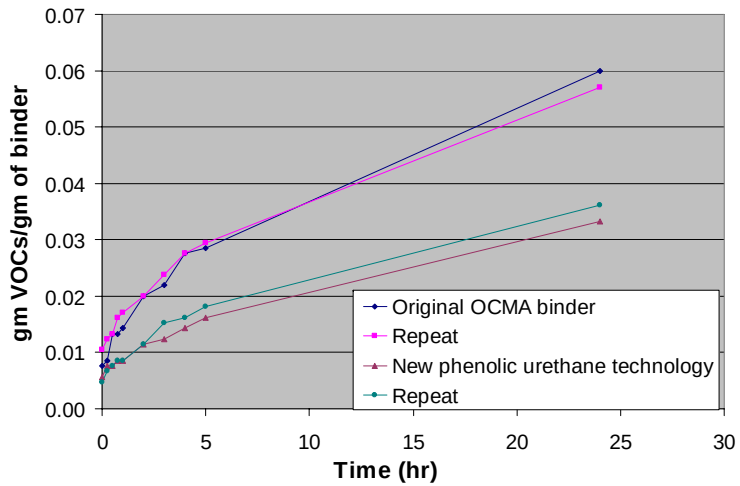
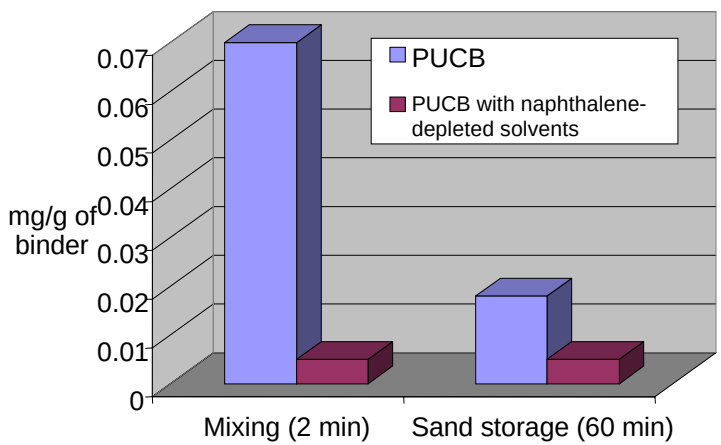
Evaporation

OCMA Weight Loss

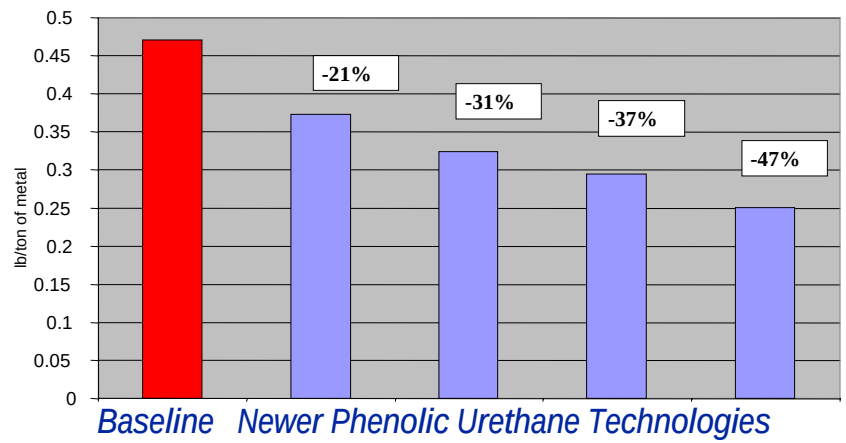


Naphthalene Emissions

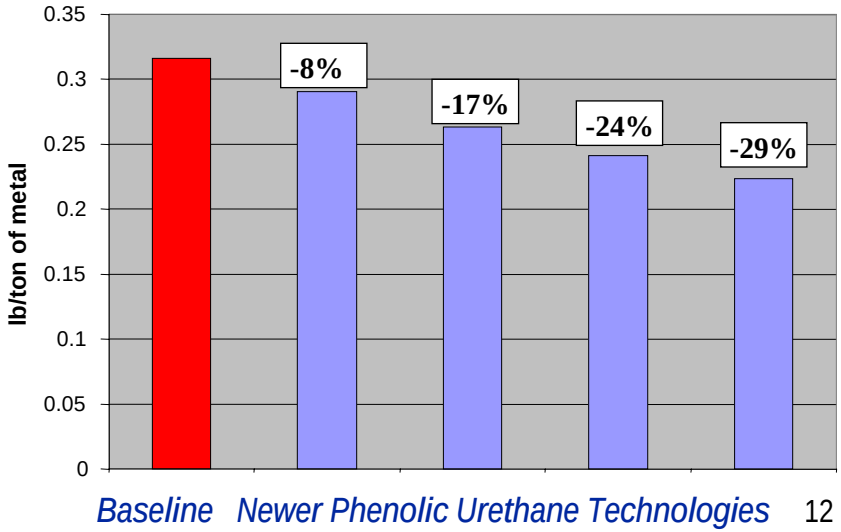


Thermal Decomposition

Total VOC Emissions



HAP Emissions



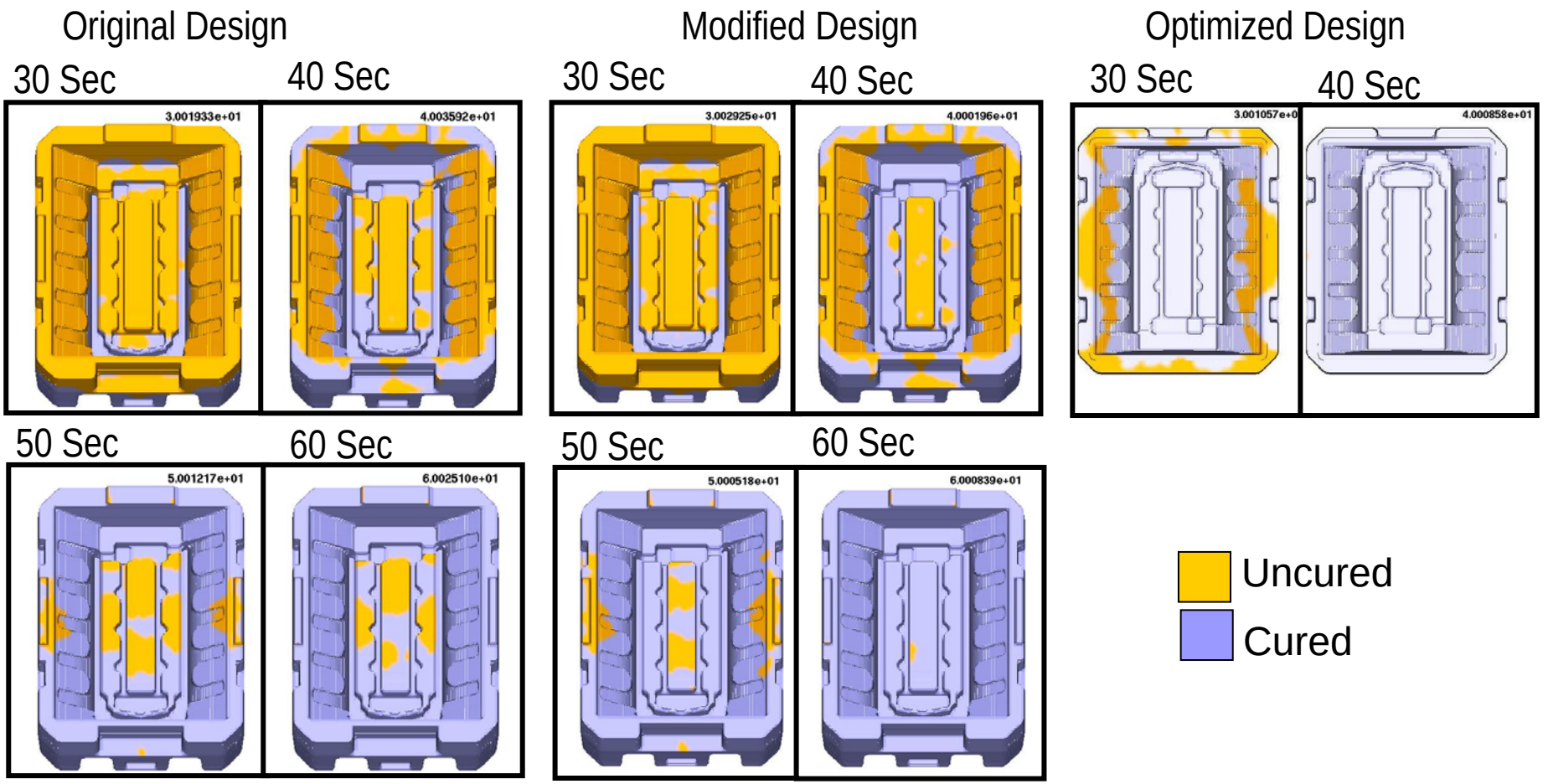
CAE / CAD Tools

- A new computational multi-phase flow dynamics tool (Arena-flow[1]) to simulate core blowing and gassing / curing processes
  - Remove trial and error
  - Design and optimize cores, molds, and tooling
  - Improve process efficiency and productivity

Predictive design for quality.
Reduced binder level requirement.

[1]Registered trademark of Arena-flow, LLC

Arena-flow[1] Simulation – Curing Comparison*



Simulation optimization:

- 40% reduction in amine requirement.
- Optimized design is 80 lbs lighter – translates to reduced binder content.

*GM Gen IV block 1Registered trademark of Arena-flow, LLC

Conclusions

- Inorganic and alternative binders result in reduced HAP emissions, but inherent performance limitations continue to exist which lead to variable performance in normal foundry operation conditions.
- Conventional cold box equipment / tooling is not suited for core making with these binders.
- Synthetic polymer based binders are proven and trusted, globally. Their uniqueness is around well constructed products for a wide array of applications and performance requirements.

Conclusions

- Incremental improvements in all major binder technologies to reduce EH&S impact stemming from the use of these binders while improving quality and productivity will continue to be made.
- Modern high-productivity phenolic urethane binders are more environmentally responsible now than ever before. Higher performing binders have been developed to reduce HAP emissions.

Conclusions

- Chemistry never stands alone!
- At present, a holistic impact improvement approach is the most reasonable
  - The combination of sophisticated binder chemistry, predictive tools to improve quality and productivity beyond current world-class levels, and effective emission control/containment technologies applied across all foundries will result in a more profound sum improvement than a major improvement in one foundry

Looking Ahead

Selecting the “right” binder is a matter of balance

Questions?