



BOF



EAF



Blast Furnace



Engineering / Innovations

New EAF Technologies and Cost Saving Improvements

- February 17, 2017



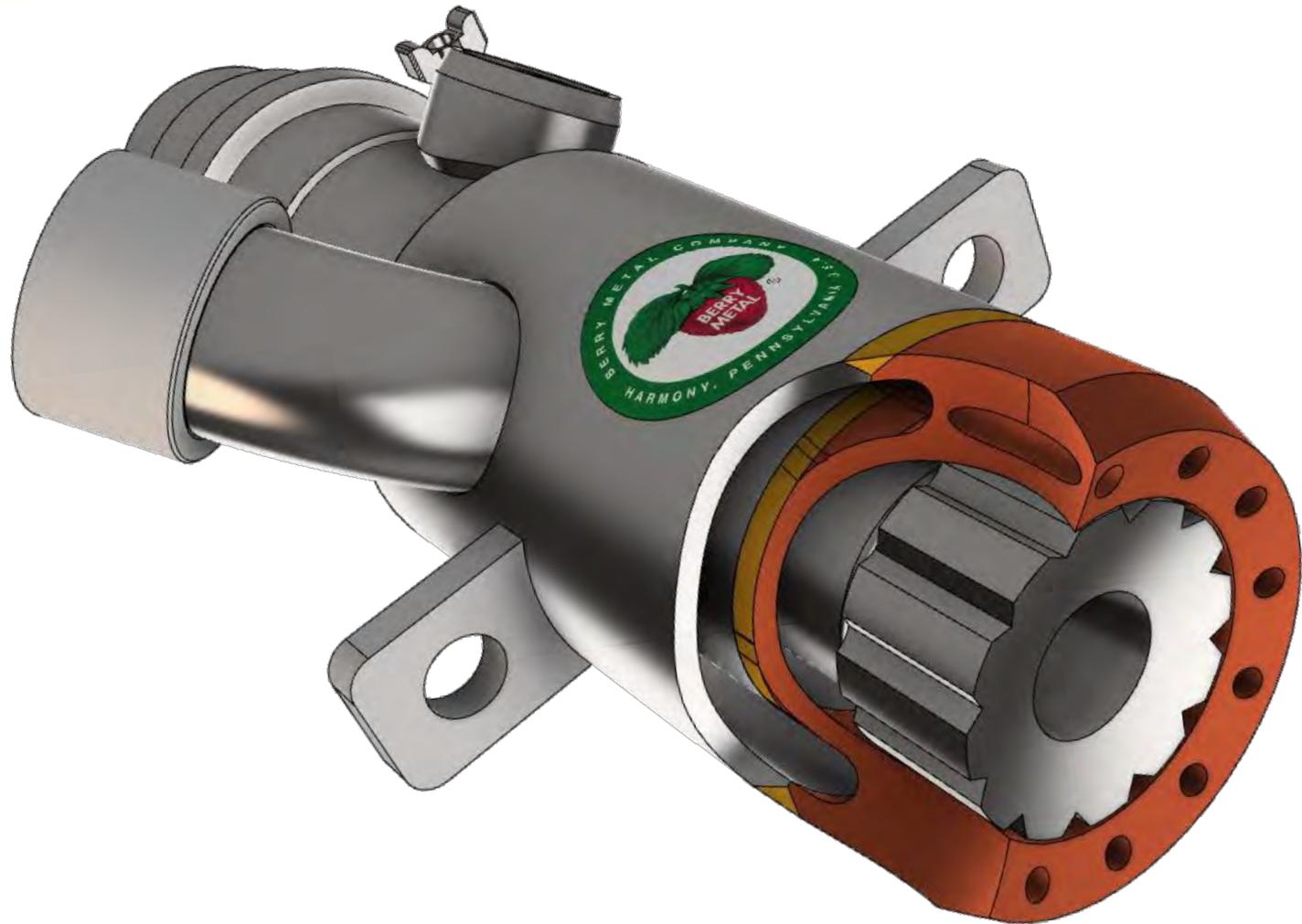


Berry Metal Burner

- Patented Technology
- More efficient combustion – potential to save oxygen, gas, and electricity.
- V-shape design combined with concave face helps push shrouded oxygen into the natural gas, leading to a more efficient burn.
- V-shape also reduces plugging/clogging making maintenance easier.
- Longer tapered OD helps improve seal to the box, reduces blow back, and extends burner life.
- 28% increase in burner mode as a result compared to a conventional shrouded burner.
- Maintenance with a removable center oxygen pipe reduces down time, and reduces repair costs.



Berry Metal DeCarb Burner Development





Burner Technology





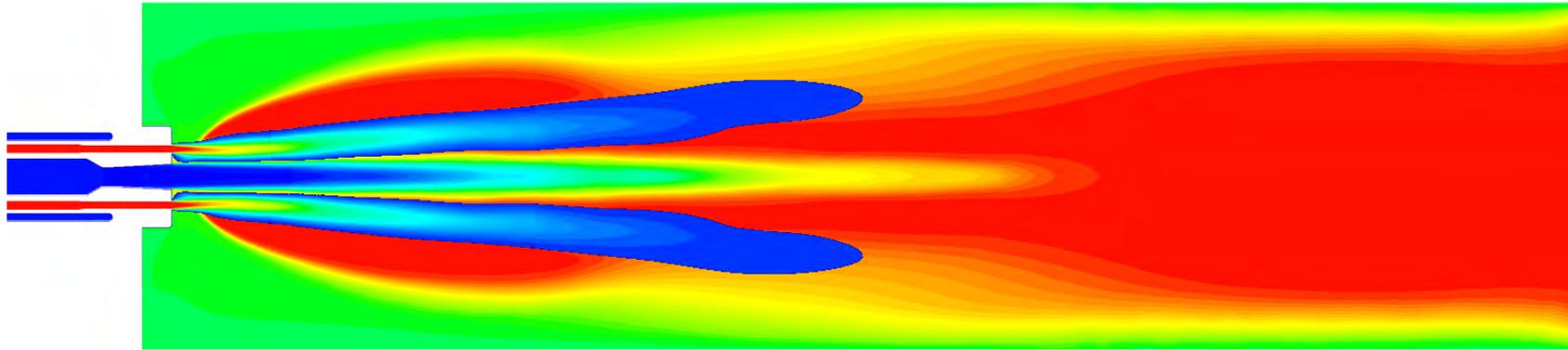
Burner Technology



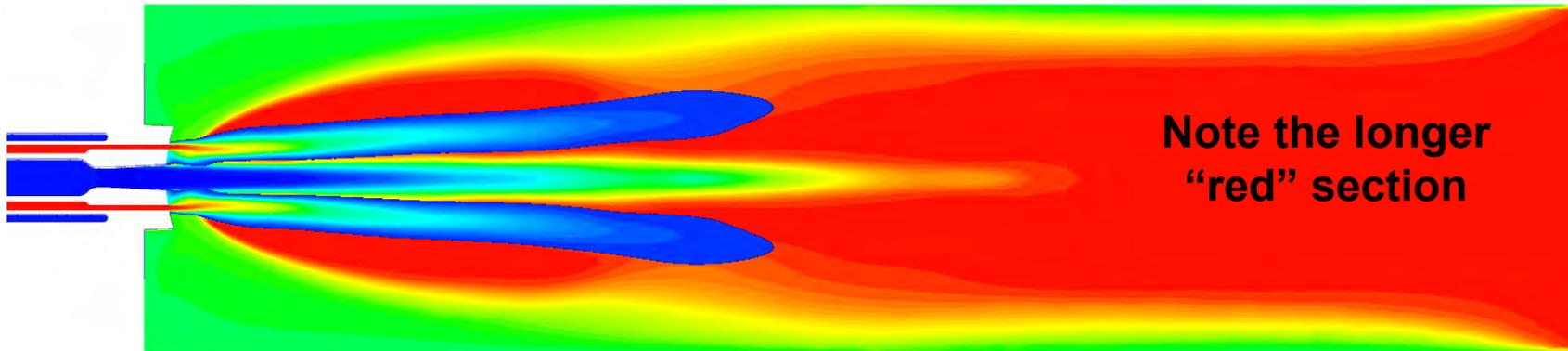


Combustion Efficiency Comparison

Competitor Shroud Burner w/ CH₄ Combustion Efficiency



New BMC Decarb Burner w/ CH₄ Combustion Efficiency



Temperature

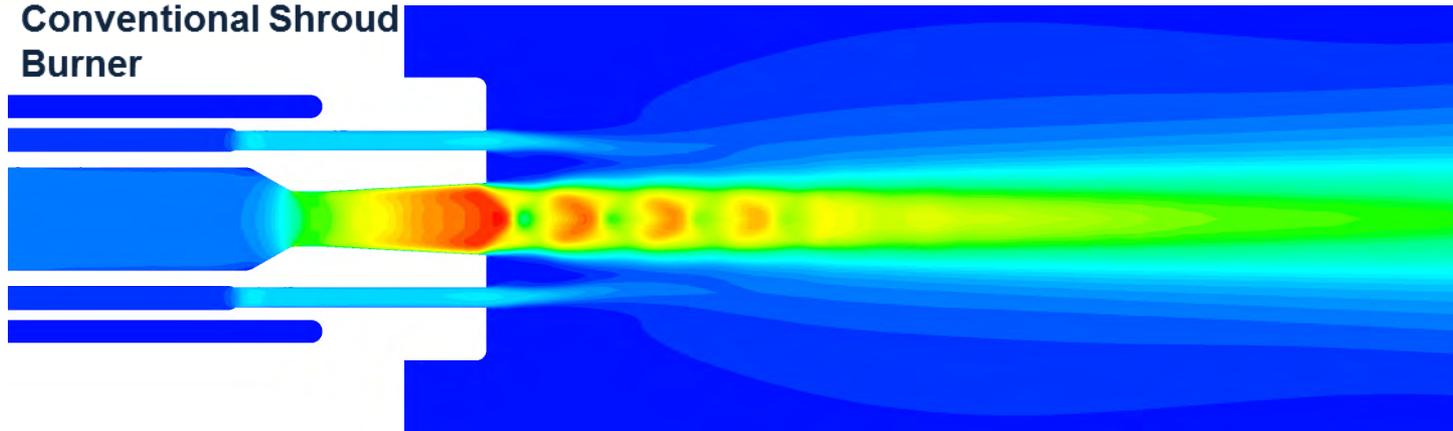
Berry Metal Company Confidential Information

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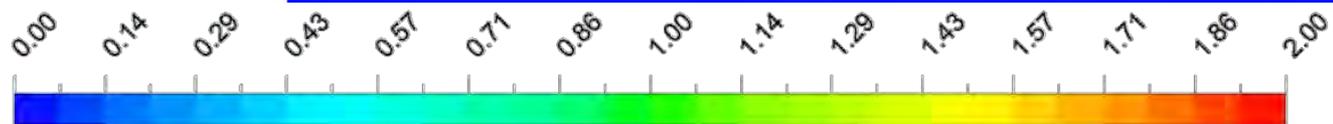
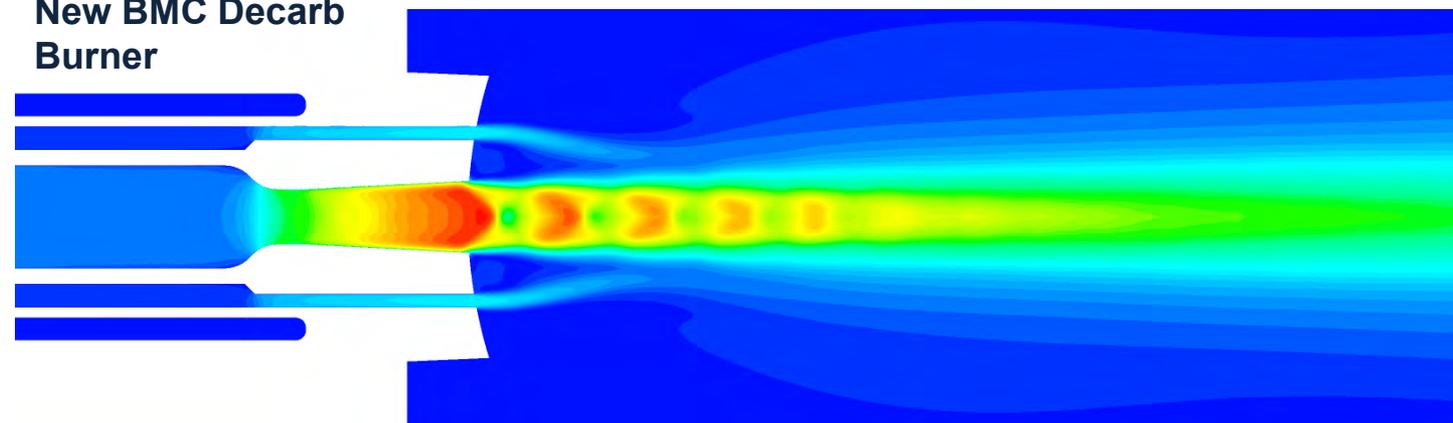


Refining Gas Efficiency Comparison

Conventional Shroud
Burner



New BMC Decarb
Burner



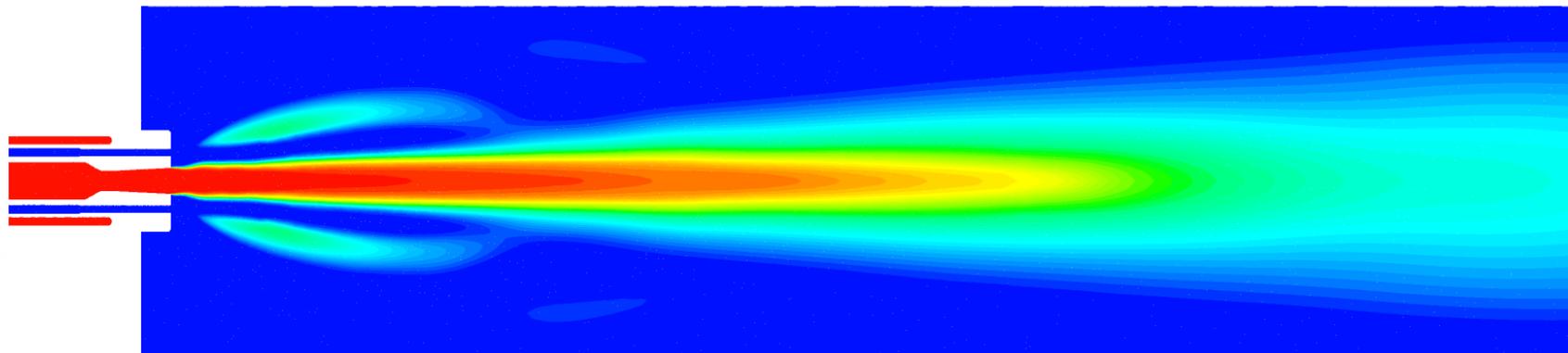
Mach Number

Berry Metal Company Confidential Information

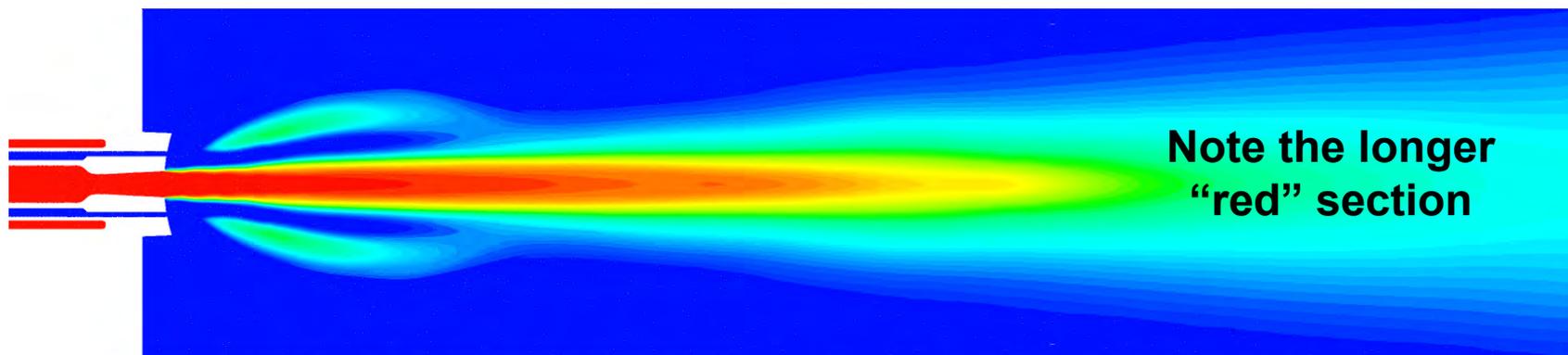


Refining Mode Oxygen Efficiency Comparison

Conventional Shroud Burner



New BMC Decarb Burner



0.00 0.05 0.11 0.16 0.21 0.26 0.32 0.37 0.42 0.47 0.53 0.58 0.63 0.68 0.74 0.79 0.84 0.89 0.95 1.00



O2.Mass Fraction



Berry Metal Field Tests

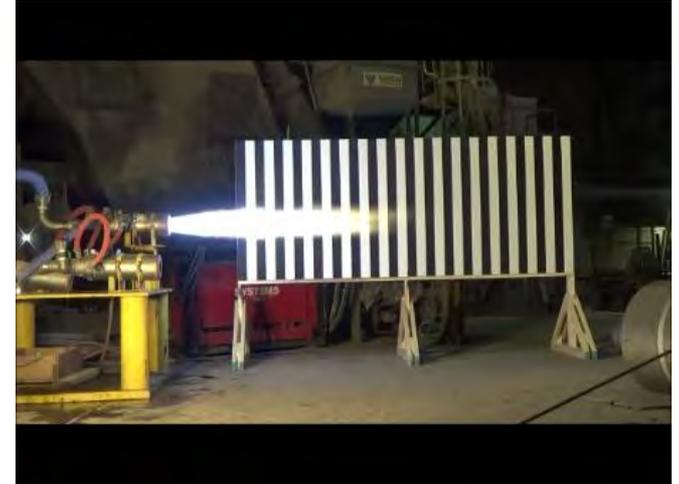
- Berry Metal recently conducted actual field tests at a modern EAF plant.
- The Berry Burner performed better than the competitors burners.
- High speed video and IR video was taken to compare the benefits of the Berry Metal burner at various flow rates.
- The Berry burner had a longer, more coherent stream and a more powerful jet.



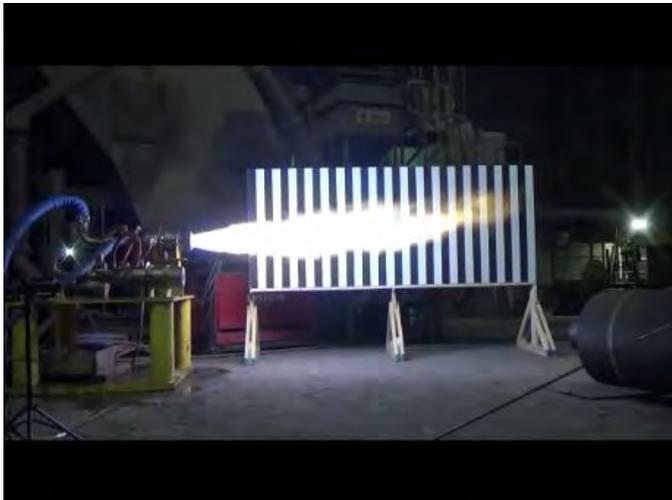
Burner Modes



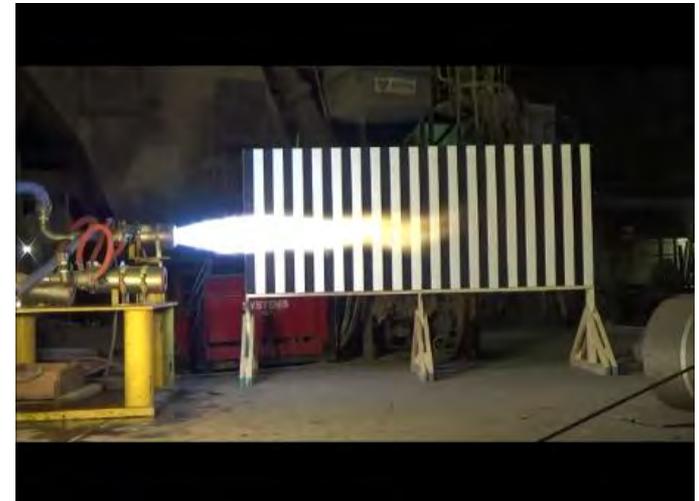
Hold Fire Mode



1800 SCFM Mode



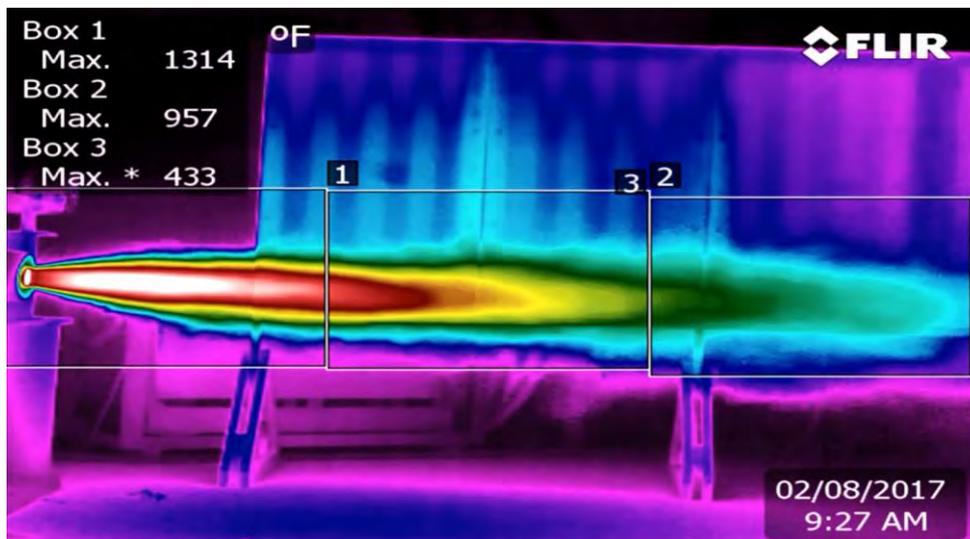
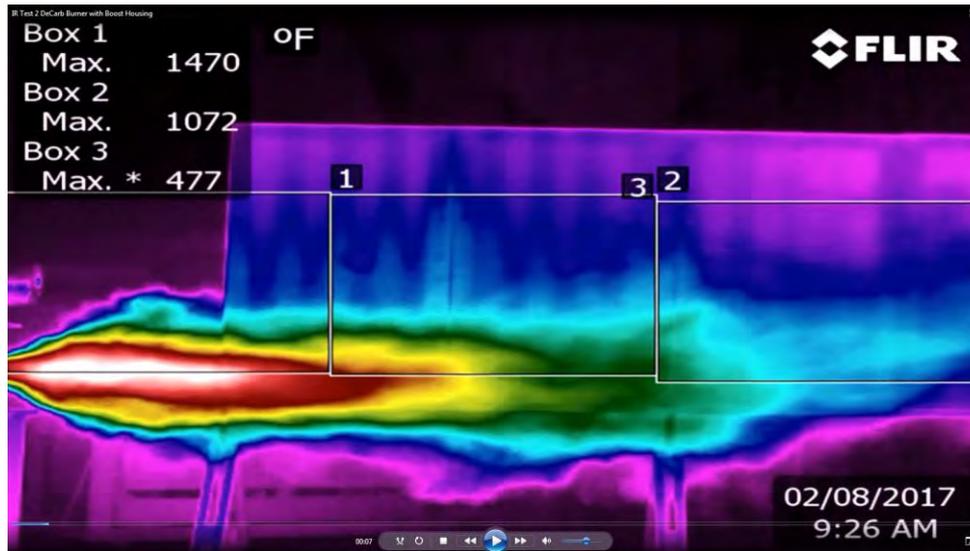
Burner Mode



2200 SCFM Mode



Berry Metal Boost Chamber

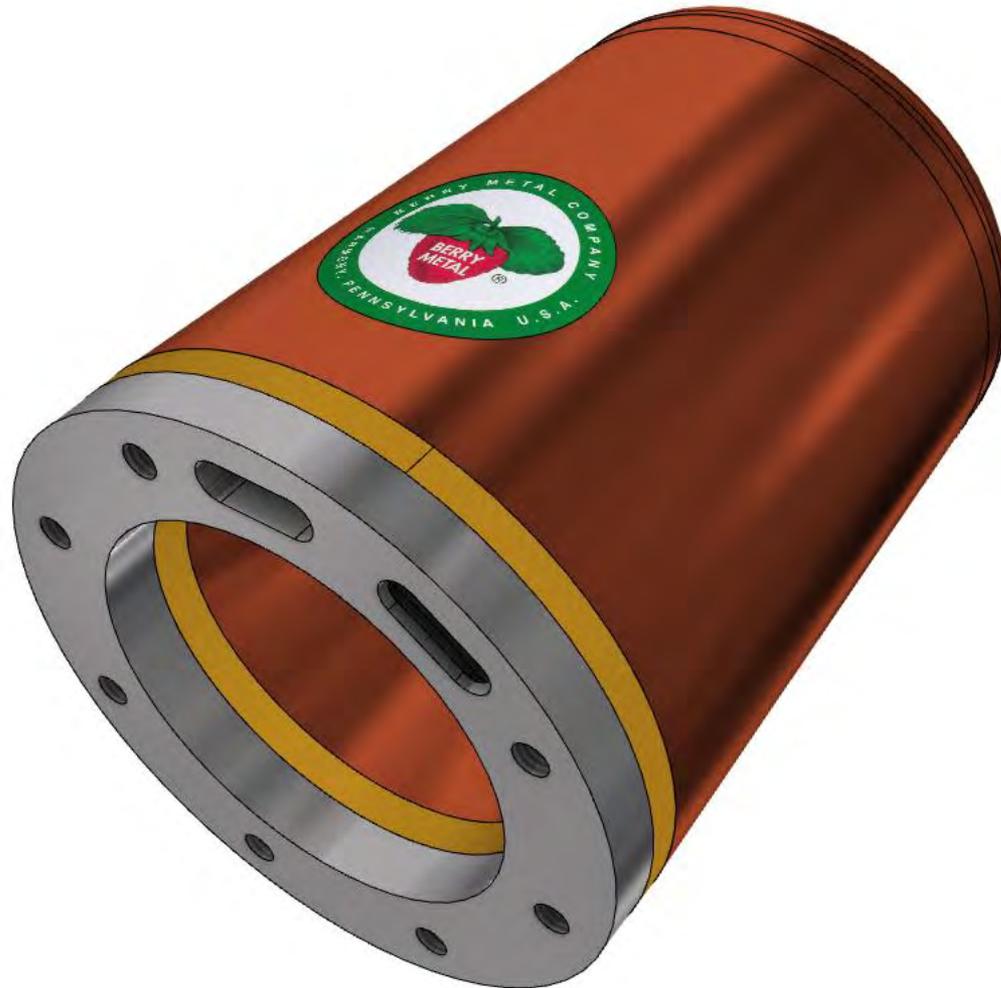


ACTUAL FIELD BURNER TEST RESULTS.

- IR video of Burner and CoJet modes.
- Burner performance was 4.3% more efficient.
- The CoJet mode was substantially longer than the baseline models.



Berry Metal Boost Chamber



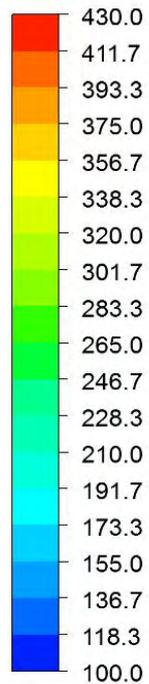


Berry Metal Boost Chamber

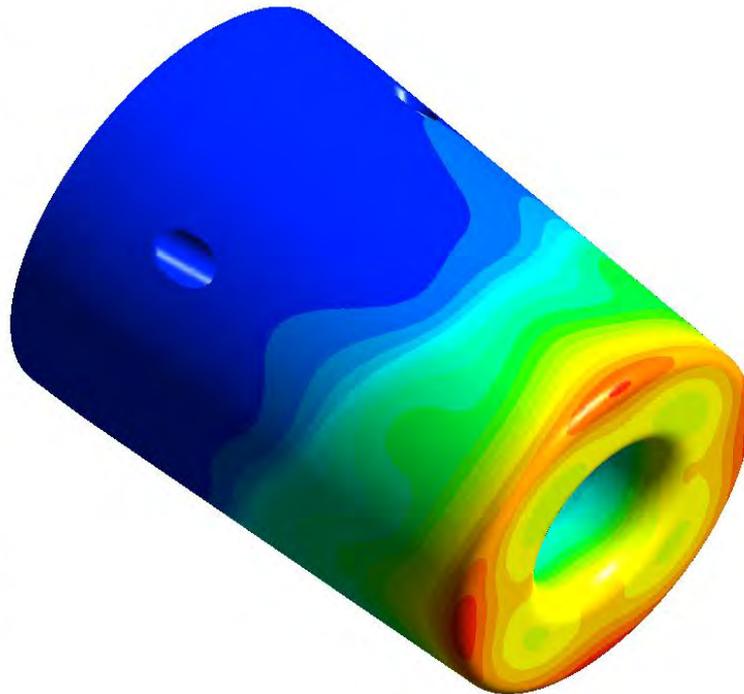
- Patented Technology
- Better Material-Solid Bar Copper vs Cast Copper
- Conductivity is much higher with Fabrication, 98% vs 93% for Cast.
- Cooling is more efficient due to the machined water passages.
- Improved oxygen concentration from better flow.
- Gets the flame closer to the bath.
- Cheaper to replace compared to the burner.



Berry Metal Boost Chamber

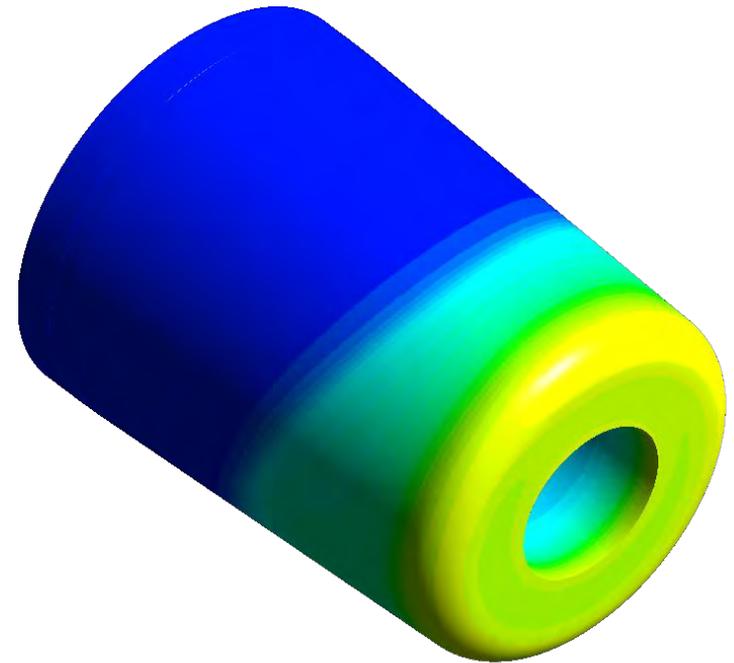


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430°F MAX

**Competitor Combustion Can
Face Temperature**

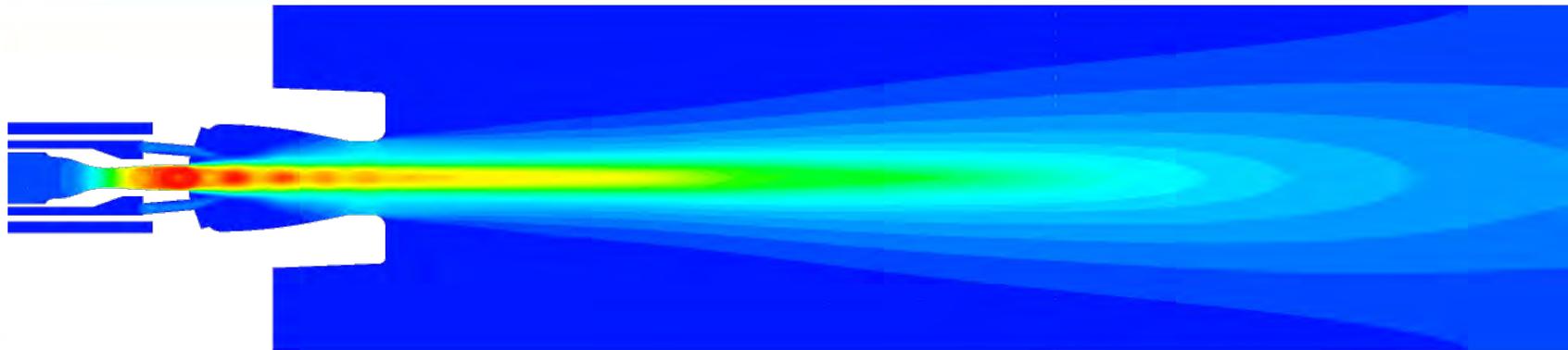


299°F MAX

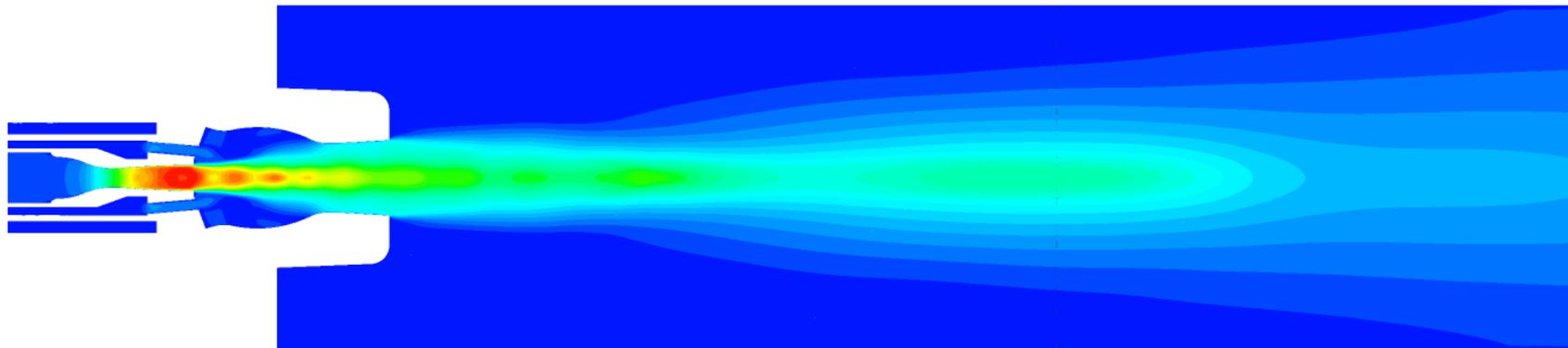
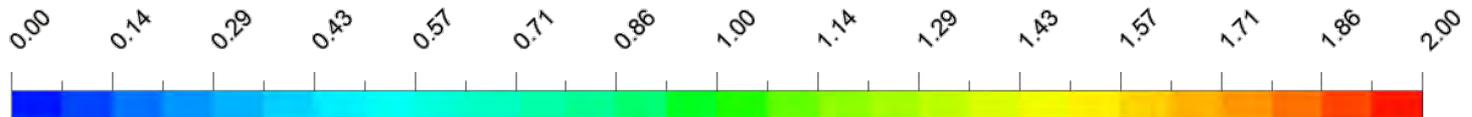
**BMC Boost
Chamber Face
Temp**



Extended Velocity Profile



Competitors Combustion Chamber Mach Velocity Profile

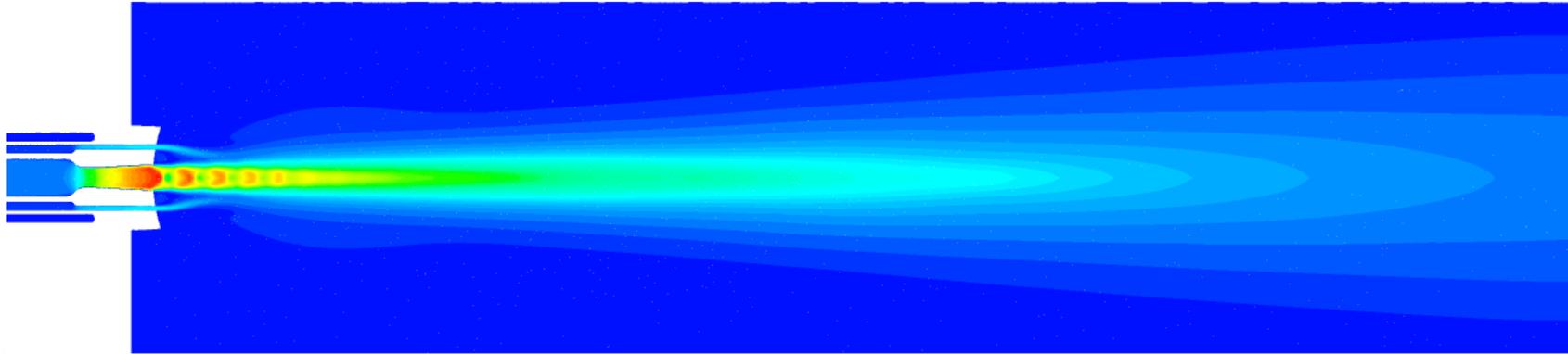


BMC Boost Chamber Mach Velocity Profile

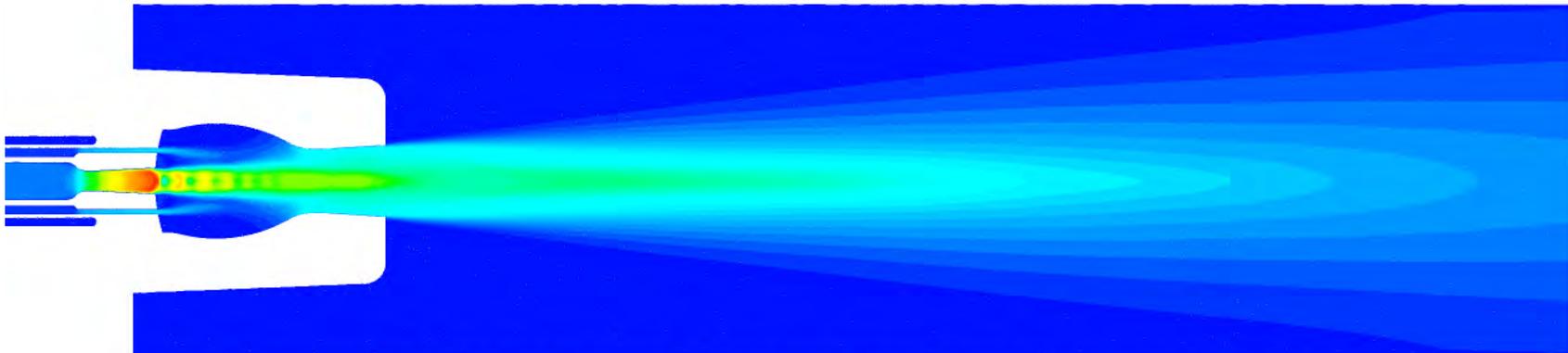


Jet Power Profile

BMC Decarb Burner Mach Velocity Profile



BMC Decarb Burner w/ B.C. Mach Velocity Profile



0.00 0.11 0.21 0.32 0.42 0.53 0.63 0.74 0.84 0.95 1.05 1.16 1.26 1.37 1.47 1.58 1.68 1.79 1.89 2.00



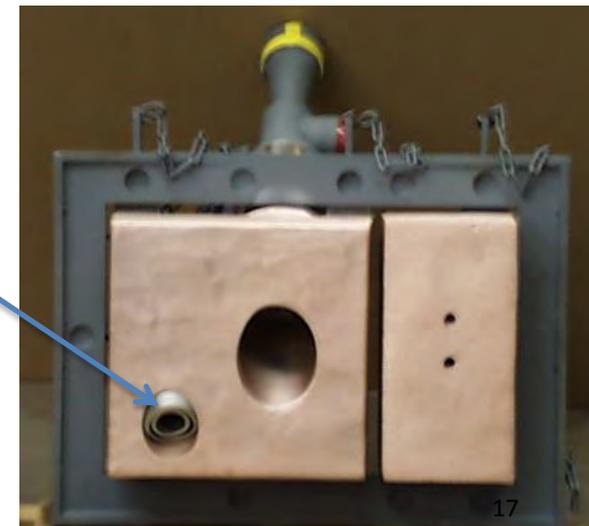
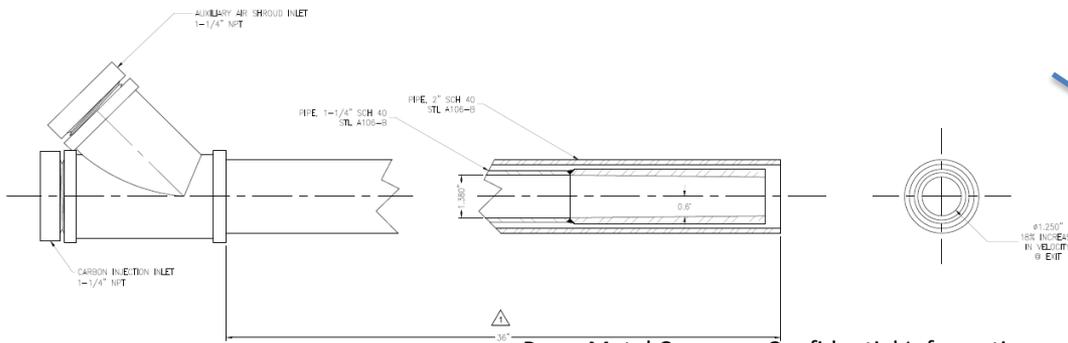
Mach Number



Air Assist Injector

The patent-pending Air Assist Carbon/Lime Injector offers the following:

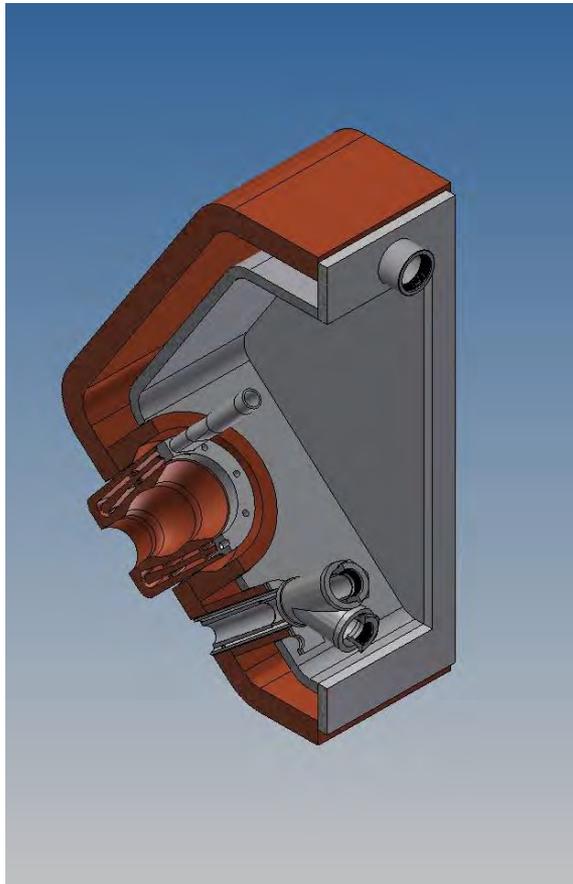
- A simple effective alternative to more complex designs
- Reduced plugging
- Improved performance / penetration into the steel bath
 - Tapered exit section
 - Increased velocity of carbon jet by 18-20%
- Improved service life
 - Heavy wall pipe
 - 20-25% increase in life vs. standard carbon pipes
- Interchangeable / direct replacement with current designs
- A custom-design to fit any application
- Low cost
- Air “boost” for better carbon efficiency





Berry Metal Fab Box

- Optional Carbon Injection below the burner for better carbon efficiency.



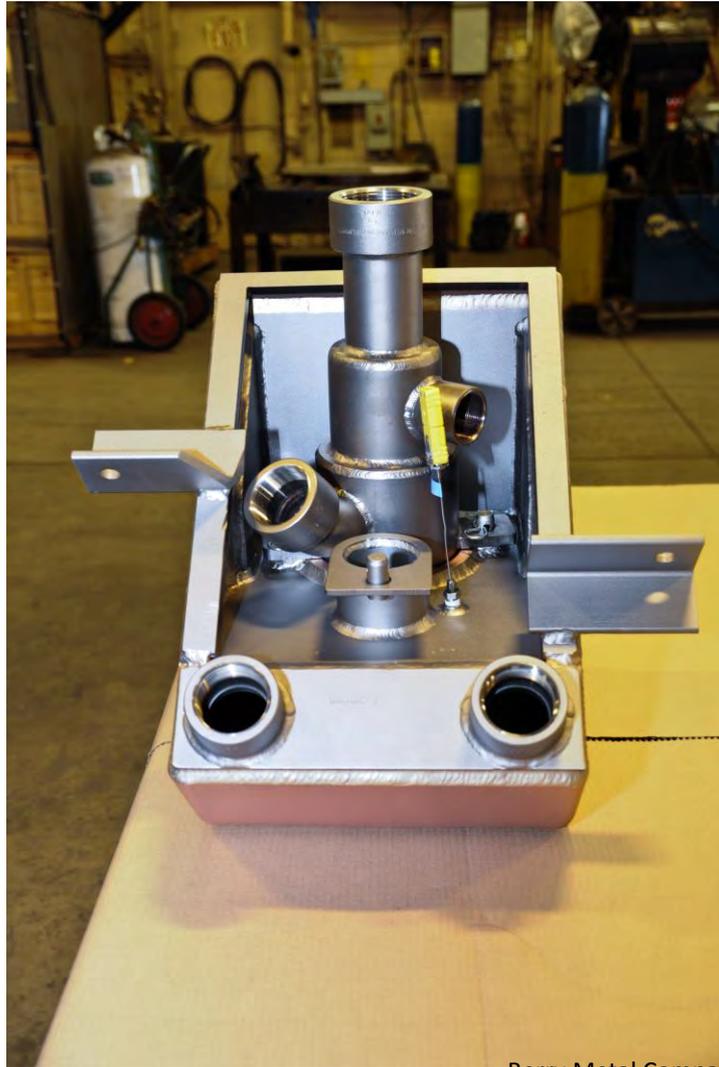


Fabricated Boxes

- Carbon port located below the Burner port for better carbon injection.
- Better materials reduces wear and improves conductivity.
- Specially engineered water baffle design creates better internal and external cooling.
- A cooler box has many advantages
 - Protects the burner, increasing burner system life.
 - Forms accretion at a faster rate for slag protection.
 - Less down time.
- Fabricated boxes have more design flexibility with faster delivery.
- Lower repair costs with reduced time out of service.

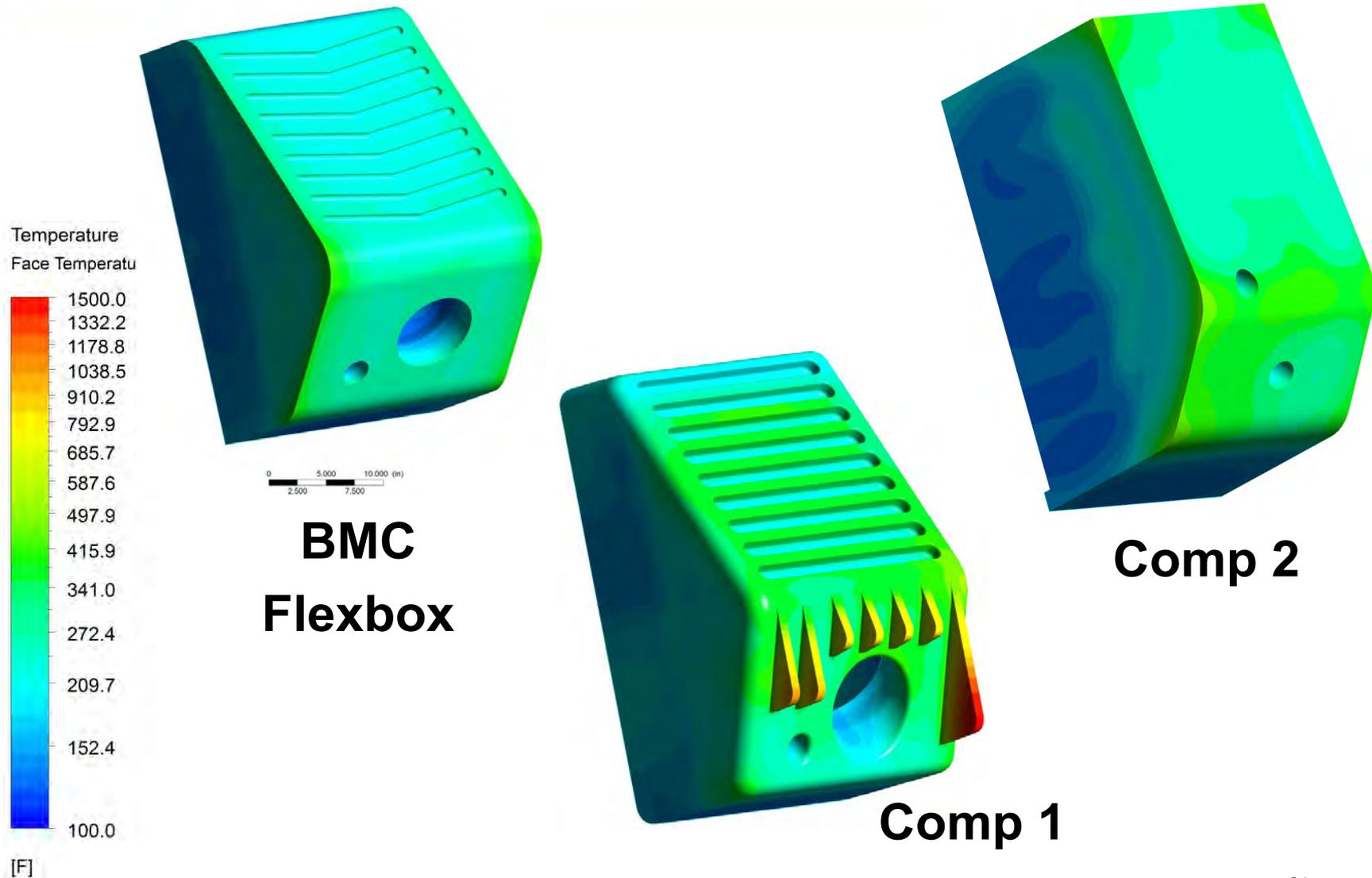


Fabricated Boxes





Fabricated Boxes





Fabricated Boxes

Parameter	Comp. 1	Comp. 2	BMC
Bottom Face Avg. Temp.	576°F	545°F	449°F
Top / Side Face Avg. Temp.	514°F	415°F	383°F
Bottom Face Max. Temp.	694°F	685°F	642°F



Summary

- Similar or lower initial cost.
- Faster repair time with lower cost.
- Longer campaign life of the entire burner system.
- Use of a boost chamber better protects the box against wear.
- Easy retrofit applications