

TIFI®

Targeted In-Furnace Injection™ Technology

Superior boiler performance, corrosion control, and acid plume elimination

Fuel Tech's patented TIFI® Targeted In-Furnace Injection™ programs can help a combustion unit maintain Maximum Combustion Rating (MCR), control derates and unscheduled outages due to slagging and fouling. The use of TIFI programs can decrease risk associated with fuel switching allowing greater operating reliability while burning lower cost opportunity fuels. TIFI programs do this by reducing slag and fouling while providing a host of related benefits. The amount of chemical injected is optimized by targeting all the heat exchangers in the furnace where slag or fouling can be a problem.

Specifically, the use of TIFI programs can allow you to:

- Maximize your boiler's performance by inhibiting slag and fouling formation in the superheat, reheat and furnace wall sections
- Minimize pressure drops across the convection passes
- Improve your boiler's reliability with a customized chemical and equipment program
- All programs include Fuel Tech's on-site Service Technicians with field-proven experience and top performance



Taken during plant shut down after use of the TIFI program for a 5 month period

- Increase Fuel Flexibility
- Improve Boiler Efficiency
- Slag Reduction
- Reduced Sootblower Operation / Maintenance
- Significant Return on Investment (up to 7:1)
- SO₃ Mitigation
- CO₂ Reduction
- Reduces Large Particle Ash Formation and SCR Fouling

How Does TIFI Work?

Fuel Tech creates a customized TIFI injection strategy for your unit to provide high chemical reactivity throughout all the targeted zones simultaneously. By using two different modeling programs and proprietary visualization software, we simulate the operating characteristics of your furnace. Using injection overlays and dosage maps, we can track exactly where the programs should be injected - ensuring nearly 100% coverage of the target zones.




FUEL TECH
Technologies to enable clean efficient energy™

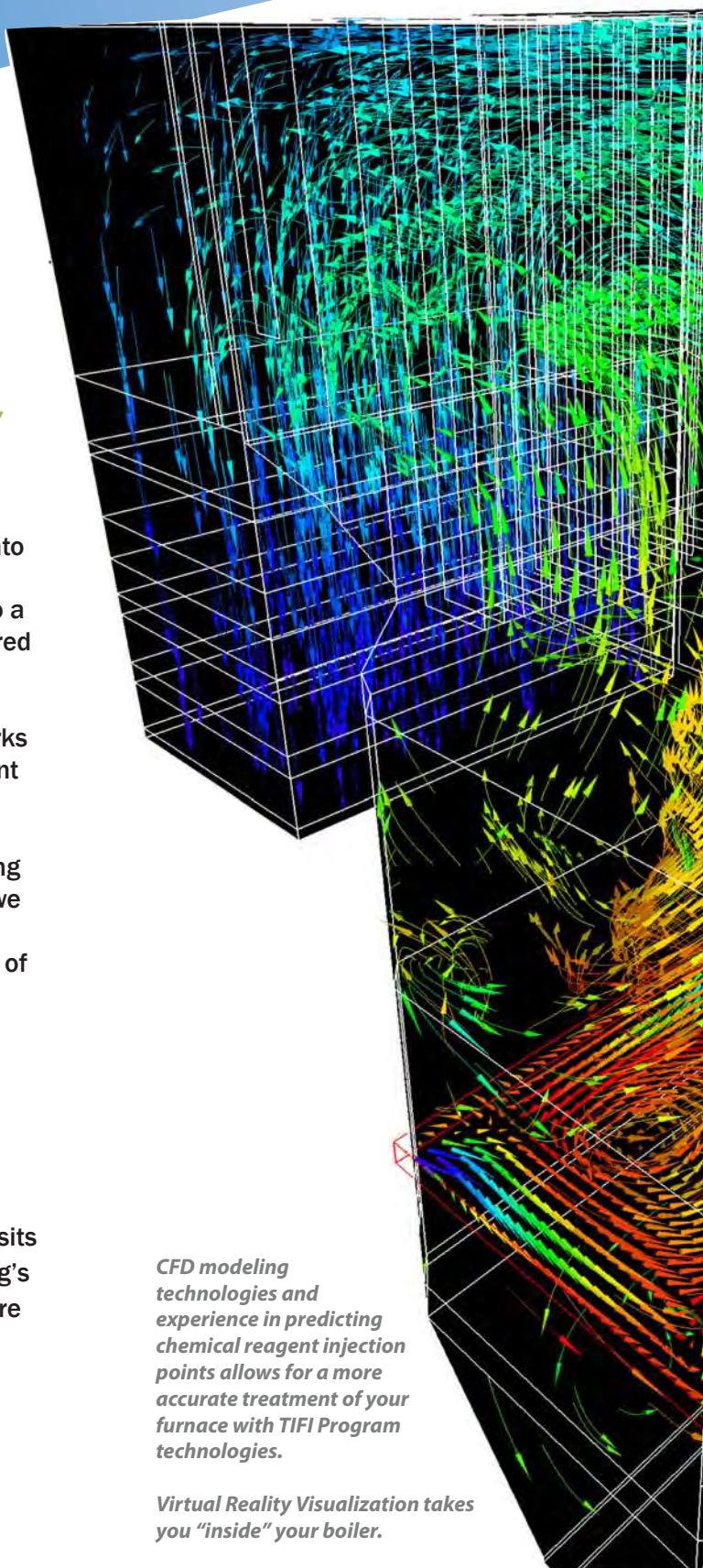
Unique Insight Into the Furnace is Key

Design process engineering is key to program effectiveness. Our computer models take into account the difference in droplet sizes - sending progressively larger droplets deeper into the furnace before evaporating, releasing and activating the chemical where needed. The process iterations converge into a dosage map that shows how much chemical has been delivered to specific areas of the furnace.

Field experience shows that Targeted In-Furnace injection works because it helps direct the correct amount of chemical reagent to the right location. Fuel Tech's abilities in Computational Fluid Dynamics (CFD) and heat transfer modeling are highly sophisticated. Using commercial and proprietary CFD modeling tools along with our own unique virtual reality design space, we recreate your boiler as a "virtual combustion unit" designing injection and dosage strategies with a goal of reaching 100% of your furnace's problem zone.

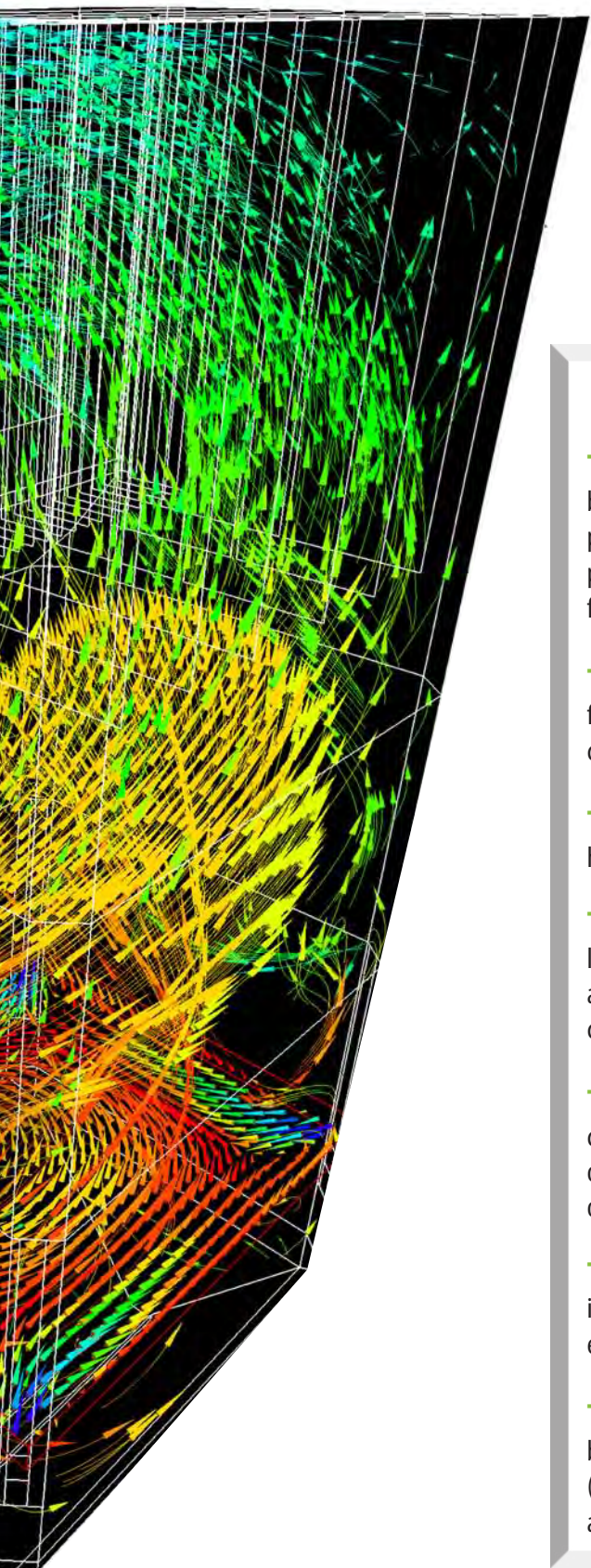
These proprietary chemical reagents are mixed with air and water and targeted at problem areas where slag and fouling interferes with heat transfer and react with undesirable gas species to form harmless by-products.

These slag control reagents also penetrate existing slag deposits to alter undesirable physical characteristics - reducing the slag's structural integrity. Slag deposits become more friable and are more easily cleaned from heat transfer surfaces. A cleaner furnace operates more efficiently and generates less SO_3 .



CFD modeling technologies and experience in predicting chemical reagent injection points allows for a more accurate treatment of your furnace with TIFI Program technologies.

Virtual Reality Visualization takes you "inside" your boiler.



TIFI® Technologies

TIFI MG™ Magnesium hydroxide injected into the combustion unit at locations defined by computer modeling, to maximize coverage of slag and fouling problem areas. TIFI MG™ programs reacts with slag as it forms and penetrates existing deposits to affect the physical crystal characteristics in areas where this is required, particularly in high calcium fuels. This technology also has strong SO₃ abatement performance.

TIFI XP™ Specifically designed to provide users both slag control and increased fuel flexibility in high iron fuels such as Illinois Basin (ILB) coal. TIFI XP™ can also help mitigate corrosion from ILB fuels with high chlorine levels.

TIFI MP™ A high performance program for the reduction of SO₂ without the material handling and ash disposal problems created by using other sorbents.

TIFI Flux™ Specifically designed for cyclone boilers, especially those burning PRB and low iron coals. TIFI Flux™ allows greater operating flexibility, lower power settings and avoidance of the use of costly kerosene or primitive iron additives to meet the demands of cyclone units.

TIFI BlueCat™ Acts as both a slag inhibitor and a combustion catalyst. Used to lower carbon monoxide (CO) and unburned carbon (LOI); it can be fed by itself for these purposes, or in combination with other TIFI technologies to provide SO₂ trim control, enhance capture of heavy metals or control SO₃ emissions.

TIFI Hybrid™ Designed for oil-fired boilers, it uses a combination of TIFI MG™ and in-fuel injection of magnesium hydroxide, TIFI BlueCat™ or other reagents to further enhance performance.

TCI™ Targeted Corrosion Inhibition™ Principally designed for boilers burning high chloride fuels such as Illinois Basin coals and those in the waste-to-energy (WTE) industry. TCI™ technology inhibits corrosion and slag build-up in a variety of solid- and liquid-fueled boilers.

The TIFI Total Program Solution

- Sophisticated CFD Modeling
- Highly Reactive and Stable Reagents
- Chemical Feed Systems
- Experienced Technical Support and System Monitoring

Fuel Types

Coal

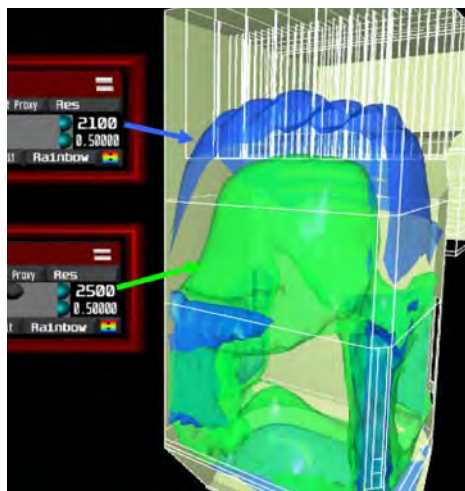
- Powder River Basin (PRB)
- Illinois Basin (ILB)
- Lignite
- Central Appalachian (CAPP)

Alternative Fuels

- Biomass
- Pet Coke
- Hog Fuels
- WTE Fuels
- Liquid Waste Fuels
- Black Liquor

Residual Fuels

- No. 6 Oil
- Waste Oil
- Bunker C

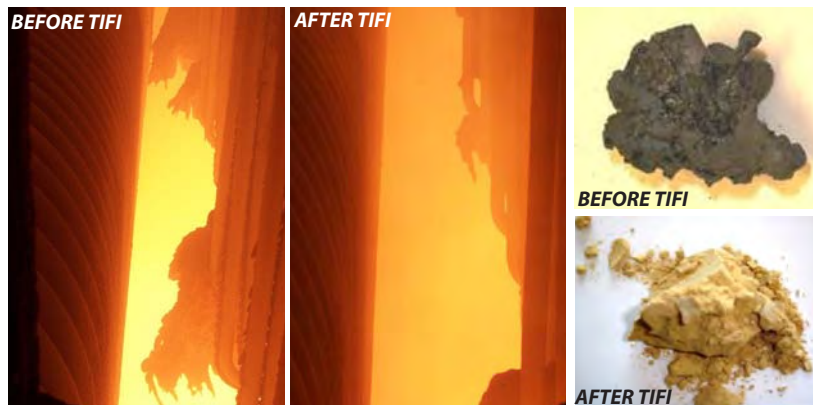


Fuel Flexibility

This CFD model depicts the fusion zones, where molten ash starts to solidify, for coals with high ash fusion temperatures (green areas) and those with lower ash fusion temperatures (blue). These lower fusion temperature coals can negatively impact heat transfer since their fusion zone is often the same temperature as the heat exchanger surfaces. TIFI programs with specifically designed reagent injection solutions can mitigate this problem.

Slag Control

Shown here are two images of a superheater tube bundle in a boiler. Before TIFI was started, slag deposits were bridging from the exchanger to the nose arch. Within hours of



initiating TIFI program feed, the bridging started to disappear, opening the gas pass and allowing better heat transfer with lower pressure differentials. Also shown here, the actual change in crystal morphology observed when a TIFI Program is applied.

In the “before” photo slag is hard and glassy; while in the “after” photo the slag has been transformed and is crumbled and soft.



SO₃ Mitigation

TIFI technologies are also used to successfully control SO₃ and the resultant PM_{2.5} acid “blue plume,” stack opacity, and air heater fouling and corrosion. This allows an operator to run the combustion unit with stack temperatures below dewpoint with no degradation in air heater performance. The end result: reduction in Total Toxic Releases (TTR).

