SCOREKlean℠

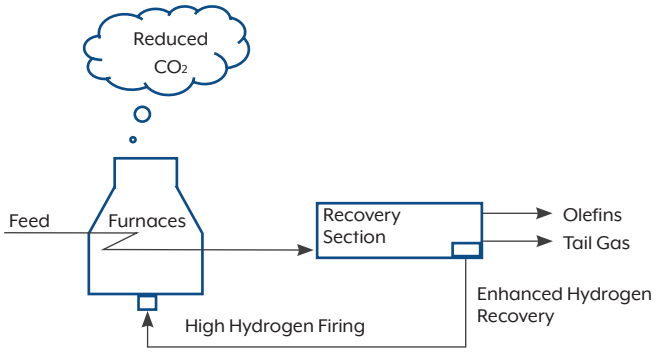
Decarbonization Solutions for Steam Crackers

SCOREKlean[SM] is a suite of decarbonization technologies for steam crackers that addresses direct process emissions, indirect emissions, and other indirect emissions in the olefins value chain.

KBR has proven reference for >84% Hydrogen as directly fired furnace fuel

Hydrogen firing is the most accessible way to decarbonize olefins production, removing carbon from the fuel gas that is combusted in pyrolysis furnaces.

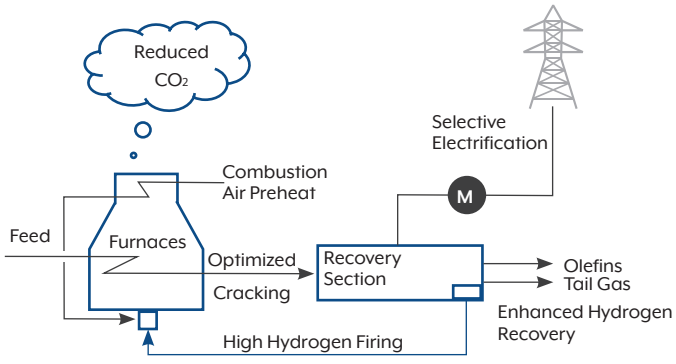
- 100% hydrogen combustion can be accommodated in SCORE® Furnace proprietary burner designs
- Connections existing in our floor fired burner designs can be used to convert to 100% hydrogen firing
- Stable 100% hydrogen firing has been proven in our test facilities over a range of operating conditions
- Fuel flexibility can be retained should hydrogen not be available
- Our ethane cracker designs have operated for many years with fuel gas hydrogen content over 84 mol%



Enhanced hydrogen recovery designs maximize the recovery of hydrogen from cracking process. Recovery section—enhanced hydrogen recovery designs, along with hydrogen firing, can be implemented as part of a grassroots cracker development or revamp to an existing unit.

Standalone low CO_2 cracker designs can reduce direct emissions by 70%

Low CO_2 cracker designs provide emission reductions without requiring carbon capture or an external source of hydrogen. Our emission reduction designs remove carbon from the pyrolysis furnace firebox and move heat from the steam system into the process.



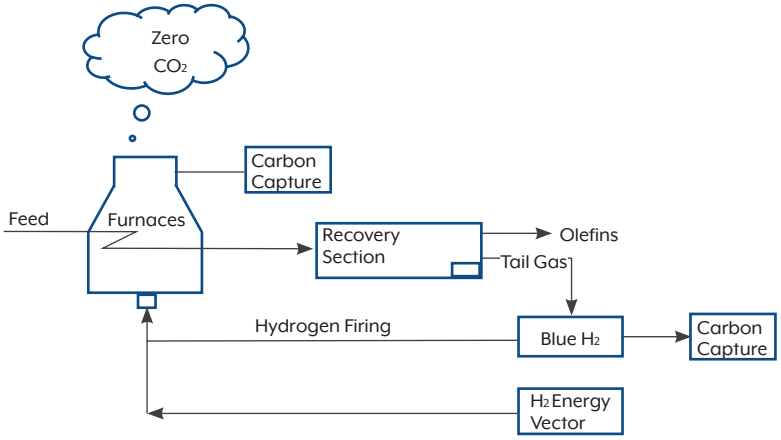
- **Cracking furnace design point optimization** uses the enhanced performance of SCORE® pyrolysis furnaces to reduce energy input
- Ultimate olefin yield can be achieved at higher severity and coil outlet pressure using SCORE® technology, reducing furnace firing rate and recovery section power requirements
- **Combustion air preheat and selective recovery section electrification** moves heat from the steam system to the cracking process
- **Hydrogen firing** combined with **enhanced hydrogen recovery** decarbonizes furnace flue gas

KBR has leveraged its experience in **unconventional feed cracking** towards developing solutions for bio-sourced and recycled feedstock.

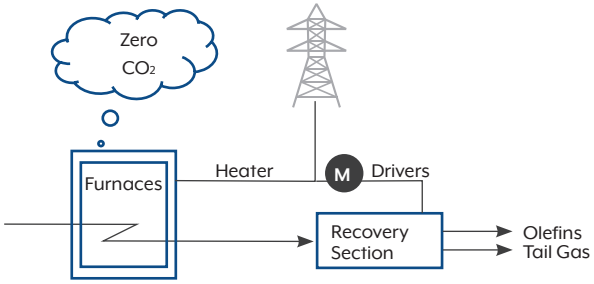
KBR Net Zero cracker designs remove direct carbon emissions from steam crackers

Net Zero steam cracker designs eliminate carbon emissions either at the combustion stage in the firebox or at post-combustion by capturing carbon from flue gas. Blue hydrogen or carbon capture units can be integrated with KBR's low CO_2 cracker designs, removing carbon in the flue gas for a net zero cracker.

- **Tail gas utilization** designs use methane in tail gas to produce a decarbonized energy carrier such as, hydrogen in a blue hydrogen unit or convert the methane into other chemical feedstocks
- **Blue hydrogen unit integration**, where a steam cracker sends methane rich tail gas to the blue hydrogen unit. The unit utilizes PSA to regenerate hydrogen used to fuel pyrolysis furnace
- Hydrogen import and energy vectors can be used to supplement hydrogen from **enhanced hydrogen recovery** in the cracking process
- **Low CO_2 cracker designs** lower the carbon intensity of the cracking process, reducing the size of an associated post-combustion carbon capture facility



KBR is developing concepts on **steam cracking furnace electrification**, to completely remove the flue stacks and direct emissions from pyrolysis furnaces.



- KBR has already designed, built, and operated an electrified cracking pilot plant in the 1990s. This was a miniature version of one of our pyrolysis furnaces
- More recently KBR has developed design concepts in steam cracking furnace electrification, with various configurations of electrical heat input, associated electrical systems, and controls

SCORE® feed-flexible olefin production technology maximizes the yield of ethylene. Our high-yield furnaces, combined with optimized recovery systems are energy and cost efficient. With 70+ years experience, KBR leads the way in innovating olefin production routes, and decarbonizing olefin production technology.

SCOREKlean: Decarbonization Solutions for Steam Crackers

Scope 1	Scope 2	Scope 3
Low CO_2 Designs Utilizing Optimized Process Performance, Air Preheat, and Selective Electrification		Cracking Unconventional Recycled and Bio-Sourced Feedstocks
Hydrogen Firing		
Net Zero Integration with Blue Hydrogen or Carbon Capture		
Furnace Electrification		

ABOUT KBR, INC.

We deliver science, technology and engineering solutions to governments and companies around the world. KBR employs approximately 30,000 people performing diverse, complex and mission critical roles in 34 countries.

KBR is proud to work with its customers across the globe to provide technology, value-added services, and long- term operations and maintenance services to ensure consistent delivery with predictable results.

At KBR, We Deliver.

Scan for more information about KBR Technology Solutions

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