Reliance
Industries Limited

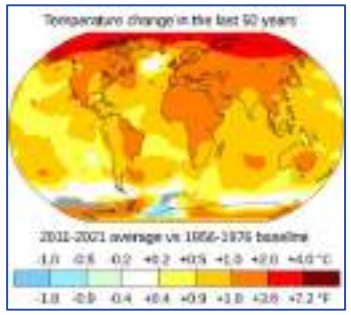
Evaluating Spark Plug Tip Temperature To Address Preignition Issues in Port Fuel Hydrogen Internal Combustion Engine for Heavy Duty Applications

Lavakumar Dasari, Suresh Bagavathy, Somashekhar Nayak, Hariganesh

Confidential

CONTENT

Key Drivers for decarbonization



Global warming and Air pollution

Key Drivers

Energy Independent

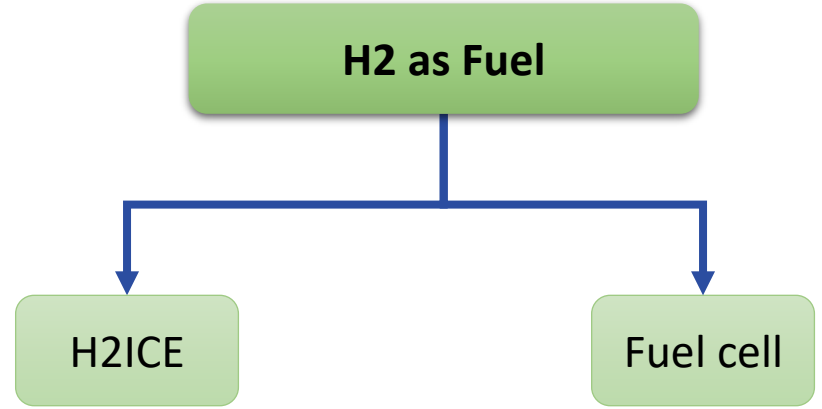
Regulations

Role of Hydrogen & Need for H2ICE

Reliance New Energy Initiative

"We target to become net carbon zero by 2035 …
We will make RIL a leading clean energy and new materials company"

- Chairman's address, 43rd AGM

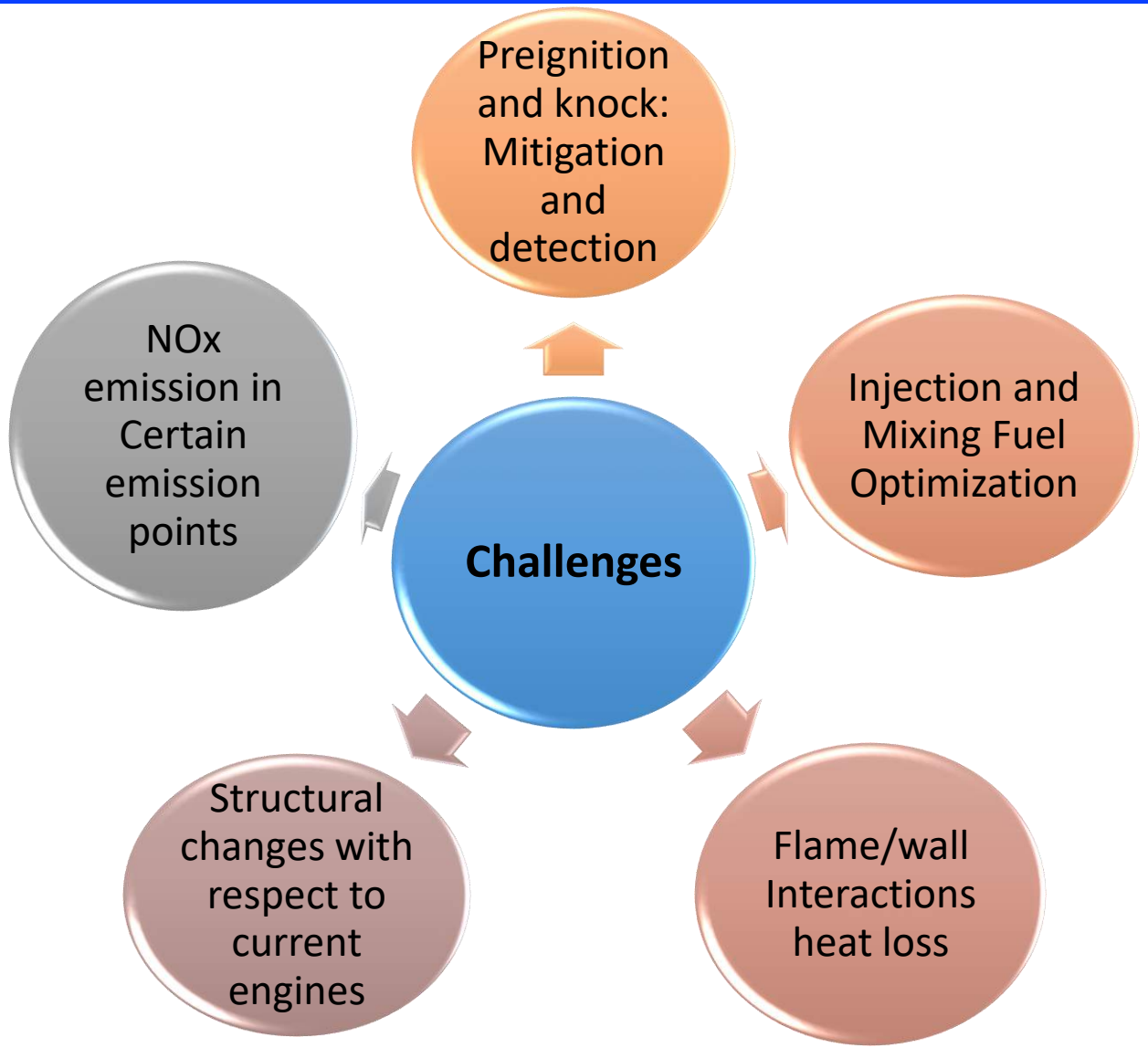


▪ Simple Layout	▪ Complex Layout
▪ Retrofit possible	▪ Entirely new system
▪ TCO lesser than FCEV	▪ Costlier than BEV
▪ Purity level 97%	▪ Purity level 99.99%

Hence H2ICE is better option in current market conditions

RIL will play a catalysing role in transitioning India and the world into an environmentally clean and sustainable economy.

Key Challenges & Changes in H2ICE



H2ICE	DIESEL/PETROL ICE	CNG
H2 Storage Tank Assembly	Fuel Storage tank	Fuel Storage tank
High pressure regulator	X	Pressure Regulator
Low pressure regulator	X	X
Fuel injection System	Fuel Injection System /Spark plugs (Petrol engine)	Fuel Injectors, Ignition coils, Injectors and Spark plugs
H2 Leak deduction sensors	X	X
H2 Storage control unit	X	X
Turbocharger	Turbo charger / Super Charger	Turbo charger / Super Charger

Challenges & Optimization of H2ICE Sparkplug

Challenges

Positioning Challenges

Construction of Spark plug

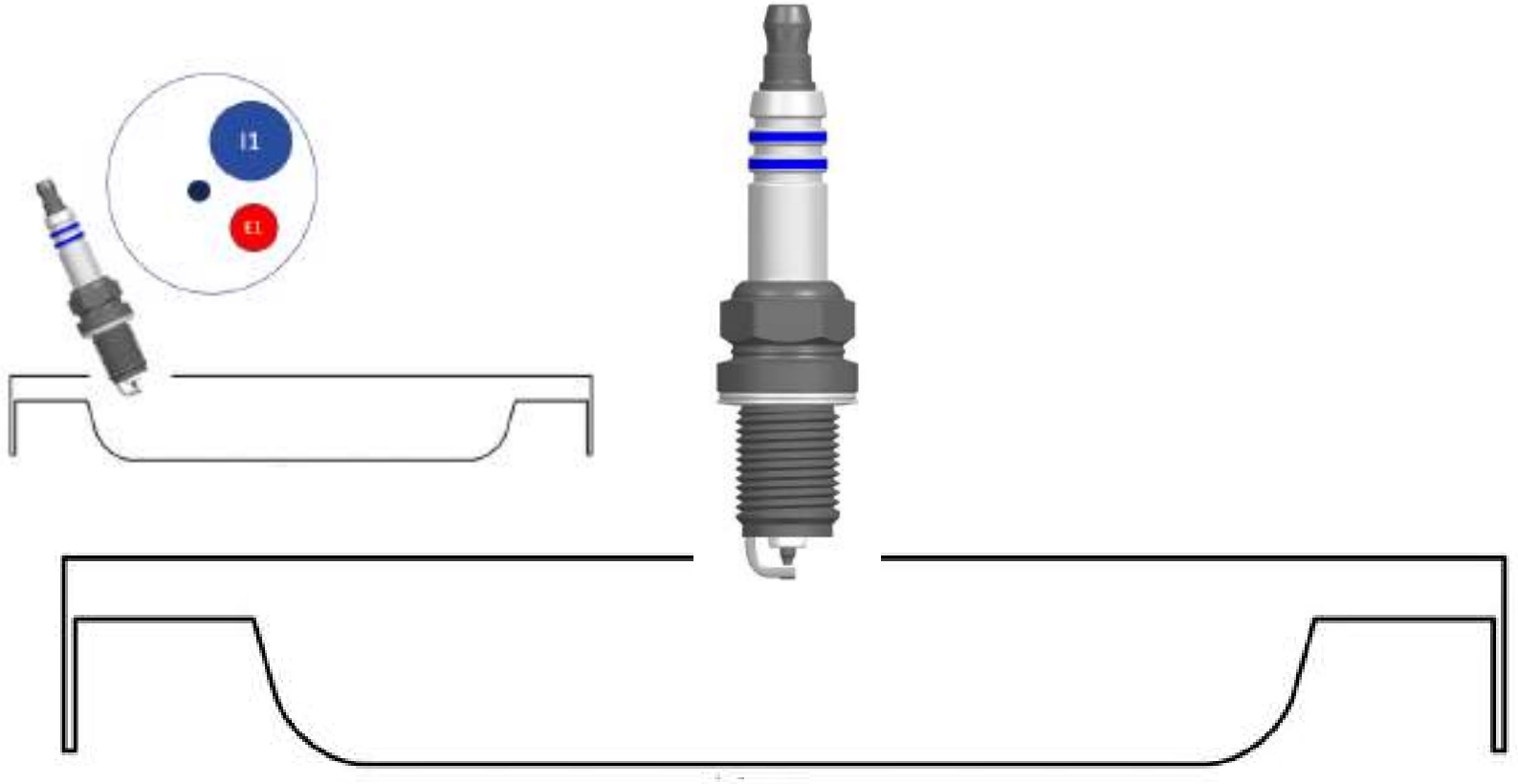
High Temperatures

Gap optimization

Material Durability

Challenges in Sparkplug of H2ICE

- Positioning Challenges
- Construction of Spark plug
- Gap optimization
- High Temperature
- Material Durability



Spark plugs can be positioned either at the center or near to valves. Even the height of the spark plug tip with respect to piston bowl effects the performance & function

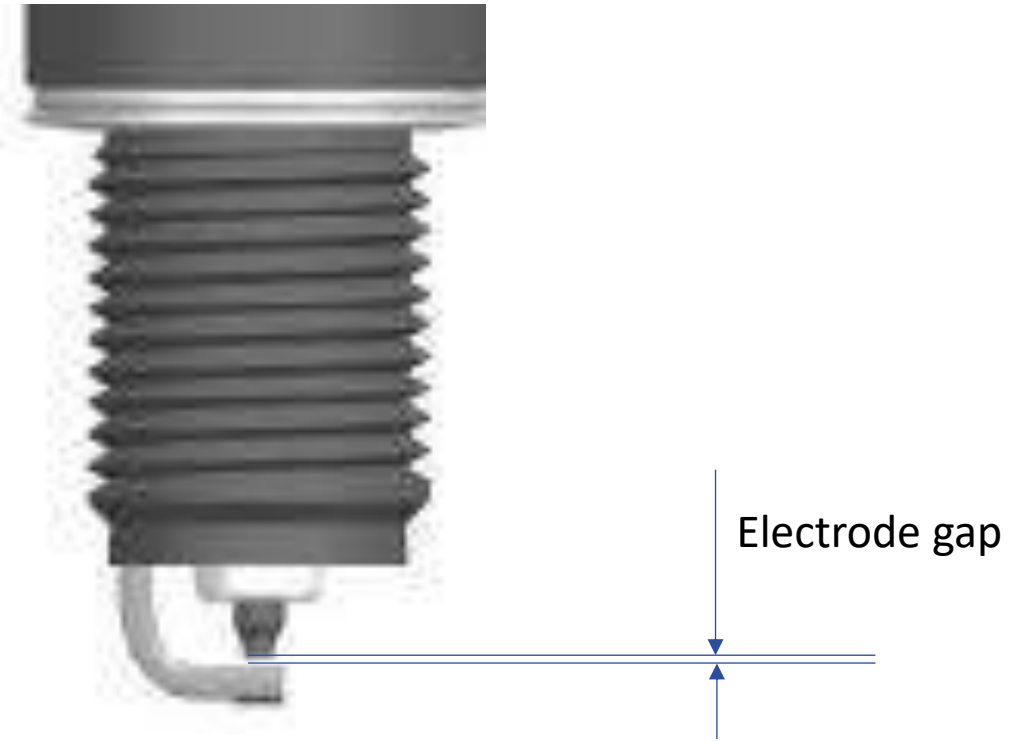
Challenges in Sparkplug of H2ICE

- Positioning Challenges
- Construction of Spark plug
- Gap optimization
- High Temperature
- Material Durability

The construction of spark plugs played a key role in function and performance of the engine

Challenges in Sparkplug of H2ICE

- Positioning Challenges
- Construction of Spark plug
- **Gap optimization**
- High Temperature
- Material Durability

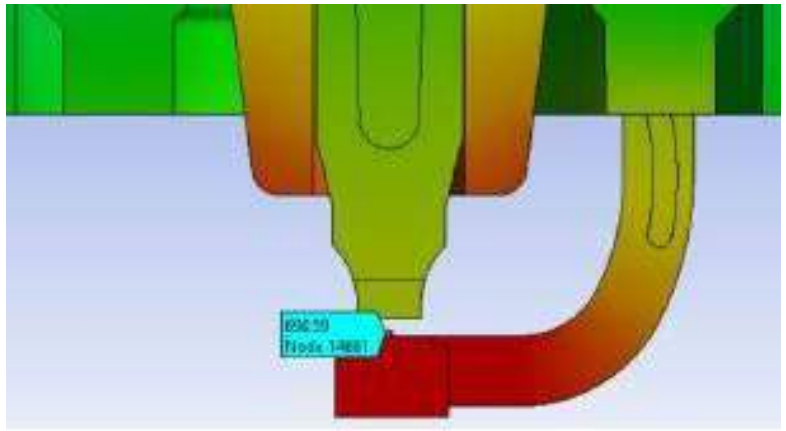


Spark plug electrode gap varies from 0.1mm to 0.35mm for H2ICE engines.

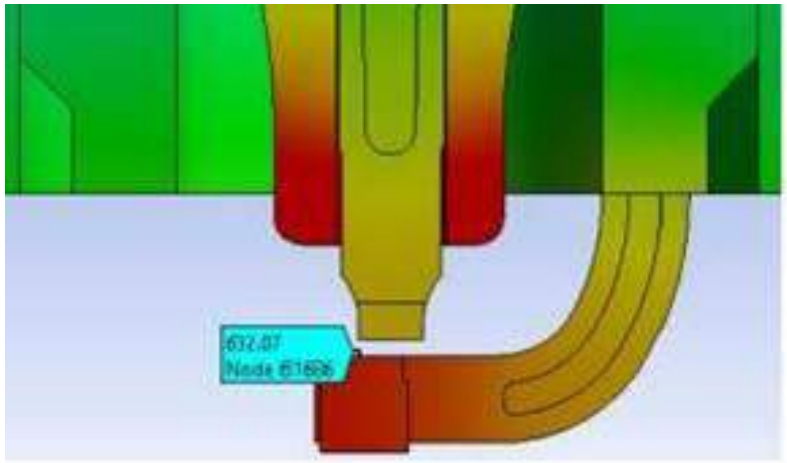
Challenges in Sparkplug of H2ICE

- Positioning Challenges
- Gap optimization
- Construction of Spark plug
- High Temperature
- Material Durability

SPARK PLUG – CONFIG 1



SPARK PLUG – CONFIG 2



The construction and gap played a key role on spark plug tip temperature.

Challenges in Sparkplug of H2ICE

- Positioning Challenges
- Gap optimization
- Construction of Spark plug
- High Temperature
- **Material Durability**

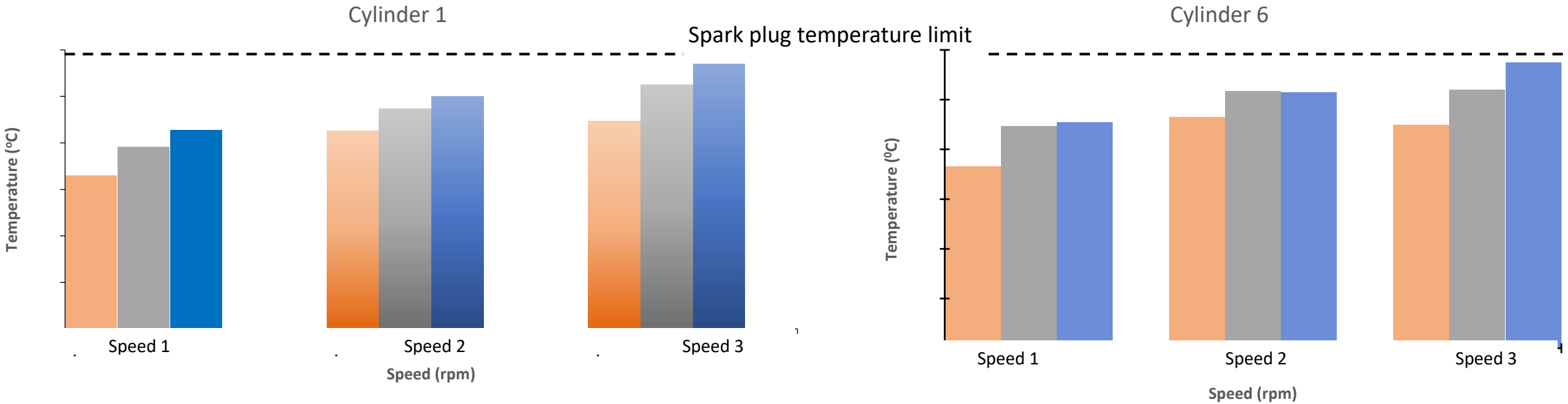
Electrode	Material
Center Electrode	NiY and Iridium Alloy
Ground Electrode	NiY with copper / Platinum – iridium and Platinum alloy

Engine Trails

Trails were conducted on multi cylinder PFI engine

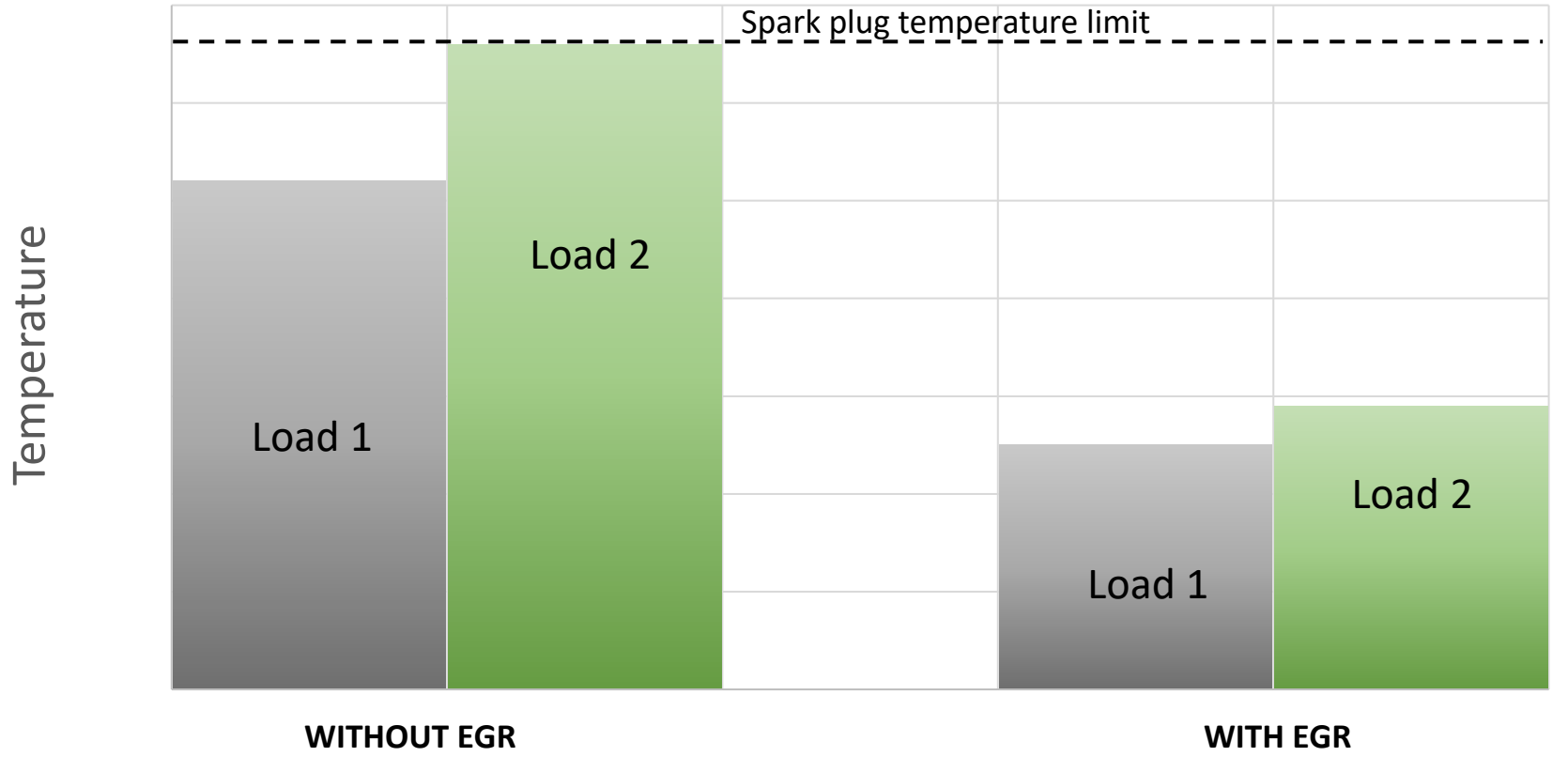
→Spark plug positions → Electrode Gaps →Material →Construction	→ Speeds →Loads → With and Without EGR conditions	Temperatures at the tip of the spark plug electrode

Result and Discussion



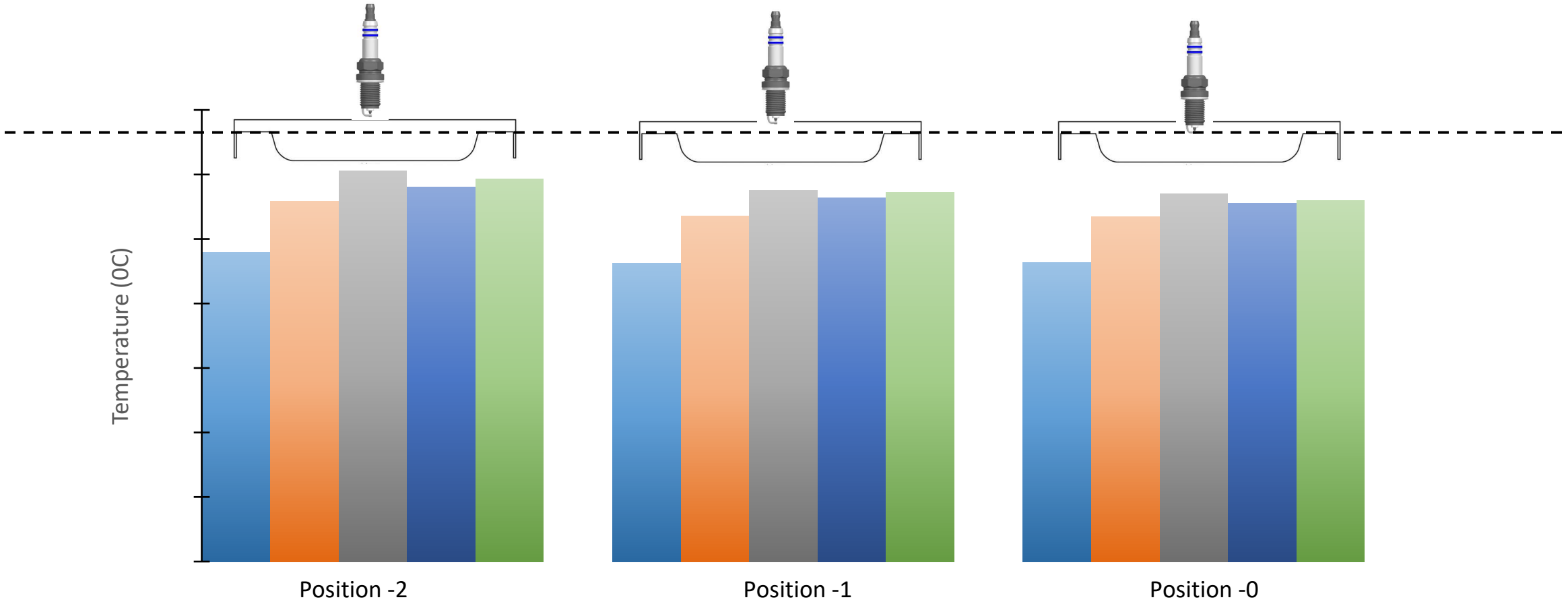
Engine was tested with 3 different loads and 2 different speeds and no cylinder-to-cylinder temperature differences observed and it is not crossing the limit temperature as well

Result and Discussion



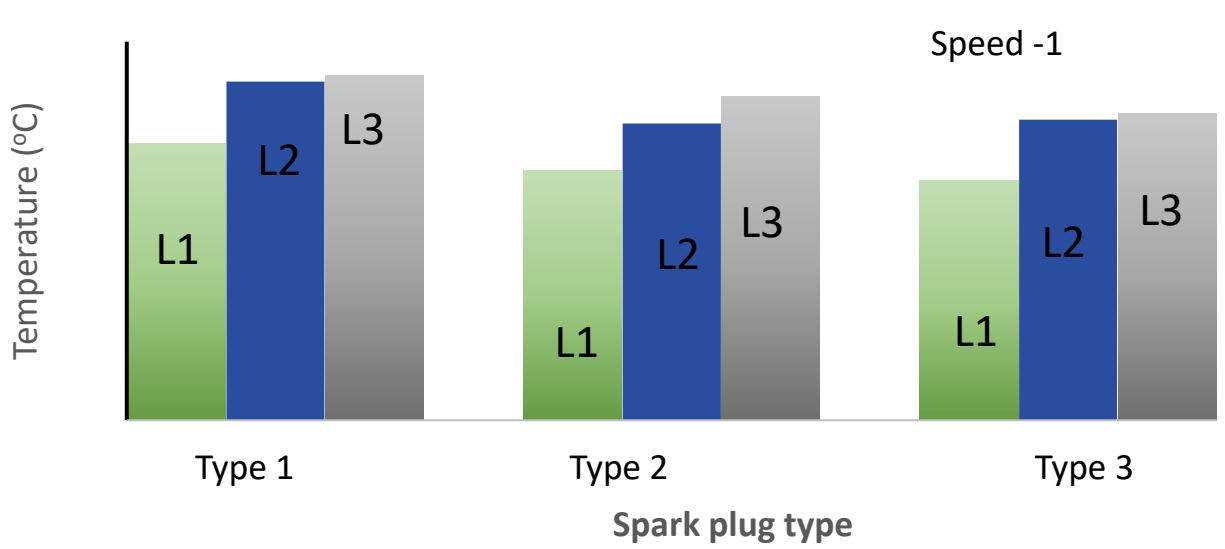
Engine was tested with and without EGR presence, without EGR @ max load points the tip temperature at the boundary.

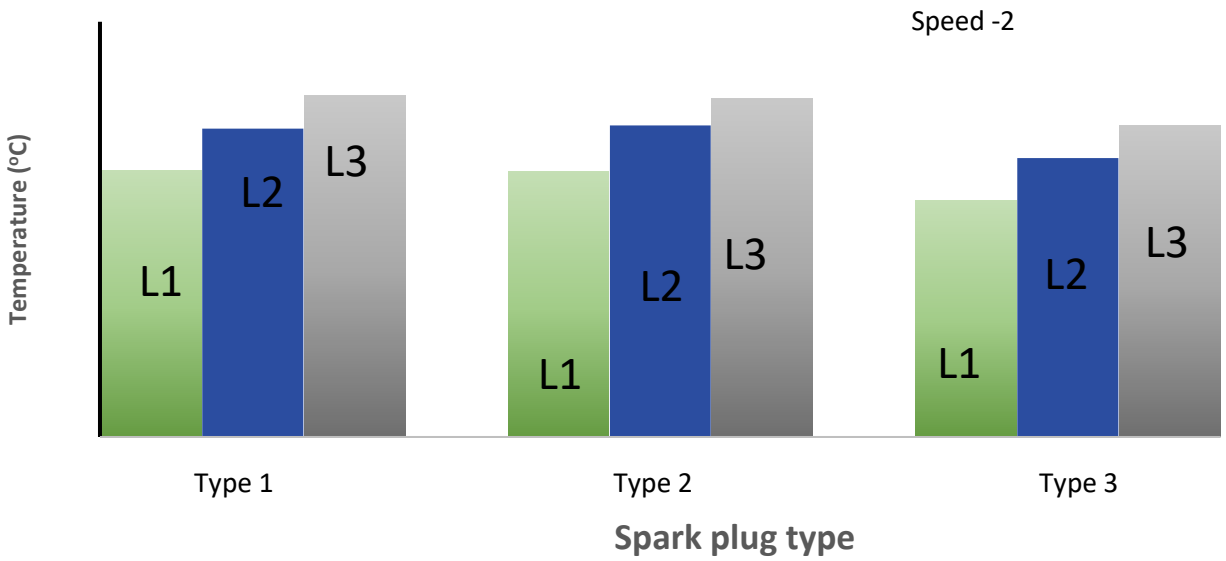
Result and Discussion



Engine was tested with 3 different positions and temperatures at the tip of the spark plug measured.

Result and Discussion





Engine was tested with 3 different spark plugs and temperatures at the tip of the spark plug measured.

Conclusion

- Hydrogen's low flammability & high sensitivity in internal combustion engines can cause pre-ignition and knocking, requiring careful design of heat sources like spark plug tips.
- Spark plug tip temperature must be controlled within hydrogen operational limits to prevent pre-ignition.
- The study determined the optimal spark plug specification and positioning for this hydrogen internal combustion engine.
- Each part/system need to be optimized to suit hydrogen combustion

Future work

- The same spark plugs behavior on engine performance to be studied after engine and vehicle validations
- Use CFD simulations to analyze in-cylinder charge motion and its interaction with sparks.
- Explore advanced materials and coatings for hydrogen-specific spark plugs to enhance heat resistance and thermal management.
- For commonisation of parts across different engines/vehicles lot of trails to be conducted
- Detailed validation tests to be done to study the behavior of parts/systems with respect to hydrogen combustion and operations.


Reimagination of
our entire energy platform
is happening now.
SUSTAINABLE CHANGE.
IT'S HAPPENING NOW.
India's 1st H2ICE technology truck on road.
• Near zero emissions
• H2ICE vehicle performance on-par with diesel ICE
• ~20% fuel OPEX saving over diesel ICE vehicle
• ~10-15% noise reduction over diesel ICE vehicle
ASHOK LEYLAND
Reliance
OFFERING INDIA'S 1ST INTEGRATED END-TO-END HYDROGEN ECOSYSTEM