Detailed numerical simulation of ammonia/diesel combustion under CI engine conditions

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Popular summary in English

I have always been inspired by the extraordinary game It Takes Two, developed by Hazelight Studio—a relatively unknown game developer in Sweden before the game's huge success. This beautiful fairy tale follows a couple on the edge of divorce who, through cooperation and mutual understanding, rediscover their bond and rekindle their love by the end of their journey.

Much like the emotional narrative in It Takes Two, my research tells the story of two unlikely partners embarking on their own complex but compelling journey: ammonia and diesel. At first glance, ammonia might not seem like a super hero: it is difficult to ignite and potentially harmful due to nitrogen oxide (NO_x) emissions if mismanaged. Yet, when handled correctly, ammonia proves to be a remarkably clean energy carrier, emitting primarily water and nitrogen with no carbon dioxide, making it a promising player in the global effort to combat climate change.

Diesel, by contrast, is like a hot-headed partner—fiery, impulsive, and quick to react. It ignites with ease, sometimes almost too eagerly, making it powerful but also unpredictable. Despite its volatile nature and the burden of heavy carbon emissions, diesel brings a tough kind of trust you can count on that is crucial for initiating combustion, especially in energy systems that demand strength and certainty.

In the spirit of It Takes Two, the thesis is about the story of ammonia and diesel, who have to work together like two very different friends on a roller-coaster adventure, each compensating for the other's limitations. Diesel takes the lead, igniting first and paving the way for ammonia to burn more cleanly and efficiently. This collaborative process is known as Reactivity-Controlled Compression Ignition (RCCI). Through detailed numerical simulations, my research looks into how these two fuels work and support each other, all aiming for a brighter goal—a cleaner, healthier planet for everyone who calls it home.

Yet, every journey has its twists and lessons:

Key Lessons

- Cooperation makes practical RCCI systems achievable in the near future.
- Success emerges from teamwork, but individual strength remains critical. Diesel ignites the initial flame, but sustainable RCCI combustion ultimately relies on ammonia's ability to sustain its own flame.
- Not everything goes as expected; high nitrous oxide (N_2O) emissions can result when these fuels burn together. Sometimes, gaining ground means losing a little along the way.
- Even the strongest partnerships sometimes need a boost from outside. Just as fairy tales often show characters taking the wind to overcome challenges, ammonia and diesel benefit greatly from a controlled airflow, which significantly reduces harmful NO emissions.

Just as the heartfelt story from Hazelight Studio touched me, I hope the tale of ammonia and diesel, told through my research, will be a story you'll enjoy too.