ENGINEERING PRACTICE

VOLUME 9 NUMBER 36 JANUARY 2023

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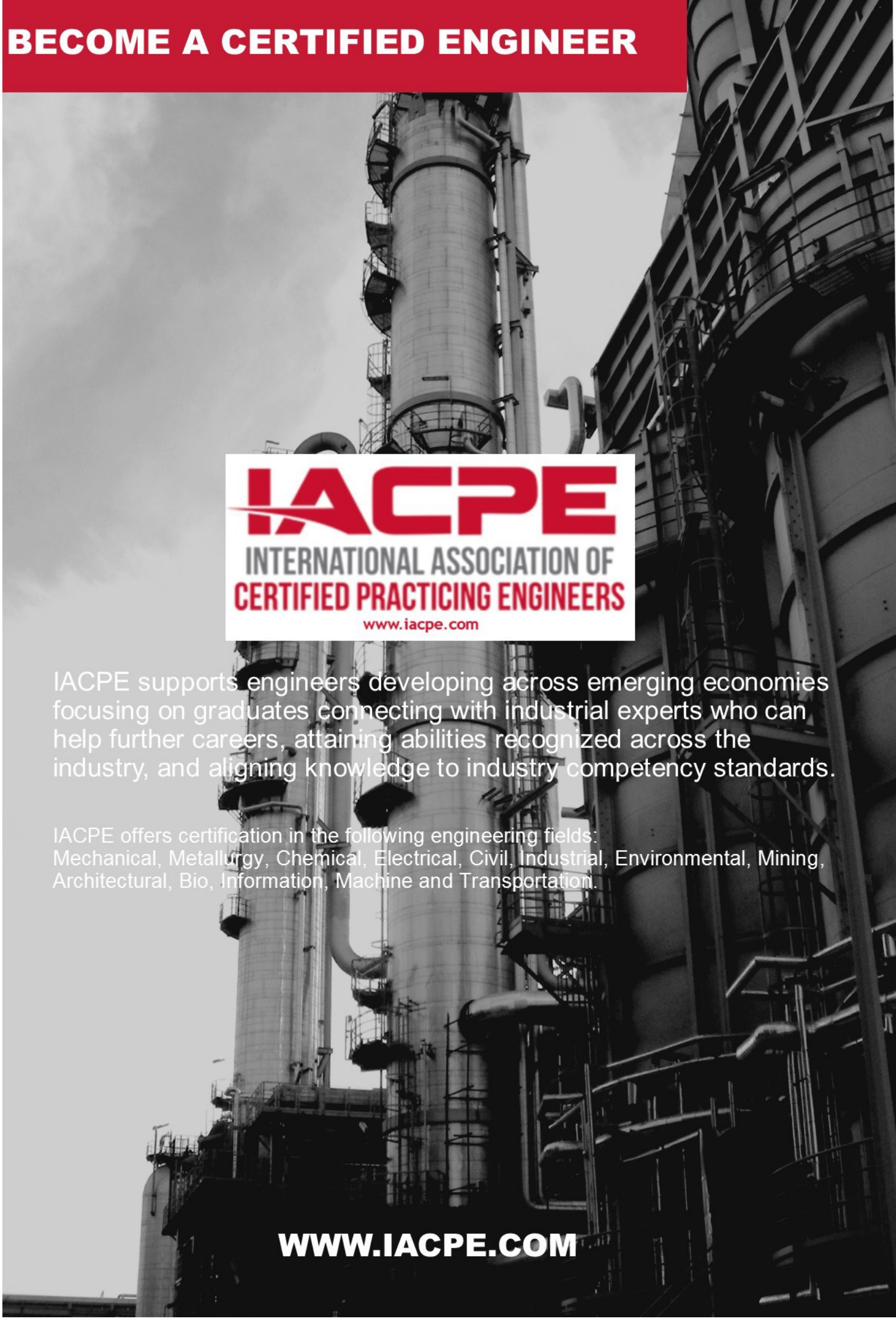

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Rock Bottom View:

Monday, December 5, 2022 Was an Important Day in Science

Fusion Nuclear Power Finally!....But Is It Safe?

Ronald J. Cormier, *Engineering Practice* Contributing Author

Happy 2023! As has been the case since EP-M's September 2022 edition, I continue penning *TVRB* while on my travels in Mexico, where it's warm and mild: a truly always-comfortable climate. That said, I expect that I will return shortly after the holidays to author the March 2023 edition from the old ranch porch back in Central Texas, probably until the weather likely again proves unbearable this summer.

Most of us are involved with precision designs which combust, and/or chemically manipulate hydrocarbons, but also "along for the ride", we stoichiometrically produce CO2, NOx, ozone, etc. These are generally undesirable by-products. Generated throughout the twentieth century and through to present times, these gases have been determined to negatively affect the earth's protective atmosphere.

We generally understand and accept mandates toward achieving "zero emissions" from our processes during the 2030-2050 period, depending on various bureaucratic and cultural edicts. Most major firms, currently producing offending emissions to water, land, or air, are at least beginning paradigm steps to improve methods geared toward achieving a better environment for future generations on planet Earth. Wind and solar alternatives will help, though issues still impede these energy sources from easy substitutes for oil/gas. Additional innovation is required to produce seamless flow of energy or product via wind/solar.

Nuclear power has often been regarded as either a miracle or a pariah, depending on your individual viewpoint. Nuclear plants must be taken care of properly to avoid a meltdown. If from uranium fission, the radioactive waste that is produced must be stored carefully so that it does not come into contact with the outside environment. In fact, any material that becomes contaminated can remain radioactive for thousands of years! Most nuclear fuel is stored underwater, but a few reactors store the older and less radioactive fuel in storage facilities located outdoors, protecting the structures with special concrete or steel shielding. Since the late 1950's, this inevitability has drawn the ire of global environmentalists.

However, that all may be changing. Scientific breakthroughs are finally occurring. "Monday, December 5, 2022, was an important day in science," Jill Hruby, the National Nuclear Security Administration Administrator, said at a press conference announcing the news in Washington D.C. "Reaching ignition in a controlled fusion experiment is an achievement that has come after more than 60 years of global research, development, engineering and experimentation."

Reaching ignition means the fusion experiment produced more energy from fusion than the laser energy that used to drive the reaction. Since the experiment, the team has been analyzing data to be able to make this official announcement.

"This is important. Earlier results were records, but not yet producing more energy out than was put in," Andrew Holland, the CEO of the industry's trade group, the Fusion Industry Association told CNBC. "For the first time on Earth, scientists have confirmed a fusion energy experiment released more power than it takes to initiate, proving the physical basis for fusion energy. This will lead fusion to be a safe and sustainable energy source in the near future."

In the experiment on Dec. 5, about two megajoules (a unit of energy) went into the reaction and about three megajoules came out, said Marvin Adams, Deputy Administrator for

Defense Programs at the National Nuclear Security Administration. “A gain of 1.5,” Adams said.

For the experiment, super high-powered lasers are all directed at a very tiny fuel target at the National Ignition Facility at the Lawrence Livermore National Laboratory in California. “During experiments, 192 high energy lasers converge on a target about the size of a peppercorn heating a capsule of deuterium and tritium to over 3 million degrees Celsius and briefly simulating the same process that powers the sun and stars,” Hruby said. This could eventually lead to an unlimited source of cheap, clean energy since no CO2 or waste is produced.

The main mission of the National Lab is studying nuclear power for use in national defense. This nuclear fusion research is part of an effort established in 1996 by then President Clinton to maintain confidence in the safety of nuclear weapons stockpiles without full-scale nuclear testing. But this discovery has massive implications for clean energy, too. In addition to the national security work, “we have taken the first tentative steps towards a clean energy source that could revolutionize the world,” Hruby said.

While this scientific breakthrough is being celebrated at the highest levels of government, it will be many years before fusion power plants are likely to provide clean abundant energy. “This is one igniting capsule, one time. And to realize commercial fusion energy, you have to do many things. You have to be able to produce many, many fusion ignition events per minute,” Kim Budil, the director of the Lawrence Livermore Lab, said on Tuesday.

“You have to have a robust system of drivers to enable that. So, you know, probably decades. Not six decades, I don’t think. Not five decades, which is what we used to say. I think it’s moving into the foreground and probably, with concerted effort and investment, a few decades of research on the underlying technologies could put us in a position to build a power plant.”

Omar A. Hurricane, Chief Scientist for the Inertial Confinement Fusion Program at Lawrence Livermore, explained, “What remains to be done from here is largely engineering, of increasing the laser energy efficiency and increasing the target energy gain with further target optimizations.”

Hurricane added, “This new result does indeed bring commercial fusion closer, as it demonstrates that there are no fundamental physics obstacles. It is starting to feel like we are entering the ‘Fusion Age.’” Interest in fusion has increased dramatically in recent years as concerns about climate change and energy security have become more acute.

More than 90 nuclear fission reactors currently operate in the United States, which employ a neutron smashing into a larger atom, causing it to split into two smaller atoms and releasing a lot of energy. Nuclear fission reactions do not release any carbon dioxide emissions and therefore are considered clean energy, according to the US Department of Energy.

The United States got approximately 19% of its utility-sized electricity generation from those nuclear power fission plants in 2021, according to the U.S. Energy Information Administration. The energy from nuclear fission reactors represents half of the clean power generated in the United States. However, those reactors generate long-lasting nuclear radioactive waste, and most countries, including the United States, currently have no long-term storage facilities for that waste. Efforts to build a permanent, underground geologic storage facility for nuclear waste have so far, not gained support.

While the fusion reaction avoids waste and associated storage, it’s proven extremely challenging to sustain a fusion reaction here on earth, and scientists have been trying for decades. In particular, it requires massive amounts of energy to generate fusion on reactions, and until this experiment, nobody had demonstrated the ability to get more energy out of the reaction than it takes to power it.
“Scientists have struggled to show that fusion can release more energy out than is put in since the 1950s,” plasma physicist Arthur Turrell told CNBC. The researchers at Lawrence Livermore have done this for the first time ever.

Fusion is already a hot space for climate and energy investors. Investors have poured almost $5B into private fusion energy startups, according to the Fusion Industry Association, and more than half of that has been since the second quarter of 2021.

Indeed, the private fusion industry is seeing this as a win. In short, this will show the world that fusion is not science fiction: it will soon be

a viable source of energy. Of course, there are still many steps between these experimental results and commercial fusion power plants, providing our upcoming STEM graduates with a rich and concentrated career paths (think IACPE Certification too!!!). Bottom Line: the Livermore breakthrough is an important milestone that brings us closer to the day when nuclear fusion will provide the world with clean, safe, and abundant energy.

In closing (and to especially to our readers in Europe, already starting to experience a shortage of winter heating products, due to the Russian/Ukrainian war), I can only imagine the avoided human pain and hardship, if nuclear fusion technology was at a commercial stage today.

Until the EPM March 2023 edition, I bid you a safe and prosperous winter.

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