CASE STUDY

How I played a pivotal role in **STAR WARS**

Whether you were around to witness the advent of STAR WARS and its subsequent updated releases, I have always had a fond memory of how I played a pivotal role in helping advance the technology to where it is today in the U.S. Air Force.

Figure 1: After decades of expensive, well-publicized failures, laser weapons may finally be on the horizon (Image credit: Nick Kaloterakis)

HYDROGEN PEROXIDE vs. NITROGEN TRIFLOURIDE SYSTEM

For a vision of war, it was almost elegant. Let me digress for a bit. It's 1977, I was using Mom's dining room table as my mock aircraft carrier launching off my innovative 1st version of a Corsair F4U-1A (Baa Baa Black Sheep fame) model airplane with the retrofitted RC motor from my L82 Corvette RC Car. I folded down the wings and launched

my first failure off the deck of the makeshift aircraft carrier. Boy did I get a whipping for the scratch left on the dining room table from the prop spinning off violently.

Now for most of us technologists, we tinkered with just about everything as kids including anything electronic for me. For my brothers they had the Millennium Falcon, one building the model and the other having the toy. We would fight with the lightsabers from the Star Wars saga as if we were Darth and Luke (See Figure 2). Little did I know at 11-years old both the saga and the future of laser weapons would come to light, no pun intended…

Figure 2: Darth Vader vs. Luke Skywalker Poster

Chemical Oxygen Iodine Laser (COIL)

Today's highly competitive global market finds the COIL technology as a modern lightsaber, using a near -infrared chemical laser. As the beam is infrared, it cannot be seen with the naked eye. It is capable of output power scaling up to megawatts in continuous mode. Its output is 13 nanometers, a transition wavelength of atomic iodine.

The laser is fed with gaseous chlorine, molecular iodine, and an aqueous mixture of hydrogen peroxide and potassium hydroxide. The aqueous peroxide solution undergoes chemical reaction with chlorine, producing heat, potassium chloride, and oxygen in excited state, singlet delta oxygen. Spontaneous transition of excited oxygen to the triplet sigma ground state is forbidden, giving the excited oxygen a spontaneous lifetime of about 45-minutes. This allows the singlet oxygen to transfer its energy to the iodine atoms present in the gas stream, the atomic iodine is nearly resonant with singlet oxygen, so the energy transfer during the collision of particle is rapid. The excited iodine atoms then undergo a stimulated emission and lases at 1.315 micromoles in the optical resonator region of the laser. The laser operates at relatively low gas pressures, the gas flow has to be nearing the speed of sound at the reaction time; even supersonic flow designs are described.

History and applications

COIL was developed by the US Air Force in 1977, for military purposes. However, its properties make it useful for industrial processing as well; the beam is focusable and can be transferred by an optical fiber, as its wavelength is not absorbed much by fused silica but is well absorbed by metals, making it suitable for laser cutting and drilling. RADICL, Research Assessment, Device Improvement Chemical Laser, is a 20 kW COIL laser tested by the United States Air Force in around 1998.

My first exposure to Laser Technology in industrial applications was in 2005 with a Mini Laser for level monitoring, a non-contact level measurement solution used on caustic hydrofluoric acid tanks at a chemical plant in Calvert City, KY. I had the unique opportunity of introducing it into my region and demonstrated its capabilities to local engineering firms with the intention of specifying the technology for future applications.

Within a year, I was tasked to provide a **CORIOLIS** metering solution for Hydrogen Peroxide (H2O2) for a Laser Turret System on the Nose Cone of a Boeing 747-400F (aka YAL-1) for the U.S. Air Force.

Figure 3: Laser Turret, said to be by the U.S. Air Force the worlds largest (see below)

The BOEING YAL-1 Airborne Laser

The Boeing YAL-1 Airborne Laser Testbed (formerly Airborne Laser) weapons system was a megawatt-class chemical oxygen iodine laser (COIL) mounted inside a modified military Boeing 747-400F. It was primarily designed as a missile defense system to destroy tactical ballistic missiles (TBMs) while in boost phase. The aircraft was designated YAL-1A in 2004 by the U.S Department of Defense.

The YAL-1 with a low power laser was test-fired in flight at an airborne target in 2007. A high-energy laser was used to intercept a test target in January 2010, and the following month, successfully destroyed two test missiles. Funding was cut for the program and cancelled in 2011. It was "Boneyard" by the 309th Aerospace Maintenance and Regeneration Group at Davis-Monthan Air Force Base in Tuscon, AZ to be kept in storage.

Ray-Gun Reality: Inside Two "Star Wars" Projects

This wasn't some relic of Reagan-era Star Wars visionaries. These were modern plans, the U.S. Army's Tactical High Energy Laser shot down dozens of Katyusha rockets and mortars out in the New Mexico desert at the White Sands Missile Range. YAL-1 with a low power laser was test-fired in flight at an airborne target in 2007. A high-energy laser was used to intercept ballistic missiles, but the megawatts needed to detonate a missile requires hundreds of gallons of toxic chemicals-ethylene and nitrogen trifluoride. The weapons grew bulky and the Army eventually cancelled its Tactical High Energy Laser project.

Figure 4: Millennium Falcon Laser from Star Wars-1977

Even the Navy was awarded $180 million over 8-years through 2014 for a multi-team effort to build a weapons grade solid state laser but instead shifted to a team at Northrop Grumman. Throw in a Major General from the Marines quoted as saying, "If I could reach into a crowd and take out one or two targets without a puff of dust or a crack of a rifle-if it could fire for a long time, without ever having to reload that is something the U.S. Marine Corp would be very, very interested in pursuing."

I personally spent 8-years in the U.S. Army being deployed several times to remote locations around the world, but there was one constant, I always look for the silver lining in everything. U.S. Air Force Lt. General Trey Obering shared in 2010 "All we have to do is get to the goal of that shoot down and when that occurs, I guarantee you the support for this program will be unstoppable for missile defense."

It's Not Science Fiction Anymore

Why is the Pentagon spending billions to bring laser weapons to the battlefield? Direct energy weapons such as lasers and high-power microwaves may soon be used to defend against drones and rockets on the battlefield. These futuristic sounding weapons are part of a new wave of devices produced from billions of dollars in research and development from the Defense Department. But how close is the U.S. military to using these weapons in the field? See the video below

Figure 5: Video on the future of war lasers.

- Don't fall into the trap of investing in early flowmeter development until the manufacturer has done Beta testing and receives recognition from industry peers. What cost $6325 for a 1" Coriolis meter prototype in 2006 now has tripled in price by 2024 to $19210 due to advancement in flowmeter technology.

- Consider inserting a flow conditioner to eliminate turbulent flow problems The goal is to create performance that is repeatable and reproducible.

- When designing new plants or retrofitting old ones, be sure to consider optimizing flowmeter requirements.

■ Ultimately, your goal should entail you becoming that **STAR** employee who fights the **WARS** at your facility by providing your fellow engineers, instrument techs, process managers and plant management the **$68348** Coriolis solution that will provide your process:

1) The best available density measurement performance
2) Exceptional Repeatability
3) The widest usable turndown
4) High performance and low uncertainty
5) Multi-Frequency Technology (MFT) for tackling liquids with entrained gases
6) ASME B16.5 pressure rating along with high burst pressures
7) The Lowest pressure drop over the widest flow range…
8) A lightweight and compact transmitter without sacrificing performance, and..
9) Permanent self-diagnostics via Heartbeat Technology for device verification during operation

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The author of this case study, Scott Hendry is the President of K&I instruments, Inc since its inception in 2004 and has 4-decades of experience with instrumentation, electronics and energy management solutions. He has authored 2-White Papers on compressed air and medical gas in addition to several case studies and application guides. His schooling includes Western Kentucky University, U.S. Army Signal School, Louisville Technical Institute and UMass-Lowell for Electronic Engineering Technology. He has also designed the companies Mobile Instrument Laminar Flowstand Trailer with more than 40-Instruments on display for educational seminars and has been providing gas measurement solutions to 200+ clients in 25-states and 4-countries. You may reach him directly at scott@k-iinstruments.com or the toll-free number listed below.

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