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The World of Ethanol at Your Fingertips

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The Project of a Lifetime

After a half century in ethanol, Raphael Katzen—one of the industry's greatest minds—still strongly believes in Project 20, a plan to produce and use 20 billion gallons of cellulosic ethanol by 2020. Now, more than ever, his vision looks attainable.

by Ron Kotrba

In journalism, opportunities to interview those with whom history credits great feats don't come along too often. What if, for example, it were possible to score an interview with Alexander Graham Bell on his invention of the telephone, and the nature of its necessity in modern society? Likewise, imagine springing quotes from James Watt, the guy who drastically advanced steam engine technology.

In the eyes of an ethanol industry reporter, a conversation with Raphael Katzen holds nearly the same weight and historical import—and that's not surprising considering he's known as one of the industry's founding fathers. Not only has Katzen been instrumental in developing modern dry mill ethanol plant technologies, he has been simultaneously absorbed in advancing the technologies for lignocellulosic conversion, and drafting the framework needed to build a tried-and-true cellulose industry, both in the United States and abroad.

Katzen's pet undertaking, Project 20, has been on the table now for almost a decade, but its development has spanned a lifetime. Project 20 is an ambitious charge to produce 20 billion gallons of cellulosic ethanol by 2020. According to the man behind the legend—and with only 15 years before the target date—Katzen told EPM that realizing Project 20 is still fully possible.

An industry 50 years-plus in the making

"Ray Katzen was contemplating ethanol from lignocellulosic feedstocks when he was in college, before people even knew how to spell 'cellulosic ethanol,'" said Philip Madson, president of KATZEN International Inc., the well-known technology company that Raphael Katzen founded in the 1950s.

In 1953, Katzen resigned from Vulcan Cincinnati (formerly Vulcan Copper and Supply Co.) and started a sole proprietorship. Later that same year, Katzen took on partners and changed the company name to Raphael Katzen Associates. Two years down the road, Katzen's company went international, changing the name once again to Raphael Katzen Associates International Inc. (RKAII), which it remained until 1997 when Katzen and his wife retired. Upon retiring, they sold their stake in the business back to the company, and set up a private consulting engineering practice in Florida. After Katzen's exit from RKAII, the company shortened its name to KATZEN International Inc.

But before Katzen formed his company and became internationally known as a compelling figurehead for the ethanol industry, he was working for the aforementioned Vulcan Copper and Supply Co., which had a Defense Plant contract with the federal government to build a cellulosic ethanol plant during the height of World War II. Converting wood waste to ethanol in Springfield, Ore. Katzen began working on that project in Cincinnati, Ohio, in 1942.

The plant was completed as the war ended. The government no longer needed the surplus ethanol after the war, so it closed the plant's doors. It did operate for a few months though—successfully, according to Katzen. "Vulcan ran the plant for a few months, mainly to prove its capacity of 300 dry tons of wood per day and yield of 50 gallons of ethanol per ton," Katzen told EPM. But ethanol could be made much cheaper from ethylene then, so Vulcan recommended abandoning the project. Even more than 50 years ago, techniques for converting lignocellulosic biomass to ethanol were on people's minds—especially Katzen's.

"The plant was using obsolete technology," Katzen said in reference to the Springfield wood-to-ethanol plant. "There were scaling problems with the tars and resins, plus calcium sulfate that was produced in degrading the sugars. It was difficult to run. Technology has changed radically since then. Now I recommend a mild acid pretreatment followed by enzymatic hydrolysis."

While still with Vulcan, Katzen became deeply acquainted with Cuba. This was before Castro and his Marxist Revolutionaries grasped hold of political and military power in 1959, much to the dismay of the fallen Fulgencio Batista, the United States and Katzen. "Castro and I are enemies," Katzen said without mixing words. "He ruined my business down there."

Prior to that, Katzen designed the Bacardi family's first modern distillation systems. Originally based in Santiago, Cuba, the still-famous rum makers moved major operations to San Juan, Puerto Rico, before Castro's reign began. KATZEN International still continues its service to Bacardi, even after all those years.

Pre-Castro Cuba enchanted Katzen. "After [World War II], we saw a market in Latin America, especially in Cuba, which was an energized and developing country," Katzen said. "I bought some property for a combined home and office in Varadero Beach, the most beautiful beach in the world. Before Castro, 85 percent of my business was in Cuba."

Although many consider Brazil as the first country to build a successful ethanol industry, chances are they learned much from Katzen. “After World War II, Ray was virtually solely responsible for the building of the fuel ethanol program in Cuba,” Madson said. “Brazil took all the credit for making ethanol from sugarcane juice and molasses, but it is believed that the Brazilians learned much from Katzen’s work in Cuba. There are certainly incestuous roots there—none of this happens in a vacuum.”

According to Madson, the Cuban people are still grateful to Katzen for revolutionizing the sugarcane industry in Cuba. “He is forever known down there as the doctor who turned on the lights [at Centrol Fransisco] in Cuba,” Madson said. Back then, electricity for the rural villages didn’t come from the government, but rather the sugar mills as a benefit to its workers, Madson explained.

After 1959, Katzen and his partners fled Cuba and the political tumult, returning to Cincinnati, Ohio, where the future held much work for them.

Foreseeing the future of two ethanol industries

In the late 1970s, before Madson began working for RKAII, Madson was searching for an ag-oriented job in chemical engineering. He kept hearing the name “Katzen,” but he couldn’t get in touch with the man. “It wasn’t until after looking coast-to-coast to find an ag-related chemical engineering job that I found Ray Katzen right in my backyard—literally,” Madson said, sort of laughing. “I could see the roof of Ray’s house (the home Katzen lived in when he founded the company) from my dining room window. Of course, I didn’t know that was his former house until after we met.” According to Madson, Katzen had the ear of everyone in the industry then, as he still does. “At the time we met, I didn’t yet appreciate the industry or his standing in it,” Madson said.

Back then, the distillation and dehydration systems varied from industry to industry. Katzen created the vision of what a proper system should be, and then Madson and others helped bring that vision to life. They delivered Katzen’s vision of an efficient continuous mashing, cooking and liquefaction process, and simultaneous saccharification and fermentation (SSF) distillation dehydration system for a disjointed ethanol industry, as it were. This is just one of many instances that exemplify Katzen’s keen foresight.

Lonnie Ingram, director of the Florida Center for Renewable Chemicals and Fuels in the University of Florida’s Department of Microbiology and Cell Science, met Katzen long ago. “He spoke, and it was clear that he was way ahead of his time,” Ingram revered. Ostensibly, the U.S. DOE agreed.

In 1978, after the two OPEC energy crises of that decade, Katzen’s company got a call from the DOE to look into ethanol as a possible source of feedstock for butadiene (synthetic rubber) production. The DOE wanted studies on the energy balance, yield and the “food versus fuel” issue. “We preferred business from industry over government, but we did what they asked,” Katzen told EPM.

The whiskey business is the original dry mill industry, so that was looked at first. That study’s findings demonstrated that fuel ethanol could be made on a large scale using one-third the energy used to make whiskey then. The study, published by the DOE, sold more than 30,000 copies and was reprinted. “Even today, we occasionally see someone pull out a dog-eared copy of that study the company did so many years ago,” Madson said.

Along with the reduced energy finding in the study, it made an amazingly accurate prediction of the optimal capacity for dry mill ethanol plants. Almost 30 years ago, before Fagen/ICM and Broin Companies plants dotted the Midwest, RKAII’s study foretold that the optimal capacity for a fuel ethanol plant would be 50 MMgy. “Now isn’t that incredible,” Madson told EPM. “He had the foresight so many years ago to envision what is true today—most plants in the U.S. are approximately that size.” Katzen also predicted that there could be 350 50 MMgy plants across the United States. That’s a grand production total of 17.5 billion gallons a year. The USDA told Katzen that if the nation’s capacity to produce ethanol exceeded 5 billion gallons, corn prices would spike due to the laws of supply and demand.

Project 20

What does this historical account have to do with Project 20? Simply put: Everything.

“It was clear that the concept of Project 20 was there from the beginning,” Madson stated. “But the actual words for the project came later, around the early 1990s. It was written in very simple and concise terms. He had hoped it would be the ‘battle cry’ of the industry.” Basically, Project 20 has been 50-plus years in the making, consciously or not.
It was clear to Katzen that the USDA’s suggestion on the theoretical maximum availability of corn for ethanol production was on target. “There is a limit,” Katzen said. “That’s why and when we started pushing cellulosic ethanol.”

To get Project 20 rolling—and without spending time considering whether or not government would certify blends of 20 percent gasoline and/or diesel as EPA-approved fuels—a commercial cellulosic ethanol industry must be started. “The key is putting together a total system package that’s economically competitive,” Madson said. “When ethanol [or corn] prices rise, that opens the door for other economically competitive technologies.”

Katzen, however, had a more narrow definition of the catalyst to spark commercialization of cellulosic ethanol. “The key to making a cellulosic ethanol industry economically competitive is the cost of enzymes,” Katzen told EPM. According to him, the DOE/NREL research and development program with Novozymes and Genencor, which has already significantly lowered the cost of enzymes needed for lignocellulosic conversion, is on the right track.

So the technology is there, but a few obstacles still exist to commercializing the production of cellulosic ethanol, one of which is sort of a chicken-and-egg conundrum. “You don’t get commercial optimization of anything … until you’re in the commercial arena, until you start commercializing,” Madson said. Nevertheless, at least four more obstacles are readily apparent: passing the needed government legislation like loan guarantees, state, local and federal incentives, and uniform fuel standards; encouraging lending reforms to stimulate more willing, yet protected, financing of cellulosic ethanol plants (because institutions are much more willing to lend money on a project like 50 others that have passed before it, rather than on a first-

of-a-kind project); continued research and development to look at things like lowering the investment costs of these plants, which are high, by developing lower-cost material alloys, for example; and, lastly, building and optimizing a biomass collection and distribution infrastructure.

On the finance issues, Ingram hit the nail on the head. “We need to mitigate risk and incentivize investors,” he said.

Also, biomass collection is a big barrier. “There are billions of tons of waste in the United States, but no one knows how to collect it economically,” Katzen said. That’s why Katzen has been talking to John Deere on modifying its harvester. “We’re looking at the harvester throwing the corn kernels into a truck on one side, blow the light stuff into the field and then the stalks and cobs get put into a second truck.” Piles of biomass left sitting in the fields rot away. “We need to keep it off the ground at harvest time,” Katzen forewarned.

Both Madson and Ingram agreed that a good point to start collection is where the biomass has become a financial burden. “The first commercial plants need to be built where companies are paying to dispose of their waste materials,” Ingram said. “It would be profitable for both sides.”

Getting financing for—and building—demonstration plants is a necessary first step, according to Katzen. Abengoa Bioenergy currently retains Katzen as a consulting engineer to do just that. Katzen is working on engineering Abengoa’s cellulosic ethanol demonstration plant in Spain and its pilot plant in York, Neb. The capacity for the Spanish demonstration plant is 5 million liters per year (1.32 MMgy) using wheat and barley straw, and is expected to be operational by mid-year.

“Project 20 is achievable,” Katzen told EPM. “The process technology is available, enzyme effectiveness and costs are good, but the investment costs are higher than in [grain] dry mill plants.” Biomass as a feedstock is much cheaper than corn though, and lignin residues can be burned to provide energy, steam and electric power.

Over more than half a century of Katzen’s unprecedented work with ethanol and cellulose is indeed a solid starting point for bringing Project 20 full-circle.

“Since Ray retired from the company, KATZEN International hasn’t changed its fundamental business strategy,” Madson said, reflecting on Katzen’s lifetime of engineering and business achievements. “It’s been 50 years, and we’re still growing on the same philosophy. That tells me Ray Katzen’s original philosophy was right.” EP

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