Carbon dioxide

Sourcing supply and opportunities from ethanol projects

By Sam A. Rushing

Ethanol is the single-largest by-product source of carbon dioxide (CO_2) supplying the merchant CO_2 industry in the US. The technology for purification, liquefaction, and supplying a viable liquid and dry ice is well known with this source type; and many such sources are relatively untapped domestically.

As of late, Continental Carbonic has committed to produce CO_2 from Pennsylvania Grain Processors plant in Clearfield, Pennsylvania, a source I always felt was viable; with plans to be operational in 2017. This plant has a second owner/operator now able to make money from CO_2 sales. On the other hand, there have been many growing pains and upsets in the US ethanol industry, including shortages of grain, therefore sometimes challenging adequate CO_2 supplied already dedicated to regional markets. Of course, there is always the possibility of shortages of raw gas, when relying on by-product plants and their form of feedstock. However, from a long-term perspective, ethanol has been reliable and available to supply a large segment of the US' raw CO_2 feedstock.

The merchant carbon dioxide industry in the US is highly driven and supplied by the ethanol industry by-product from fermentation, at times approaching 40% of this greater market supply. During the mid to later 1990s and into the 2000s, there was a period of rapid growth of CO_2 sourcing from fermentation; up to a decade of rapid growth. The primary market for the ethanol has been the gasoline market, as a fuel additive, from 5 to 15% of some domestic gasoline content is ethanol. The ethanol added to gasoline was initially considered to be a replacement of the oxygenate MTBE, which was discontinued due to reported health risks from leaking storage tanks.

An early CO_2 source from ethanol was New Energy's source in South Bend, Indiana, which was closed after a long run, and acquired by a new principal. Other early plants are owned by ADM Corporation, which supplied some of Linde's Midwestern needs after their direct marketing for a short time. Over the years, plants grew from around 15-20 million GPY (gallons per year) of production) to 40-55 million GPY, during this rapid growth period which ran for over a decade or so. Eventually, the plants were often built to produce 100-150 million GPY or greater. The consensus now indicates the ethanol industry increased its production capacity well beyond the demands of the gasoline market; which is the majority of the application for ethanol. There was simply too much production capacity installed. There are a few plants which have been dedicated primarily to denatured or beverage grade alcohol, or for pharmaceutical purposes; however small in number.

According to the Renewable Fuel Association (RFA), today there are 214 nameplate ethanol plants in the US. There have been a number of consolidations and bankruptcies among the ethanol plants in America over recent years. Most of this occurred well past the period of rapid growth of ethanol plant construction. A Spanish–headquartered renewable energy and US ethanol producer by the name of Abengoa Bioenergy took bankruptcy, and sold its five Midwestern US plants for around $357m; which was hoped to stave off Spain's largest ever bankruptcy. Beyond Abengoa, there were a number of additional ethanol plants which took bankruptcy; from partially constructed plants, to operating facilities. Some claim this was due to corn prices, which is a primary driver of ethanol economics. Then, the repeal of economic tax subsidies could be a claim leading to ethanol's hardships; and there was of course the recession. Further, support from congress has been challenged, which affects mandates requiring the addition of ethanol to fuel.

Lion's share

Nearly 40% of America's approximate 100 CO_2 plants are sourced from ethanol. The lion's share of ethanol sourcing to the CO_2 industry is in the greater Midwest, since the majority of the corn is grown in this greater region.

Some of the more distant ethanol plant, such as in Texas, California, and New York import corn and sorghum as the fermentation feedstock. Over the rapid development period of CO_2 plants from ethanol by-product, many ethanol/CO_2 plants in well located or more distant strategic markets were evaluated and considered. These possible CO_2 plants were to be built in such places as in the Middle Atlantic, the Pacific Northwest, Southern California, and Florida; however, they never came to pass, or failed to produce as planned. Many of those looking to develop such projects were under-capitalised. On the other side of the coin, today, a large percentage of domestic corn consumption is dedicated to fermentation; I simply do not see this disappearing – and the ethanol industry has largely stabilised.

40%

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Then, the era of second generation biofuels became a hot topic. A few domestic projects from cellulosic materials were developed, a very few number of these became reality. Among those which were only built, include Abengoa's project in Kansas, a 25 million GPY plant from cellulosic biomass. Others, achieved success, such →

as Du Pont's 30 million GPY in Nevada, Iowa, a cellulosic plant, and an expansion of the corn-based Quad County Ethanol plant which added a cellulosic biomass operation. There are a few more, however, and the hopeful trend toward developing a significant number of cellulosic ethanol plants is moving slowly, which was thought to develop into commercial reality much faster.

During the era of stronger oil prices, beginning at $60/barrel, and growing, numerous captive sources of CO_2 were considered for service to dedicated industries via pipeline, primarily enhanced oil recovery (EOR) projects. One of these, is White's Energy project in Russell, Kansas, which has injected CO_2 from its fermentation plant in Russell, Kansas into the regional Hall-Gurney oilfield for the enhanced recovery of oil. Logically the source and destination fit, when CO_2 from fermentation is located near oil producing regions. However, EOR economics call for steady oil prices, with a baseline of $60/barrel, and hoping for much more, perhaps $80 to $100/barrel. These are long-term reliable sources of income, given the economics surrounding the investment and oil prices work.

Positive trend

As for ethanol sourcing CO_2 projects, the trend remains positive from a gas company investment scenario, whereby Air Products & Chemicals invested in new ethanol projects since the acquisition of EPCO Carbon Dioxide to support its Midwestern operations; which was already heavily invested in ethanol. These plants are a 400 tonnes per day (tpd) plant off the SW Iowa Renewable Fuels ethanol plant in Council Bluffs, Iowa, and a 250 tpd plant in Boyceville, Wisconsin, receiving raw gas from the Big River Resources ethanol plant. These projects were announced in 2013 and 2014.

In reality, there will always be the nation's many grain-based ethanol plants, most of which are within and surrounding the Midwest; unless ethanol as a fuel additive should disappear, which is highly unlikely. Given this, the challenge for sourcing from ethanol as a by-product source, is logical, simply put. This statement should consider the gas company having a diverse sourcing capability.

One type of by-product CO_2 sourcing became obviously problematic in California, when sourcing primarily from refinery (reformer) operations in California, which led to shortages of CO_2 due to increased and new environmental and operational regulations within the refinery sector. Then, along came a few ethanol projects in the US West and in California, which are partly owned and operated by Pacific Ethanol. Further, toward the supply of CO_2 from ethanol in California, which would also fill the gap caused by the reliability of supply from the refineries, came the plan to produce ethanol from sugarcane in California's Imperial Valley. However, at least two such projects never came to pass. Part of the problem was likely the drought, where the Colorado River once held a precedent for supplying irrigation water to the agricultural industry in the Imperial Valley. Further challenges occurred in this market, which are the same as with other cellulosic projects. These challenges include being capital-challenged, and

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the lack of sufficient investors – unlike the honeymoon period previously enjoyed by grain-based ethanol developers.

The future of ethanol for the supply of CO_2 sources should remain bright. Further still, as investors return to these projects for advanced biofuels in particular, as with cellulosic ethanol, more opportunities from fermentation will make the opportunity for more strategically located CO_2 sources. The ultimate challenge for CO_2 firms in this industry is logistics, when considering one source type; otherwise such a CO_2 player with one source type could become regional, not national. There needs to be a mix of various source types, including ethanol (fermentation) from first generation ethanol as corn and sorghum-based feedstocks; then advanced biofuels from cellulosic projects, and new advanced biofuel source types which are also under development. Then, other traditional source types including anhydrous ammonia, ethylene oxide, reformer, titanium dioxide, and natural sources, as the dominant source types are all key to making a successful supply network for any CO_2 company.

For the CO_2 companies, it is recommended that they continue to look at new strategic opportunities and, where possible, diversify their sourcing capabilities. Since sustainability is a major drive for any viable company, particularly when seeking raw feedstock for refining and marketing, a diverse portfolio of sources is critical for long-term success.

As the CO_2 industry has consolidated in a very significant way, particularly of late, one might look back at history to predict future insight; as fewer majors operate in this industry, logically there remain greater opportunities for new CO_2 firms to appear for sourcing, production and supply to the markets. To this end, when ethanol by-product is considered as a viable raw gas for refining and marketing, it is among the best in terms of a known source type to produce within the industry. When these developments occur in the future, there will need to be well-capitalised entities to find success and, as with other well entrenched and well-known suppliers, investment in ethanol sources will be a partial solution to a sustainable supply network of CO_2 for the markets. gw

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