

Renewable Fuels



Renewable Fuels Foundation



Renewable Fuels Association



Ethanol Production: From Then to Now

Unit 1 Lesson 3

Precepts

E. Awareness

E1. Address issues important to the community.

National Standards

NL-ENG. K-12.2. Reading for understanding.

Student Learning Objectives

As a result of this lesson, the student will ...

1. Recognize significant dates in ethanol's history.
2. Identify ethanol's current state of importance.
3. Recognize the impact that ethanol could have on the future.

Time

Instruction time for this lesson: 75 minutes.

Resources

http://www.fuel-testers.com/ethanol_fuel_history.html
<http://www.eia.doe.gov/kids/history/timelines/ethanol.html>

Tools, Equipment, Supplies

Writing surface
Overhead projector
Note cards for ethanol history cards
String or rope
Clothes pins or paper clips
AS.A - one per student
TM.A
TM.B
TM.C
Assess. A - one per student

INTEREST APPROACH

Randomly hand out ethanol history cards to students when they enter. Cards can be made by putting each bullet point from TM.A on a note card. Hang a string or rope in the front of the room that will become an ethanol history timeline. Ask students to progressively stand up depending upon the ethanol history date located on their card. When everyone is standing have the students come forward and using clothes pins or paper clips assemble an ethanol history timeline.



Today, we hold a piece of history. The card you received explains an important date and event in the development and progression of ethanol. The task is to put those events in order in the form of a timeline. Who thinks they have the first date on the timeline? Whoever has 1826 please stand up. What does that card say? *Allow student to read the card.* Ethanol has been around for a while according to that card. As I call the time frame that your card pertains to, stand up and remain standing until we have called everyone. Anyone before 1900? 1900 to 1950? 1951 to 1979? 1980 to 1990? 1991 to 2000? 2001 to today? We were able to see the other students that have cards that are in the same time frame as our card. When we hear the word “construct” come to the front of the room and use a clothes pin (or paper clip) to assemble an ethanol history timeline. What questions are there? Construct.

Allow students to assemble the ethanol history timeline. While the students are doing this hand out AS.A.



Thank you for assembling the timeline. On the desk in front of you is a table that we will use to capture the information on our timeline. Find a writing utensil, put your brain in a historical mode, and get ready for a trip down the ethanol timeline.

OBJECTIVE 1. Recognize significant dates in ethanol's history.

Have students use AS.A to write a summary of the timeline they have just created. Read the timeline cards off in order and post the events on the overhead using TM.A. Remind students to summarize so the timeline is useful to them in the future when asked to recall the information.



Use the table provided to develop our own ethanol history timeline. Listen as I read the cards, look at the events as I post them on the projector, and then summarize what you hear and see to produce a timeline that you can use in the future.

Continue by reading and posting the events.

I. Ethanol's basic timeline of events:

- 1826 Samuel Morey developed an engine that ran on ethanol and turpentine.
- 1860 German engine inventor Nicholas Otto used ethanol as the fuel in one of his engines.
- 1862 The Union Congress put a \$2 per gallon excise tax on ethanol to help pay for the Civil War. Prior to the Civil War, ethanol was playing a major role in eliminating oil in the United States. After the tax was imposed, ethanol cost too much to be used this way.
- 1896 Henry Ford built his first automobile, the quadricycle, to run on pure ethanol.
- 1906 More than 50 years after imposing the tax on ethanol, Congress removed it, making ethanol an alternative to gasoline as a motor fuel.
- 1908 Henry Ford produced the Model T. As a flexible fuel vehicle, it could run on ethanol, gasoline or a combination of the two.
- 1917 - 1918 The need for fuel during World War I drove up ethanol demand to 50-60 million gallons per year.
- 1920's Gasoline became the motor fuel of choice. Standard Oil began adding ethanol to gasoline to increase octane and reduce engine knocking.
- 1930's Fuel ethanol gained a market in the Midwest. More than 2,000 gasoline stations in the Midwest sold gasohol, which was gasoline blended with between 6 percent and 12 percent ethanol.
- 1941-1945 Ethanol production for fuel use increased, due to a massive wartime increase in demand for fuel, but most of the increased demand for ethanol was for non-fuel wartime uses.
- 1945-1978 Once World War II ended, with reduced need for war materials and with the low price of fuel, ethanol use as a fuel was drastically reduced. From the late 1940s until the late 1970s, virtually no commercial fuel ethanol was available anywhere in the U.S.
- 1974 The first of many legislative actions to promote ethanol as a fuel, the Solar Energy Research, Development, and Demonstration Act led to research and development of the conversion of cellulose and other organic materials (including wastes) into useful energy or fuels. To this day, there is still not a commercial plant using cellulose as the feedstock.
- 1975 U.S. begins to phase out lead in gasoline. Ethanol becomes more attractive as a possible octane booster for gasoline. The Environmental Protection Agency (EPA) issued the initial regulations requiring reduced levels of lead in gasoline in early 1973. By 1986 no lead was to be allowed in motor gasoline.
- 1978 The first time gasohol was defined, it was in the Energy Tax Act of 1978. Gasohol was defined as a blend of gasoline with at least 10 percent alcohol by volume, excluding

alcohol made from petroleum, natural gas or coal. For this reason, all ethanol to be blended into gasoline is produced from renewable biomass feed stocks. The Federal excise tax on gasoline at the time was four cents per gallon. This law amounted to 40 cents per gallon subsidy for every gallon of ethanol blended into gasoline.

- 1979 - Marketing of commercial alcohol-blended fuels began. Amoco Oil Company began marketing commercial alcohol-blended fuels, followed by Ashland, Chevron, Beacon and Texaco. About \$1,000,000,000 (\$1 billion) eventually went to biomass related projects from the Interior and Related Agencies Appropriation Act.
- 1980 - 1984 - First U.S. survey of ethanol production was conducted. The survey found fewer than 10 ethanol facilities existed, producing approximately 50 million gallons of ethanol per year. This was a major increase from the late 1950s until the late 1970s, when virtually no fuel ethanol was commercially available. Congress enacted a series of tax benefits to ethanol producers and blenders. These benefits encouraged the growth of ethanol production.
- 1980 - The Energy Security Act offered insured loans for small ethanol producers (less than 1 million gallons per year), up to \$1 million in loan guarantees per project that could cover up to 90 percent of construction costs on an ethanol plant, price guarantees for biomass energy projects, and purchase agreements for biomass energy used by federal agencies.
- 1980 - Congress placed an import fee (tariff) on foreign-produced ethanol. Previously, foreign producers, such as Brazil, were able to ship less expensive ethanol into the United States.
- 1980 - The Gasohol Competition Act banned retaliation against ethanol resellers.
- 1980 - The Crude Windfall Tax Act extended the ethanol-gasoline blend tax credit.
- 1983 The Surface Transportation Assistance Act increased the ethanol subsidy to 50 cents per gallon.
- 1984 The number of ethanol plants in the U.S. peaked at 163. The Tax Reform Act increased the ethanol subsidy to 60 cents per gallon.
- 1985 Many ethanol producers went out of business, despite the subsidies. Only 74 of the 163 commercial ethanol plants (45%) remained operating by the end of 1985, producing 595 million gallons of ethanol for the year. One reason for producers going out of business was the very low price producers could receive for their ethanol (even with a subsidy of 60 cents per gallon), since the prices of crude oil and gasoline were so low. Despite the very low price of corn, which is the main driver of the cost of producing ethanol, nothing was enough to prevent the high rate of market change.
- 1988 The first oxygenate used in gasoline was ethanol. Denver, Colo., mandated oxygenated fuels (i.e., fuels containing oxygen) for winter use to control carbon monoxide emissions. Other oxygenates added to gasoline included MTBE (Methyl Tertiary Butyl Ether - made from natural gas and petroleum) and ETBE (Ethyl Tertiary Butyl Ether - made from ethanol and petroleum). MTBE dominated the market for oxygenates.
- 1990 Omnibus Budget Reconciliation Act decreased the ethanol subsidy to 54 cents per gallon of ethanol. Ethanol plants began switching from coal to natural gas for power generation and adopting other cost-reducing technologies.
- 1992 The Energy Policy Act of 1992 (EPACT) provided for two additional gasoline blends (7.7% and 5.7% ethanol). EPACT also defined ethanol blends with at least 85% ethanol as “alternative transportation fuels.” It also required specified car fleets to begin

purchasing alternative fuel vehicles, such as vehicles capable of operating on E-85 (a blend of 85% ethanol and 15% gasoline). The EPACT also provided tax deductions for purchasing (or converting) a vehicle to that could use an alternative fuel such as E-85 and for installing equipment to dispense alternative fuels. The Clean Air Act Amendments mandated the winter-time use of oxygenated fuels in 39 major carbon monoxide non attainment areas (areas where EPA emissions standards for carbon monoxide had not been met) and required year-round use of oxygenates in 9 severe ozone non attainment areas in 1995. MTBE was still the primary oxygenate used in the U.S.

- 1995 The excise tax exemption and income tax credits were extended to ethanol blenders producing ETBE. The EPA began requiring the use of reformulated gasoline year round in metropolitan areas with the most smog.
- 1995 - 1996 With a poor corn crop and the doubling of corn prices in the mid-1990s to \$5 a bushel, some states passed subsidies to keep the ethanol industry solvent.
- 1997 Major U.S. auto manufacturers began mass production of flexible-fueled vehicle models capable of operating on E-85, gasoline, or both. Despite their ability to use E-85, most of these vehicles used gasoline as their only fuel because of the scarcity of E-85 stations.
- 1998 The ethanol subsidy is extended through 2007 but will be gradually reduced. The ethanol subsidy of 54 cents per gallon will be reduced gradually to 51 cents per gallon in 2005.
- 1999 Some states began to pass bans on MTBE use in motor gasoline because traces of it were showing up in drinking water sources, presumably from leaking gasoline storage tanks. Because ethanol and ETBE are the main alternatives to MTBE as an oxygenate in gasoline, these bans will increase the need for ethanol as they go into effect.
- 2000 EPA recommended that MTBE should be phased out nationally.
- 2001 Ethanol subsidy was reduced to 53 cents per gallon starting January 1, 2001.
- 2002 U.S. automakers continued to produce large numbers of E-85-capable vehicles to meet federal regulations that require a certain percentage of fleet vehicles to be capable of running on alternative fuels. More than 3 million of these vehicles were in use. At the same time, several states were encouraging fueling stations to sell E-85. With only 169 stations in the U.S. selling E-85, most E-85 capable vehicles are still operating on gasoline instead of E-85.
- October 2003, a total of 18 states had passed legislation that will ban MTBE - but none of the states that are major users of MTBE, such as Calif., Conn., Ky., Mo., and N.Y., have their ban in effect yet. MTBE is the technology to make ethanol from sugar and corn predates the automobile.
- 2005 The Energy Policy Act of 2005, written by the EPA contains regulations to ensure that gasoline sold in the United States contains a minimum volume of renewable fuel.
- September 2006 The Renewable Fuel Standard Program (RFS) is signed. This national renewable fuel program is designed to encourage the blending of renewable fuels (ethanol) into our nation's motor vehicle fuel. The nationwide Renewable Fuels Standard (RFS) will double the use of ethanol and biodiesel by 2012.
- December 2007 Energy Independence and Security Act signed by Congress and the President, which requires the use of 15 billion gallons of renewable (ethanol) fuel by 2015. In 2007 about 6.5 billion gallons were produced.
- 2007-2008 Surge in individual states mandating the use of 10% ethanol E10 gasoline. Rapid increase in documented engine problems, and lawsuits related to E10 blends of

gasoline.



As we can see, the use of ethanol as a fuel has been around for quite some time. Looking at the timeline also shows us that many steps have been taken on the national level to further the use of ethanol. All of these events have played an important role in the development of the ethanol industry.

OBJECTIVE 2. Identify ethanol's current state of importance.

Use a Little Professor Moment to present the information for Objective 2 and Objective 3. Students will need to work in pairs for the teaching strategy. One student will be Nicholas Otto and the other Henry Ford. Otto will instruct Ford pertaining to Objective 2.



We finished the timeline that gives a very complete picture of the history of ethanol, but what about today and the future? It is time for us to take an active teaching role when it comes to ethanol. You and your neighbor will take turns teaching each other about the current state and the potential future state of ethanol. One of you will be Nicholas Otto and the other will be Henry Ford. Find your seatbelts because here we go.

Make sure students pair up for the strategy and lead them through the information using the Little Professor Moment. During Objective 2 Otto will be teaching Ford. Information for Objective 2 can be found on TM.B.

II. Ethanol plays an important role on the economy and agriculture today.

A. Corn is the main feedstock for ethanol in the United States - due to its abundance and low price. The starch in the corn must first be turned into sugar, which is then fermented into alcohol.

Sugar cane and sugar beets are the feed stocks most frequently used in producing ethanol around the world. Since alcohol is created by fermenting sugar, sugar crops are the easiest to convert into alcohol. Brazil, the country with the world's largest ethanol production, makes most of its ethanol this way.

B. Other crops or wastes from food or beverage processes are used as the feedstock at some ethanol plants. These feed stocks include wheat, milo (or sorghum), potatoes, and beverage wastes.

C. Today's ethanol production has two ways to make ethanol from corn: Ethanol production using plants such as corn as the feedstock either use a wet or dry mill process.

Upon completion have Ford thank Otto and move into Objective 3.



Great job Mr. Otto. You did a fine job teaching about the current state of ethanol to Mr. Ford. Mr. Ford thank Mr. Otto for the thorough and complete information that has been shared to you. It is time to switch roles Mr. Otto and Mr. Ford.

OBJECTIVE 3. Recognize the impact that Ethanol could have on the future.

Continue the Little Professor Moment with Objective 3. Information for Objective 3 can be found on TM.C. Henry Ford will now instruct Nicholas Otto.

III. Ethanol will continue to play an important role in the future.

A. Cellulose: The ethanol from the cellulose process is complex and costly and is still currently in the research and development stage. In recent years, pilot plants have proven the technical feasibility. Several North American companies have considered building factories that would convert the cellulose from organic plant wastes into ethanol.

B. Ethanol plants continue to pop up all along the Midwest and corn belt where supplies are abundant and resources allow.

Upon completion of Objective 3 have Otto thank Ford.



Fine job Mr. Ford. Your teaching about the potential future of ethanol should be commended. Mr. Otto please thank Mr. Ford for his wisdom and efforts. We now have the complete timeline of ethanol and have a very thorough knowledge to continue to work from in the future.

REVIEW/SUMMARY

Use a Bob the Weather Guy Moment to review and summarize the content from the lesson.



We have discussed the history, current state and future of ethanol today. It is time to summarize the information into a 30 second report. The challenge is to summarize it into a report similar to a weather report. You will briefly mention what has happened with ethanol in the past, describe what is happening now, and predict the future of ethanol. You will have eight minutes to script your weather report and get it ready to be delivered to the class. You will work with your teaching partner to develop the report. Questions? Begin.

Allow students to prepare for the Bob the Weather Guy Moment and lead them through the activity. Upon completion have the students thank each other and mention they will be learning more about Ethanol in future lessons.



Tell your teaching partner thank you for helping with the ethanol weather report. We have added to our ethanol knowledge today by learning about the past, current and potential future state of ethanol. We will continue to build on this knowledge in future lessons.

APPLICATION

Extended classroom activity: *Pick three events from the ethanol history timeline and conduct further research into the events. Put together a short report that explains the events in depth and the effect they had on ethanol production in the short term and long term.*

FFA activity: *Use the information from the lesson to put together an informative speech on the development of ethanol. The speech could be presented to local civic groups with an interest in ethanol or used for an FFA speaking event.*

SAE activity: *Contact a legislative official that has been active in the development of ethanol. Discuss with them what background they have and how they have become active in promoting ethanol. Spend some time putting together a list of pros and cons pertaining to a career in legislation to determine if it might be an area of future career interest.*

EVALUATION

Assess. A

Answers to Assessment:

True or False.

1. False
2. True
3. True
4. False
5. True

Short Answer.

1. Cellulosic

TM.A

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TM.B

Ethanol plays an important role on the economy and agriculture today.

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TM.C

Ethanol will continue to play an important role in the future.

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AS.A**From Then to Now Timeline**

Date	Summary of Occurrence	Significant Impact on Ethanol Industry
1826		
1860		
1862		
1896		
1906		
1908		
1917-1918		
1920		
1930		
1941-1945		
1945-1978		
1974		
1975		
1978		
1979		
1980-1984		
1980		
1983		
1984		

Ethanol Production: From Then to Now

Unit 1 Lesson 3

1985		
1988		
1990		
1992		
1995		
1995-1996		
1997		
1998		
1999		
2000		
2001		
2002		
2003		
2005		
2006		
2007		
2007-2008		
Today		
Future		

Assess.A

True or False. For each of the dates given determine if the statement is true or false.

1. _____ Henry Ford was the first individual to create an engine that ran on ethanol.
2. _____ In September 2006, The Renewable Fuel Standard Program was signed.
3. _____ Ethanol production was banned during WWII.
4. _____ Ethanol production peaked in the 1980s.
5. _____ In 2007 and 2008, there were a record number of lawsuits recorded in the use of E10 blends.

Short Answer.

1. What type of ethanol production is currently being researched?