Bad wine makes for good energy
Waste from improper fermentation can transform into electricity, hydrogen
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A bad bottle of wine could drop your electrical and gas bills.

Using widely available microbes, scientists in the United States and India are turning the unused sugar and unwanted vinegar resulting from improper fermentation into electricity and hydrogen.

The technology could provide a new and cost effective way to clean wastewater from wineries and get some value out of a bad bottle of wine.

"There is nothing special about the bacteria," said Bruce Logan, a scientist at Penn State University who recently installed a microbial electrolysis cell at a winery in Napa Valley, Calif. "We just give them a good environment to grow in."

A good home and plenty of food, that is. It takes a lot of water to grow, harvest, process and ferment the sugar in grapes into the alcohol Americans love to consume by the bottle.

All that wastewater, loaded with unfermented sugar, improperly fermented vinegar, biomass and other contaminants, has to be cleaned, and cleaning wastewater is expensive.

According to Logan's estimates, about 1.5 percent of all the electricity in the U.S. goes into wastewater treatment. Up to 5 percent of all the country's electricity goes into our nation's water management systems.

The winery, Napa Wine Co. in Oakville, Calif., doesn't have specific statistics on how much they pay to treat their wastewater, but it is expensive.

To offset the cost of treatment, the winery owners installed a 1,000-liter, refrigerator-sized microbial electrolysis cell to help treat some of the wastewater. Until this point, Logan's microbial fuel and electrolysis cells have been smaller than a teakettle.

Two steps are required to treat the water flowing into the unit. First, one group of bacteria turns unused sugar and unwanted vinegar from improper fermentation into electricity. It's a small amount, however, not enough to reach the 1.2 volts necessary to split water; therefore, a little extra electricity from the normal power grid is needed.

Another group of bacteria uses that electricity to split water molecules into oxygen and hydrogen, which escape into the atmosphere.

At least, that's the idea. "We are producing more methane than we wanted," said Logan, who is trying to correct the problem. The scientists could collect the hydrogen for a fuel cell or burn the methane for heat, said Logan, but for now they let it escape into the atmosphere.

The microbial electrolysis cell only treats one-tenth of 1 percent of all the winery's wastewater, most of which flows into a traditional treatment lagoon.

The project isn't meant to save the winery a significant amount of money, just to prove the technology is feasible. Logan estimates it will take three to five years before a commercially viable microbial electrolysis cell is available.

While Logan uses a microbial electrolysis cell to split water, a group of scientists from India recently developed a microbial fuel cell that uses wine to produce energy.

"Sugars like glucose, alcohols and effluents containing sugars or alcohols can be used (to produce electricity)," said Sheela Berchmans, a professor at the Central Electrochemical Research Institute in India, who recently co-authored a paper in the journal Environmental Science and Technology.

Two different bacteria can spoil wine, Acetobacter aceti and Bluconobacter roseus. The scientists from India created microbial fuel cells using single cultures of each bacteria as well as both together.

A fuel cell with A. aceti or B. roseus produced a mild electrical current, about 213 milliwatts for the former and 395 milliwatts for the latter. Put them together, however, and the combination can generate 859 milliwatts of power.

"The mixture of the cell cultures improves metabolic degradation," said Berchmans.
B. roseus is great at breaking down the glucose into acetic acid but not great at creating electricity. A. aceti can't use sugar as well as B. roseus can, but it can turn acetic acid into electricity.

In other words, one bacteria's waste is another bacteria's food.

However, the electricity is produced not much — at least not yet.

The scientists hope that the technology could eventually be scaled up to produce more electricity or help to save electricity that would normally be used to treat wastewater.

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