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Biodiesel: The Renewable Oil Well

The Louisiana bayou is an endless expanse of still and glassy water dotted with numerous cypress trees and swamp grass. The rich biodiversity in these areas is the lifeblood of the people who reside within close proximity of them. Much of traditional Cajun cuisine, tourism, and other industries rely on what these ecosystems have to offer in regards to the different organisms they contain. For example, crawdads, shrimp, catfish, alligators, and frogs are a staple in Cajun cuisine. A dramatic reduction of these ingredients would almost certainly destroy the local food culture and much of the existing bayou-based industries—tourism and fishing. This, unfortunately, is exactly what is happening in Louisiana due to our insatiable thirst for oil. A fact unknown to many is that Louisiana is one the largest gas producing states in the nation. The large-scale infrastructure dedicated to this oil refinement process also happens to exist in close proximity to the crucially important bayous and neighborhoods that are located along the Mississippi River. This places many plants, animals, and humans in the way of harm. The pollution created by these facilities eventually enters the waterways of the bayous, which contaminates the aquatic organisms that the native people have come to rely on for food and other industries. If and when these plants or animals are ingested the contaminants that they harbor are deposited within our bodily tissues, and if this persists, the development of many illnesses, cancers, and, in some cases, pre-mature death ensues.

This reliance on fossil fuels is definitely not considered a viable solution for

future inhabitants of the earth. This is not only due to the scarcity and finite nature of these resources, but also their adverse affects on human health and the well being of other living organisms when exposed to them directly and even indirectly. As was mentioned, traces of oil and other fossil fuel contaminants can sometimes be found in the food you eat, the water you drink, and even the air you breathe. However, with the development of cleaner and renewable forms of alternative energy—such as biodiesel—we will sever our reliance from fossil fuels and the harmful carcinogens they contain, thereby creating a healthier environment for all.

What exactly is biodiesel? Why are petroleum-based fuels so bad for our health? Will biodiesel help us in our quest to finding a viable alternative energy sources without a drastic change in current infrastructure dedicated to the production of carbon-based fuel sources? The feature film *FUEL* answers these questions and many others. This documentary takes an in-depth view of the mission of Josh Tickell, the director and narrator of the movie. He was adversely affected by the petrochemical industry and decided to help spearhead the movement for the development and innovation of biofuels—a cleaner burning fuel now derived from cooking grease, animal fats, and vegetable oils—in order to find a safe alternative to carbon-based fuels.

When the movie begins, Josh Tickell describes the initial stages of his quest to promote biodiesel. He first discovered this type of alternative energy when he was studying on a European farm as part of a degree in sustainable living from The New College of Florida. During his work on these organic farms, he discovered that the machinery used for the farm's upkeep was powered by biodiesel manufactured from the biomass of the crops that the farmer grew. After finishing his degree, he flew to the

United States and began a project that would advertise the "biodiesel cause" to America. His idea was to purchase a regular diesel-powered Winnebago R.V. and tour the country propelled solely by used vegetable oil acquired from restaurants throughout the journey. His trip lasted from 1997 to 1999 and came to an abrupt end when Tickell learned that his mother had fallen desperately ill.

At the time his mother, Deborah Dupre, lived in Louisiana. This state also happens to be the largest gas producing state in the nation as a result of their numerous oil deposits and refining and processing centers. In fact, there are 150 petrochemical facilities within a 100-mile area along the Mississippi River between Baton Rouge and New Orleans (*FUEL*). The Environmental Protection Agency of Louisiana pronounces the air and soil surrounding these petrochemical facilities as the fallout area because of the large concentrations of lethal chemicals that are present in these areas (qtd. in Environmental Protection Agency of Louisiana). The households that happen to be within these fallout areas have become subject to high levels of oil refinement byproducts that are correlated with the onset of many debilitating and, in some cases, life-threatening diseases—e.g. asthma, bronchitis, and cancer (*FUEL*).

These chemicals are released during the gas refinement process. Initially, crude oil is heated in distillation towers where oil vapors are released through the top of the tower and into the environment. According to the scientific data compiled by Dr. Cheryl L. Waldner and Dr. Edward G. Clark, experts in the field of environmental and occupational health, the vapor extruded into the atmosphere contains a mixture of highly dangerous chemical agents including, hydrogen sulfide, sulfur dioxide and volatile

organic compounds (VOCs) (6)[1]. Waldner and Clark have also found correlations between the different chemicals emitted by the petrochemical factories and the various diseases that are prominent when chronically exposed. Close contact with high levels of hydrogen sulfide and sulfur dioxide are commonly connected with symptoms that include increased incidence of respiratory infections, bronchial hypersensitivity, coughing and wheezing, negative effects on airway resistance and lung function, permanent neurobehavioral impairment, and increases in the incidence of diseases of the nervous system and sense organs (7). The inhalation of VOCs, such as benzene and toluene, is associated with respiratory tract irritation, central nervous system dysfunction and the suppression of bone marrow function (inhibits cell-mediated and humoral immune responses). (Waldner 7)

The chemical agents emitted from the distillation towers are not the only byproducts of the crude oil refinement process. In addition, solid toxic waste must be discarded. According to Tickell, the oil companies in Louisiana have been dumping the remaining hazardous waste in waterways and on patches of land for the past seventy years. As a result of the continued dumping, the local biota in the river and land systems—such as small animals, fish, and plants—have also been affected. The continued pollution of these environments causes highly detrimental side effects to the local ecosystem and, in some cases, destroys the life that inhabits the area.

According to the Oregon State University's toxicology database, these chemicals enter the various plants and animals by means of bioaccumulation and biomagnification.

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[1] The research work conducted by Dr. Waldner and Dr. Clark, was done primarily to test the effects of the oil and gas industry on the birthrates of cattle in Canada. However, within their abstract they also included the effects of these chemicals on humans.

The process of bioaccumulation is defined as an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment (Oregon State University). Biomagnification is a process that results in the accumulation of a chemical in an organism at higher levels than are found in its food. It occurs when a chemical becomes more and more concentrated as it moves up through a food chain—the dietary linkages between single-celled plants and increasingly larger animal species (Oregon State University). The interplay between the processes of biomagnification and bioaccumulation result in abnormally high concentrations of contaminants within the environment's intricate food web. This can lead to various diseases, syndromes, deformities, and in some cases, death (*FUEL*).

Due to the prevalence of these health abnormalities, the neighborhoods and parishes surrounding the petrochemical facilities along the Mississippi River are known as "Cancer Alley." Barbara Koeppel, an investigative reporter for *The Nation*, describes Cancer Alley as place where:

> People living nearest the factories and waste dumps are sick and dying. Clusters of asthma, stillbirths (a full-term baby that dies at or within 1 hour of birth), miscarriages, neurological diseases and cancers have mushroomed. And residents have long claimed that the waste has poisoned domestic animals, wildlife and fish. (16)

The article also refers to the case study of eight-year-old Caleb Thomas. Caleb and his family lived in Gonzales, Louisiana, which sits in the wake of five petrochemical plants and several hazardous waste dumps. On his second birthday, Caleb's parents made a gruesome discovery. Caleb had contracted rhabdomyosarcoma, a rare childhood cancer

that afflicts one in a million children a year (16). Koeppel also adds in her article, "But in Gonzales, cancer is no rarity. Two other boys were also diagnosed with rhabdomyosarcoma, bringing to three the total who fell ill within fourteen months" (16). The claim regarding the rarity of this cancer can be validated with the scientific findings collected by the Greenebaum Cancer Center of the University of Maryland. This institution states that as of 2009 there are on average 240 cases of children being afflicted with this disease each year (Greenebaum Cancer Center). This figure coincides with the claim made by *The Nation* according to the latest population data provide by the U.S. Census Bureau, who say that the United States is home to 310,532,637 people (U.S. Census Bureau).

Koeppel also indicates that four other similar instances occurred forty miles away in Zachary. In 1999, five more children in or near Gonzales had developed leukemia (16). Koeppel also concludes that:

> Six children, who lived within three miles of an oil and chemical waste dump that operated in the sixties and seventies, developed neuroblastomas, deadly cancers of the central nervous system—a rate 120-200 times higher than the norm (17).

In addition to various types of cancers, residents of the parishes surrounding the petrochemical facilities have high rates of asthma and the development of other respiratory diseases (Koeppel 17). Imagine how the lives of these children could have been spared if those oil companies would have been refining and processing biodiesel without the addition of harmful additives into the surrounding area.

According to the 2000 Toxics Release Inventory (TRI) published annually by the

U.S. Environmental Protection Agency, Louisiana is nationally ranked third for total releases within the state, second throughout the nation for total onsite releases, and first for the total amount of production-related waste managed. The total amount of waste produced by all of the petrochemical facilities in Louisiana is 9,416,598,055 pounds (Toxics Release Inventory 1). In other words, the waste generated at these alarming rates puts many of the surrounding communities in extreme danger due to the oil companies' inability to properly dispose these large amounts of toxic effluence. This build up of hazardous material eventually ends up in the surrounding ecosystem.

Unfortunately, this is not the only "Cancer Alley" that exists. Wherever oil is processed there are usually a high volume of cases of localized incidences of cancer. For example, cancer rates are higher than normal in Westville, New Jersey; Vicksburg, Mississippi; Robinson, Illinois; and Torrance, California among others (*FUEL*).

In addition to the negative impacts experienced by humans, the long-term exposure to these petrochemical facilities affects our livestock as well. As noted earlier, the team of Canadian researchers, led by Dr. Cheryl L. Waldner and Dr. Edward G. Clark, began an investigation to determine the association between exposure to emissions from the oil and gas industry and the pathology of the immune, nervous, and respiratory systems, and skeletal and cardiac muscle in beef calves. The experimental group for the study consisted of 203 herds (29,713 cows) of cattle in the areas of Saskatchewan, Alberta, and northeastern British Columbia. The cow pastures studied were at least 1.6 km away from an oil and gas facility/facilities. After the study concluded, researchers reported that 1,531 calves out of 29,970 total births were aborted, stillborn (a full-term calf that died at or within 1 hour of birth, or a full-term calf that was found dead, had not

been observed alive, and was obviously recently born), or dead more than 1 hour after birth (6). Postmortem examinations of the calve tissues revealed startling results. In regards to the immune system of the calves, forty-nine percent of the tissue examinations reported lympholysis—destruction of the lymph cells (21). Lesions[2] to the nervous system occurred in five percent of the brain and spinal cord tissues examined (31). The most common lesions in the skeletal and cardiac muscle tissues examined were degeneration[3] and necrosis[4] and occurred in more than twenty-five percent of the samples obtained (23).

These results show that the exposure to various chemical agents—such as hydrogen sulfide, sulfur dioxide, and volatile organic compounds—associated with the combustion of crude oil in petrochemical facilities, are presumably detrimental to the immune system and the skeletal and cardiac muscle tissue of baby calves. Accordingly, if the newborn calves endure the ingestion of these contaminants and survive until they are ready to be slaughtered, their meat that is sent to the grocery stores is likely to harbor these pollutants and will biomagnify within our tissues when consumed. Over time, if the consumption of these tainted products continues, those continually exposed will be at a greater risk of contracting the diseases associated with the chemicals found in the meat.

After discovering the existence of "Cancer Alley" and the harmful effects of our reliance on oil, Tickell also realizes that long-term, and even momentary exposure to these chemicals can have a detrimental impact on anyone's health. When Josh Tickell finished tending to his mother, he once again began his public outreach mission to teach

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2 An abnormal change in the structure of an organ due to disease

3 Loss of muscular tissue

4 Premature death of cells and living tissue

people about the potentials of biodiesel. In *FUEL*, Tickell presents the advantages of biodiesel as a form of renewable, alternative energy. In regards to carbon dioxide (CO_2) emissions, gasoline and regular crude oil-based diesel emit twenty pounds per gram when burned, while biodiesel creates two to four pounds of CO_2 per gram of fuel (*FUEL*). That is an eighty to ninety percent offset in the release of carbon dioxide. Josh Tickell also states that, as compared to the combustion of regular diesel, biodiesel reduces the output of soot, airborne particulates, and volatile organic compounds.

Many of the claims made by the film, in regards to the advantageous health implications of using biofuel, can be validated by the published scientific findings of Dr. Mustafa Balat, an expert in the field of biodiesel research from the Sila Science Universite in Turkey. In his study, he examines the fuel characteristics and the use of biodiesel as a transportation fuel. Dr. Balat's findings indicate that:

> The use of biodiesel decreases the solid carbon fraction of particulate matter (since the oxygen in biodiesel enables more complete combustion to CO_2) [and] pure biodiesel is essentially sulfur free and results in a total reduction of sulfur dioxide (SO_2) emissions as well sulfate aerosols in particulate matter. (861)

As was mentioned earlier, the reduction of sulfur particulate greatly decreases the occurrence of ailments afflicting the respiratory system. Therefore, a switch to the mass production of biodiesel, for instance, would greatly reduce a fuel refinery worker's propensity of contracting ailments that are closely associated with exposure to carbon-based fuels.

Dr. Robert L. McCormick, a researcher at the National Renewable Energy

Laboratory, conducted a study to test the impact of biodiesel on pollutant emissions and public health. By comparing the emission compositions of regular petroleum-based diesel, B20 diesel (a blend of twenty percent pure biodiesel and eighty percent oil-based diesel), and pure biodiesel, the environmental health benefits were clear. Biodiesel blends of twenty percent produce reductions of fifteen percent or higher in emissions of particulate matter, carbon monoxide, total hydrocarbons, and a group of toxic compounds including vapor-phase hydrocarbons, aldehydes, ketones, and selected semi-volatile and particle-phase PAH and NPAH (1033). In other words, there is a considerable reduction in the amount of carcinogens and other harmful chemicals that are released from the combustion of biodiesel as compared to regular, oil-based biodiesel. The absence of these contaminants will promote a healthier environment and less of a likelihood of contracting ailments associated with carbon-based fuel byproducts.

The byproducts reduced by the use of B20 diesel are the primary contributors to ground-level ozone (smog). Ground-level ozone is correlated with incidences of airway irritation, coughing, wheezing and other breathing difficulties, respiratory tissue inflammation, aggravation of asthma, increased susceptibility to respiratory illnesses like pneumonia and bronchitis, and permanent lung damage with repeated exposures (Ground-level ozone).

Also, the use of pure biodiesel reduces the harmful chemicals from exhaust emissions even further, in some cases up to a forty-two percent decrease as compared to petroleum-based diesel (McCormick 1037). As you can see, not only is biodiesel a viable, renewable energy resource, but also it is a leader in the race to reduce harmful pollutants as byproducts of combustion.

In summation, the scientific evidence presented and the resulting public awareness regarding the benefits of biodiesel have added momentum to the biofuel movement. Given the amount of technical knowledge that we harness today, there is no reason as to why infrastructure for the advancement of biodiesel is not already in place. The world has known about the feasibility of biofuels for decades. For example, *FUEL* uncovered an in invaluable energy relic from the presidency of Jimmy Carter (1977-1981). This artifact was a project proposed in the Department of Energy's Aquatic Species Program, which examined the feasibility of a new form of biodiesel derived from algae that was fed with wastewater. This government project concluded that ALL of America's fuel needs could be grown using only fifteen percent of the Sonoran Desert in Arizona (18,000 square miles) and only cost $25 million[5] over twenty years (qtd. In Aquatic Species Program). Keep in mind that this idea was proposed almost 30 years ago! This came from a president who managed to reduce America's energy usage by twenty five percent during his term in office (*FUEL*).

Not only is biodiesel more feasible to produce in regards to the space needed, its obvious health benefits, and the lower cost of production, but it also yields more energy. For every 1 unit of energy—BTU—burned in the production of petroleum, it yields only 0.8 BTU per unit of oil (*FUEL*). In other words, the production of petroleum is energy negative. On the other hand, for every 1 BTU consumed in the production of biodiesel, it yields 3 BTUs per unit of biodiesel (*FUEL*). With all of the time and money invested towards the research into the benefits of biodiesel, why don't we make the switch? Well, many consumers and businesses have answered the calling for change. According to The

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[5] Adjusted for inflation as of October 2010

National Biodiesel Board, a national trade association representing the biodiesel industry, the amount of biodiesel consumed in 2009 was approximately 700 million gallons. Also, the current production capacity for the 173 companies that are involved with biodiesel is 2.29 billion gallons per year (U.S. Biodiesel Production Capacity). Notice the large disparity between the amount of biodiesel consumed and the production capacity. This gap can only be filled with your help. This vision for the mass-consumption of biodiesel can become a reality if, for instance, consumers who are interested in a healthier tomorrow contact their local gas stations and demand biodiesel. In addition to purchasing power, becoming politically active and explaining to your congressman how biodiesel will promote a healthier environment can assist in spread of the biodiesel cause. While it may seem cliché, government representatives do in fact listen to their constituency whether it is an individual or an entire grassroots organization. There are a number of politically active groups you can easily become a part of, including The Veggie Van Organization and the Association for the Advancement of Sustainability in Higher Education. Join the movement. Speak to your government representative. Utilize the fuel that the renewable oil well provides.

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Process Memo

This journey through Paper #2 has been a time-consuming and arduous, but still extremely rewarding. In all of my years spent writing research papers, I have never gotten so involved with my writing like I have with this piece. When researching my topic, I discovered things that I could have never dreamed were true about alternatives energies. Facts such as, the dramatically lowered concentrations of sulfate particulate in biodiesel exhaust, have caused a dramatic shift in my outlook on carbon-based fossil fuels. As a result of my research and the critical analysis of the set issue—the need to instigate the widespread use of biodiesel due to the adverse health effects that are associated with exposure to oil processing and refining—I have become a fervent advocate of cleaner energy. When we were presented the description of Paper #2, I chose the medium, *FUEL*, because my high school AP Environmental Science teacher recommended it to me. He knew that I was passionate about the subject of alternative energy. Although my writing journey had its share of obstacles, I was not left astray. I received helpful feedback from Kaylen Hendrick, Samantha Peters, and Shelah Woodruff. Even though, this piece is still not perfect, I would like to improve it if I was allotted extra time. One of the main additions would be an experiment that I would conduct myself regarding the concentrations of oil byproducts in the waterways of the Gulf Coast. As a result of the recent BP spill, many oil patches in the Gulf of Mexico have been "remedied" by setting them ablaze. When these newly released carcinogens are swept up by the prevailing winds they are deposited within various water systems along the coast. With the correct supplies and supervision, I feel that this study would have be a valuable addition to my paper. I would have also liked to seek the research ideas of an expert in the field of

biodiesel. In the end, this paper was an incredible learning experience that I will always remember.