

Undergraduate Thesis Prospectus

Production of Syngas and Gasoline from Electronic Waste

(technical research project in Chemical Engineering)

Human vs. Animal Welfare: Canine Ear Cropping and Tail Docking

(STS research project)

by

Caitlin Rudy

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technical project collaborators:

Matt Denecke

Rachel Ho

Jonathan Zheng

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

signed: _____ date: _____

approved: _____ date: _____
Peter Norton, Department of Engineering and Society

approved: _____ date: _____
Eric Anderson, Department of Chemical Engineering

General Research Problem

How are human convenience and environmental welfare balanced in practice? Human convenience and environmental welfare can be in competition. For example, supporters of fracking note that it has “created millions of American jobs” and “reduced energy prices” (IPAA, 2019). Opponents of fracking fear it will damage the local environment and exacerbate climate change (Oakland Post, 2013). Even environmental values may be in competition with each other. Wind turbines are championed as a sustainable source of energy, but are responsible for hundreds of thousands of bird and bat fatalities, which provokes opposition (U.S. Fish and Wildlife Service, 2018). Such divergence in values complicate controversies.

Production of Syngas and Gasoline from Electronic Waste

How can syngas be produced and then used to selectively form gasoline? My capstone is a team project for the Chemical Engineering Department, overseen by Eric Anderson. My team is Matt Denecke, Rachel Ho, and Jonathan Zheng. Gasification of electronic waste can recover metal and produce syngas. With increasing pressures to address mounting waste in the U.S., scientists are researching how to convert waste into energy. Researchers from the International Telecommunication Union (ITU) estimate that about 44.7 million metric tons of electronic waste (e-waste) were generated worldwide in 2016. Only 20% of it was recycled through appropriate channels (Baldé et al., 2017). E-waste could be recycled more effectively. E-waste is made up of a mixture of various metals; namely copper, aluminum, iron, and nickel, as well as various plastics, resins and ceramics (Flandinet et al., 2012, p. 485). We will research how to convert e-waste into synthesis gas (*syngas*) which can later be treated and converted into gasoline. Syngas is typically processed from natural gas; thus, this project has the environmental advantage of

replacing a non-renewable feedstock with a non-degradable one, solving two issues in sustainability.

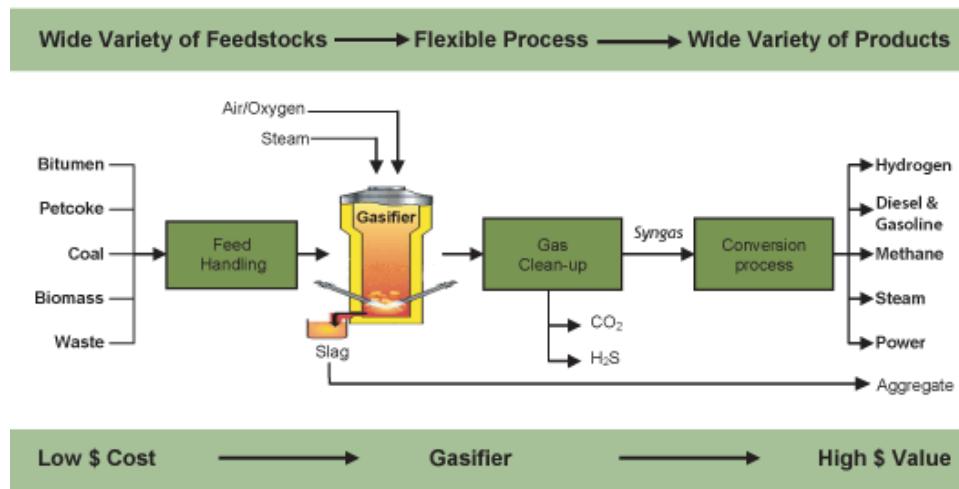


Figure 1. General process for producing syngas from gasification. (Bhat, N. 2016)

Syngas is a mixture of hydrogen, carbon monoxide, and carbon dioxide, typically produced using methane from large natural gas reserves. Syngas is used for a variety of processes, including diesel production, methanol production, and hydrogen synthesis, for the Haber-Bosch process used to irrigate most of the world's crops (Sartipi et al., 2013).

The first challenge in our process is breaking down e-waste into syngas. Gasification is a common method of converting organic waste into syngas; however, traditional gasification techniques may not handle the metals in e-waste without additional processing. Our process must be compatible with potential contaminants and produce high yields of clean syngas. Thus, we propose gasifying the e-waste using molten salt, which exhibits excellent heat transfer properties, a high operating temperature range, and does not require metal to be separated before gasification. Kinetic data for a eutectic mixture of lithium, sodium, potassium carbonates (LNK) molten salts reacting with e-waste has been published, supporting its viability in gasification (Salbidegoitia et al., 2015).

Once the e-waste converts into syngas, the syngas will be processed into gasoline. Historically, the Fischer-Tropsch process, pioneered in the 1920s, has been used to convert syngas into fuel. Recent developments in catalyst technology have improved the process' selectivity towards gasoline-grade hydrocarbons, reducing the need for hydrocracking (Sartipi, S., et al., 2013). Another mechanism converts the syngas into methanol, then into dimethyl ether, then into gasoline through a series of fluidized bed reactors (Primus Green Energy, 2019). Gasoline is a profitable product critical to society, and its production from waste may be an environmentally friendlier alternative to conventional petroleum extraction.

We will analyze our system through a collection of material and energy balances, while using MATLAB to solve the kinetic and thermodynamic equations that define our process. Our process will be simulated with *Aspen Plus VII*, which will guide our economic and unit operation analyses. We will determine if this process is energy-efficient. If the energy costs are high, then it may cost the environment more in burning fuel to run the process than it saves by recycling waste. The project will evaluate both the economic and environmental viability of producing gasoline from syngas generated from e-waste.

Human vs. Animal Welfare: Canine Ear Cropping and Tail Docking

How do critics and defenders of canine ear cropping and tail docking advance their respective agendas? Canine ear cropping and tail docking (C&D) are controversial procedures often considered cosmetic and unnecessary. C&D originated to minimize injuries in working dogs, such as guard, farm, hunting, and army dogs. The American Kennel Club, founded in 1884, integrated the altered appearance into the breed standard of many working dogs, although modern show lines usually are not working lines. In the AKC's 2018 list of most popular dog

breeds, six of the top twenty breeds have cropped or docked breed standards (AKC, 2018). C&D surgeries are usually performed on puppies. Critics consider it cruel to hurt a puppy for cosmetic alterations and usually deny that any benefits exist. The debate pits animal welfare and rights versus human preferences and convenience.

C&D is illegal in most European countries under the *European Convention for the Protection of Pet Animals* (Council of Europe, 1987), but is unrestricted in the United States, with the exception of some states that require C&D be done under anesthesia by a licensed veterinarian (Khuly, 2015). The AKC breed standard requires that show dogs, whose champions preserve purebred lines, be altered in order to stand in the ring.

The debate over C&D loosely parallels that over abortion. A common pro-choice saying is “my body my choice;” however opponents cite about the welfare and the rights of the affected fetus. This parallels the debate between the dog owners’ autonomy versus the dogs’ welfare. Castration, a common alteration, is more invasive than C&D, correlates with serious health complications in dogs fixed too young, and is practiced for human convenience (Bennett, 2001). Yet unlike C&D, castration is encouraged by veterinarians and the American Society for the Prevention of Cruelty to Animals (ASPCA, 2019).

The Doberman Pinscher Club of America (DPCA), a non-profit, is the only National Doberman Breed Club recognized by the American Kennel Club (AKC). The DPCA states that its “major objective. . . is to encourage and promote purebred Doberman Pinschers and to do all possible to bring their natural qualities to perfection.” The AKC controls the Doberman breed standard which calls for the ears to be “normally cropped and carried erect,” and the tail to be “docked at approximately second joint” (AKC, 1990). The DPCA released an *Illustrated Standard* for judges that clarifies “‘normally cropped’ [ears] means cropped in a normal

manner,” and “does not mean ‘usually cropped’” (Vandiver et al., 2006). The AKC’s official policy states that it “recognizes that ear cropping, tail docking. . .as described in certain breed standards, are acceptable practices *integral to defining and preserving breed character* and/or enhancing good *health*” (AKC, 2008, emphasis added).

Upholding tradition is significant to many breeders and owners; the altered standard is the *correct* one. One Doberman owner wrote on a forum, “I have one of each, a natural floppy and one cropped. The only thing that bothers me about the natural floppy look is that no one knows what breed she is” (My2Girls, 2017). For owners, cropping and docking legitimizes a breeder. Backyard breeders are less likely to crop because they rarely show their dogs. “Reputable breeders always send their puppies home cropped,” another owner posted on the forum (Archer, 2017).

Working dog enthusiasts disagree that C&D is cosmetic and refer to its health benefits and practicality. For guard or army dogs, C&D removes any handle that could be seized by an attacker. In the United Kingdom docking is illegal except for working dogs (Parliament of the United Kingdom, 2006). In World War II, C&D were practiced on Dobermans (Dobermans Den, 2009). For hunting dogs, docking may prevent tail injury in the underbrush (AMVA, 2019). For farm dogs protecting livestock, cropping may prevent ear injuries which bleed excessively and heal slowly (Senza Tempo Cane Corso). Theresa Mullen, a member of the DPCA education committee, thinks that erect ears improve “sound localization” (Mullen, 2010). Although Mullen fails to substantiate the claim, the idea is echoed in Doberman forums.

Some supporters agree that C&D is cosmetic, but not cruel. Protection Dog Sales (PDS) breeds and trains personal protection dogs. PDS crops and docks all of their Dobermans and

Giant Schnauzers, specifically for the intimidating appearance, and not for any practical or health function (Harris, 2016).

Critics contend that C&D causes unnecessary pain. The Canadian Veterinary Medical Association president, Dr. Troye McPherson, “believes that cosmetic alteration, including tail docking in canines, is painful and produces no benefit to the animal” (CMVA, 2018). PETA says that “unscrupulous veterinarians perform cruel, disfiguring surgeries that cause dogs great suffering” and “that simply perpetuate the image that dogs are fashion accessories” (PETA, 2010). The CMVA cites a study in which participants perceived cropped and docked dogs *and* their owners more negatively than their natural counterparts, even if the participants were unaware that the dog’s appearance was unnatural (Von Keyserlingk, 2016).

Another criticism is that C&D may have behavioral and health consequences. The American Veterinary Medical Association notes uncertainty about the long-term consequences of docking, suggesting that it could impair a dog’s ability to communicate and cause underdeveloped pelvic musculature (AMVA, 2013).

Some support of C&D is a reaction to the claim that C&D is cruel and that its supporters are immoral. The hashtag *#croppedandloved* has been used on 40,197 Instagram posts featuring cropped pets. Avery Bennett, President of the Association of Avian Veterinarians, asked: “is spaying and castrating any less inhuman than declawing, ear cropping, devocalizing, or pinioning?... Who has the right to decide?... YOU do... But along with that goes the obligation to be tolerant of the values, beliefs, and morals of our colleagues” (Bennett, 2001). Cane Corso breeder Rachel Hattig, in response to criticism for cropping her puppy’s ears, said “you don’t get to claim that people who crop their dogs’ ears are horrible people. You don’t get to do that” (Senza Tempo Cane Corso, 2018).

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