

Internal combustion engine

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An internal combustion engine is an engine that generates rotational motion by driving a piston with the expansion of combusting gas. In order for this to occur, a fuel and oxidizer must be mixed and ignited, usually with a spark plug with most fuels or compressing air until it is hot and introducing diesel. This rotational motion can then be linked to wheels, pumps, propellers, or other mechanical devices via shafts, belts, and gears. On Earth, most internal combustion engines run on gasoline, but other fuels can be used, such as natural gas, propane, biodeisel, or ethanol.^[1]

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General design

The combustion and engine cycle occur in a cylinder in the engine. A piston compresses a mix of fuel and oxidizer before combustion occurs. Combustion occurs in a combustion chamber and expands the gas to push the piston to its original position. Each piston is linked to the crankshaft with the piston rod. The crankshaft rotates, turning the linear motion of the cylinder into rational motion.^{[2][3]}

Engine cycle

Internal combustion engines have staged engine cycles. Most combustion engines have four staged cycles, but many engines also have two or six cycles.^[3]

Fuels

Internal combustion engines can operate on a wide variety of fuels. While gasoline is the most common, hydrogen, methane, propane, and more engines are operated.

Methane

A methane or compressed natural gas internal combustion engine is partially attractive because of its lower emissions. Methane has a lower flame speed and the durability of these engines can be very high.^[4]

The disadvantages of these fuels for spark-ignited internal combustion engines are that methane has a slow burning velocity and it is difficult to lean-burn. Therefore, these engines suffer from a low thermal efficiency and large cycle-by-cycle variation, both contributing to a less than ideal fuel efficiency.^[4]

Proposed use in space exploration

Advantages

Internal combustion engines have a few big advantages over batteries. For one, in many cases, it is easier to transfer and store larger amounts of fuel and oxidizer in bulk than electricity in batteries. Batteries require a complex chain of manufacturing to be produced. Thus, they likely will not be produced on Mars until moderate scale industrial operations are established. Internal combustion engines too require complex manufacturing, but one only needs one engine to convert a massive store of fuel and oxidizer into usable energy. With batteries, the batteries *are* the store of energy, so they would be required in bulk.^[5]

The engines allow a great deal of portability. Smaller engines can be used for small vehicles traversing the surface or excavation, while larger engines can be used to generate electricity during night or emergencies. Waste heat from these engines can be recycled into heating the vehicles and habitats or into nearby industrial processes, such as warming ice into water.^[5]

References

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3. Hall, Nancy. "Four Stroke Internal Combustion Engine." (<https://www.grc.nasa.gov/www/k-12/airplane/engopt.html>) NASA Glenn Research Center. Last modified May 5, 2015.
4. Çeper, Bilge Albayrak (2012-10-17). "Use of Hydrogen-Methane Blends in Internal Combustion Engines." (<https://www.intechopen.com/books/hydrogen-energy-challenges-and-perspectives/use-of-hydrogen-methane-blends-in-internal-combustion-engines>) *Hydrogen Energy - Challenges and Perspectives*. doi:10.5772/50597 (<https://doi.org/10.5772/50597>).
5. See discussion on NasaSpaceFlight Forums: "How to develop lots of good surface vehicles for Mars colonists?" (<https://forum.nasaspaceflight.com/index.php?topic=30882.0>)

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- This page was last edited on 8 December 2019, at 17:43.