Comparison of Traditional and Alternative Fuel Engines

Yu Hao *
Zhengzhou no.9 high school, Zhengzhou, 45000, China
* Corresponding Author Email: haoyu3788@gmail.com

Abstract. Over the past one hundred years, traditional engine have an undeniable impact on the development of human civilization.It is precisely because of the invention of traditional engines that significant breakthroughs have been achieved in many fields. Nevertheless, the use of them contribute large amount of greenhouse gas, such as carbon dioxide. The emission of these gas significantly deteriorate global environment. Additionally, due to the excessive reliance of humans on traditional engines, a large amount of fossil energy has been consumed. The fuels used in traditional engines are mostly non-renewable fossil energy. Therefore, the use of traditional engines has always been detrimental to the sustainable development of humanity in the future. In response, alternative fuel engine (hybrid engine,battery electric engine,fuel cell engine), have developed by people. As time went by and with the development of the times, their appearance gradually replaced the use of traditional engines.In this era where both traditional engines and alternative fuel engines are indispensable, this article focuses on the analysis of their working principles, performance comparisons, advantages and disadvantages comparisons, as well as emissions comparisons.

Keywords: Traditional engine, comparison, alternative fuel engine, emission.

1. Introduction

Over the past one hundred years, traditional gasoline and diesel engines have been the cornerstone of global transportation and industrial activities for over a century. From simple cars to large trucks for industrial use, the development of traditional engines has made significant contributions. The reason why traditional engines can be widely applied is due to the mature technology of traditional engines, their high thermal efficiency, and the complete process of fossil energy extraction. Although traditional engines have many of the aforementioned advantages, their disadvantages are equally obvious. That is, they are highly dependent on the extraction and use of fossil fuels, which mainly consist of coal, oil and natural gas. These fossil energy sources are all non-renewable. Their formation takes millions of years, and the amount of fossil energy is not abundant. Therefore, humans cannot rely entirely on fossil energy. Not to mention that the extraction and utilization of fossil energy will cause significant damage to the environment. During the extraction process, it will also destroy the original local ecology. Moreover, the utilization of fossil energy will release a large amount of greenhouse gases, such as carbon dioxide. This will result in global warming and climate change. All of these pose potential risks to the sustainable development of humanity in the future.

Under such context, in order to reduce the harm to the environment and the excessive reliance on fossil energy, alternative fuel engines were invented. Thanks to their significant advantage in having extremely low or zero emissions of harmful gases, they gradually replaced traditional engines in some fields. Especially in the field of household cars, alternative fuel engines can provide cars with a relatively quick starting speed, and the cost of charging is also lower. The fact that no heavy-duty tasks are required also makes one of the disadvantages of alternative fuel engines less noticeable.

Yet, alternative fuel engines still have some drawbacks. Their technical level is not as mature as that of traditional engines, and they cannot perform the same functions as traditional engines in large-scale industrial tasks. The construction of charging stations is not yet complete, and the charging time is relatively long.

2. Analysis of Working Principles

2.1. Working Principle of Traditional Engine

Internal combustion engines (IC) come in various types, including two-stroke, four-stroke and six-stroke engines [1].

2.1.1 Four-stroke engine

The intricate operating sequence that defines a four-stroke gasoline engine encompasses these discrete phases: intake induction, compressional phase, power delivery cycle, and expulsion process.

Induction Stroke: Initiated through the strategic actuation of the intake valve whilst maintaining secure closure of the exhaust counterpart, is an event whereby the piston descends away from its zenith to achieve nadir within the chamber confines. An observable amplification in available spatial parameters atop the piston ensues during such descent, manifesting vacuous conditions internally. From observations, atmospheric pressure exerts superiority over the retained internal values; henceforward, pervades a volatile amalgamate—atomized gasoline synergistically allied with air — through avenues defined by carburetor channels or injected directly into the operative sphere. As contiguous progression beyond this lowest point transitions with valve cessation, proportional ascendancy encapsulates pistonic movement initiating compaction of the gaseous synthesis.

Compression Phase: Retaining uncompromised sealing for both interfaces defining intake and discharge pathways gives rise to intensive compaction influencing flammable constituents embroiled on-cylinder apex oriented trajectories—a precursor exhibiting escalated thermal states coupled conspicuously with augmented pressure gradations. With measurable proximity nearing ultimate elevation (top dead center), discernable intensifications reflect pressures scaling 0.6–1.2 MPa metrics visually paired vis-a-vis temperature thresholds attaining domains situated around 330C–430C strata.

Power Delivery Cycle: As compression approaches denouement, catalytic ignition marks the sparking interface positioned amid cylinder apices effectuating significant combustive engagement upon entrapped pressurized matter engineer rapid adjuncts regarding caloric boundary transforms synchronized amidst gas-related kinetics reaching points between 3–6 MPa periods presenting at parity allowances proximate toward thermogenic elevations established roughly at 2200C–2500C paradigms. Augmented force generation becomes evident via subsequent expansion cycles urging drastic pistion return migration towards nadir under potentions driving external applied mechanistic conversions realized along crankshaft connectively linked rod conduits—the initiation cast thereof delineating valvular openings undergoing active unhindered participatory influxes.

Expulsion Conduit Activity: Sequentially commencing lacking postponements post-antecedent operant perspectives witnessing vented exhaust port emergence terminally compelling intra-chamber stratum contrasts escalating beyond baseline atmospheric station thereby prompting conductive release for high-temperature gasses escaping flux bears witness synchronous conductive auditory arcs traversing said apertures impelled by gravitational ascentums reversed brought back hereunto pinnacle positions exert alternate discharges propelling vestigial stores reside within vessels eventually subjugated eliminating exclusions conferring ori law recovery sites dissolved guarantees loosely deferral penetration maximum discretion displaced hereby emplaced extrusions affiliated outcomes indicative specific architecture coining engines preside dictatorial control mediate propulsion utilities amassed diversely applying apparatus metallic derivatives incompletely exclusive utility constructional tasks surviving illustrative narrative scenarios circumscribed four-stroking models rendered demonstratively integral universality inclines disciplined debaters derive comprehensions extensively recognized instances.

2.1.2 Two-stroke engine

Embedded within the structural confines of the engine's cylinder block reside a triad of apertures: those designated as the intake, exhaust, and scavenging conduits. These openings undergo sequential occlusion by the piston at predetermined intervals--a pattern emblematic of the machine’s operational choreography. The mechanics thereof bifurcate into two integral strokes:

Initial Stroke: Hailing from the nadir termed 'bottom dead center', one observes the piston in vertical migration toward its upper extremity.

Upon the sealing of all diacritic apertures, observable is the compression that impacts the air-fuel concoction infiltrating the cylinder. In contrast, exposure of the intake orifice permits ingress into the crankcase by the combustible admixture.

Within the second stroke operational phase: Nearing the top dead center does the piston proceed when ignition occurs through the spark plug, propelling expansion within the gaseous substance and thus exerting downward force upon the piston towards laborious execution. The closure characterizes this period; specifically, the vehicular portal or intake aperture remains sealed, maintaining compression of the mixture therein contained within the confines of the crankcase. Approximating the bottom dead center once more renders open the exhaust pathway, facilitating egress for spent gases. Subsequent to the preceding occurrence, a revelation arises wherein immersion within the cylinder facilitates direct propulsion of the pre-compressed combustive aggregate. From this emerges the ability to extricate it entirely from lingering gaseous residues, ultimately achieving exhaustive expulsion.

Within the scope of contemporary examination lies the efficacy of two-stroke engines in devices akin to chain saws and nautical jet skis. Exemplifying derivation from distinctly advantageous attributes are these mechanical systems when juxtaposed with four-stroke variants: initiation unfazed by elaborate valvular structures results in simplified construction, culminating in attenuated weight. Peculiar solely to their operational characteristic is each rotational completion concomitant with active ignition—a stark contrast to quadripartite stroke configurations necessitating interceding cycle ignitions—this yielding enhanced power transition. Freedom from orientation-bound constraints marks another idiosyncratic feature; configurations such as arborist sawing instruments demonstrate distinct indispensability given frequently shifting operative angulations during use. Observed therein would be complexities without steadfast erect positioning implicating lubricative circuit viability enhancement and multiplied mechanism intricacies. Thus conferred may be centralized merits comprising mass reduction symbiotically aligned with cost-effective manufacturability and augmented potency, potentially procuring duplicative thrust operations per equivalent volumetric validation credibly ensconced within dual-action cyclic energy transmissions endemic singularly, imbuing tangibility to practical employment choice [2].

2.2. Working Principle of Alternative Fuel Engine

2.2.1 Hybrid electric engine

By examining the configuration required for a hybrid vehicle, an observation emerges showing the necessity of integrating at least two disparate origins related to energy storage devices. Within the structural framework of such vehicles, power conversion devices are compulsory components; these can include an internal combustion engine or possibly an electric motor—systems that possess the capacity to convert stored energy into kinetic action. From this analysis, it becomes apparent that the mechanical force exerted on wheel propulsion arises feasibly from diverse and manifold sources [3]. Embedded within the operations of a hybrid electric vehicle, the elemental construct encompasses the control architecture, propulsion mechanisms, supplementary energy frameworks, alongside the battery ensemble. Illustrative by consideration is the series variant of such an electric-hybrid conveyance; thus shall be delineated the modus operandi associated with this vehicular type. In the nascent stage of vehicular activation lies the capacity state of the battery at its zenith, whose energetic dispensation adequately suffices the operational requisites engendered by the said vehicle—the auxiliary power arrangement remains inactive accordingly. It becomes observable that should the charge retention of the battery descend beneath the threshold of sixty percent, commencement of operation by the supplementary power amalgamation ensues. Instances wherein elevated demands for energy manifest from the vehicle’s systems are met with simultaneous contributions emanating both from the secondary power apparatus as well as the battery matrix towards fulfilling the propulsive needs. Conversely, upon experiences of diminished demand for power from the vehicular construct, provision of motive force by the auxiliary and concomitant replenishment of the cellular collective occur conjointly. Seen through examination pertains stabilization, thus imparted to engine operational parameters—a result of the incorporated battery faculties—culminates in beneficial alterations pertaining to emission reductions.

2.2.2 Battery electric engine

Power is converted from the DC battery to AC for the electric motor. The accelerator pedal sends a signal to the controller which adjusts the vehicle's speed by changing the frequency of the AC power from the inverter to the motor. The motor connects and turns the wheels through a cog. When the brakes are pressed or the electric car is decelerating, the motor becomes an alternator and produces power, which is sent back to the battery [4].

2.2.3 Fuel cell engine

The current produced by a few cell scales with the size of the reaction area where the reactant the electrode and the electrolyte meat, in other words, doubling a few cells area approximately doubles the amount of current produced. Although this trend seems intuitive, The explanation comes from a deeper understanding of the fundamental principles involved in the electrochemical Energy generation through power devices, as previously expounded upon, involves the metamorphosis of primal energy sources into a current continuum. Such conversion is inextricably linked to a requisite energetic transference stage wherein fuel-source energy finds itself imparted onto electrons. Upon examination of the flow in question, it's apparent that this transfer encumbers limitations concerning velocity and necessitates its occurrence at an inter facial or reactivity-determined plane surface. Consequently, explicated herein is the relationship between electrical output magnitude and reactional interface dimension. Should transfer locales exist, increased surface dimensions ostensibly yield augmented currents. To achieve optimal path-oriented operation and enhance the search-to-volume quotient, fuel cells typically adopt oligodynamic planar configurations, thinned for dimensional efficiency. Augmentative of reactive areas are the electrodes designed meticulously poised to facilitate maximal gaseous interacts on one flank endowed with energetic molecules whilst the converse side embraces a talar electric layer, serving as a spatial separator preventing coalescence of fuel and oxygen within respective electrode domains therein maintaining discrete semi-reactions. An analysis comparing such planetary-configured structures against rudimentary fuel cells reveals conspicuous differences yet discernible homologous characteristics persist across both constructs [5].

3. Performance Comparison

To begin with, the thermal efficiency of traditional engine is similar to alternative fuel engines except battery electric engine. Furthermore, in the comparison of acceleration, the advantages of alternative fuel engine are extremely outstanding. In terms of maximum speed, the four engines perform almost identically. The sole advantage of traditional engines is that they are capable of handling large-scale tasks and have shorter recharge times. The performance comparasion is shown in Table 1.

Table 1. Performance Comparison

	Traditional engine	hybrid engine	battery electric vehicles	fuel cell vehicle
thermal efficiency	30-45%	35-50%	The motor efficiency is 85-95%	40-60%
acceleration performance	low	Fast	Extremely fast	Close to BEV (Motor Drive Characteristics)
maximum velocity	150-250km/h	Close to traditional cars	150-250km/h	150-200km/h
endurance mileage	600-1000km	600-1000km	300-1000km (depending on battery capacity, low-temperature drop 30-50%)	500-1000km (after hydrogen refueling)
Energy replenishment time	5 minutes needed to refuel	Refueling for 5 minutes	Fast charging for 30 minutes	Hydrogenation for 3 to 5 minutes

4. Emission Comparison

In contemplation of the aerodynamic resistance coefficient considered, vehicular carbon dioxide emissions for both gasoline and diesel internal combustion engine vehicles have been quantitatively appraised. Noteworthy is the observational data where from an associative proportionality between variations in drag coefficients and resultant emission calculations arises. With regard to the estimation of battery electric vehicles, an assumption was initially made considering a singular source responsible for the generation of electricity. An analysis conducted on various vehicle categories within each distinct energy provision shows that increases in the coefficient of drag are reflected through commensurate surges in estimated carbon dioxide emissions. At the national level examined further, reliance hinges upon specific national configurations linked to the production of electricity. Comparative inquiries proceed among models pertaining to gasoline and diesel vehicle classes, set against country-dependent average emission ratios tied to particular techniques of electricity production; these are compared with metrics standardizing purely electric vehicle performances. Collectively analyzed, predictions drawn from idealized Laplacian kinetic models exhibit significant convergence when juxtaposed with empirical methods, hitting its peak in fully electric vehicular simulations—and evidenced by an average variance approximating no more than 0.04%. Equally compelling is found in the projections concerning gasoline vehicles, displaying an average deviation established at -0.06%. However noticeable yet elucidated, models exploring diesel variants demonstrate conspicuous deviations, although these disparities comfortably rest at a divergence measured around -0.35% away from calculated theoretical benchmarks [6].

5. Conclusion

The discourse herein engages in an extensive analysis of both traditional internal combustion engines and their alternative fuel counterparts, the prism through which factors like environmental ramifications, energy efficiency metrics, performance indices during operational conditions, and examination of economic viability are viewed. What emerges from this inquiry is that despite the incremental subsumption of conventional engines by novel fuels, such engines retain a pivotal station within society's current framework—underscored particularly when opining on technologically matured systems accompanied by entrenched infrastructural networks. This conjunction renders them unparalleled regarding cost-efficacy and dependability, saliently within geopolitically influenced locales where access to non-traditional resources may be circumscribed.

Inferring promptly juxtaposed capabilities, it becomes evident that conventional machines boast superior proficiency for arduous tasks vis-a-vis innovative alternatives. Alongside, manifest are palpable ecological benefits brandished by these advanced mechanisms: fuel cell constructs are lauded for approaching emissions negligible at vehicular terminations; whereas electric propulsion reliant solely upon battery storage manifests considerably reduced exhaust outputs relative to antiquated combusting analogs. It is observable therein, although hybrid iterations proffer emissions somewhat elevated within peer electrical paradigms—their aggregate atmospheric discharge remains decidedly advantageous against historically ubiquitous engine forms.

References

[1] Ikpe A E, Owunna I B. Modelling the performance characteristics of four stroke internal combustion renault engine cycle using matlab simulation tool[J]. ARID zone journal of engineering, technology and environment, 2022, 18(2): 267-280.

[2] Brain M. How two-stroke engines work[J]. Internet),(cited 2 November 2004), available from World Wide Web:< http://science. howstuffworks. com/twostroke. htm, 1998.

[3] Mi C, Masrur M A. Hybrid electric vehicles: principles and applications with practical perspectives[M]. John Wiley & Sons, 2025.

[4] Arivazhagan T A A. Battery electric vehicles vs internal combustion engine vehicles[J]. Energy, 2020, 7(05): 2395-2472.

[5] O'hayre R, Cha S W, Colella W, et al. Fuel cell fundamentals[M]. John Wiley & Sons, 2016.

[6] Athanasopoulou L, Bikas H, Stavropoulos P. Comparative well-to-wheel emissions assessment of internal combustion engine and battery electric vehicles[J]. Procedia CIRP, 2018, 78: 25-30.