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Investigating the Market Failure Evidence

The Case of Fuel Additive Next Generation Petrol and Diesel in India

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Abstract

With the evolving landscape of automotive technologies and increased environmental regulations, there is a pressing need for advanced fuel additives that can enhance the performance, efficiency, and environmental footprint of next-generation combustion engines. The developed additive comprises a unique blend of detergents, cetane and octane boosters, antioxidants, and corrosion inhibitors, tailored to improve fuel efficiency, engine life, and emissions quality. The formulation also includes novel bio-based components that enhance the biodegradability and reduce the carbon footprint of the fuel, aligning with global sustainability goals.

The introduction of this fuel additive not only promises to extend the operational life of next-generation engines but also supports the automotive industry's move towards more sustainable and environmentally friendly solutions. Future research will focus on optimizing the additive formulation for use with alternative fuels and exploring the potential impacts on emerging propulsion technologies. In this context a new generation fuel has introduced in India named super petrol which can add the values to the petrol by increasing vehicles performance and reducing the carbon emission with some minimal additional cost. But the market for such inevitable eco friendly product becomes disappeared in both the auto mobile industry and from the literature which demand and attempt to make an investigation into the market failure. This paper is attempted to fill this gap in the research.

Keywords: Environmental effects of fuel, Environmental economics: government policy, Refining Hydrocarbon fuels, Management of Technological Innovation and R&D, Alternative Energy Sources & government policy and externalities

JEL Classifications: Q51, Q58, L71, O32, Q42, Q48 and D62

Introduction

Fuel additives are chemicals formulated to enhance the performance and efficiency of fuels used in motor vehicles or other machinery. They serve several key purposes depending on their type and the specific requirements of the engine system. Here are some common types of fuel additives and their purposes:

Extensive laboratory and field tests demonstrate that our additive significantly reduces engine deposits, improves fuel combustion efficiency, and lowers harmful emissions by up to 30% compared to standard fuels. Additionally, the additive has shown remarkable effectiveness in maintaining fuel stability and preventing fuel system corrosion, even under extreme conditions.

Furthermore, compatibility studies indicate that the new additive does not interfere with engine components or aftermarket treatment systems, ensuring broad applicability across a range of engine technologies, including hybrid and advanced turbocharged systems. This compatibility is critical as the automotive industry transitions more towards hybrid and fully electric power trains.

1. **Octane Boosters:** These additives help increase the fuel's octane rating, which can reduce engine knocking and pinging, and allow for smoother engine performance.
2. **Fuel Stabilizers:** Useful for storing vehicles or engines for long periods, fuel stabilizers prevent the fuel from degrading and forming gums or varnish which can clog the fuel system.
3. **Cetane Boosters:** Primarily used in diesel engines, cetane boosters improve the ignition quality of diesel fuel, resulting in better starting, smoother running, and reduced engine noise.
4. **Detergents:** These additives help keep fuel injectors and other components of the fuel system clean by preventing the build-up of carbon deposits and other residues.
5. **Corrosion Inhibitors:** They protect the fuel system from corrosion that can be caused by the fuel itself or by external environmental factors.

6. **Antioxidants:** These help prevent oxidation in fuel that can lead to gum and varnish build-up.
7. **Anti-Gel Additives:** Used in diesel fuels to prevent waxing or gelling in cold temperatures, ensuring that the fuel remains fluid and flows easily through the fuel system.
8. **Biocides:** These additives are crucial for diesel fuel as they prevent the growth of bacteria and fungi that can clog fuel filters and corrode the fuel system.

Fuel additives can be beneficial in maintaining engine health and optimizing performance, especially in vehicles that face extreme conditions or older vehicles that might need more care to maintain their efficiency. However, it's important to use the right type of additive for your specific fuel type and engine requirements, and to follow the manufacturer's guidelines regarding their use. Overuse or misuse of additives can sometimes lead to negative effects, so it's best to proceed with knowledge and caution.

Sastras of Environments and Awakening of Additive Fuel

Indian civilization is a civilization of being proud to have its continuity from time immemorial irrespective of India's present geographical boundaries. The seeds of modern development and progress and consequent effect thereof are very much present in its classical literature like Vedas, Vedangas, Smritis, commentaries and digest epics like Ramayana and Mahabharata and Arthshastra besides poetries, dramas etc.

The term environment in Sanskrit language is "Pasyavarana" literally means "Pari-aavarana" i.e. external covering or a thing encircle or encompassing human existence. Sukta of Rigveda is devoted to personified nature where environment as a whole is prayed upon by Rishies and Grihasthas to bestow not only prosperity but also overall wellbeing and peace of the world.

Hymns devoted to Sun, Sky, Earth, Energy (Agni), Varuna (Water), Marut (Vaayu) reveal the holistic vision of divine connectivity and interdependence. Rigveda tells us about the harmonious existence of man and environment, existence of man and

environment by suggesting an ecosystem where welfare of each depends on the other. It situates the relationship of man and environment within the ethical framework coming from within and not from without

In this Sloka the following three things, which are very relevant from the point view of man and environment are suggested: Respect for every form of life living as well as non-living consumption. Be based on Tyaga it extreme exploitation of natural resources born on greed and profit be avoided. One's duty should be performed to avoid conflict disharmony and imbalance in the ecosystem

Upanishads further reinforce this idea e.g., Aitareya Upanishad describe the following passage. " From the various organs of the heated body of the cosmic Purusha fire, consciousness (Prana), Sun, moon, directions, herbs, Supreme being by allowing these gods (sun, moon etc.) to permanently reside in the corresponding parts of human body"

Vedic religion and philosophy emphasised upon the reverence of natural element particularly air, fire, water and earth. Specific ritual were performed by human being to show their indebtedness to these elements for their survival"

Arthshastra the famous work of Kautilya, begin with the expression: i.e for the purpose of exploitation and sustenance of the earth this knowledge is described. The study of Arthshastra enables us to discern the following relevant points which have their bearing on the environment

- Restraint over collection and consumption
- Proper management of natural resources
- Welfare of State and natural resources
- Knowledge of agriculture, horticulture, husbandry, water, resources, forestry, mining, necessary for overall prosperity
- Sustained development and production policies to be followed by the State
- Material respect and regard for interdependence which need to be addressed in the context of auto motors transportations.

Rational for the Case Study

The environmental friend fuel discussed above has the capacity to enhance food production and organic farming, resolving energy crises, conversion of wastes into useful resource, preventing salinity and water logging, changing climate, preventing harmful effect of mining operation , preventing natural calamities, checking human disease, preventing deforestation and desertification, checking soil erosion, soil conservation, preventing environment pollution. Even such worthy and environmental friendly characteristics are n built within the nature of the super petrol and additive diesel it fail to sustain in market due to various unknown reasons for which an investigation attempted through this paper.

Review of Literature and Research Design

Fuel additives have been a critical component in improving the performance and longevity of combustion engines for decades. However, as the automotive industry progresses towards more stringent environmental regulations and advanced engine technologies, the role of fuel additives has evolved significantly. This literature review summarizes recent research and developments in the field, highlighting the advancements and challenges associated with formulating additives for next-generation engines

Environmental Impact and Emission Reductions are found in the recent studies emphasize the need for fuel additives that not only enhance engine performance but also mitigate environmental impacts. Akhbari, M., & Azar, A. (2020) explored additives containing oxygenates which reduce carbon monoxide and unburned hydrocarbons. Similarly, Chandran, S., & Balan, V. (2018) investigated the effects of bio-based cetane boosters on diesel engine emissions, demonstrating significant reductions in NO. Ghosh, P., & Das, D. (2019) examined the stability of novel antioxidant additives in high-performance engines, noting improvements in fuel stability and a reduction in engine deposits even under severe operating conditions.

Fuel Efficiency and Performance are analysed by Indian Oil Corporation Limited. (2021) showed that modern detergent additives could enhance fuel economy by

keeping newer high-precision fuel injectors clean, which is critical for maintaining the efficiency. Moreover, enhanced detergents and friction modifiers are being studied for their dual benefits of reducing internal engine friction and improving overall thermal efficiency, as discussed in the report of the Ministry of Petroleum and Natural Gas, Government of India. (2023). Research by Mohan, R., & Sharma, A. (2020) highlights the development of corrosion inhibitors that are effective in bio fuel contexts, which are prone to higher levels of moisture and can lead to increased corrosion in fuel systems.

Combining all the literature together it identifies several challenges, including the variability in fuel quality globally, which can affect the performance of additives (Sengupta, S., & Dutta, S. 2019 and Tiwari, A., & Sisodia, G. 2023). Furthermore, there is a need for a better understanding of the long-term effects of additives on engine components and emission systems, especially with respect to newer materials and coatings used in advanced engines. From the core literature review on the topic of the paper reveals that it lacks a comprehended enquiry of the failure of additive fuel in India which calls for an attempt to explore the market response.

Methodology

First a comprehensive literature review of existing literature on market failures, fuel additives and relevant theories, concepts were chosen for the study of ground realities and found the absence of empirical data on the issues of use of fuel additives, market trends, regulatory frameworks, and consumer preferences in India and decide to use the participatory observation method to gain insights from industry experts and analysis of government policies.

Second applied economic theories of market failures, such as externalities, information asymmetry, and public goods, were selected to analyze the market for fuel additives in India and identified specific instances where market failures may be occurring, such as inadequate information about additive effectiveness, negative externalities from emissions or barriers to entry for new technologies.

Thirdly a qualitative analysis, including case studies and informal discussion with all stakeholder and the insights into the underlying factors driving market failures and barriers to the adoption of next-generation petrol and diesel with fuel additives reached compelling conclusion about the consumers understanding about their perceptions and challenges.

Forth, the findings are validated with peer review and expert consultation to ensure rigor and reliability of the methodology and conclusions.

Additive Fuel in India

Fuel additives are compounds that are added to fuel to enhance its performance, efficiency, or environmental characteristics. In the context of India, where the automotive industry is rapidly growing and environmental concerns are paramount, the use of additive fuel has garnered attention as a potential solution to address both performance and environmental challenges.

One of the primary objectives of using additive fuel in India is to improve the efficiency of vehicles and reduce harmful emissions. With a significant portion of India's population reliant on automobiles for transportation, the need to mitigate the environmental impact of vehicular emissions has become increasingly urgent.

Additive fuel formulations aim to achieve cleaner combustion, leading to reduced emissions of pollutants such as carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM), which are major contributors to air pollution and public health concerns. Moreover, additive fuel technologies offer the promise of enhancing engine performance and prolonging the lifespan of vehicles. Fuels, additive fuel technologies align with India's efforts to diversify its energy sources and promote sustainable development.

1. Bio-Mileager

The company has started in 2000 with the prime objective to achieve zero carbon emission by 2025 through providing fuel enhancement experience to all diesel and petrol based engines through natural eco friendly additive.



Image Source: Powered by Google Image Search.

Bio-Mileager is a herbal fuel enhancer made of plant enzymes. This is one hundred percent safe for any vehicle engines. It increases mileage up to 40% (petrol/Diesel) and increase vehicle pickup by 30% and reduces pollution by 80% which is tested by I-CAT & ARAI - Govt. of India automotive testing Laboratory.

2. Cetane Boosters

The screenshot shows the Amazon India product page for Cetane-X Alcohol Free Diesel Cetane Booster. The page layout includes a top navigation bar with the Amazon logo, delivery location (Ambattur 600050), and search bar. Below the navigation bar, there are category links like 'Car & Motorbike', 'Electronics', etc. The product title is 'Cetane-X Alcohol Free Diesel Cetane Booster for Mileage Boost, Lubrication, Maximum Horsepower - Suitable for All Diesel Car (Pack of 3, 300 ml Each)'. The price is ₹1,530.00, and it has a 4.7-star rating. A 'Customers who viewed this item also viewed' section shows three related products: Liqui Moly 1811 Diesel Purge (₹938.00), Cetane-X All in One Cetane Booster (₹550.00), and Liqui Moly Super Diesel Additive (₹546.00). The main product image shows two bottles of Cetane-X. The right sidebar displays the price (₹1,020.00), delivery details (FREE delivery Friday, 17 May), and purchase options (Add to Cart, Buy Now).

Cetane boosters are diesel fuel additives that boost the cetane number when added in low concentrations. In the US, most fuels are blends of distillate fuels and cracked petroleum hydrocarbons. Cracked hydrocarbons are often deficient in cetane compounds, and to meet the cetane number demands of most diesel engines, it is necessary to add cetane boosters to these blends.

Cetane boosters modify engine combustion by encouraging early and uniform ignition of fuel and help depress premature combustion and excessive rates of pressure increase during the combustion cycle. Most cetane boosters contain alkyl nitrates, which break down freely to provide extra oxygen for improved combustion.

3. Speed and Extra Premium Petrol



Speed premium petrol offers higher octane ratings, optimizing engine performance and reducing knocking in high-performance vehicles. It provides cleaner combustion, potentially improving fuel efficiency and reducing emissions in modern engines.



All these product discussed above were quit the market due to various reasons and now the same is introduced by government with extra cost in the name of Barat Stages

Emissions Standards in India – (Bharat Stage-BS)

"Bharat Stage I" (BS-I), is an emission standard instituted by the government of India for regulating the output of air pollutants from internal combustion engines and spark-ignition engines, including motor vehicles. Here's some information about it:

1. Introduction: Bharat Stage I emission norms were first introduced in India in the year 2000. They were equivalent to Euro 1 standards.
2. Regulations: BS-I aimed to regulate the emission of pollutants such as carbon monoxide (CO), unburned hydrocarbons (HC), and oxides of nitrogen (NO_x) from vehicles with petrol engines. For diesel engines, it focused on controlling particulate matter (PM) emissions.
3. Impact: Implementation of Bharat Stage I marked the beginning of regulating vehicular emissions in India, leading to the adoption of cleaner technologies and fuels.
4. Challenges: However, compliance with BS-I norms was a challenge due to the need for technological upgrades in vehicles and fuel quality improvements.
5. Succession: Bharat Stage I was succeeded by Bharat Stage II (BS-II) in 2001, which introduced tighter emission standards. Subsequently, India has progressed through BS-III, BS-IV, and BS-VI, with each stage introducing more stringent emission norms in alignment with international standards.

Research Issues

While fuel additives are instrumental in enhancing engine performance and efficiency, their integration into next-generation vehicles presents several challenges and issues which can be discussed as follows

As automotive technology advances, engines are becoming more complex and operating under higher pressures and temperatures. These new engine designs, including hybrid engines, high-performance turbocharged engines, and direct injection systems, may have different requirements for additives. Fuel additives

must be compatible with emission control technologies such as catalytic converters and particulate filters. Some additives can lead to increased deposits or damage these components, resulting in decreased effectiveness in controlling emissions or causing failures in emission control systems, which can be costly to repair and counterproductive to environmental compliance. Although fuel additives can improve engine efficiency and reduce certain types of emissions, they can also introduce additional toxic compounds into the environment. For instance, some metallic additives may increase the emission of heavy metals, posing risks to both human health and the environment. This contradiction calls for the need for developing safer, more environmentally friendly additive formulations.

Different countries have varying standards and regulations regarding the permissible additives in fuels, which can complicate the formulation and distribution of global additive products. Additionally, as environmental regulations become stricter, the formulation of fuel additives must continually adapt to meet these evolving standards without compromising performance. There can be resistance to the adoption of new additives from both manufacturers and consumers due to concerns about cost, potential engine compatibility issues, and the actual benefits of these additives. Convincing stakeholders of the advantages of new additive formulations requires transparent communication of benefits and potential drawbacks.

The long-term effects of continuous use of certain additives on engine components and performance are still not entirely understood. Continuous use might lead to unforeseen wear and tear or degradation of engine parts, necessitating further studies and continuous monitoring. With a global push towards sustainability and reduced reliance on fossil fuels, the role of fuel additives in future energy scenarios needs to be reconsidered. There is a need for more research into additives for alternative fuels like biodiesel, ethanol blends, and possibly for fuels of the future that align with a lower carbon footprint.

Findings and Theoretical Validations

The theoretical validation for this research is carried through selected relevant theories such as theory of market failure, theory of public goods and externalities, information asymmetric and co ordination failure in the industry. The Hirschman's theory of unbalanced growth which describes the relationships between parties involved along the supply chain which are all discussed under..

1. **Market Failure Theory:** The paper can theoretically validate its title by exploring various types of market failures that might occur in the context of fuel additives in India. Market failures such as externalities, information asymmetry, and public goods could be relevant in this context.
2. **Externalities:** The use of fuel additives may generate positive or negative externalities that are not fully accounted for in the market price. For instance, if the fuel additive leads to reduced emissions, it creates a positive externality by benefiting society through cleaner air. Conversely, if the additive has harmful effects on the environment or public health, it represents a negative externality.
3. **Information Asymmetry:** Consumers may lack sufficient information about the effectiveness, safety, or long-term impacts of fuel additives. This information asymmetry can lead to suboptimal choices and market failures. The paper could explore how information gaps contribute to market failure in the context of fuel additives in India.
4. **Public Goods:** Clean air and environmental sustainability are often considered public goods, as they benefit society as a whole. If the use of fuel additives contributes to these public goods, but the market fails to provide adequate incentives for their adoption, it indicates a market failure that warrants investigation.
5. **The backward linkages** describe the process of how a company in a given sector purchases its goods, products, or supplies from a company in a different sector; these are called inputs. **Forward linkages** which the process of how a company in a given sector sells its goods, products, or supplies to a company in a different sector;

these are called outputs which are (Wang, L., Xie, R., & Liu, J. 2011) reported repeatedly as the prime factor that determine the firm's success and sustainability.

6. Most of the stake holders revealed their expression while informal discussions that these additive firms were not sound in the forward linkages for the marketing of their products. One of the mechanic Mr. Vonoth who recommend the fuel additive to 30 customers on an average daily reported that the additive fuel firms discussed in above were not at all in touch with them in anyway and the similar type of response given by the showroom manager Mr. Kashish Kaushik that the additive fuel companies were not even contacted at least even after completing the sales their products to all their customers with compulsory instruction to use it continuously. This validates the impact of the absence of forward linkages to the firms and its mpact on the market and environment and extends to policy implications. So it is clear that market failures are identified as the lack of forward linkages and demanded the policy interventions to correct these failures through the introduction of Bharath stages from one to six.

Conclusion

Addressing these issues requires ongoing research and collaboration between additive manufacturers, automotive companies, and regulatory bodies. Innovations in additive technology must not only improve engine performance and longevity but also align with global environmental goals and adapt to the rapidly evolving landscape of automotive technologies.

The literature indicates a robust trajectory towards developing fuel additives that align with the future needs of automotive technologies and environmental goals. Ongoing research is critical to address the existing challenges and to ensure that these additives are effective, sustainable, and safe for widespread use in next-generation combustion engines.

The investigation into market failure evidence concerning the case of Next Generation Petrol and Diesel additives in India highlights several significant factors. Despite the promising potential of these additives to enhance fuel efficiency and

reduce emissions, their market penetration and adoption have been hindered by various challenges. These challenges include regulatory hurdles, lack of consumer awareness, distribution constraints, and scepticism regarding their efficacy. Through effective regulatory frameworks, incentivization mechanisms, and awareness campaigns, the market prospects for Next Generation Petrol and Diesel additives in India can be improved.

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