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Ethanol Blending in Petrol: Current Status and Prospects in India

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Abstract

India has experienced rapid industrialization, propelling it to be the world's 3rd largest energy consumer. Among the sectors driving this energy consumption, the transportation industry plays a significant role. In the fiscal year 2022-23, India witnessed a surge in petroleum consumption, reaching a record high of 222.3 million tonnes. However, the country's crude oil production remained at 29.2 million tonnes during the same period, leading to a substantial reliance on imports. In fact, India imported crude oil of 232.4 million tonnes in 2022-23, amounting to a cost of approximately USD 158.3 billion. To curtail its dependence on imports, the Indian government has promoted ethanol as a renewable fuel alternative for several years. Although policies supporting the ethanol blended program have been in place since 2003, they struggled to meet their targets until the introduction of the national biofuel policy in 2018. The policy incorporated several modifications, and aimed to address the shortcomings of previous efforts. Presently, ethanol blending with petrol is being offered at a maximum concentration of 10% across the country, with the ultimate goal of completely replacing petrol with ethanol. This study analyzes India's ethanol blending program, evaluating the policy impacts on distribution and production. It identifies challenges in feedstock availability, the role of oil marketing companies (OMCs), and vehicular technology hindrances. The proposed solutions include utilizing alternative feedstocks, supported by the PLI schemes. OMCs should address logistical issues and reduce transportation costs by promoting local ethanol production. Optimizing petrol engines and expediting the introduction of flex engines are recommended.

Keywords: *Ethanol, Biofuel, Renewable, Energy, Fuel.*

1. Introduction

India is a developing country that has experienced significant industrialization over the last three decades, contributing to 10% of global growth [1]. As a result, India has become the world's third-largest energy consumer, surpassing both China and the United States, with primary energy consumption of 31.98 EJ [1]. India's energy consumption is expected to double by 2040, as per the international energy agency's energy outlook 2021 [1]. However, India relies on fossil fuel imports to meet its energy demands including coal, crude oil, and natural gas, with 208.93 MT (million tonnes) of coal, 212.0 MMT (million metric tonnes) of crude oil, and 30.776 BCM (billion cubic meters) of natural gas imported during the 2021-22 fiscal year [2]. If this trend continues, India's energy consumption could quadruple by 2040, posing a significant threat to the country's energy security [1].

The transportation industry is a major consumer of energy in India, accounting for 10.22% of total energy consumed during the 2020-21 fiscal year, with crude oil imports as the primary energy source [2]. Commercial and passenger vehicles are the biggest consumers of diesel, which accounts for 70% of overall diesel use, while petrol is responsible for approximately 40% of consumption in light motor vehicles, with two-wheelers accounting for the remaining 60% [3, 4, 5, 6]. Figure 1 shows the projected growth of vehicles number in India, and Figure 2 depicts the trend in petrol consumption [5, 6]. India's over-reliance on imported crude oil could threaten the country's energy security, highlighting the need for alternative energy sources and sustainable practices to ensure a secure energy future for the country [1].

India has been actively searching for renewable alternatives to counter its ever-increasing dependence on imported fossil fuels. Ethanol is a renewable liquid fuel that has been used in several countries as an alternative to petrol, and it can be

produced domestically from surplus agro resources and wastes, making India more self-reliant [7]. Additionally, ethanol has lower emissions of harmful pollutants compared to petrol, making it environmentally friendly. Therefore, in 2003, the Indian government initiated the Ethanol Blended Petrol (EBP) program to promote ethanol as a fuel alternative [7]. Later that year, the government announced national policy on biofuel, which set the framework for the biofuels' development and utilization in India.

In India, the researchers have mostly concentrated on the technical feasibility of the ethanol blending in conventional petrol engines, but there is still a lack of knowledge on the challenges of ethanol blending program's effective implementation and the impact of various policies on the usage of ethanol in India. Thus additional research is required to examine the various policies impacting ethanol production and distribution in the country. This study aims to provide valuable insights into the challenges and opportunities of ethanol blending in India and recommend actionable steps for policymakers, industry stakeholders, and researchers to address these gaps.

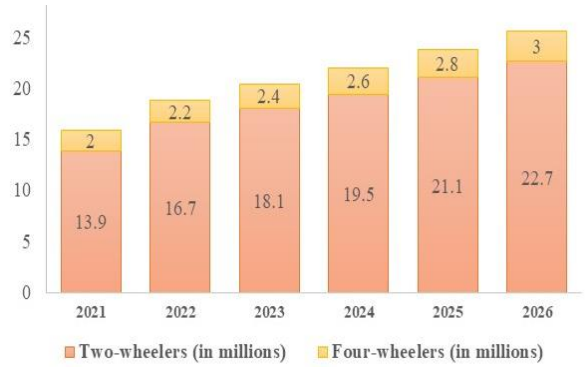

Figure 1. Vehicle population growth [5, 6].

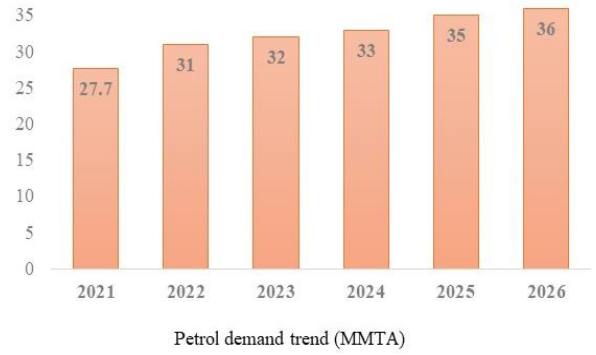

Figure 2. Petrol demand trend [5, 6].

2. Methodology

The research is concerned with biofuel policies in relation to ethanol as a fuel substitute for petrol in conventional gasoline engines. Additionally, the research aims to investigate several problems in the procedure. We began by evaluating the literature on the issue in Scopus and SCI-indexed journals. Moreover, we relied on information from government organizations such as the India Government's Ministry of New & Renewable Energy (MNRE), Ministry of Petroleum & Natural Gas (MOPNG), and Ministry of Statistics and Programme Implementation (MOSPI). We were able to find loopholes in India's biofuel policies, supply chain inefficiencies, and ethanol usage technologies in petrol engines.

3. Present status of ethanol blending in India

Sugar fermentation produces ethanol. Commonly, sugarcane molasses is used for making edible sugar in India [7]. According to the Press Information Bureau of the Government of India, India produced 5000 lakh metric tonnes (LMT) of sugarcane in the Oct 2021-22 season [8, 9]. Sugar mills processed 3574 metric tonnes of sugar cane and produced 394 metric tonnes of sugar. Then, in 2021-22, 35LMT of sugar will be used to produce 113 crore liters of ethanol. In the coming years, ethanol production is expected to increase by 12.68%. Ethanol has the potential to cut oil imports. Furthermore, they are significantly more environmentally benign than fossil fuels. Their production & utilization has excellent potential to create jobs & doubling the sugar cane farmers' income in the future.

In 2003, the Government of India's Ministry of Petroleum and Natural Gas launched the Ethanol Blended Petrol initiative [5]. The Ministry of Petroleum directed that 5% blended petroleum be available in 20 states and four union territories [4, 5, 7]. The policy was a failure. It had several limitations. Because the programme was not mandated, it had little impact, and OMCs continued to follow their old strategy. Then there were procurement issues to address. Because of food security concerns, the Indian government only approved molasses for ethanol production and prohibited cereal grain. Suppliers were also dissatisfied with the pricing policy, which was tied to crude oil prices. Then, at a higher rate of 18 %, ethanol was taxed. It also faced several administrative difficulties, such as multiple tenders [5, 7]. In 2014, the Indian government took several steps to increase ethanol output. The pricing policy has been revised. OMCs were required to pay shipping fees and taxes previously handled by suppliers beginning in 2016. The IDR act was amended in October 2016 to exempt extra neutral alcohol from VAT, as opposed to

consumable alcohol [5, 7]. In 2018, an interest subsidy plan was introduced to encourage ethanol providers to offer discounted short-term financing [5, 7, 10]. The national policy on biofuel was then introduced in 2018, broadening the policy's scope to include alternative biofuels [11].

The policy aims to develop and promote biofuel cultivation, production, and use as a replacement for petroleum fuels. The policy calls for a 20% ethanol/biodiesel blend. The current ethanol blend is 10%, with the Government of India aiming for 20% by 2025. According to the NBP 2018, crops for biofuels can be planted in government and community-owned wastelands, degraded lands, and non-forest areas [10, 11]. A minimum support price is set for such crops to be promoted at first.

Furthermore, financial and economic incentives for biofuel cultivation, production, and use will be provided. Farmers and landless laborers will be able to benefit from the campaign. Corporations can also opt for contract farming. The policy requires OMCs to purchase ethanol made from molasses and other feedstocks, such as sugar in the form of sugar syrup, and damaged food grains that are unfit for human consumption [7, 10].

4. Challenges of ethanol blending

The ethanol blending programme has been facing some challenges, which are related to feedstock for ethanol production, distribution of ethanol to end consumers and vehicular technology for the adoption of the new fuel.

(1) Feedstock: In India, feedstocks such as sugar, molasses, and maize are primarily derived from sugarcane and maize, both food crops [5]. Figure 3 depicts the ethanol yield from various feedstocks [5]. Food security is a major concern now that food crops are allowed for ethanol production. When surplus FCI grains were allowed for ethanol production under the biofuel policy, states such as Chhattisgarh raised the issue. This may raise food prices, contributing to the country's food inflation. Furthermore, the feedstock yield is weather dependent. Droughts and floods caused by climate change frequently impact crop production, and thus feedstock availability is not consistent year after year. It has an effect on both ethanol production and pricing. Furthermore, crops such as sugarcane necessitate a large amount of water for cultivation. Increased sugarcane cultivation in response to ethanol demand may have long-term climate consequences. However, crops such as maize require less water than sugarcane. As a result, many scientists advocate for the promotion of maize for ethanol production [5]. However, the over-promotion of certain crops such as palm in Malaysia and Indonesia, and sugarcane in Brazil, has resulted in ecosystem destruction. Rather than depending on a few feedstocks, the horizon of feedstocks should be broadened.

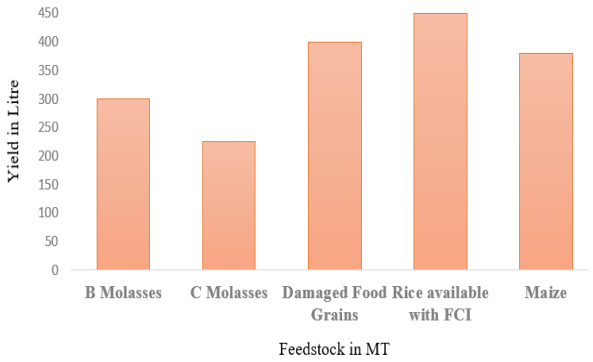

Figure 3. Ethanol yield from various feedstocks [5].

(2) Challenges to Oil Marketing Companies (OMC): oil marketing companies such as HPCL, BPCL, and IOCL must ensure that ethanol blends are available throughout the country. Otherwise, popularizing ethanol blends among the general public will be extremely difficult. However, ethanol production is not consistent across the country. As a result, in terms of production, ethanol must be moved from rich to poor states. In India, the IDR 1951 regulates ethanol movement from one state to another [5]. Even though it was amended in 2018, many states have yet to implement its provisions. As a result, OMCs will face numerous logistical challenges in the coming years to ensure the availability of ethanol blends. Furthermore, while transporting ethanol, the OMCs will incur transportation costs, raising the fuel cost for customers [11].

(3) Vehicle technology barriers: Ethanol is a low-calorie fuel. Ethanol-blend gasoline will have a lower calorific value than regular gasoline. To compensate for lower efficiency, conventional gasoline engines must be redesigned in terms of compression ratio and spark timing for E5 and E10 blends. Furthermore, the rubber parts that come into contact with the fuel should be compatible with the blends. Currently, engine parts in India can support E10, and engines are optimized to provide the best performance at E5 [5]. In the future, the government must ensure those car manufacturers produce engines that are optimized in terms of efficiency and parts for higher blends, such as E20. Furthermore, the old vehicles will require retrofitting. Car part manufacturers must also create parts that are compatible with the blends. India will have to embrace flex engines that run on pure ethanol sooner or later. Flex engines are twenty to thirty

thousand rupees more expensive than conventional petrol engines [12, 13, 14]. It will raise consumers' initial ownership costs (IOC). Even though flex engines can run E100, their operating costs are always higher than those of petrol engines. According to various studies, it can range from 80 to 106% [12, 13,14].

5. Conclusions

Energy is crucial for India's economic growth as a developing nation. The ethanol blending program holds the potential to support India's transition into a multitrillion-dollar economy. Recently, the program saved the country 40,000 crores in foreign exchange and contributes to India's goal of achieving net zero carbon emissions. However, there are challenges that need to be addressed. The study focuses on these challenges and proposes specific approaches:

Feedstock:

- Exploration of crop lingo-cellulosic residues for second-generation ethanol production.
- Utilization of PLI schemes and other funding mechanisms for alternative feedstock projects.

Oil Marketing Companies (OMC):

- Addressing logistical challenges in ethanol transportation.
- Encouraging local producers to reduce transportation costs with OMC support.
- Promoting projects that enhance local ethanol production by OMCs.
- Resolving noncompliance issues with IDR act amendments for smooth interstate ethanol movement.

Vehicle technologies:

- Redesigning engines, ensuring part compatibility, and optimizing for higher ethanol blends.
- Focusing on E20 and higher blends for improved efficiency, compatibility, and cost-effectiveness.
- Promoting flex engines running on pure ethanol as a long-term solution.
- Providing incentives and subsidies to offset initial costs of adopting flex engines.

Furthermore, there is a need for further study on lignocellulosic feedstocks for future utilization in India. Additionally, a techno-economic study on flex engine usage in the Indian transportation sector is recommended to guide policymakers in making informed decisions.

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