High Octane Fuels

Engine efficiency through ethanol blending

Engine efficiency gains through increased ethanol blending are a proven effect and present the lowest cost of carbon abatement in global transportation.

The phenomenon

Modern internal combustion engines require ever higher octane fuels as new designs increase engine efficiency. Higher-octane is the cure for "knocking", the inability of fuel combustion to match the timing needed by the engine. Ethanol has a high octane level (109), much higher than average petrol (87-92), so ethanol can be used as an octane-booster.1 When ethanol is blended in fuel the resulting higher-octane fuel mix can combust more efficiently resulting in the engine capturing more of the potential energy. The engine is thus more efficient.

A higher ethanol blend fuel such as E20 (20% ethanol blended in petrol) has a higher octane and so can increase overall engine efficiency. This allows for downsizing of engines, a promising way forward for more efficient vehicles bringing GHG and fuel economy benefits to consumers.

While petrol itself can be upgraded to increase its octane, doing so is expensive, energy intensive and itself releases GHGs. Ethanol is therefore an ideal octane enhancer and much better for the environment than alternatives such as MTBE (which is now illegal in the United States but still used in Europe) or aromatics.

Benefit and cost

Oil is projected to remain the dominant transport fuel worldwide in 2030, but both upcoming petrol and hybrid vehicles will require alternatives.

A small increase in fuel octane rating results in a surprisingly large overall impact since the benefits of higher octane are not isolated to the "E" component of fuel but extend also to the fossil component. Accordingly, octane enhancement is an almost unbeatably inexpensive way to achieve GHG reductions through efficiency.

[1] There are two predominant methods for expressing gasoline octane, the "research octane number" (or RON) and the "motor octane number (or MON). In Europe and most of the rest of the world, RON is dominant. In North America, the dominant practice is RON+MON/2 (also known as the "anti-knock index"). The numbers above are expressed in the North American form. The ratios would be similar for Europe although the numbers themselves would be different. For example, ethanol's RON number is 120.

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Unnecessarily slow progress
Few policymakers or stakeholders are aware of this phenomenon, let alone recognize its significance. The science and economics are clear, but changing fuel standards requires either political will or decades of committee meetings.

Technical standards have been in development both at the EU (CEN) and US (ASTM) levels, and there is no real difficulty in adopting E20 or even higher blend standards such as E30. However, due to the lack of clear political mandates, the development and adoption of these technical standards have been stalled near the final stages for years.

Two things are needed for market penetration and optimal benefits: optimised engines and high octane fuels. Since the fuels standardisation process has been lagging behind engines are not optimised to reap maximum benefits from higher octane fuels, but more and more engines today would benefit from higher octane fuel, including all E85 compatible vehicles and all vehicles for which a "premium" fuel is recommended.

Notably, high octane fuels are not on the market specifically because in practice increasing levels of ethanol in gasoline do not result in higher octane fuels. To date, refiners have used ethanol's octane benefits primarily in order to reduce the quality (and octane level) of their gasoline blendstock (and realize cost savings as a result) rather than to deliver better octane to customers. There is no regulation in place to require a minimum octane level of gasoline blendstock.

Way forward
A final push is needed for High Octane Fuels (HOFs).

- Cheap climate measures are in short supply. Political momentum needs to be created to advance one of the most cost-effective road transport decarbonization measures, such as E20/E30.
- Fuel standards for high octane fuels (E20 in particular) should be adopted to enable the design of more efficient engines, bringing GHG reductions, better fuel economy, and greater torque to consumers. The sooner manufacturers start introducing engines designed for higher octane fuel, the sooner the social benefits will be reaped.
- Climate and renewable energy policies should reflect the benefits provided by high octane fuels. HOFs should be recognized for their climate benefits. Electrification is important, but for the upcoming internal combustion engine and hybrid vehicle fleet, sustainable liquid fuels, including HOFs, should be supported.

The science is clear, the technical details are easy to sort out, and only a political decision is needed. One of the most cost-effective transport decarbonization measures could be introduced globally in a year.

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