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Ethanol in gasoline: environmental impacts and sustainability review article

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Abstract

This study concerns the use of ethanol as a gasoline (petrol) additive, at levels around 10% by volume ('E10') as well as an 85% blend ('E85'). By detailed reviews of the peer-reviewed and technical literature, five environmental aspects of ethanol enrichment are examined: (1) its purported reduction in air pollutant emissions; (2) its potential impact on subsurface soils and groundwater; (3) its purported reduction in greenhouse gas emissions; (4) the energy efficiency of ethanol; and (5) the overall sustainability of ethanol production. The study indicates that E10 is of debatable air pollution merit (and may in fact increase the production of photochemical smog); offers little advantage in terms of greenhouse gas emissions, energy efficiency or environmental sustainability; and will significantly increase both the risk and severity of soil and groundwater contamination. In contrast, E85 offers significant greenhouse gas benefits, however it will produce significant air pollution impacts, involves substantial risks to biodiversity, and its groundwater contamination impacts and overall sustainability are largely unknown.

Keywords: Gasoline; Ethanol; Energy; Groundwater; Air pollution; Environmental management

Contents

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1. Introduction

Since their introduction one to two decades ago, gasoline oxygenates such as methyl tertiary-butyl ether (MTBE) and ethanol have been mired in controversy. For example, over the past 2 years there has been a widespread public controversy in Australia over the sale of ethanol-enriched unleaded gasoline (petrol). During 2002, press reports revealed that gasoline was being sold at levels in excess of 10% ethanol by volume, and in some cases higher than 20%, in particular by independent retailers in Sydney and Wollongong, without any labeling to indicate this fact [1–3]. The problem arose from the lack of regulation of the ethanol content of gasoline or labeling under Australia's fuel quality regulations [4]. Following a protracted (and damaging) public debate, which mainly focused on the potential damage to car engines and components, the Australian Government announced that it would limit the ethanol content of gasoline to 10%, taking effect on 1 July 2003 [5]. This threshold was selected despite evidence that possibly a third of Australia's cars will not operate satisfactorily on a 10% ethanol blend [6]. Subsequent to this decision, the major oil producers in Australia have largely avoided retailing ethanol-enriched gasoline, due to the poor public relations image of ethanol-enriched blends, although one producer is retailing a 10% ethanol blend through a subsidiary brand at five trial sites in one state [7]. However, the Australian government has also announced a production target of 350 million litres (ML) of biofuels (both ethanol and biodiesel) by 2010 [8,9]. Moves are afoot by some parties, especially ethanol producers and farming interests, to make the 10% ethanol in gasoline mandatory [10]. Although Australia does not mandate the oxygen content of gasoline, and has largely avoided the use of MTBE as a gasoline additive, the political dimensions of the ethanol-in-gasoline debate are broadly similar to the US [11,12] and Canada [13].

Proponents of ethanol enrichment, in Australia, North America and Europe, make three main environmental arguments: (1) a purported reduction in air pollutant emissions during combustion; (2) a purported reduction in greenhouse gas emissions and dependence on