



## HOW TO AVOID THE RVP NOOSE: ADDRESSING THE COMPLEXITIES OF THE FUTURE NOW

MARK ROUTT  
CHIEF ECONOMIST - AMERICAS

On October 1, 2015 the US Environmental Protection Agency (EPA) introduced new regulations lowering limits for National Ambient Air Quality Standards (NAAQS) of ground-level ozone from 75 to 70 parts per billion (ppb). The ruling became effective on December 28, 2015. The EPA justified this move by citing a close link between ozone and numerous respiratory and pulmonary health concerns.

While the majority of states affected by this regulation today are in the US Midwest or the East and West Coasts, the EPA projects that nearly *all* US counties will need to meet these standards in 10 years.

### Technical Background

<sup>1</sup>Ozone forms when precursor compounds such as nitrogen oxides (NOx) and volatile organic compounds (VOCs) react in the atmosphere. The EPA explicitly sets standards for six pollutants: ground-level ozone, particulate matter, carbon monoxide, lead, nitrogen dioxide and sulfur dioxide. As a result of recent studies, the EPA ordered a reduction in ground level ozone concentrations (8-hour average) to 70 ppb.

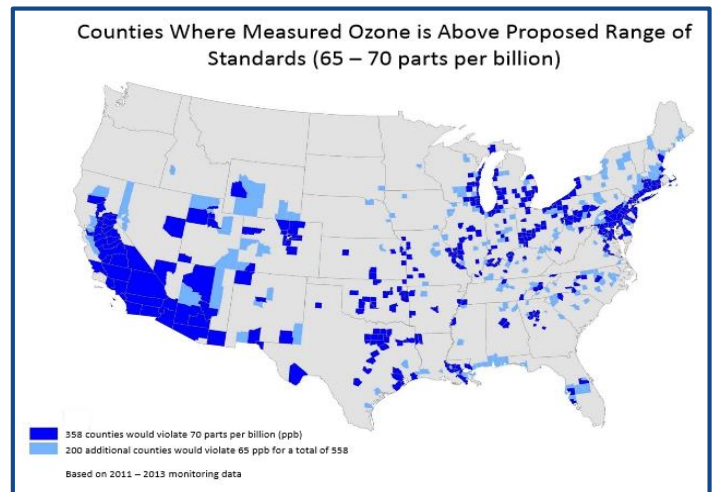
The new regulations are designed to allow those areas not currently in compliance with the new standards some time to comply. The amount of time allowed varies based on the ozone concentration at the local level. In general, state recommendations are required by October 2016 (one year after rule) with final rules by October 2017. Individual State Implementation Plans (SIPs) are required by October 2018, with regions graded from Marginal to Extreme (5 groups) having from three to 20 years to reach attainment.

### Industry Challenge

The EPA has already signalled its desire for even lower ground level ozone standards. Hydrocarbon processing emissions are not the sole cause of ozone, but they are stationary emissions sources and thus easily targeted, individually. The relationship between NOx and VOC emissions and ozone has been well documented<sup>2</sup>. Thus the regulatory challenge for refiners is how to reduce both NOx and VOCs—not only inside their ‘fence-line’, but also in the products they produce—primarily gasoline. And for gasoline, that means a reduction in gasoline Reid Vapor Pressure (RVP).

Just as regulatory standards are becoming more stringent, the supply of domestic US light tight oil (LTO) has increased. By definition, ‘light’ oil means relatively more light and volatile components in the C<sub>3</sub> – C<sub>5</sub> range. Effectively these new regulations mean that the gasoline volatility is being reduced just as the supply of volatile feedstocks is increasing.

Several processing solutions to manage product volatility are technically possible. The real challenges though are the economic impact and meeting demand for octane that is already in short supply. For fuels refiners the critical questions are, “How do we manage gasoline RVP against physical and commercial limits? What do we do with excess C<sub>5</sub> and C<sub>6</sub>?”



<sup>1</sup> <http://www3.epa.gov/ozonepollution/pdfs/20141126-ozonemaps.pdf>

<sup>2</sup> <http://www.epa.gov/gasoline-standards/gasoline-reid-vapor-pressure> ; §80.45 Complex emissions model The complex model equation for VOC is a function of RVP



Some have already investigated C<sub>5</sub> (amylene) alkylation. While that does manage excess C<sub>5</sub>, the trade-off of a 5 research octane number (RON) loss<sup>3</sup> for an 8 psi RVP credit is expensive and moves refiners further away from octane pool targets. Expanding renewable ethanol content in the gasoline pool amplifies this problem by increasing gasoline volatility and reducing the blending room for other light hydrocarbon components.

Chemically, one could look at either destroying or reacting the C<sub>5</sub> surplus in other processes. However, oligomerisation of two C<sub>5</sub> molecules to make C<sub>10</sub>, and reaction products that together would require hydrotreating and disposal into either the tail-end of the gasoline cut, or the front of the jet/diesel cut. In either case, the main objection still remains: the loss of a 94 RON blending component from the gasoline pool.

Catalytic cracking is one major source of these C<sub>5</sub> and C<sub>6</sub> molecules. Could we possibly saturate the olefins? Hydrogen in the US context is often available inexpensively, but the value and utility of the resulting C<sub>5</sub>/C<sub>6</sub> paraffins will still be low, there will still be an octane loss and they will likely have to be shipped to a low-value export market.

If we are to process either the C<sub>5</sub>/C<sub>6</sub> olefins or resulting paraffins, why not instead simply blend the material to higher RVP export gasoline quality? The 'best' chemical solution to processing C<sub>5</sub>/C<sub>6</sub>s and meeting the new VOC constraint and demand for octane will be individualised to your own facility and conditioned by your own economics.

These are complex issues, and KBC has even seen some refining clients consider deliberately overbuilding and overspending on new conventional units: butane dehydrogenation with conventional alkylation, butane isomerisation and acid / caustic handling systems. They are doing this largely to manage more low RVP, high octane material and remain within the regulatory, complex model<sup>4</sup> criteria.

## Finding Your Solution

We think solving the RVP challenge, meeting a minimum capex mandate and increasing octane demand requires a combination of all the above: avoiding some production, correctly valuing the cost of new feedstocks, maximising the use of existing capital equipment and considering new blending operations. Only as a last resort should capital be spent on smart ways to separate, saturate or further process select chemical streams.

The interplay between all these potential solutions is complex and differs from refiner to refiner and within one's own integrated refinery circuit. The overall solution must also comply with the refiner's corporate strategic plan.

***If there were a single technology solution, it would be well known by now.***

Finding the right solution for your refinery requires the ability to understand the real impacts of feedstock choice, new technologies and modified operating conditions in the context of the whole refinery. KBC Advanced Technologies has developed its Petro-SIM™ refinery simulation software – a market-leading refinery-wide modelling system.

Refinery-wide models quickly evaluate multiple trade-offs, different plant layouts and processing schemes and thus ensure optimal solutions for specific refining assets. A tool like Petro-SIM can efficiently quantify the most promising alternatives. The result is confidence that the chosen solution is the best one to meet your needs. In collaboration with our consulting engineers KBC is uniquely placed to help you find the best solution for your own specific set of issues.

## About KBC

KBC Advanced Technologies is a leading consultancy and software provider to the global hydrocarbon processing industry. With over 30 years of experience, KBC combines industry leading technology with experienced engineers and operations personnel using robust methodologies to create personalised, sustainable solutions for its clients.

For more information, visit [www.kbcat.com](http://www.kbcat.com).

To contact any of our offices, please visit <http://www.kbcat.com/locations>.

<sup>3</sup> Amylene octane is about 94, so alkylating a C<sub>5</sub> olefin to make alkylate results in a 5 number loss.

<sup>4</sup> Following extensive discussion and litigation, the EPA required that starting January 1, 1998, domestic and foreign refineries and importers use a "complex" model to calculate emissions of volatile organic compounds (VOC), toxic air pollutants (TAP), and nitrogen oxides (NO<sub>x</sub>) from motor gasoline. The main differences from the previous "simple" model were stricter standards for sulfur and olefin content of reformulated gasoline (RFG) and accountability for NO<sub>x</sub> emissions.