Fuel Ethanol Blending Protocols at Depots/Terminals

Table of contents

1. INTRODUCTION AND PURPOSE

The Regulations regarding the mandatory blending of biofuels with petrol and diesel promulgated on 23 August 2012 came into effect on 1 October 2015. These regulations regulate the mandatory blending of bioethanol with petrol to produce a biofuel blend that may be sold in the Republic. The regulations permit the blending of bioethanol in the range from 2 up to 10% (volume fraction), while complying with the requirements of the South African National Standard for petrol (SANS 1598). These regulations were subsequently amended in September 2021.

To enable the blending of bioethanol at downstream fuel distribution terminals/depots, the purpose of this document is to:

- provide guidance to designers and operators of fuel distribution depots/terminals on recommended practices for the receipt, storage and blending of fuel ethanol and distribution of the resultant ethanol containing petrol.
- assist interested parties to understand the properties of fuel ethanol and ethanol containing petrol and how to manage the introduction of ethanol blending at fuel distribution terminals and provide quality assurance of ethanol containing petrol.
- address the associated safety, health and environmental aspects as required by relevant regulations.

2. BASE FUEL AND FUEL ETHANOL QUALITY CONSIDERATIONS

2.1. Quality of base fuel

The South African National Standard for petrol (SANS 1598) allow for the blending of fuel ethanol up to 5% for standard grade petrol and 5 up to 10% for E10 petrol. This specification is applicable at the retail site fuel dispenser nozzle and includes the properties to which the final product shall adhere when fuel ethanol is blended into petrol. The blending of fuel ethanol into petrol has a marked influence over the properties of the petrol, therefore a petrol product that is suitably adjusted, commonly termed Blend Stock for Oxygenate Blending (BOB) must be provided. The impacted product properties are driven by the percentage of fuel ethanol to be added, but typically are:

- Distillation characteristics including the Temperature for 50 % (volume fraction) evaporated, Evaporated to 70 °C (E70) and Evaporated to 100 °C (E100)
- Oxygen Content
- Reid Vapour Pressure (RVP)
- Octane number – Research Octane Number (RON) and Motor Octane Number (MON)

There are also seasonal considerations relating to the volatility characteristics such as Reid Vapour Pressure (RVP) and Vapour Lock Index that must be accounted for when providing a BOB suitable for blending of final product from the Refinery or the terminal Tank to Truck Loading Rack (TTLR).

The use of other oxygenates shall be limited to ensure the fungibility of BOB products when this product is conveyed via Multi Product Pipelines or co-mingled with other BOB in terminal and downstream infrastructure. The use of these oxygenates is controlled by the oxygen content of the final fuel blend and must be considered in totality as percentage of the final blend.

For BOB conveyed through the Transnet Pipelines conveyance system, it is required that the base fuel comply with the requirements of SANS 1590, which specifies the product requirements at pipeline injection and pipeline receipt for the addition of fuel ethanol. Terminal operators are advised to take note that Transnet Pipelines may blend pipeline interface material into the BOB up to the limits allowed in SANS 1590. Additional quality assurance measures such as testing of critical properties of the base fuel at a suitable frequency are recommended.

SANS 1590 may also be utilised as guidance for base fuel formulation for product import and refinery blending of fuel ethanol for road and rail dispatch, depending on the fuel ethanol responses of the specific refinery fuel formulation. It is recommended that these formulations are tested to demonstrate compliance with the requirements of SANS 1598 after the blending of the required fuel ethanol content, taking into account supply chain considerations.

2.2. Fuel ethanol quality assurance

2.2.1. Fuel ethanol quality

The fuel ethanol shall comply with the South African National Standard for fuel alcohol (SANS 465). It is recommended that the manufacturing of fuel ethanol be aligned with quality management principles such as the ISO quality management system, and SANS 1462, which provides guidance specific to fuel ethanol manufacturing. It is recommended that a certificate of analysis (COA) for each final product tank batch of fuel ethanol accompany each road tanker or rail tank car (RTC) of fuel ethanol received.

It is recommended that fuel ethanol is denatured with a denaturant, meeting the requirements of the revenue authority and non-harmful to vehicle and petroleum distribution systems. SANS 465 provides guidance on suitable denaturants and recommended quantities thereof. Where denaturant is utilised, it is recommended that the type and concentration of denaturant utilised to be indicated on bill of loading (BOL) or certificate of quality per road tanker/rail tank car.

It is recommended that suitable corrosion inhibitors are added to either the fuel ethanol or to the blended fuel to provide protection to vehicle and petroleum distribution systems. Where corrosion inhibitors are added to the fuel ethanol, it is recommended that the type and concentration of additives utilised be indicated on bill of loading (BOL) or certificate of quality per road tanker or rail tank car of fuel ethanol received.

2.2.2. Fuel ethanol transportation

Road tankers and rail tank cars suitable for the transportation of fuel ethanol shall be utilised. It is recommended that road tankers or rail tank cars utilised for fuel ethanol transported are inspected by the supplier (or qualified third party) prior to loading to ensure cleanliness and dryness. It is recommended that inspection records are maintained by the supplier for a period of at least three months. It is recommended that road tankers or rail tank cars are sealed and shall comply with the requirements of the revenue authority including provision of traceability. Fuel ethanol may be transported in dedicated road tankers or rail tank cars or backhauled with compatible products (ULP 93 or ULP 95 complying with SANS 1598). If tankers are not dedicated, records of previous three loads with compatible products and cleanliness certificate are recommended.

2.2.3. Fuel ethanol off-loading

It is recommended that suitable quality assurance procedures are put in place prior to off-loading of road tankers or rail tank cars. This includes potentially analysis of critical properties to provide assurance of the integrity of the fuel ethanol received. When sampling the road tankers, samples should be taken from each compartment and a composite prepared for analysis. For rail deliveries, each rail tank car may be analysed separately or a composite prepared. A suitable frequency of analysis should be determined. The critical properties recommended are appearance, density and water content. Off-loading gantries should be designed to minimise rain ingress. Suitable fire protection should be provided. It is also advised to consider changes in the supply tanks from producers, as this may result in variability between batches.

2.3. Fuel ethanol storage

Where possible, it is recommended that fuel ethanol is stored in at least two storage tanks to enable off-loading into one tank and testing and blending from the second tank.

A suitable frequency of testing of fuel ethanol for critical properties during storage is recommended based on a value chain risk assessment. The critical properties recommended are appearance, density, water content, ethanol and denaturant content. Further, where added by ethanol producers, measures should be put in place to verify the addition of corrosion inhibitors at suitable dose rates.

3. FUEL ETHANOL BLENDING PRACTICES

The choice of blending system and infrastructure for a specific terminal will depend on several factors such as terminal throughput, initial capital cost, ongoing operating costs and ease of maintenance, while maintaining adherence to final product quality and safety requirements. Several blending techniques are available, with the most commonly used being batch blending and rack blending consisting of splash blending, sequential blending and ratio (in-line) blending.

3.1. Batch blending

Batch blending refers to the blending of fuel ethanol and BOB in dedicated storage tanks appropriate for the storage of fuel ethanol (see section 5.2). While this technique is possible, there are several risks to be considered such as the difficulty of accurately achieving the correct blend ratio, the difficulty of ensuring sufficient mixing and potential for stratification and the potential for water ingress. Further, once a tank goes off specification, it can be costly and time-consuming to correct, while delaying dispatch to the market.

3.2. Splash blending

Splash blending refers to blending at a terminal rack sequentially using different loading arms, where each loading arm has its own control valve and meter. In this operation, the operator is responsible for manually calculating the volumes of each component and ensuring that the correct blend ratio is achieved, with no automated checking of the accuracy thereof. Further, the fuel ethanol and BOB could be blended at the same or different locations. There are several risks associated with this mode of operation, such as the potential for human error, leading to an inaccurate blend ratio, potential for overfill and spillages. The high degree of human intervention could also lead to long loading times, impacting terminal throughput. The blend only meets specification requirements once both components are completely loaded and relies on turbulence generated during loading and on route to destination for mixing, which may not be adequate to ensure a homogeneous blend. Further, it is recommended that where splash blending is undertaken that the BOB is loaded before the fuel ethanol to ensure that the vapour concentration in the compartment headspace is above the upper flammability limit.

Splash blending could be suitable as an interim solution while a comprehensive blending system is being installed. Alternatively, it could be utilised in terminals with low throughputs, where the high capital investment could not be justified. However, this does not negate the need for quality assurance procedures to ensure adherence to final product quality requirements.

3.3. Sequential blending

Sequential blending refers to the loading of each component, one at a time, using a single meter and control value, using a single loading arm. This can be done manually or electronically. In this operation, the blend only meets specification requirements once both components are completely loaded and relies on turbulence generated during loading and on route to destination for mixing. As the components are loaded in series, this could lead to longer loading times. As a single meter and control valve is utilised for both components, this can reduce capital costs, however, requires that the meter is calibrated accurately for both components, using specific meter conversion factors for each. This practice may not be acceptable for custody transfer and metrology standards. Electronic sequential blending is preferred to manual sequential blending to improve safety, ensure product quality and reduce loading times.

3.4. Ratio (in-line) blending

Ratio blending (also referred to as inline blending) is the simultaneous loading of both components through dedicated meters and control valves to a common blending point, which is transferred through a single loading arm to a road tanker/rail tank car. There are several benefits to ratio (in-line) blending to the other blending techniques previously described. Mixing occurs at the blending point, ensuring a homogeneous mixture. The ratio of components is controlled electronically, with no manual intervention required and are maintained at the correct blending ratio throughout the blend. As each component will have a dedicated meter, this allows for accurate calibration of each meter for metrology and custody transfer purposes. As the components are blended simultaneously, this results in higher blend rates, reducing loading times. While ratio (in-line) blending allows the highest blending accuracy, and shorter loading times, it also has the highest capital cost compared to the other blending techniques, which is offset to some extent in lower labour costs due to the higher degree of automation.

Ratio (in-line) blending or sequential blending is recommended due to the overall higher blending accuracy and safety considerations and is widely used in industry for fuel ethanol blending. However, the other blending techniques could be considered, in specific circumstances, with due consideration of the risks highlighted while developing quality assurance systems to provide the required level of product quality.

4. DOWNSTREAM QUALITY ASSURANCE

4.1. Blending quality assurance systems

A set of quality assurance requirements need to be defined before the introduction of fuel ethanol into a supply chain. This should be done both for the neat fuel ethanol and the ethanol petrol blends using a risk-based sampling and testing methodology with the goal to always deliver fit for purpose products to the customer. Product quality is maintained through a combination of hardware systems, procedures, and testing. Analysis of product quality should be performed across the full supply chain, from the ethanol manufacturer to intermediate storage, and at the terminal where the fuel ethanol will be blended. Requirements established for these areas are to be included in the training of all parties involved in operating terminals.

The overall effectiveness of product quality controls is to be monitored through the following:

4.1.1. Management of change

Utilize the Management of Change (MOC) process prior to changing any system or activity to identify potential product integrity consequences. The MOC review is to incorporate the following considerations:

- Adequacy of system segregation, water and particulate protection and product identification.
- Compatibility of relevant materials of construction for fuel ethanol and E10 blends
- Assurances that written procedures are in place and adequately cover the change.
- Requirement for any change in testing to provide the necessary quality assurance.
- Provision for additional training, including refresher training and new hires.
- The MOC's to be documented and filed for retention.

4.1.2. Procedures

The following is a summary of the procedures required to maintain a constant supply of clean, dry and uncontaminated fuel ethanol from the point of terminal receipt to delivery into secondary carrier equipment:

- All terminals to have up to date, site-specific product quality instructions.
- Checklists to be used where appropriate to guide the operator and to document activities.
- Infrastructure such as tanks and pipelines should be clean and dry before the introduction of fuel ethanol. This is necessary due to the ability of fuel ethanol to clean accumulated rust and other solid matter in the distribution infrastructure. A pro-active process to assess the relevant infrastructure prior to the introduction of fuel ethanol is recommended. The assessment should include the detection of free water, leaks and solid matter in the storage tanks.
- Filter elements should be designed for fuel ethanol service. Conduct a check on filters regularly and look for particulates. (Note no water will be present since it is soluble in fuel ethanol)
- Take tank bottom samples at a suitable frequency to check for particulate contamination.
- Conduct inspections of bleeders on block and bleed valves each time they are closed.
- Avoid blending pipeline interface product generated in a terminal or market returns into fuel ethanol.

- Avoid blending fuel ethanol into interface product.
- The truck loading rack should preferably be equipped with an out-bound filter (40 µm)
- All filter vessels and systems to be equipped with water, differential pressure gauges, and pressure relief valves.
- Suitable records to be maintained of last filter change-out dates.
- The bottom and sides of fuel ethanol storage tanks are to be suitably coated for the storage of fuel ethanol.
- Proper labelling of linework, tanks and associated equipment shall be maintained in line with relevant legislative requirements.

4.1.3. Training

All impacted personnel are to be adequately trained in the applicable standard operating procedures and works instructions.

4.2. Quality assurance for batch blending

4.2.1. Prior to fuel ethanol introduction, suitable blending envelopes to be developed by the facility operator for the ratios of BOB and fuel ethanol, to be blended.
4.2.2. Tanks should be inspected prior to the introduction of fuel ethanol, to ensure that they are clean and dry.
4.2.3. If blending of fuel ethanol and base fuel is undertaken in the terminal tank, it is recommended that a suitable quality assurance process is in place to demonstrate that the blended product adheres to the requirements of SANS 1598 on critical properties . The critical properties recommended are appearance, RON, MON, RVP and ethanol content. If the sample is hazy, the water tolerance test should be performed.
4.2.4. It is recommended that retention samples for each product batch are maintained for a period of no less than 3 months.
4.2.5. Where practical, a laboratory blend may be prepared of fuel ethanol and BOB to verify critical properties to prior to tank blending.
4.2.6. Product reconciliations are recommended to be undertaken for each batch blended to verify the ethanol content.
4.2.7. Blending equipment including control valves, pumps and volumetric meters to be designed to ensure sufficient accuracy required for blending. Meters to be calibrated at suitable frequency and records maintained.
4.2.8. The blending system to be designed to ensure sufficient mixing of BOB and fuel ethanol.
4.2.9. Due precautions to be taken to limit the ingress of water into storage tanks during design and operations.

4.3. Quality assurance for rack blending

4.3.1. Prior to ethanol introduction, suitable blending envelope to be developed by the facility operator for the ratios of BOB and fuel ethanol, to be blended.
4.3.2. For rack blending, fuel ethanol content shall be determined by the ratio of measured fuel ethanol and BOB volumes. It is recommended that suitable records be maintained of the volumes of BOB and fuel ethanol loaded per road tanker/rail tank car compartment. The bill of lading to indicate the percentage of fuel ethanol blended per compartment.

4.3.3. Loading equipment including control valves, pumps and volumetric loading meters to be designed to ensure sufficient accuracy required for blending. Loading meters to be calibrated at suitable frequency and records maintained.
4.3.4. It is recommended that product reconciliations are undertaken daily on the volumes of BOB and fuel ethanol blended to verify the fuel ethanol content blended.
4.3.5. Representative samples at a suitable frequency to be taken at suitable point after blending to demonstrate adherence to the requirements of SANS 1598. The critical properties recommended are appearance, RON, MON, RVP and ethanol content. If the sample is hazy, the water tolerance test should be performed.
4.3.6. It is recommended that retention samples are taken at suitable frequency after blending and maintained for a period of no less than 3 months.
4.3.7. Regular market surveillance at retail sites is recommended to verify adherence to the requirements of SANS 1598.
4.3.8. Additional monitoring and sampling are recommended during the commissioning of the blending system, to verify satisfactory operation of the system at the required accuracy and consistency.

4.4. Product loading

4.4.1. Relevant procedures for the loading of road tankers/ rail tank cars at facilities to be reviewed to ensure cleanliness, dryness and no left on board product. Inspection records to be maintained by the facility operator for at least three months.
4.4.2. E10 may be transported in tankers dedicated for this purpose or hauled with other compatible products (not diesel). If tankers are not dedicated, records of previous three loads and cleanliness certificate to be provided.

4.5. Management of off specification material and market returns

4.5.1. For product not fit for purpose, petrol containing fuel ethanol needs to be isolated and managed as per the capabilities of the different facilities.
4.5.2. A suitable process for the handling of off-specification product needs to be developed by the operator, if the product does not meet the requirements as per 4.2 or 4.3 (as applicable) after fuel ethanol blending and deemed outside any waiver limits.
4.5.3. Any contamination related market returns, needs to be handled as per company specific protocols and isolated from any other fit for purpose fuel.

4.6. Site water management

4.6.1. Any loss of primary containment shall be handled in accordance with the facility operating procedures including the requirements of the product data sheet.
4.6.2. Seek advice from the company’s environmental and product stewardship specialist.

4.7. Additive impacts

4.7.1. In order to ensure fit-for-purpose petrol, corrosion inhibitors are strongly recommended to be added to fuel ethanol by ethanol producers, or petrol blenders. Suitable fuel additives compatible with the finished petrol are recommended in the appropriate amount.

4.7.2. A fit for purpose evaluation is recommended for the addition of corrosion, stability, and/or performance additives including optimization or validation at higher ethanol blend percentages.

4.7.3. It is recommended for rack blending to install a physical distance of 2-3 meters between the additive and ethanol junctions, as well as allow sufficient distance to allow for volumetric expansion (refer to 4.9 below).

4.7.4. Where utilized, performance additive packages should not be injected into neat fuel ethanol.

4.7.5. Dyes may be required for differentiation of finished product.

4.8. Phase separation

4.8.1. Fuel ethanol is fully miscible in water. In contrast, non-ethanol containing petrol has a low solubility with water. The presence of ethanol in petrol thus increases the overall solubility of water in ethanol-petrol blends. The quantity of water that can be absorbed in a petrol-ethanol blend is dependent on the amount of ethanol present, the mixture temperature and the base petrol composition. Typically, at 15.5 °C, a 2% ethanol containing petrol can absorb up to ±0.1 vol% water, while a 10% ethanol containing petrol can absorb up to ±0.5 vol% water.

4.8.2. Any additional water will cause the ethanol to separate from the petrol and form a separate solution with the water, which is known as phase separation. When phase separation occurs, the water/ethanol solution forms a layer at the bottom of the tank leaving the upper petrol layer as an off-specification fuel with respect to parameters such as octane and volatility. If phase separation occurs, the process is irreversible. The appearance of turbidity (haze or cloudiness) in the ethanol-petrol blend is good measure of the onset of phase separation.

4.8.3. A drop in temperature could have a similar effect. A rise in temperature will however not reverse the process of phase separation.

4.8.4. Discovery of phase separation in a storage tank may be an early indication of a tank or tank system defect. The tank should be immediately removed from service and the water phase should be disposed of in accordance with national and local regulations and permits. The ethanol-depleted petrol in the upper phase should be managed as off-specification product.

4.8.5. To minimize the risk of phase separation, fuel ethanol used for blending with petrol should adhere to the requirements of SANS 465. The susceptibility of petrol-ethanol blends to water requires that the tank and the entire piping system be clean and dry before ethanol blends are introduced. Good housekeeping practices are recommended to keep water from entering the system.

4.9. Volumetric expansion

4.9.1. The blending of a base fuel with fuel ethanol results in a small volumetric expansion of the resultant blend. Albeit small, this volumetric increase should be accounted for in product reconciliation and blending system design.

4.9.2. The magnitude of this volumetric increase is dependent on the fuel ethanol blend ratio, the base fuel composition and temperature of the blend components.

4.9.3. It is important that the design of the fuel ethanol blending system allow for sufficient distance between the blending point and the control volumetric meter to account for this expansion. To ensure accurate volume measurement, it is recommended that the blend point location be at least 2 meters upstream of the control volumetric meter.

5. FUEL ETHANOL HANDLING

5.1. Transportation

For the purpose of transport, fuel ethanol shall be classified as dangerous goods as listed in SANS 10228. Fuel ethanol is classified with the United Nations (UN) number: 1170 with the UN proper shipping name: "ETHANOL (ETHYL ALCOHOL)".

Transport of fuel ethanol by road shall be in accordance with SANS 10231 and SANS 1518.

Transport of fuel ethanol by rail shall be in accordance with SANS 10405.

Where applicable, the transporter of fuel ethanol shall adhere to the requirements of the relevant revenue authority.

Fuel ethanol producers, transporters and petrol blenders to note the potential for fuel ethanol to absorb water present in the supply chain and are advised to take necessary precautions to prevent the absorption of water.

5.2. Storage

Storage equipment for fuel ethanol shall be in accordance with SANS 10089-1, SANS 10089-2, SANS 10089-3, SANS 10140-3, SANS 10263-0 and SANS 10131 and shall comply with any other relevant national and local regulations.

Fuel ethanol can be stored in fixed roof tanks with or without an internal floating cover (IFC). Tanks with external floating covers can allow water to enter the tank and are not recommended for storing fuel ethanol. The design of the storage tanks and associated infrastructure should minimise the potential ingress of water.

The vapour concentration above neat liquid fuel ethanol will be in the flammable range when the liquid temperature is between about 12 and 43 ºC. Because impurities in the fuel ethanol can alter this range, however, it is good engineering practice to assume that the vapour phase above fuel ethanol is always in the flammable range and procedures and equipment should be used that ensure safe storage conditions. For this reason, procedures, similar to those used for petrol storage, should be used to ensure against ignition, especially when fixed roof tanks are used to store liquid ethanol. These procedures can include the use of inerting gas systems to avoid a flammable mixture in the vapour space although this approach may not be practical in all situations. The type of vent on a fixed roof tank will not greatly affect the average flammability condition whether the vents are open or Pressure/Vacuum (P/V) vents. (A P/V vent is a venting device that reduces the free flow of air and vapours in and out of the tank).

5.3. Safety and firefighting measures

5.3.1. Safe Handling

Fuel ethanol is classified as a **Flammable Liquid, Hazard Class 2**. Safety precautions and equipment for storing and handling ethanol/petrol blends are similar to those used for conventional petrol.

The relevant Safety Data Sheet (SDS) should be consulted for recommendations on safe handling and related procedures for fuel ethanol and ethanol/petrol blends.

The following hazard statements apply for fuel ethanol: **H225 Highly flammable liquid and vapour; H319 Causes serious eye irritation.**

The following precautionary statements apply, and the supplier specific SDS should be referred to for additional guidance:

Handling:
- Keep away from heat / sparks / open flames / hot surfaces – No smoking.
- Ground/bond container and receiving equipment to reduce the possibility of static spark-initiated fire or explosion.
- Take precautionary measures against static discharge.
- Use explosion-proof electrical / ventilating / lighting equipment. Use only non-sparking tools.
- Wear protective gloves / protective clothing /eye protection.
- Wash skin thoroughly after handling.
- If on skin or hair remove/ take off immediately all contaminated clothing. Rinse skin with water.
- If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

Storage:
- Store in a cool, dry well- ventilated area away from sparks, flames and other sources of ignition. Eliminate all sources of static electricity.
- Store in approved flammable liquid storage containers.
- Keep containers tightly closed as this material readily absorbs moisture.
- Store away from incompatible materials.

5.3.2. Fire Protection and Fire-Fighting Agents Involving Ethanol/Petrol Blends

Personnel should approach an ethanol/petrol blend fire with the same caution as they would use in approaching a conventional petrol fire, and similar fire-fighting techniques should be used. The use of alcohol resistant foams is required when fighting fires involving fuels containing high levels of ethanol. For fighting fires involving petrol containing up to 10% v/v ethanol, such foams may not be required but it is strongly advised that responsible personnel review their specific operations and use appropriate equipment based on local safety requirements. Fires involving fuel ethanol do not produce smoke and the flames are difficult to see in daylight.

Use dry chemical, alcohol-resistant foam or carbon dioxide to extinguish fire. Water may be ineffective but should be used to cool fire- exposed containers, structures and to protect personnel. If leak or spill has not ignited, ventilate area and use water spray to disperse gas or vapour and to protect personnel attempting to stop a leak. Use water to dilute spills and to flush them away from sources of ignition. Do not flush down public sewers or other drainage systems.

5.3.3. Sources of Ignition

The presence of ethanol does not substantially increase the risk of static electricity since ethanol has a high electrical conductivity. Lightning could be a problem but a well-grounded metal tank with a well-maintained P/V vent or flame arrestor on the vent is considered safe. Excessive friction could cause ignition inside an internal floating roof tank if, for example, the floating roof were to develop a mechanical problem.

Obviously, hot repair work or other human activities near the open vent of an in- service tank must be avoided because these practices could cause ignition to occur. Procedures, similar to those used for conventional petrol tanks, should be in place to avoid these problems.

5.3.4. Surface Spills and Leaks

Surface spills and underground leaks of ethanol/petrol blends should be treated in the same manner as petrol spills and leaks, including notification of the relevant authorities. The supplier's SDS should also be reviewed for recommendations on spill clean-up procedures for fuel ethanol.

5.3.5. Fuel ethanol-containing effluent handling

The disposal of ethanol-containing effluent streams must be done in accordance with all national and local regulations and permits including the National Environmental Management: Waste Act (2008).

Fuel ethanol can be difficult to remove from drains and wastewater because it is soluble in water. For this reason, the only way to efficiently remove fuel ethanol is through biological treatment. If the bacteria in treatment facilities have not been acclimatised to fuel ethanol, much of the fuel ethanol will pass through the treatment plant before it is degraded. Several weeks to a month may be required before a treatment plant can efficiently process ethanol-containing effluent streams. Facilities can gradually increase the ethanol content in their wastewater system as the bacteria become more efficient at degrading ethanol. It is important to test degradation performance in the laboratory and analyse the plant effluent for ethanol content over time to determine the degradation rate.

Because terminals do not usually have biological treatment facilities, fuel ethanol will most likely pass through the mechanical treatments that are commonly used. If the terminal sends its wastewater to a municipal treatment plant, it is important to check with the treatment plant operators whether their facility can handle ethanol-containing effluent.

5.4. Material compatibility, corrosion, and permeability of fuel distribution systems

Before any system is converted to handle fuel ethanol or ethanol/petrol blend, the materials of the individual system components should be evaluated for suitability and replaced as required (in consultation with equipment suppliers), including evaluation of maintenance philosophies. Tables 1 and 2 provide an overview of materials that are either recommended for use or should be avoided when handling fuel ethanol or ethanol/petrol blends.

With respect to the compatibility with materials typically used in fuel supply and distribution systems, ethanol is different from fuel hydrocarbons in three important ways: the presence of the polar hydroxyl (-OH) group, the relative size of the ethanol molecule, and the higher conductivity of ethanol (and of ethanol/petrol blends). Because of these differences, various components in the fuel distribution system may be less compatible with ethanol/petrol blends than they are with hydrocarbon-only fuels.

Many fuel system elastomers that have excellent compatibility with hydrocarbon-only fuels are themselves characterized by polar constituents. These constituents contribute to the stability of the elastomer through hydrogen-bonding and other interactions. These interactions may be vulnerable to substitution by the hydroxyl group of the ethanol. For this reason, some elastomers can lose their structural integrity over time due to the loss of stabilizing hydrogen bonding interactions when the elastomer is exposed to ethanol/petrol blends. Ethanol can also extract plasticizers in the elastomers, reducing the flexibility and toughness of the elastomer products. Fuel system components such as seals, gaskets and piping that are made from polymers and elastomers must be designed to retain their structural integrity, strength and flexibility after extended exposure to ethanol/petrol blends.

Because ethanol is a smaller and more polar molecule than other oxygenates, there is a lower energetic barrier for ethanol diffusing into and through elastomeric materials. Over time, ethanol can accumulate in these materials, causing them to swell and soften, leading to an overall weakening of the elastomeric structure.

In comparison to hydrocarbons, ethanol has a high conductivity and contains an active oxygen functionality. This can contribute to corrosion and wear problems of some metal components. Furthermore, the suspension of water within the ethanol/petrol blend may enhance rusting and/or galvanic corrosion. The tendency of ethanol to loosen varnish and gum deposits can also have a significant impact. By loosening these deposits, ethanol may accelerate wear of metallic components that are in regular contact with fuel by scouring internal surfaces with suspended particles. The use of corrosion inhibitors can help mitigate this problem although the compatibility of these additives with ethanol/petrol blends must be thoroughly evaluated.

Table 1 Recommendations for materials Considered for use in ethanol and ethanol/petrol blend applications

Material	Recommended	Not Recommended
Metals	Carbon steel with post-weld heat treatment of carbon steel piping and internal lining of carbon steel tanks Stainless steel Bronze Aluminium	Zinc and galvanized materials Brass Copper Lead/tin coated steel Aluminium (may be an issue for E100)
Elastomers	Buna-N (hoses & gaskets) Fluorel Fluorosilicone Neoprene (hoses & gaskets) Polysulfide rubber Viton	Buna-N (seals only) Neoprene (seals only) Urethane rubber Acrylonitrile-butadiene hoses Polybutene terephthalate
Polymers	Acetal Polypropylene Polyethylene Teflon Fibreglass-reinforced plastic	Polyurethane Polymers containing alcohol groups (such as alcohol-based pipe dope) Nylon 66 Fibreglass-reinforced polyester and epoxy resins Shellac
Others	Paper Leather	Cork

Table 2 Compatibility of ethanol with materials commonly used in fuel distribution systems

Item	Recommended	Not Recommended
Containment system (around tank and loading racks)		Clay liners. Ethanol may dry out the liner and allow cracks to develop
Tanks used for E5	Mild steel Fibre glass-reinforced plastic (newer types)	Some lining materials commonly used to prevent small leaks such as older types of epoxy or polyester resin-based materials. If a tank is relined, the manufacturer should be contacted for advice.
Tanks used for E100	May require a tank constructed of a special chemical resin	
Pumps used for E100	Carbon & ceramic seals Teflon-impregnated packing materials	
Pipe sealants used for E5 and E100	Teflon tape	Alcohol based pipe sealants
Meters used for E5	When first converting to ethanol/petrol blends, it is advisable to recalibrate meters after 10-14 days to ensure that the fuel change has not caused any meters to over-dispense	
Meters used for E100	Internal O-rings & seals should be selected that are specifically designed for use with ethanol	
Fuel Filters for E5	It may be necessary to change the fuel filter shortly after converting to ethanol/petrol blends. Once the dispensed fuel is clear and bright, the filter life should be similar to those in regular petrol applications.	Ethanol can dissolve the glue in filter elements that are not specifically designed for this service. Filters containing shellac
Hoses used for E5	No problems reported	
Hoses used for E100	Contact the manufacturer	
Nozzles used for E5	No problems reported	

6. TAX TREATMENT OF BLENDING OF ETHANOL WITH PETROL

6.1. Tariff classification

In order to understand the tax treatment of ethanol it is important to first establish its classification in terms of the Customs and Excise Act (Customs Act) and subsequent tariff classifications. This is very important from a tax treatment point of view and the applicable duties applied to ethanol and to petrol.

Ethanol is classified in terms of Schedule No1 Part 1 of the Customs Act under either of the following tariff subheadings:

- 2207.10 – Undenatured ethyl alcohol of an alcoholic strength by volume of 80% vol. or higher;
- 2207.20 – Ethyl alcohol and other spirits, denatured, of any strength.

The ethanol is subject, in terms of Sch. 1 P 2A of the Customs Act to excise duty, the rate of which is reviewed annually by the National Treasury. This excise duty is referred to as "Spirits DAS".

The ethanol will comply with the following definitions; (Section 36B of the Customs Act)

- **"bioethanol"** means a biofuel as specified in and described in any note to any heading or in any subheading of Part 1 of Schedule No. 1, any item of Section A of Part 2 or Part 5 of the said Schedule No. 1 or any item of Schedule No. 3, 4, 5 or 6 capable of use as a substitute for or additive to petrol. (Note: This legislative amendment has not been completed)
- **"biofuel"** means any goods used as liquid fuel manufactured from any vegetable or other material, not being any material from which mineral fuels, oils or other goods are obtained as provided in Chapter 27 Part 1 of Schedule No. 1.

Tariff classification of the blended product - the blended product will be classified in terms of Schedule No1 Part 1 of the Customs Act under tariff subheading 2710.12.02 (Petrol, as defined in Additional Note 1(b) to Chapter 27).

Fuel taxes (Sch1 P 2A Excise Duty, Sch. 1 P 5A Fuel Levy and Sch1 P5 B RAF Levy): The bioethanol content of a bioethanol/petrol blend will be subjected to a rate of fuel taxes, at the same rate as petrol.

Blending: Bioethanol will not be used as an automotive fuel in its pure form. The bioethanol will be blended with petrol to a content not exceeding 30% and the blending location of such products will take place both at refineries and distribution terminals.

6.2. Current regulatory environment

6.2.1. Ethanol manufacturing

The ethanol has to be manufactured in a facility licensed at SARS as a primary spirits manufacturing warehouse ("VMP"). The bioethanol production will be accounted for to SARS on a form DA 260. Should the ethanol be removed (in its pure form) from the VMP warehouse, the following spirits DAS principles will apply:

- Removal to a petroleum manufacturing (VM) warehouse: Rebate Item 621.05 provides for a full rebate of duty for "Spirits entered for mixing with petrol in a customs and excise warehouse approved for this purpose by the Commissioner" which would be a VM warehouse.
- Removal to a depot: Rebate Item 621.08 provides for a full rebate of duty for "Spirits for industrial use or for use in the manufacture of other non-liquor products". In this case the depot will have to register as a rebate user. In addition, the rebate user has to maintain a rebate register to account for the receipt, use and stock of spirits received under rebate of spirits DAS. Where the rebate user is unable to account for any volume of spirits or is unable to prove that the spirits were used for the purpose as prescribed in the rebate item, the rebate user will be liable for the payment of the spirits DAS on the spirits.

6.2.2. Denaturing

The bioethanol may be denatured in a warehouse licensed at SARS as a special storage warehouse ("SOS") for the denaturing of spirits. The spirits DAS liability is transferred from the VMP to the SOS. "Denature" is defined as ethyl alcohol rendered unfit for human consumption as liquor by the addition of a denaturant. Denaturants may, in terms of the Customs Act, either fully or partially denature the spirits. Fully denatured spirits contain a denaturant that cannot be separated from the spirits through a simple process.

- Removal to a petroleum manufacturing (VM) warehouse – refer above.
- Removal to a depot: Rebate Item 621.08 provides for a full rebate of duty for "Spirits for industrial use or for use in the manufacture of other non-liquor products". In this case and under the assumption that the spirits are fully denatured, the depot will not have to register as a rebate user and maintain a rebate register.

6.3. Blending of bioethanol with petrol

6.3.1. General

Section 37B to the Customs Act contains certain provisions regarding the definition of bioethanol and the blending of bioethanol and petrol. Section 37B (2) of the Customs Act provides, amongst others, that:

- Unless otherwise provided in the Customs Act, Rule or Schedule to the Act, any reference to petrol shall be deemed to include a reference to bioethanol or mixture of petrol and bioethanol; (Section 37B(2)(a)(ii) of the Customs Act).
- The Commissioner may, with certain proviso's, exempt any person from the payment of any duty on any quantity of bioethanol manufactured by him.

In line with the provisions of Section 37B of the Customs Act, <u>biodiesel</u> was defined in an additional note to Schedule No 1 Part 1 to the Customs Act, Rules were published to regulate and prescribe the manufacture and blending of biodiesel and specific rates of excise duty, fuel levy and RAF levy were prescribed for biodiesel. As opposed to biodiesel, no specific Rules were published relating to bioethanol or the blending of bioethanol with petrol and no specific rate of petroleum DAS was published.

6.3.2. Blending of bioethanol and petrol in a VM

As indicated above, the spirits DAS can be neutralised through the application of rebate item 621.05. After blending, the normal petroleum DAS rules will apply and the licensee of the VM will account for the petroleum DAS on the full volume of blended petrol.

6.3.3. Blending of bioethanol and petrol in a depot

The blending of the bioethanol and petrol will, in terms of Section 1 to the Customs Act, be a manufacturing process. In terms of Section 27 (1) to the Customs Act, this manufacturing process may only take place in a customs and excise manufacturing licensed at SARS. This will require that any depot earmarked for the blending of bioethanol and petrol will need to be licensed as a VM.

7. REFERENCES

The following references provide additional guidance on fuel ethanol blending at fuel distribution depots/terminals:

American Petroleum Institute. (2010). *API Recommended Practice 1626: Storing and Handling Ethanol and Gasoline-ethanol Blends at Distribution Terminals and Filling Stations (Second Edition).*

CONCAWE. (2008). *Report 3/08 Guidelines for blending and handling motor gasoline containing up to 10% v/v ethanol*

Energy Institute. (2016). *Guidance for the storage and handling of fuel grade ethanol mixtures at petroleum distribution installations (Second Edition).*

SANS 465. (2018). *Automotive fuels - Requirements and specifications for fuel ethanol as a blending component with petrol. Edition 2.*

SANS 1598. (2019). *Automotive fuels - Requirements and test methods for petrol. Edition 3.1.*

SANS 1590. (2017). *Supply chain specifications for white petroleum products – Pipeline specification. Edition 1.*

Van der Merwe, D.G., Roots, P.N.J., Goosen, R. and Botha, J.J. (1999). *Methodology of introducing Sasol Fuel Alcohol as a gasoline component in South Africa.* Proceedings from International Symposium on Alcohol Fuels (ISAF XIII).