## **Supporting Information**

# Investigation on a Novel Mixed Dialkyl Oxalates System as an

# **Oxygenated Fuel Additive**

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### 1. The synthesis route of different mixed dialkyl oxalates (mDAOs)

All reagents were purchased commercially and used without further purification.

Preperation of mMiPO: 100 g of dimethyl oxalate, 101.7 g of isopropanol and 0.85 g of light magnesium oxide were added to a flask. The mixture was heated in an oil bath at 100 °C, refluxed for 6 hours, and then cooled to room temperature. The byproduct methanol and unreacted isopropanol were recycled by distillation. The residual dialkyl oxalates was collected to afford the colorless and transparent liquid mixture of 105 g.

Preperation of mMBO :100 g of dimethyl oxalate, 106.6 g of n-butanol and 0.85 g of light magnesium oxide were added to a flask. The mixture was heated in an oil bath at 100 °C, refluxed for 6 hours, and then cooled to room temperature. The byproduct methanol and unreacted n-butanol were recycled by distillation. The residual dialkyl oxalates was collected to afford the colorless and transparent liquid mixture of 108 g.

Preperation of MEBO: 100 g of diethyl oxalate, 86.2 g of n-butanol, 0.68 g of light magnesium oxide were added to a flask. The mixture was heated in an oil bath at 100 °C, refluxed for 10 hours, and then cooled to room temperature. The byproduct ethanol and unreacted n-butanol were recycled by distillation. The residual dialkyl oxalates was collected to afford the colorless and transparent liquid mixture of 111 g.

### 2. Determination of heating value and density of oxalates

The combustion energies of MEO, mMEO and mMBO was investigated by a high precision automatic calorimeter (Shanghai Mitong Electromechanical Technology Co., Ltd. MTZW-A4). The tests are repeated five time to get the average result. The density of oxalates was measured by pipette and electronic balance.

### 3. The pH stability of mMEO and mMEO/gasoline during storage

The water-soluble acids and alkalis of petroleum products can be determined by measuring the pH of water extract. According to the China national standard (GB/T 259-1988), the pH stability test method is as follows: 50 ml of MEO/gasoline blends and 50 ml of distilled water were added to a flask. The mixture was shake vigorously for about 10-20 seconds and separated. The pH of aqueous phase was measured by a universal pH test paper on day 0, 7 and 30 respectively. MEO/gasoline blends with different proportions were prepared. The blends were filtered through dry filter paper and stored in sealed bottles. Samples were tested on. The measurement results are shown in Table 1. During the storage period of 30 days, the pH of the extract did not change significantly. Test results were in the range of 5 to 9, which is the requirements of china national standard (GB 19147-2016) for the water-soluble acids and alkalis

content of gasoline. The result showed that the fuel is stable under the storage conditions.

1 2		0	
	0 d	7 d	30 d
mMEO	7	7	7
10% mMEO/gasoline	6~7	6~7	6~7
20% mMEO/gasoline	6~7	6~7	6~7
30% mMEO/gasoline	6~7	6~7	6~7
40% mMEO/gasoline	6~7	6~7	6~7

Table 1. The pH stability of mMEO and mMEO/gasoline with one month

### 4. Experiment: The flame extinguishing of mMEO with water



Figure 1. (a) Water was adding in the beaker following by the burning mMEO, then (b) the flame of mMEO extinguished and mMEO sank to the bottom. (c)The burning mMEO was adding to the beaker following by water, then (d) the flame of mMEO extinguished immediately.