CLAIMS

1. A fuel composition comprising:

(1) greater than 50 wt % of a hydrocarbon fuel boiling in the gasoline or diesel range;

(2) a minor amount of

a primary low-speed pre-ignition (LSPI)-reducing additive selected from 5,6-dimethylbenzotriazole, prolinol, trioctylmethylammonium chloride, N,N'-dicyclohexylmorpholine-4-carboximidamide (morphguam), 2-aminobenzimidazole, AHPD, N,N-dimethyl-N-octylbenzamidinium-2-oxide, benzoxazole, 2-methylquinolin-8-amine, or 2-aminobenzoxazole, 1,4,5,6-tetrahydropyrimidine, 1,2-dimethyl-1,4,5,6-tetrahydropyrimidine, 1,2-diethyl-1,4,5,6-tetrahydropyrimidine, 1,5-diazabicyclo[4.3.0]non-5-ene (DBN), 2-phenyl-1H-benzo[d]imidazole, 1,8-diazabicyclo[5.4.0]-undece-7-ene (DBU), 1,1,3,3-tetramethylguanidine (TMG), 2-tert-butyl-1,1,3,3-tetramethylguanidine(BTMG), 1,5,7-triazabicyclo[4.4.0]dec-5-ene (TBD), 1,2-diphenylguanidine, or 7-methyl-1,5,7-triazabicyclo[4.4.0]dec-5-ene (MTBD)

,

; and

(3) a secondary LSPI-reducing additive selected from 2-ethylhexanoate, isostreate, proline, diketone, oleate, toluene carboxylate, tetralin carboxylate, phenoxide, phenol carboxylate, hydroxy acid, 2-hydroxy-5-(tetracosa-1,3,5,7,9,11,13,15,17,19,21,23-dodecayn-1-yl)benzoic acid-dihydrogen, or ketoester,

wherein the primary LSPI-reducing additive and the secondary LSPI-reducing additive form a salt.

2. The fuel composition of claim 1, wherein the primary LSPI-reducing additive is 5,6-dimethylbenzotriazole.

3. The fuel composition of claim 1, wherein the primary LSPI-reducing additive is prolinol, trioctylmethylammonium chloride morphguam, 2-aminobenzimidazole,

AHPD, N,N-dimethyl-N-octylbenzamidinium-2-oxide, benzoxazole, 2-methylquinolin-8-amine, or 2-aminobenzoxazole.

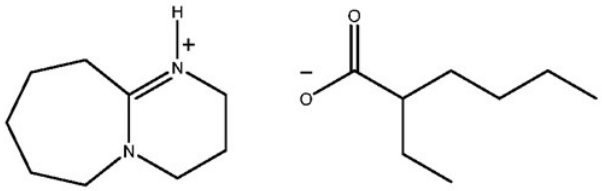
4. The fuel composition of claim 1, wherein the primary LSPI-reducing additive is 1,4,5,6-tetrahydropyrimidine, 1,2-dimethyl-1,4,5,6-tetrahydropyrimidine, 1,2-diethyl-1,4,5,6-tetrahydropyrimidine, 1,5-diazabicyclo[4.3.0]non-5-ene (DBN), 2-phenyl-1H-benzo[d]imidazole, or 1,8-diazabicyclo[5.4.0]-undece-7-ene (DBU).

5. The fuel composition of claim 1, wherein the primary LSPI-reducing additive is 1,1,3,3-tetramethylguanidine (TMG), 2-tert-butyl-1,1,3,3-tetramethylguanidine(BTMG), 1,5,7-triazabicyclo[4.4.0]dec-5-ene (TBD), 1,2-diphenylguanidine, or 7-methyl-1,5,7-triazabicyclo[4.4.0]dec-5-ene (MTBD).

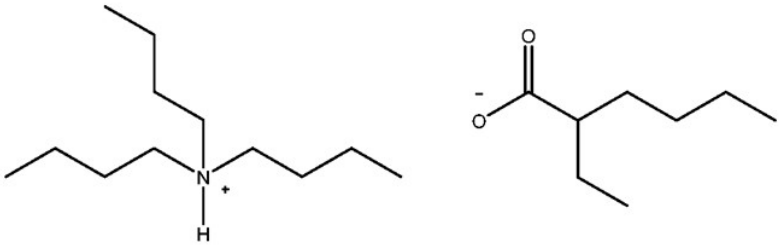
6. A fuel composition comprising:

(1) greater than 50 wt % of a hydrocarbon fuel boiling in the gasoline or diesel range; and

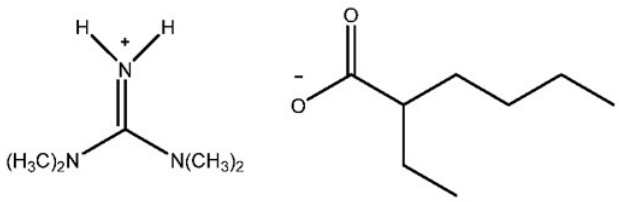
(2) a minor amount of a salt selected from:



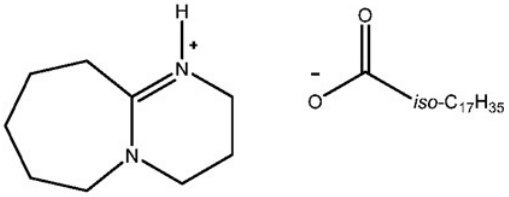
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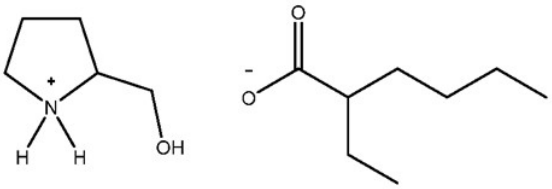
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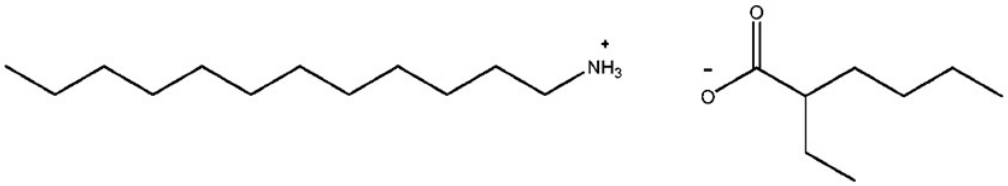
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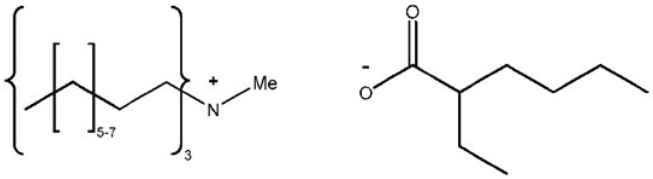
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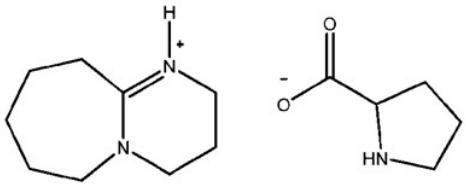
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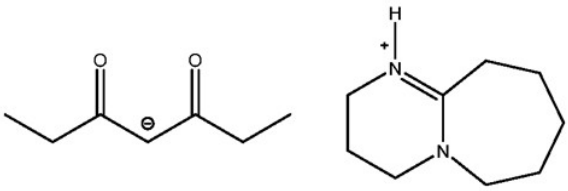
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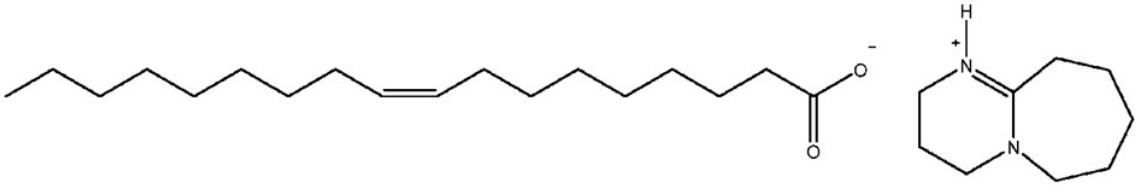
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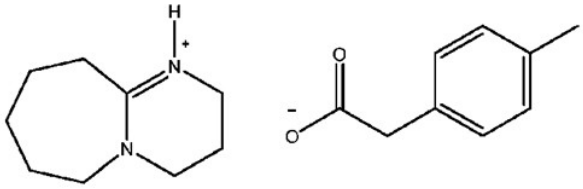
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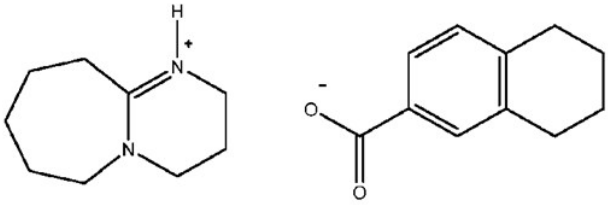
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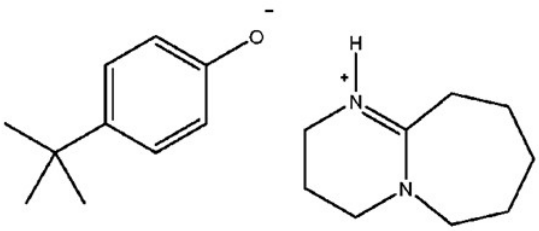
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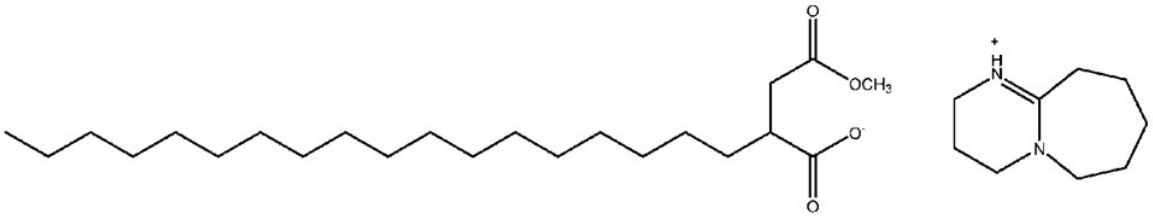
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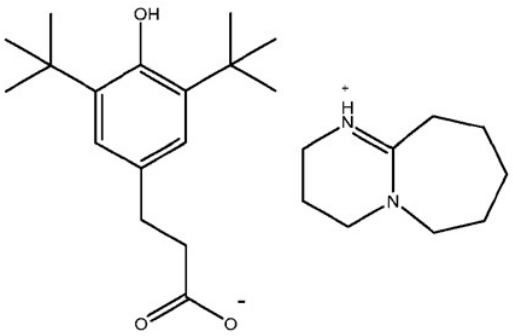
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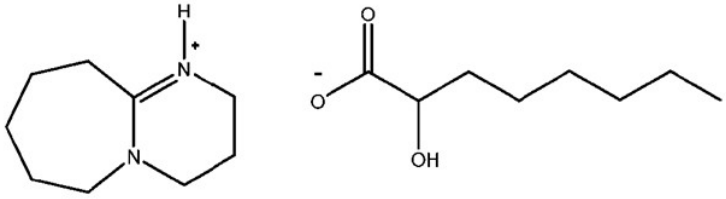
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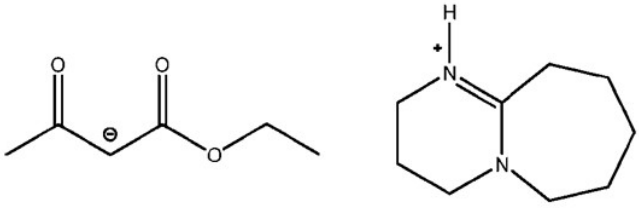
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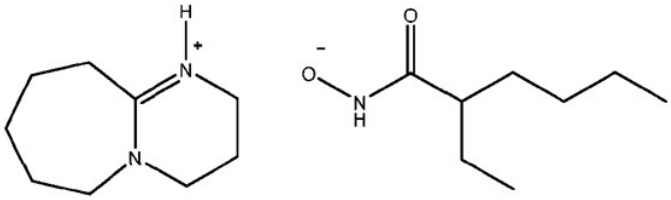
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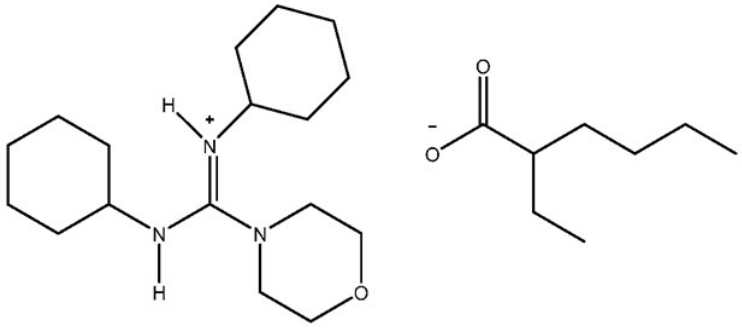
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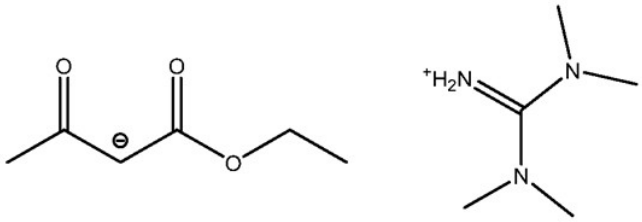
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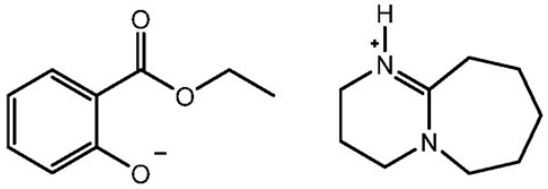
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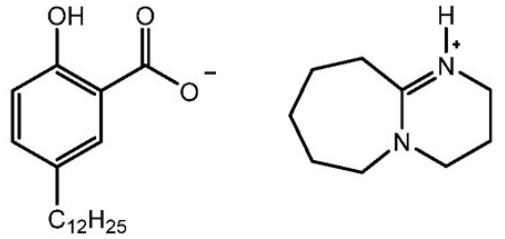
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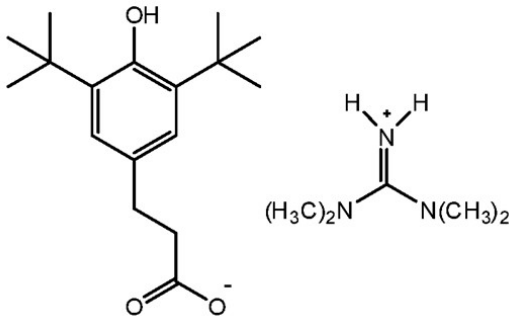
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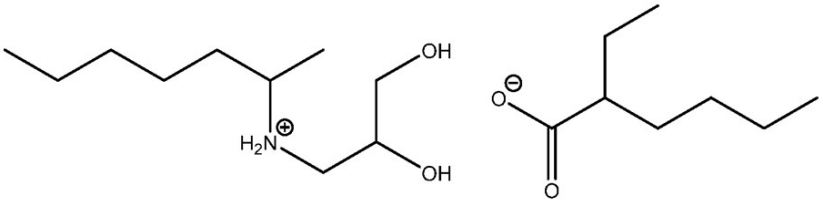
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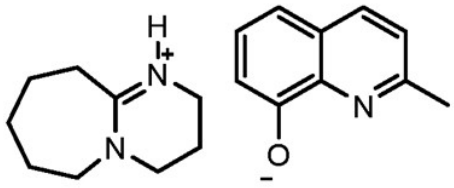
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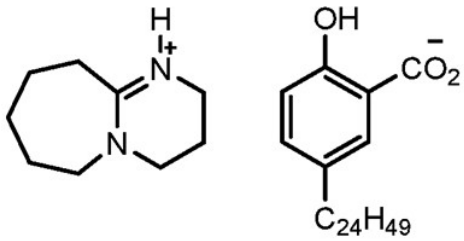
(Formula 24X),



(Formula 24Y),



(Formula 24Z), and



(Formula 24AA).

7. A fuel concentrate comprising:

(1) from 90 to 30 wt % of an organic solvent boiling in a range of from 65°C to 205°C;

(2) from 10 to 70 wt % of a primary LSPI-reducing additive selected from 5,6-dimethylbenzotriazole, prolinol, trioctylmethylammonium chloride, N,N'-dicyclohexylmorpholine-4-carboximidamide (morphguam), 2-aminobenzimidazole, AHPD, N,N-dimethyl-N-octylbenzamidinium-2-oxide, benzoxazole, 2-methylquinolin-8-amine, or 2-aminobenzoxazole, 1,4,5,6-tetrahydropyrimidine, 1,2-dimethyl-1,4,5,6-tetrahydropyrimidine, 1,2-diethyl-1,4,5,6-tetrahydropyrimidine, 1,5-diazabicyclo[4.3.0]non-5-ene (DBN), 2-phenyl-1H-benzo[d]imidazole, 1,8-diazabicyclo[5.4.0]-undece-7-ene (DBU), 1,1,3,3-tetramethylguanidine (TMG), 2-tert-butyl-1,1,3,3-tetramethylguanidine(BTMG), 1,5,7-triazabicyclo[4.4.0]dec-5-ene (TBD), 1,2-diphenylguanidine, or 7-methyl-1,5,7-triazabicyclo[4.4.0]dec-5-ene (MTBD); and

(3) a secondary LSPI-reducing additive selected from 2-ethylhexanoate, isostreate, proline, diketone, oleate, toluene carboxylate, tetralin carboxylate, phenoxide, phenol carboxylate, hydroxy acid, 2-hydroxy-5-(tetracosa-1,3,5,7,9,11,13,15,17,19,21,23-dodecayn-1-yl)benzoic acid-dihydrogen, or ketoester;

wherein the primary LSPI-reducing additive and the secondary LSPI-reducing additive form a salt.

8. The fuel concentrate of claim 7, wherein the primary LSPI-reducing additive is 5,6-dimethylbenzotriazole.

9. The fuel concentrate ofclaim 7, wherein the primary LSPI-reducing additive is prolinol, trioctylmethylammonium chloride, morphguam, 2-aminobenzimidazole, AHPD, N,N-dimethyl-N-octylbenzamidinium-2-oxide, benzoxazole, 2-methylquinolin-8-amine, or 2-aminobenzoxazole.

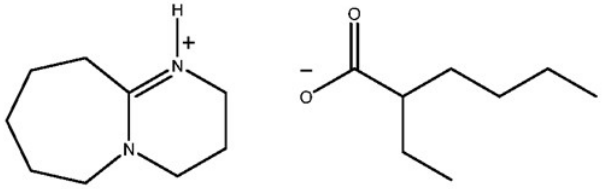
10. The fuel concentrate of claim 7, wherein the primary LSPI-reducing additive is 1,4,5,6-tetrahydropyrimidine, 1,2-dimethyl-1,4,5,6-tetrahydropyrimidine, 1,2-diethyl-1,4,5,6-tetrahydropyrimidine, 1,5-diazabicyclo[4.3.0]non-5-ene (DBN), 2-phenyl-1H-benzo[d]imidazole, or 1,8-diazabicyclo[5.4.0]-undece-7-ene (DBU).

11. The fuel concentrate of claim 7, wherein the primary LSPI-reducing additive is 1,1,3,3-tetramethylguanidine (TMG), 2-tert-butyl-1,1,3,3-tetramethylguanidine(BTMG), 1,5,7-triazabicyclo[4.4.0]dec-5-ene (TBD), 1,2-diphenylguanidine, or 7-methyl-1,5,7-triazabicyclo[4.4.0]dec-5-ene (MTBD).

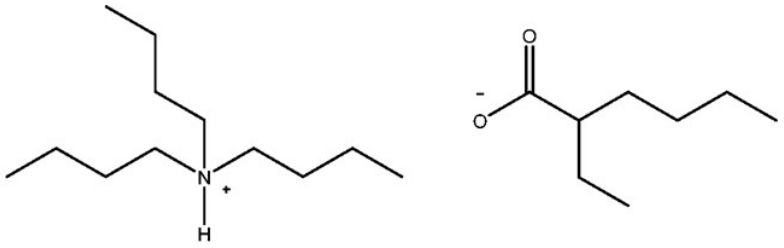
12. A fuel concentrate comprising:

(1) from 90 to 30 wt % of an organic solvent boiling in a range of from 65 °C to 205 °C;

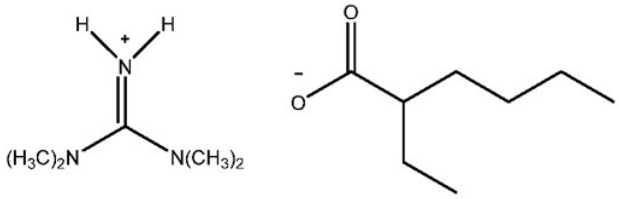
(2) from 10 to 70 wt % of a salt selected from:



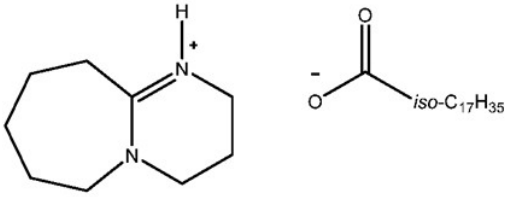
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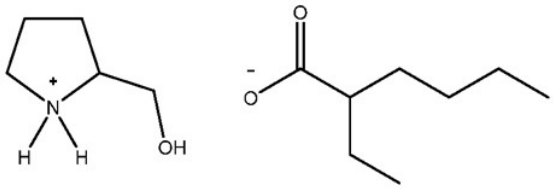
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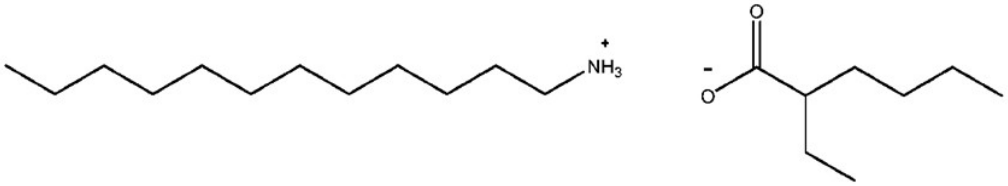
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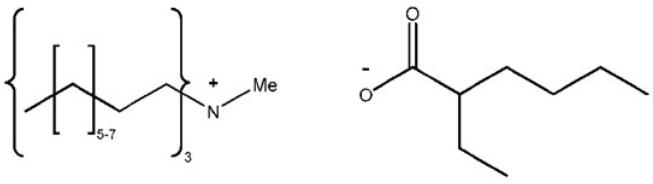
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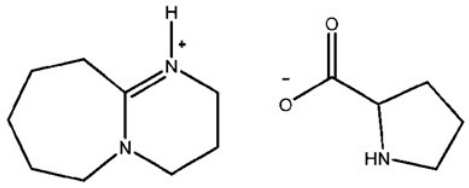
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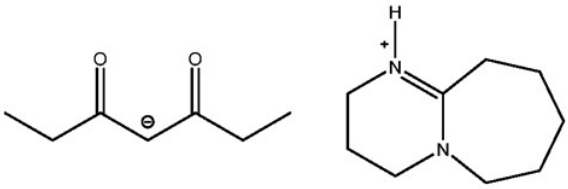
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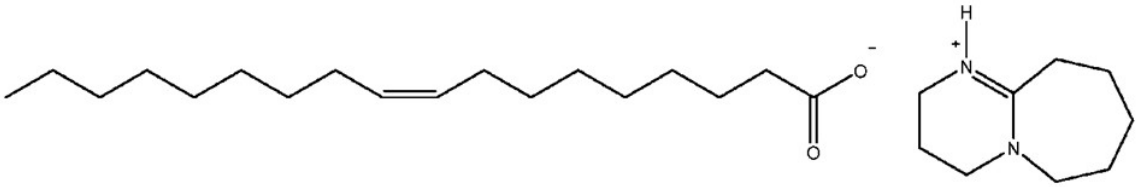
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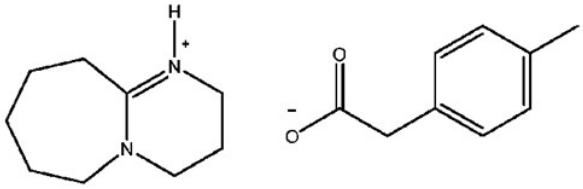
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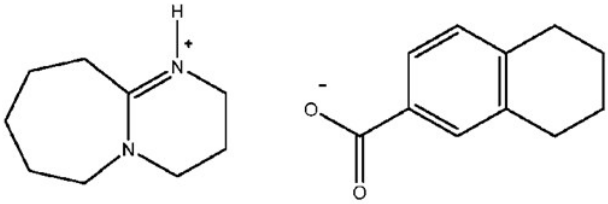
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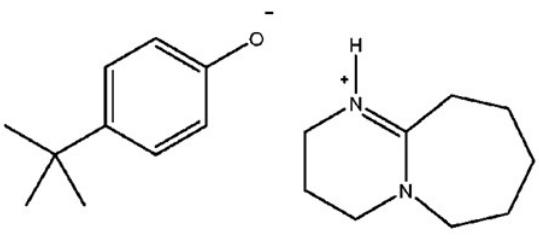
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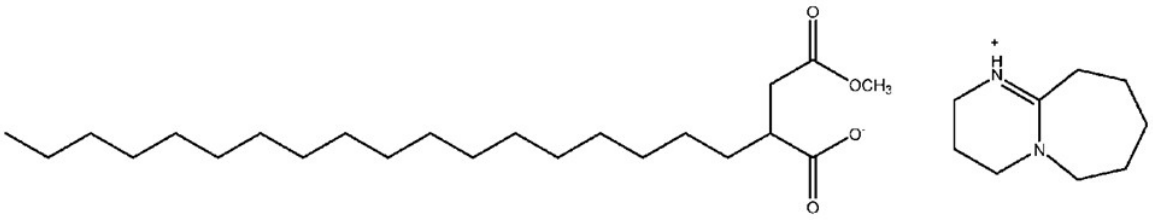
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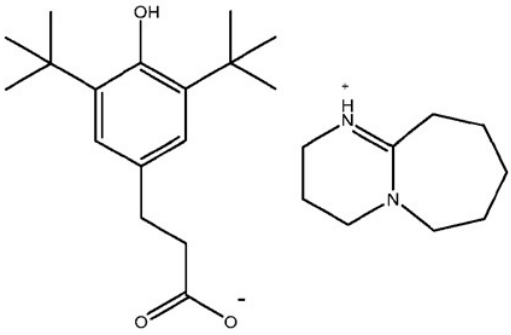
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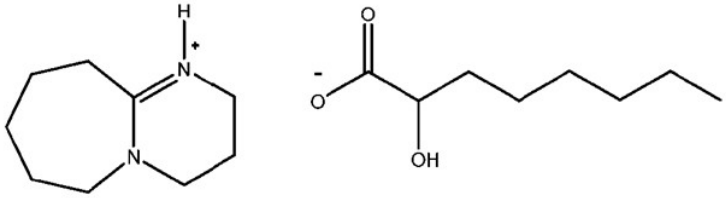
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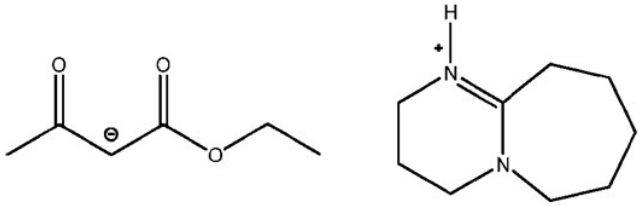
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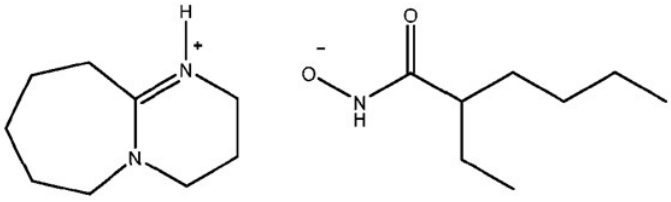
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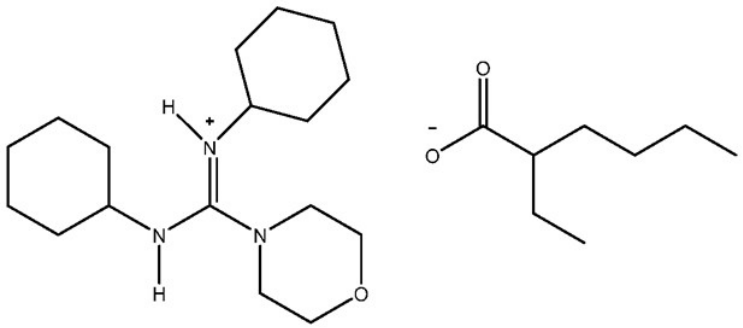
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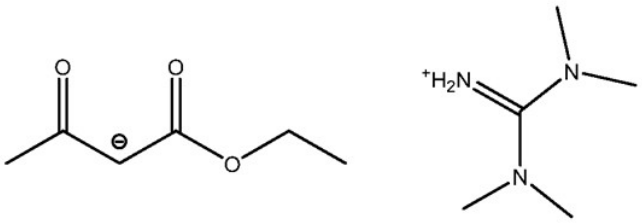
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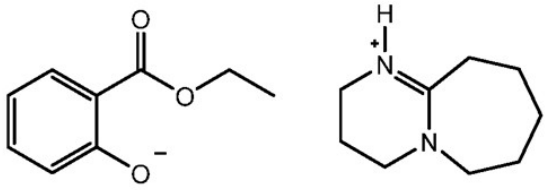
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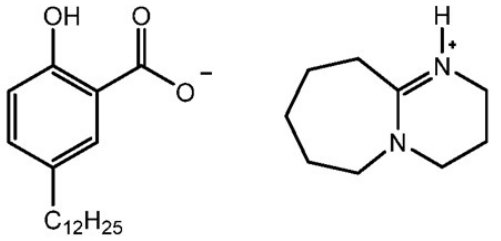
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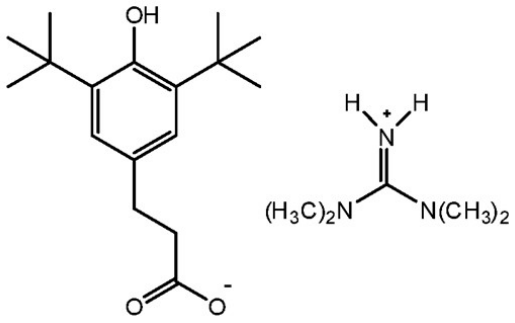
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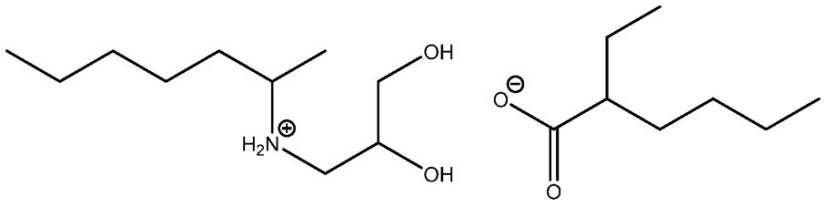
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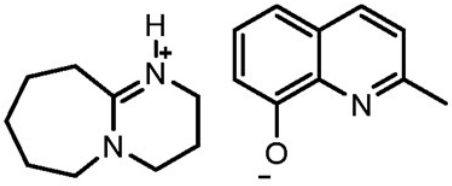
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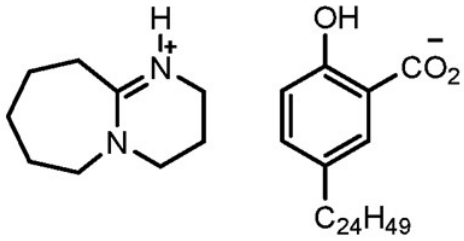
(Formula 24X),



(Formula 24Y),



(Formula 24Z), and



(Formula 24AA).

13. A method for preventing or reducing low speed pre-ignition events in a spark-ignited internal combustion engine, the method comprising supplying to the engine the fuel composition of any one of claims 1 to 6.

14. The method of claim 13, wherein the spark-ignited internal combustion engine is operated at a speed of less than 3000 rpm.

15. The method of claim 13 or 14, wherein the spark-ignited internal combustion engine is operated under a load with a brake mean effective pressure of at least 10 bar (1 MPa).

16. Use of the fuel composition of any one of claims 1 to 6 to prevent or reduce low speed pre-ignition events in a spark-ignited internal combustion engine, wherein the fuel composition is supplied to the engine.

17. The use of claim 16, wherein the spark-ignited internal combustion engine is operated at a speed of less than 3000 rpm.

18. The use of claim 16, wherein the spark-ignited internal combustion engine is operated under a load with a brake mean effective pressure of at least 10 bar (1 MPa).