CLAIMS

I/We claim:

**1.** A method for lubricating an internal combustion engine, the method comprising:

supplying a lubricating oil composition to a cylinder of an internal combustion engine, wherein the internal combustion engine has a mean effective pressure of no less than 1.3 MPa,

wherein an integrated intensity ratio of peaks of CaO in an X-ray diffraction spectrum of an ash is no more than 16.5%, the ash being obtained by incinerating the lubricating oil composition in an air at 950°C;

a calcium content in the lubricating oil composition is 0.53 to 1.60 mass% on the basis of the total mass of the composition; and

the internal combustion engine is a premix combustion crosshead diesel engine using a first fuel as a main fuel, wherein the first fuel has a flash point of no more than 15°C.

**2.** A method for lubricating an internal combustion engine, the method comprising:

supplying a lubricating oil composition to a cylinder of an internal combustion engine, wherein the internal combustion engine has a mean effective pressure of no less than 1.3 MPa,

wherein an integrated intensity ratio of peaks of CaO in an X-ray diffraction spectrum of an ash is no more than 16.5%, the ash being obtained by incinerating the lubricating oil composition in an air at 950°C;

a calcium content in the lubricating oil composition is 0.45 to 1.20

mass% on the basis of the total mass of the composition;

the lubricating oil composition has a kinematic viscosity at 100°C of 13.0 to 16.3 $mm^2/s$; and

the internal combustion engine is a premix combustion medium-speed trunk piston diesel engine using a first fuel as a main fuel, wherein the first fuel has a flash point of no more than 15°C.

**3.** The method according to claim 1 or 2,

the lubricating oil composition comprising:

a mineral base oil or a synthetic base oil or a mixture thereof, as a lubricant base oil; and

(A) a metallic detergent,

wherein a molar ratio B/Ca of a boron content B (unit: mol) of the lubricating oil composition derived from the component (A) and a calcium content Ca (unit: mol) of the lubricating oil composition derived from the component (A) is no less than 0.52.

**4.** The method according to claim 3,

the component (A) comprising:

(A1) a calcium borate-containing carboxylate detergent, and/or a calcium borate-containing sulfonate detergent.

**5.** The method according to claim 4,

the component (A) further comprising:

(A2) a calcium carbonate-containing metallic detergent.

**6.** The method according to any one of claims 1 to 5, the method comprising:

operating the internal combustion engine using the first fuel as a main fuel.

**7.** The method according to claim 6,

the first fuel comprising a hydrocarbon having a carbon number of 1 to 4.

**8.** The method according to claim 6 or 7,

the first fuel comprising one or more selected from the group consisting of: methane, ethane, ethylene, propane, butane, methanol, ethanol, and dimethyl ether.

**9.** A method for lubricating an internal combustion engine, the method comprising:

supplying a lubricating oil composition to a cylinder of an internal combustion engine, wherein the internal combustion engine has a mean effective pressure of no less than 1.3 MPa,

the lubricating oil composition comprising:

a mineral base oil or a synthetic base oil or a mixture thereof, as a lubricant base oil; and

(A) a metallic detergent,

the component (A) comprising (A1) a calcium borate-containing

carboxylate detergent, and/or a calcium borate-containing sulfonate detergent,

wherein the component (A) does not comprise (A2) a calcium carbonate-containing metallic detergent;

a molar ratio B/Ca of a boron content B (unit: mol) of the lubricating oil composition derived from the component (A) and a calcium content Ca (unit: mol) of the lubricating oil composition derived from the component (A) is no less than 0.52;

an integrated intensity ratio of peaks of CaO in an X-ray diffraction spectrum of an ash is no more than 16.5%, the ash being obtained by incinerating the lubricating oil composition in an air at 950°C; and

the internal combustion engine is a turbocharged gasoline engine.

10. The method according to any one of claims 3 to 9,

the lubricating oil composition further comprising one or more selected from the group consisting of: (B) an ashless dispersant, (C) a phosphorus-containing anti-wear agent, (D) an amine antioxidant, and (E) an oil-soluble organic molybdenum compound.

**11.** A lubricating oil composition for an internal combustion engine, the lubricating oil composition comprising:

a mineral base oil or a synthetic base oil or a mixture thereof, as a lubricant base oil; and

(A) a metallic detergent,

wherein an integrated intensity ratio of peaks of CaO in a X-ray diffraction spectrum of an ash is no more than 16.5%, the ash being obtained by

incinerating the lubricating oil composition in an air at 950°C; and

a molar ratio B/Ca of a boron content B (unit: mol) of the lubricating oil composition derived from the component (A) and a calcium content Ca (unit: mol) of the lubricating oil composition derived from the component (A) is no less than 0.52;

a calcium content in the lubricating oil composition is 0.53 to 1.60 mass% on the basis of the total mass of the composition; and

the lubricating oil composition is used to lubricate at least a cylinder in a premix combustion crosshead diesel engine using a first fuel as a main fuel, wherein the first fuel has a flash point of no more than 15°C.

**12.** A lubricating oil composition for an internal combustion engine, the lubricating oil composition comprising:

a mineral base oil or a synthetic base oil or a mixture thereof, as a lubricant base oil; and

(A) a metallic detergent,

wherein an integrated intensity ratio of peaks of CaO in a X-ray diffraction spectrum of an ash is no more than 16.5%, the ash being obtained by incinerating the lubricating oil composition in an air at 950°C;

a molar ratio B/Ca of a boron content B (unit: mol) of the lubricating oil composition derived from the component (A) and a calcium content Ca (unit: mol) of the lubricating oil composition derived from the component (A) is no less than 0.52;

a calcium content in the lubricating oil composition is 0.45 to 1.20 mass% on the basis of the total mass of the composition;

the lubricating oil composition has a kinematic viscosity at 100°C of 13.0 to 16.3 $mm^2/s$; and

the lubricating oil composition is used to lubricate at least a cylinder in a premix combustion middle-speed trunk piston diesel engine using a first fuel as a main fuel, wherein the first fuel has a flash point of no more than 15°C.

**13.** The lubricating oil composition according to claim 11 or 12,

the component (A) comprising:

(A1) a calcium borate-containing carboxylate detergent, and/or a calcium borate-containing sulfonate detergent.

**14.** The lubricating oil composition according to claim 13,

the component (A) further comprising:

(A2) a calcium carbonate-containing metallic detergent.

15. A lubricating oil composition for an internal combustion engine, the lubricating oil composition comprising:

a mineral base oil or a synthetic base oil or a mixture thereof, as a lubricant base oil; and

(A) a metallic detergent,

the component (A) comprising (A1) a calcium borate-containing carboxylate detergent, and/or a calcium borate-containing sulfonate detergent,

wherein the component (A) does not comprise (A2) a calcium carbonate-containing metallic detergent;

an integrated intensity ratio of peaks of CaO in a X-ray diffraction

spectrum of an ash is no more than 16.5%, the ash being obtained by incinerating the lubricating oil composition in an air at 950°C;

a molar ratio B/Ca of a boron content B (unit: mol) of the lubricating oil composition derived from the component (A) and a calcium content Ca (unit: mol) of the lubricating oil composition derived from the component (A) is no less than 0.52; and

the lubricating oil composition is used to lubricate at least a cylinder in a turbocharged gasoline engine.

**16.** The lubricating oil composition according to any one of claims 11 to 15, further comprising:

one or more selected from the group consisting of: (B) an ashless dispersant, (C) a phosphorus-containing anti-wear agent, (D) an amine antioxidant, and (E) an oil-soluble organic molybdenum compound.