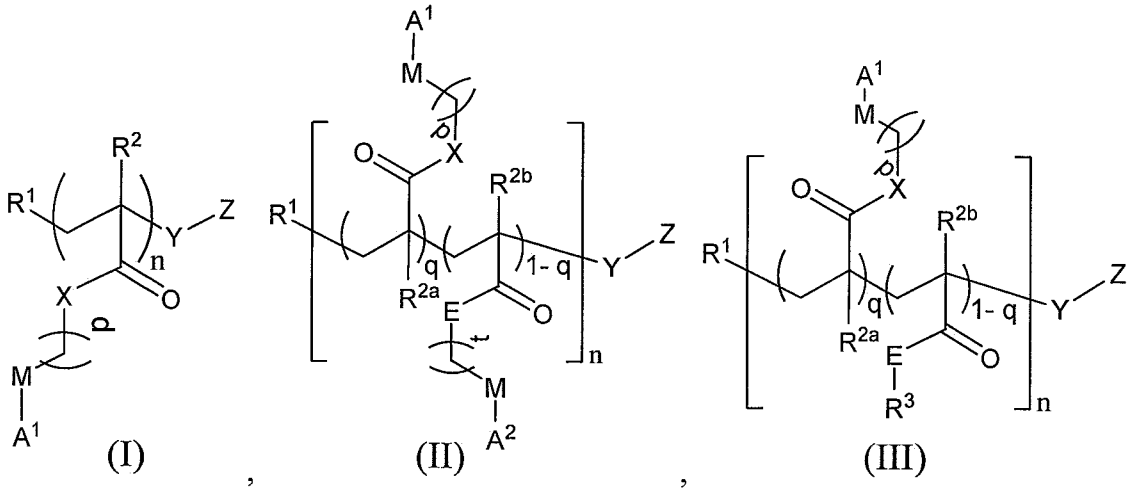
containing TBN boosters that have hitherto been proposed have been known to suffer poor solubility and stability in oil.

Commercial sources of ashless TBN in automotive applications are also primarily derived from dispersants which individually have relatively low BN values (e.g. 14 – 70 mg KOH/g) but which collectively contribute to high level of TBN. However, it is difficult to obtain desirable levels of TBN in this manner whilst also formulating a lubricant at the common viscosity grades (e.g. 0W, 5W, 10W, 20W-20, 30, 40 and 50). For at least these reasons, the use of such TBN boosters in a commercial setting is beset with complications.

There remains a need for alternative ashless TBN boosters which are capable of substantially increasing the TBN of a lubricating composition, thereby minimising the amount of overbased detergents that are required, whilst exhibiting good oil solubility and stability and allowing for the formulation of lubricants at the common viscosity grades.

The present invention is based on the identification of an amine-containing polymer which has properties which make it particularly suitable for use as an ashless TBN booster. Tertiary amine groups on the polymer act as basic groups which are able to neutralise acid and thereby contribute to an increase in the TBN of a lubricant composition in which the polymer is dispersed.

In one aspect, the present disclosure provides a lubricating composition comprising a base oil of lubricating viscosity, one or more lubricant additives and an ashless TBN booster selected from an amine-containing diblock copolymer according to Formula I, II and/or III below:



(I) , (II) , (III)

wherein:

compounds (for example, copper dihydrocarbyl thio- or thio-phosphate, copper salts of a synthetic or natural carboxylic acids, for example a C_8 to C_{18} fatty acid, an unsaturated acid or a branched carboxylic acid, for example basic, neutral or acidic Cu^I and/or Cu^{II} salts derived from alkenyl succinic acids or anhydrides), alkaline earth metal salts of alkylphenolthioesters, suitably containing C_5 to C_{12} alkyl side chains, calcium nonylphenol sulphide, barium *t*-octylphenyl sulphide, dioctylphenylamine, phosphosulphised or sulphurised hydrocarbons, oil soluble phenates, oil soluble sulphurised phenates, calcium dodecylphenol sulphide, phosphosulphurised hydrocarbons, sulphurised hydrocarbons, phosphorus esters, low sulphur peroxide decomposers and the like. The at least one anti-oxidants may be present in the lubricating oil composition in a total amount of up to about 5 % by weight of the lubricating oil composition, for example from about 1 to 3 % by weight of the lubricating oil composition.

In at least some examples, the at least one lubricant additive includes at least one antifoam. Examples of suitable anti-foam agents include silicones, organic polymers, siloxanes (including poly siloxanes and (poly) dimethyl siloxanes, phenyl methyl siloxanes), acrylates and the like. The at least one anti-foaming agents may be present in the lubricating oil composition in a total amount by weight typically of about 10 to about 100 ppm of the lubricating oil composition, for example in a total amount by weight of about 25 to about 75 ppm of the lubricating oil composition

In at least some examples, the at least one lubricant additive includes at least one seal swell agent. Examples of suitable seal swell agents include long chain organic acids, organic phosphates, aromatic esters, aromatic hydrocarbons, esters (for example butylbenzyl phthalate) and polybutenyl succinic anhydride.

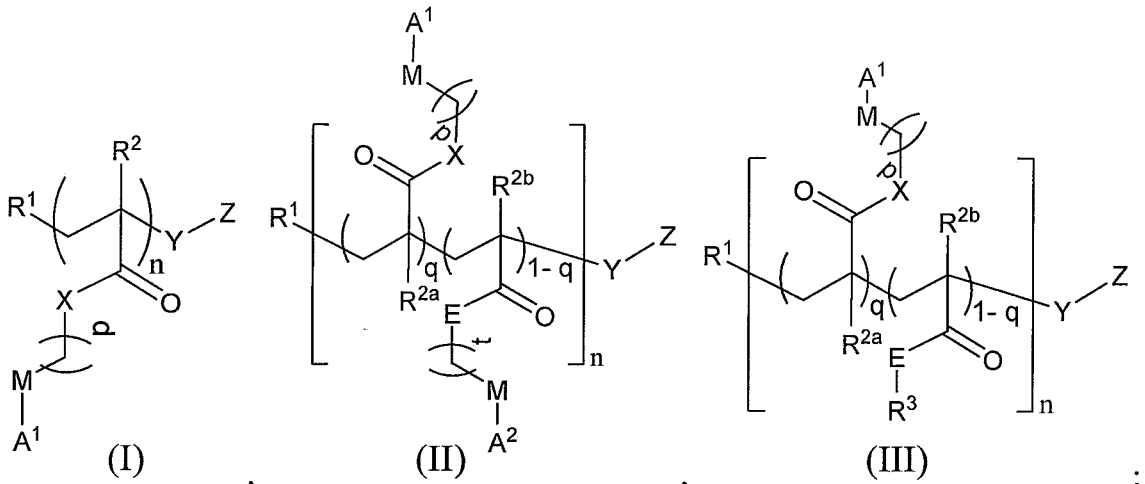
In another aspect, the present disclosure provides a method for lubricating an internal combustion engine, such as two-stroke or four-stroke diesel engines, comprising supplying to said engine a lubricating composition as defined herein.

Suitable internal combustion engines include, for example, engines used in automotive applications, engines used in marine applications and engines used in land-based power generation plants.

In at least some examples, the lubricating composition of the invention is used to lubricate the crankcase of an internal combustion engine at any temperature which is typically encountered in an engine environment, for example a temperature in the range of

ambient to about 250 °C, e.g. about 90 to about 120 °C. Typically, ambient temperature is 20 °C, but according to at least some embodiments, ambient temperature is for example less than 20°C, for example 0°C.

In another aspect, the present disclosure also provides an amine-containing diblock copolymer according to Formula I, II and/or III below:



wherein R^1 to R^3, A^1, A^2, M, E, X, Y, Z, n, t, p and q are as defined hereinbefore.

In a further aspect, the present disclosure provides a use of an amine-containing diblock copolymer according to Formula I, II and/or III as defined hereinbefore for increasing ashless TBN in a lubricating oil composition comprising a base oil of lubricating viscosity and one or more lubricant additives.

Embodiments of the present invention will now be illustrated by way of the following examples and with reference to the following figures:

Figure 1: Graph showing number weighted distribution of hydrodynamic diameter for a diblock copolymer according to Formula I of the invention (DMAEMA Mod) analysed by dynamic light scattering (DLS) in hexane;

Figure 2: Graph of pK_a values for diblock copolymers according to Formula I of the invention (DMAEMA Mod) of various molecular weights (1, 2 and 85 kDa) compared with the corresponding non-end group modified polymers (DMAEMA RAFT).

Figure 3: Graph of pK_a values for diblock copolymers according to Formula I of the invention (DEAEMA Mod) of various molecular weights (1, 2 and 85 kDa) compared with the corresponding non-end group modified polymers (DEAEMA RAFT).