



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/GB99/03101</p> <p>(22) International Filing Date: 5 October 1999 (05.10.99)</p> <p>(30) Priority Data: 9822578.2 16 October 1998 (16.10.98) GB</p> <p>(71) Applicant (for all designated States except US): CASTROL LIMITED [GB/GB]; Burmah Castrol House, Pipers Way, Swindon, Wiltshire SN3 1RE (GB).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): CARLISLE, William, Daniel [GB/GB]; Millstones, Chilton Way, Hungerford, Berkshire RG17 0JR (GB). SNOXELL, Alison [GB/GB]; 22 The Park, Harwell, Oxfordshire OX11 0HB (GB). OGLE, Andrew, David [GB/GB]; 4 Holton Heath, Bracknell, Berkshire RG12 9RX (GB).</p> <p>(74) Agent: LEWIS, Pauline, Therese; Burmah Castrol House, Pipers Way, Swindon, Wiltshire SN3 1RE (GB).</p>		<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> <i>With international search report.</i></p>
<p>(54) Title: AN ENGINE OIL COMPRISING A POLYALKYLENE GLYCOL USED IN A DIRECT INJECTION ENGINE</p>		
<p>(57) Abstract</p> <p>An engine oil comprising less than 5% by mass of polyalkylene glycol. The polyalkylene glycol is used to improve piston cleanliness and ring sticking performance of the engine oil in a direct injection engine. The polyalkylene glycol is also used to improve the performance of an engine oil in a direct injection engine.</p>		

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## **AN ENGINE OIL COMPRISING A POLYALKYLENE GLYCOL USED IN A DIRECT INJECTION ENGINE**

This invention concerns a method for improving the performance of an engine oil. In particular, this invention concerns a method for improving the performance of an engine oil in a TDi engine test such as the Volkswagen TDi test. The abbreviation 'TDi' stands for turbo direct injection.

Examples of direct injection engines can be found in the following passenger cars: VW 1.9TDi, Rover 620 Turbo diesel, and Mitsubishi Charisma GDi.

The Volkswagen TDi test (Standard Test Method: CEC L-78-T-97) is a standard direct injection engine test that is commonly used in the industry for measuring the performance of an engine oil in a direct injection engine. This test is included in the ACEA (Association des Constructeurs Européens d'Automobiles) B4 passenger car diesel oil specification, further details of which can be obtained from the ATIEL (Association Technique de l'Industrie Européenne des Lubrifiants) Code of Practice, available from ATIEL, Madou Plaza, 25th floor, Place Madou 1, B-1030 Brussels, Belgium. The test can be purchased at several European engine test laboratories such as I.S.P. Motorenprüfstände GmbH.

Two of the criteria measured in the Volkswagen TDi test are piston cleanliness and ring sticking. Piston cleanliness and ring sticking are measured in accordance with industry approved rating methods such as CEC M-02-A-78 for ring sticking and DIN 51 361 Part 2 for piston cleanliness.

The VW TDi test first became available in late 1996. It was included in the 1998 update of the ACEA specification to compliment the existing indirect injection diesel test based on the VW 1.6 litre intercooled turbo diesel engine (PV1431 or CEC L-46-T-93). The new test is significantly more severe than the PV1431 test in the areas of increased overall oil temperature (+15°C) and top piston ring zone temperature (+40°C).

Oils developed for the PV1431 test may not be robust enough for the new test. Standard engine oils run in the TDi test often give poor piston cleanliness and severe ring sticking results as they are not designed to protect these parts at these elevated temperatures. Severe ring sticking often leads to increased blow-by rates which in turn leads to increased oil consumption. In some cases almost 100% of the sump fill can be consumed during the test, resulting in complete engine failure.

An oil that is suitable for a direct injection engine will be suitable for an indirect injection engine. The reverse is not always true.

There are well-known methods for improving diesel engine performance in terms of piston cleanliness; however, the need to adhere to other industry specifications often limits the extensive use of these methods. For example, one method is to increase the level of sulphated ash in an oil formulation. However, ACEA and Volkswagen specifications allow only a maximum amount of 1.5% mass sulphated ash in passenger car motor oils.

A further method for improving diesel engine performance is to increase the level of ashless dispersant additive used in the oil. Unfortunately, increasing the level of ashless dispersant additive in the oil can lead to a significant derating of performance in the Volkswagen elastomer test, which is part of the current Volkswagen PCMO (Passenger Car Motor Oil) specifications. Increasing the level of ashless dispersant additive can also lead to poor cold-temperature performance, which will make it more difficult to blend low viscosity oils.

The aim of the present invention is to improve the performance of engine oils used in direct injection engines.

A further aim of the present invention is to improve the performance of an engine oil in the Volkswagen TDi test (CEC L-78-T-97).

In accordance with the present invention there is provided an engine oil comprising less than 5% by mass of polyalkylene glycol.

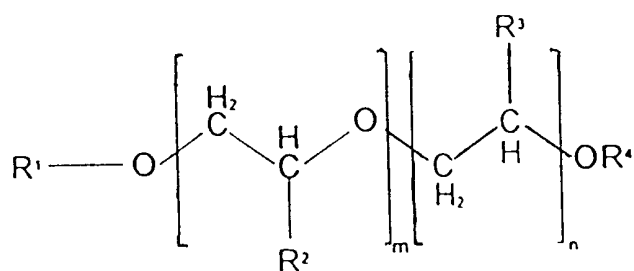
The polyalkylene glycol is preferably used in an amount more than 0.01% by mass.

In accordance with the present invention there is also provided use of a polyalkylene glycol to improve the performance of an engine oil in a direct injection engine.

In accordance with the present invention there is further provided use of a polyalkylene glycol to improve piston cleanliness and ring sticking performance of an engine oil in a direct injection engine.

The polyalkylene glycol is preferably used in an amount less than 3% by mass, more preferably in an amount less than 1% by mass, and most preferably in an amount between 0.1% to 0.5% by mass.

The polyalkylene glycol preferably has the following formula:



wherein:

R<sup>1</sup> is H, alkyl, substituted alkyl, aryl, substituted aryl, alkenyl, substituted alkenyl alkylaryl or substituted alkylaryl;

R<sup>2</sup> is H, alkyl, substituted alkyl, aryl, substituted aryl, alkenyl, substituted alkenyl alkylaryl or substituted alkylaryl;

R<sup>3</sup> is H, alkyl, substituted alkyl, aryl, substituted aryl, alkenyl, substituted alkenyl alkylaryl or substituted alkylaryl

R<sup>4</sup> is H, alkyl, substituted alkyl, aryl, substituted aryl, alkenyl, substituted alkenyl alkylaryl or substituted alkylaryl;

m is an integer from 1-30; and

n is an integer from 1-30.

In the formula given above, R<sup>1</sup> is preferably alkyl or alkylaryl; R<sup>2</sup> is preferably alkyl; R<sup>3</sup> is preferably alkyl; and R<sup>4</sup> is preferably H.

In the formula given above, R<sup>1</sup> is preferably alkylaryl; R<sup>2</sup> is preferably methyl; R<sup>3</sup> is preferably methyl; and R<sup>4</sup> is preferably H.

Polyalkylene glycol having the above formula can also be known as polyether.

The engine oil may also include the following additives: detergents, dispersants, viscosity modifiers, zinc dithiophosphates, rust inhibitors, anti-foaming agents, pour point depressants, and antioxidants.

The invention will now be described with reference to the following example:

#### Comparative Example 1

A fully synthetic, high performance engine oil was measured for its piston merit, average ring stick and maximum ring stick in accordance with (CEC L-78-T-97). The results are given in the table below.

### Example 1

1% by weight of an alkyl propoxylate, available from Shell Chemicals under the name SAP949, was added to the engine oil used in comparative example 1. The engine oil was measured for its piston merit, average ring stick and maximum ring stick in accordance with (CEC L-78-T-97). The results are given in the table below.

### Example 2

0.5% by weight of a polyalkylene glycol, available from BP Chemicals under the name ADX750, was added to the engine oil used in comparative example 1. The engine oil was measured for its piston merit, average ring stick and maximum ring stick in accordance with (CEC L-78-T-97). The results are given in the table below.

### Example 3

1.0% by weight of a polyalkylene glycol, available from BP Chemicals under the name ADX750, was added to the engine oil used in comparative example 1. The engine oil was measured for its piston merit, average ring stick and maximum ring stick in accordance with (CEC L-78-T-97). The results are given in the table below.

### Results

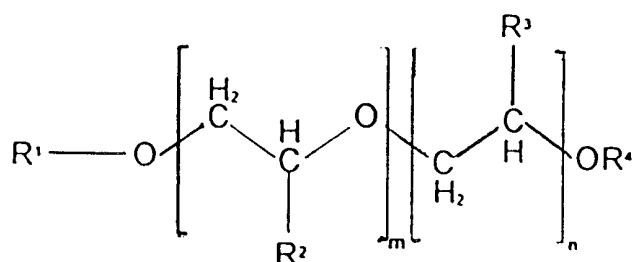
<b>Example</b>	<b>Top-treat</b>	<b>Piston Merit B4: <math>\geq</math> 65</b>	<b>Average Ring Stick B4: <math>\leq</math> 0.7</b>	<b>Maximum Ring Stick B4: <math>\leq</math> 2.5</b>
Comparative Example 1	-	59.4	2	10
Example 1	1% SAP 949	65	0.7	2.5
Example 2	0.5% ADX750	66	0	0
Example 3	1.0% ADX750	67	0	0

The results show that the addition of polyalkylene glycol to an engine oil can improve its piston merit, average ring stick and maximum ring stick.



Claims

1. An engine oil comprising less than 5% by mass of polyalkylene glycol.
2. The engine oil claimed in claim 1, wherein the polyalkylene glycol is present in an amount less than 3% by mass, preferably less than 1% by mass, preferably more than 0.01% by mass, and most preferably between 0.1% and 0.5% by mass.
3. The engine oil claimed in claim 1, wherein the polyalkylene glycol has the following formula:



wherein:

R<sup>1</sup> is H, alkyl, substituted alkyl, aryl, substituted aryl, alkenyl, substituted alkenyl alkylaryl or substituted alkylaryl;

R<sup>2</sup> is H, alkyl, substituted alkyl, aryl, substituted aryl, alkenyl, substituted alkenyl alkylaryl or substituted alkylaryl;

R<sup>3</sup> is H, alkyl, substituted alkyl, aryl, substituted aryl, alkenyl, substituted alkenyl alkylaryl or substituted alkylaryl

R<sup>4</sup> is H, alkyl, substituted alkyl, aryl, substituted aryl, alkenyl, substituted alkenyl alkylaryl or substituted alkylaryl;

m is an integer from 1-30; and

n is an integer from 1-30.

4. Use of the polyalkylene glycol defined in any one of claims 1-3, to improve the performance of an engine oil in a direct injection engine.

5. Use of the polyalkylene glycol defined in any one of claims 1-3, to improve piston cleanliness and ring sticking performance of an engine oil in a direct injection engine.
  
6. A method for improving the performance of an engine oil in a direct injection engine, the method comprising the step of adding the polyalkylene glycol defined in any one of claims 1-3 to the engine oil.
  
7. A method for improving piston cleanliness and ring sticking performance of an engine oil in a direct injection engine, the method comprising the step of adding the polyalkylene glycol defined in any one of claims 1-3 to the engine oil.

# INTERNATIONAL SEARCH REPORT

Internat. Application No

PCT/GB 99/03101

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 C10M145/26 C10M145/36 //C10N30:04,C10N40:25

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C10M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 780 229 A (MULLIN GERALYN) 25 October 1988 (1988-10-25) column 1, line 37 - line 44 column 5; table 1 column 6; table 4 column 7, line 31 - line 39 ---	1-7
X	US 5 498 355 A (PEROZZI EDMUND F ET AL) 12 March 1996 (1996-03-12) column 4, line 15 - line 36 column 25, line 15 - column 26, line 13; examples 1-4, 15, 18 ---	1-7
X	US 4 493 776 A (RHODES ROBERT B) 15 January 1985 (1985-01-15) column 2, line 25 - line 40 column 4, line 3 - line 13 ---	1-3
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Patent family members are listed in annex.

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Date of the actual completion of the international search

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Date of mailing of the international search report

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication where appropriate, of the relevant passages	Relevant to claim No.
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