LUBE-TECH

NO.13

ACEA SPECIFICATION SYSTEM FOR ENGINE OILS

Summary of ACEA system

In the previous issue of 'LUBE' (Issue 39), the Lubetech article briefly described specification systems for automotive engine oils, and why it is important for the motorist to be able to identify the lubricant requirements for his or her particular vehicle.

Two main performance specification systems were described, the American API (American Petroleum Institute) system and the European ACEA (Association des Constructeurs Européenne d'Automobile) system. One may well ask, with the increasing 'globalisation' of world trade, why is it necessary to have two separate specification systems?

The answer lies in the differences in vehicle design and usage patterns between America and Europe. In the US cars are generally powered by large engines operating under far lower stress levels than their European counterparts. Due to the low price of fuel in the US, fuel economy has not been an issue, until more recently. Also, the passenger car light-duty diesel engined vehicle is virtually non-existent in the US, but extremely common in Europe.

The lubricant requirements of the hotter-running, higher-revving, more fuel-efficient European engines were significantly different to those of the US vehicles to warrant the development of a series of lubricants tailored specifically to European requirements.

Such a need for was recognised many years ago by the organisation CCMC (Comité des Constructeurs d'Automobiles du Marche Commun), which was comprised only of European car manufacturers and therefore excluded non-European manufacturers. With the high proportion of imported cars into Europe, this was clearly not a satisfactory state of affairs, and the situation was rectified in 1991 with the formation of ACEA.

However, even though the CCMC requirements became obsolete many years ago, some suppliers of engine oils are still claiming performance requirements to CCMC levels on their container markings, in addition to the current ACEA and API categorisation systems

BASIC REQUIREMENTS

The ACEA sequences of engine test requirements were first published late in 1995 and formally replaced the existing CCMC sequences from 1 January 1996. A set of nine engine test sequences were described covering

- gasoline engine oils;
- light duty diesel engine oils;
- heavy duty diesel engine oils.

To ensure that manufacturers of lubricants conformed to the requirements specified by these engine test sequences, a European engine lubricants quality management system (EELQMS) was developed by ATIEL (Association Technique de l'Industrie Europe en des Lubrifiants) and ATC (Technical Committee of Petroleum Additive Manufacturers). The requirements were embodied in two Codes of Practice, one by ATC which specified engine tests, procedures and record keeping, and the other, by ATIEL, which provided a technical framework within which automotive lubricants were to be developed and marketed. A significant requirement in this Code was the need for all elements to be incorporated into a recognised quality management system such as ISO 9000 thus enabling conformance to requirements to be assessed by external accreditation bodies such as the British Standards Institution in the UK. This in effect relieves ACEA of the need to "police" conformance by aftermarket auditing.

The gasoline sequences were:

- AI:96 for engines designed to use low friction oils with high temperature/high shear values down to 2.9mPas. These oils could be unsuitable for use in some engines.
- A2:96 conventional oils for mainstream use - essentially an update of the old CCMC G4. Again, these oils could be unsuitable for use in some high performance engines.
- A3:96 for high performance engines and/or long drain intervals. These oils could be used where the old CCMC G4 or G5 were previously specified.

The light duty diesel sequences were:

- B1:96 for use in passenger car or light van diesel engines designed to use low friction oils with high temperature/high shear values down to 2.9mPas. These oils could be unsuitable for use in some engines.
- B2:96 for use in most passenger car or light van diesel engines although these oils were not necessarily suitable for use in some high performance engines. They could be used where oils to the old CCMC PD2 quality were previously specified.
- B3:96 for high performance passenger car diesel engines and/or long drain intervals. They could be used where oils to the old CCMC PD2 quality were previously specified.

The heavy duty diesel sequences were:

- El:96 for use in heavy duty diesel engines. They could be used where oils to the old CCMC D4 quality were previously specified.
- E2:96 oils of super high performance diesel (SHPD) qualities intended for more severe use in heavy duty diesel engines including extended drain intervals and in turbocharged engines.
- E3:96 oils of super high performance diesel (SHPD) qualities intended for the most severe use in heavy duty diesel

(Continued on Page II)

(Continued from Page I)

engines including extended drain intervals and in turbocharged engines. They could be used where oils to the old CCMC D5 quality were previously specified.

Following lengthy consultations between the vehicle manufacturers (represented by ACEA), the lubricants industry (represented by ATIEL) and the additive manufacturers (represented by ATC), these sequences have since been upgraded to reflect current trends in engine development; these revised versions first coming into effect on 1 March 1998. They included both increased severity in certain of the existing tests and also the updating of certain technical requirements but with no change in the severity, e.g. the replacement of the OM 364A engine test, designed to evaluate bore polish and piston deposits, with the OM 364LA. The changes reflected the move towards longer drain intervals, higher overall performance, better emissions and fuel economy.

The gasoline sequences became:

Al:98- severity increased in Sequence IIIE and Peugeot TU3 high temperature tests. In addition, the Ml11E fuel-economy test had been added, which uses a four-cylinder, 2.0 litre, 16 valve engine equipped with electronic multiport fuel injection to measure fuel economy against an SAE 15W/40 reference oil.

- A2:96 Issue 2-no change in severity.
- A3:98 - severity increased in the Peugeot TU3 high temperature test.

The light duty diesel sequences became:

- B1:98-additional parameters were added to the OM 602A test, also the M111E fuel-economy test was added.
- B2:98 - additional parameters added to the OM 602A test.
- B3:98 - additional parameters added to the OM 602A test.
- B4:98 - new category. This sequence was added to cater for oils used in direct injection diesel engines with a special lubricant requirement. A new engine test used a four-cylinder 1.9 litre direct-injection) turbocharged, intercooled VW diesel engine) and assessed piston deposits and ring sticking. The inclusion of this test reflected the anticipated increase in importance and relative proportion of passenger car direct injection diesel engines.

In addition, the Peugeot XUD 11BTE engine, with electronically-controlled injection and new pistons and rings) replaced the XUD 11ATE engine in all of these categories once the new engine test had received "T" status.

The heavy duty diesel sequences became:

- El :96 Issue 2 - largely unchanged apart from the use of new reference oils.
- E2:96 Issue 2- largely unchanged apart from the use of new reference oils.
- E3:96 Issue 2- largely unchanged apart from the use of new reference oils.
- E4:98 - new category. This sequence used a six-cylinder, 10.9 litre, Euro II, direct-injection diesel engine (OM441LA) to evaluate bore polish and piston deposits after a period of 400 hours.

A further change introduced for 1998 was the concept of "fit-for-purpose" limits (FFPLS). These limits, determined on a statistical evaluation of reference test oils and subjected to regular review, were introduced in the cases of certain tests which did not currently conform to CEC "T" status requirements. Alternatively, test acceptance could be obtained by written approval from appropriate engine manufacturers for each specific product/formulation.

E5-99 - new category introduced in September 1999. This category included a turbocharger deposit test and a bench oxidation test. At the same time the tests and limits of the E2 and E3 categories were re-evaluated.

SUMMARY

In spite of some moves towards a "Europeanisation" of the typical US automobile, there is still a sufficient difference between the US and European markets in both vehicle design and usage patterns to warrant differences in crankcase lubricant formulation requirements. The concept of the "global"' vehicle manufacturer together with the need for corresponding "global" lubricants is still some way from reaching reality. There is therefore a continuing need for crankcase lubricants to be tailored to these two individual markets, and the API and ACEA sequence requirements reflect these differences. However, the two organisations have adopted completely different approaches in addressing the not inconsiderable problem of compliance enforcement, with API opting for a "quality control" approach, using aftermarket auditing, and ACEA opting for the more upstream "quality assurance" approach, and making use of external auditors to monitor conformance to requirements.

The ACEA classification system is less straightforward for the user to interpret than the US API system since alphabetical progression does not necessarily imply a move to higher 'quality', also the year of introduction needs to be taken into account in addition to the performance level specified.

The consumer is advised to consult the vehicle handbook for the correct grade of oil for the vehicle, and to use the most recent version as denoted by the year of introduction, since successive introductions indicate a move towards higher quality levels. The vast majority of engine oils now available, certainly from reputable manufacturers, will refer to an ACEA specification on the package marking, to which that particular oil conforms. Any product which does not claim any ACEA specification is most unlikely to afford the degree of oil performance and engine protection which is to be expected from a product purporting to be a motor oil.

David Margaroni

PETROLEUM WAXES

Waxes derived from crude oils are mainly obtained from 'paraffinic' type crude oils, and consist mainly of straight-chain, branched chain, and cyclic paraffins, or alkanes, with carbon numbers ranging from C12 to C85.

Although generally regarded as undesirable in the major petroleum products, i.e. fuels and lubricants, waxes have found many uses in areas such as wire cable protection and lubrication, cosmetics, food additives, candle making, chipboard manufacture, cosmetics, crayons, polishes, hot melts, cheese and fruit coatings, general lubrication, paper and board printing inks, telephone cable fillers, electrical power cables, flexible packaging materials, textiles, lost wax casting, etc.

Waxes are extracted from crude oil fractions during the refining process, typically by chilling a solution of the waxy oil in a suitable solvent, such as methyl ethyl ketone and toluene, whereupon the waxy concentrate separates out and may be filtered off. The wax concentrate at this stage is referred to as Slack Wax, and may contain from 2 to 30% of residual oil.

Slack Waxes may be used directly in other products without further modification, or they can be further treated to produce a range of Refined Waxes.

Residual oil is removed, and the purified wax may then be subjected to hydrofinishing (treatment with hydrogen under elevated pressure and temperature and in the presence of a suitable catalyst) or clay treatment (absorption of residual impurities by passing through a bed of activated clay).

REFINED WAXES

These fall into a number of categories, as described below:

Paraffinic Waxes have average molecular weights usually less than 450. They have a well-defined macrocrystalline structure of large needles or plates, with a melting point in the range of 43°C to 68°C, typically around 55°C. They have a translucent white to yellow colour and consist mainly of isoalkanes, cycloalkanes, with a very low concentration of alkylated aromatic hydrocarbons.

Microcrystalline Waxes have higher molecular weights than paraffinic waxes and consist of substantial amounts of iso- and cycloalkanes usually with a lesser amount of normal alkanes and trace amounts of alkylated aromatic hydrocarbons.

Intermediate Waxes or Semi-Microcrystalline Waxes have properties intermediate between the two basic refined types.

Petrolata are semi-solid petroleum waxes containing substantial amounts of oil, normally above 10%, and are either slack waxes obtained during the initial solvent dewaxing process described earlier, or blends of slack wax with base oils or base oil extracts formulated to specific requirements. Blends of highly purified waxes and white mineral oils are commonly known in pharmacists as petroleum jelly.

The uses of waxes in food and cosmetic applications have already been referred to, and the health and toxicity aspects of petroleum waxes have accordingly been the subjects of a number of studies.

GENERAL TOXICITY

The EU Scientific Committee for Food (SCF) and the WHO Joint Expert Committee on Food Additives (JECFA), having assessed the suitability of waxes for use as food additives and food contact materials, have set Acceptable Daily Intakes (ADIs) for food grade waxes as follows:

SCF

0-20 mg/kg bodyweight for waxes of not less than 11 centistokes at 100°C, of carbon number not less than 25 at the 5% boiling point and an average molecularweight of not less than 500

JEFCA

0-20 mg/kg bodyweight for microcrystalline waxes.

Also an Occupational Exposure Limit for paraffin wax fume has been established in the UK by the HSE as:

2 mg/m^3 8 hour time weighted average

6 mg/m^3 15 minute short term exposure limit.

ACUTE TOXICITY

Although there are no published data on the acute toxicity of slack waxes, a number of studies involving paraffinic and microcrystalline waxes have shown them to have a low order of both acute and of dermal toxicities, e.g. typically above 5000 mg/kg for rat oral toxicities.

IRRITATION AND SENSITISATION

Published data confirms that paraffin and microcrystalline waxes are at the most only slightly irritating to both skin and eyes. There are no equivalent data for slack waxes.

SUB-ACUTE/ SUB CHRONIC TOXICITIES

No adverse effects were observed in one skin exposure study involving paraffin wax, although no studies have been performed on slack wax, petrolata or other refined waxes. There are no reports

PHYSICO-CHEMICAL PROPERTIES OF WAXES AND PETROLATA.

	Melting Point °C	Kinematic Viscosity at 100°C (mm2/sec)	Oil Content (%mass)	Carbon Number Range	Penetration (25°C)
	ASTM D127	ASTM D445	ASTM D721 or D3235	ASTM D2502	ASTM D1321 or D937
Slack Waxes/ Petrolata	43-63	3-30	2-30	12-85	9-80
Paraffin Waxes	43-68	3-6	<1.5	18-60	9-50
Microcrystalline Waxes	60-95	10-30	<5	23-85	3-60
Intermediate Waxes	64-74	6-10	<2.5	22-75	12-30
Petrolata	36-60	3-30	>10	12-85	>60

of sub-acute or sub-chronic oral studies on slack wax or petrolata.

The results of a number of 90-day feeding trials conducted some years ago were inconclusive, but some were of sufficient concern, however, to prompt MAFF into proposing a ban on the use of mineral hydrocarbons in food although this was never actually implemented. Studies conducted since have not satisfactorily explained differences in strain sensitivity between rat species, and why certain waxes caused some effects under the protocol conditions, whereas others did not. Neither is there any evidence to show that these effects are relevant to man.

CHRONIC TOXICITY/CARCINOGENICITY

An early study (1951) involving skin contact studies of slack wax showed evidence of weak carcinogenic activity, although this effect was subsequently attributed to the aromatic oil content of the wax, and not to the wax itself.

Later skin contact studies with a series of refined waxes and petrolata produced some irritancy, but no evidence of a treatment-related increase in tumours. Neither were there any treatment-related changes following oral feeding studies involving refined wax and petrolata. No such studies have been performed on slack wax.

Tumours resulting from the subcutaneous implantation of wax disks (but not from the implantation of powdered wax) were judged to be related to the physical form of the implant rather than to inherent tumorigenicity.

Data obtained on petrolata yielded broadly similar results.

No data are available on genotoxicity or on reproductive toxicity.

HEALTH ASPECTS

As would be expected following the widespread uses of waxes in a number of medicines and cosmetics for many years, studies have confirmed that these types of products are without significant effect on humans.

HANDLING ADVICE

Waxes and related products should be handled according to good industrial hygiene practices. High standards of personal hygiene and plant cleanliness should be maintained at all times

The following is recommended:

- Individuals handling or using waxes or petrolata should be advised of the hazards and the proper handling instructions especially where the waxes may be handled at high temperatures in the molten state.
- Contact with hot wax may cause burns and skin contact with molten wax should therefore be avoided. Hands should be washed thoroughly after contact with wax.
- Prolonged or repeated skin contact with either fresh or used product should be avoided.
- Avoid contact with the eyes. If splashing of hot, molten material is likely to occur a full-face visor or chemical goggles as appropriate should be worn.
- Clothes should be laundered regularly; soiled clothes should be removed after use and laundered.
- Disposable cloths should be used and they should be discarded after use. Soiled cloths should never be put into pockets.
- Rags and paper or other materials that have been used to absorb spillages represent a fire hazard and should not be allowed to accumulate. They should be disposed of safely immediately after use.

  Stored product should not be allowed to overheat.
- Protect drains from spills and prevent entry of hot molten material, since this may result in blockage on cooling. If this should happen, notify the appropriate authority immediately.

  Clean up spillages promptly as these may make surfaces slippery.

EMERGENCY TREATMENT

During normal handling and use, waxes and petrolata are unlikely to cause any harmful effects. However, in the event that over-exposure has occurred the following measures are recommended.

EYES

Cold wax:

Wash eye thoroughly with copious amounts of water, ensuring that the eyelids are held open. Obtain medical advice if any pain or redness develops or persists.

Hot wax:

Flood with water to dissipate heat. In the event of any material remaining, do not try to remove it other than by continued irrigation with water.

OBTAIN MEDICAL ATTENTION IMMEDIATELY.

SKIN

Cold wax:

Wash contaminated skin with soap and water.

Remove contaminated clothing and wash underlying skin as soon as reasonably practical.

Hot wax:

Flood the skin with cold water to dissipate heat, cover with clean cotton or gauze, obtain medical advice.

INGESTION

If contamination of the mouth occurs, wash out thoroughly with water.

Except as a deliberate act, the ingestion of large amounts of wax or petrolatum is unlikely. If it should occur, do not Induce vomiting, obtain medical advice.

INHALATION

If inhalation of fumes from overheated wax or petrolatum causes irritation of the nose or throat, or coughing, remove the patient to the fresh air.

Obtain medical advice if symptoms persist.

DISPOSAL

The need to dispose of large quantities of wax or petrolatum should seldom arise. However, in the event that it should be necessary, it is preferable to arrange for the product to be recycled. Disposal should be accomplished through an authorised person/licensed waste disposal contractor in accordance with local regulations.

Incineration of product may be carried out under controlled conditions, provided that local regulations for emissions are met.

In the event of a spill of molten wax, care should be taken to prevent the spilled material from entering drains or ditches.

The bulk of spilled solid material should be scraped up and any liquid should be removed using sand or other suitable absorbent material. If necessary, clean the contaminated area using hot water and detergent, absorb the washings - do not wash them into drains.

General advice on how to handle waste or spilled material can be obtained from previously published CONCAWE reports (CONCAWE, 1980; 1981; 1983; 1988).

Acknowledgement

Material for this article was derived from the recently published CONCAWE Product Dossier no. 99/110 Petroleum Waxes and Related Products.

Those wishing to obtain more information on the subject are advised to obtain a copy of the Dossier from CONCAWE, Madouplein 1, 1210 Brussel, BELGIUM.

Tel : +32 2 220 31 11. Fax : +32 2 219 46 46.

David Margaroni