LUBETECH

NO.4

Static Diesel Engine Development

London Branch held a technical visit to Allen Diesels at Bedford on the 18th September and included as part of the proceedings the BLF London Branch AGM. All who attended were extremely impressed by the range of products, which included digitally controlled fuel injected massive static diesel engines, gas turbines units and various other engines. The overall level of technical development and quality achievement was very impressive.

We were met by Dr G.H. Youdan, Product Technology Manager of Allen Diesels, one of the five business units, which form Allen Power Engineering Ltd, a trading company within Rolls Royce Industrial, and Marine Power Group. Dr Youdan acted as our guide for the tour of the manufacturing facility. The BLF party was made very welcome and the visit began with a presentation to ensure that everyone was up to speed on the various technical developments that Allen Diesels had incorporated into their products.

Allen Diesels shared with us some of the major innovations they had incorporated into their designs. These included very high strength cast iron, computer aided design for casting mould production and the associated feed rates for molten metal used, plus the use of electronic management systems/controls for the power units. The improvements incorporated into manufacturing process have facilitated reduced lead times for new products and the production of castings, which are many times stronger than conventionally cast components. Electronic management of fuel metering, injection and boost controls have improved output and new designs to pistons and crankshafts have increased reliability.

We saw assembly and construction of many of the different ranges of Allen engines, including versions used as pipeline engines and electric power generating units. We saw examples of the Allen 3000 & 4000 series with its massive V12 & V16 units with power output up to 5Mwe (7000+ bhp). Both these types of engines have some common features. These include, high efficiency turbochargers tailored to suit requirements and latest generation piston rings faced with ceramic/chrome materials, for lower wear rates and low lubricating oil consumption and remote monitoring and special instrumentation options.

The 4000 Series range of engines are moderately rated with an engine speed of 720 - 750 r/min, Mean Piston Speed of 9.25 m/s at 750 r/min and a B.M.E.P. of 17.2 bar. These are low mechanical and thermal stressed units and have a reputation for reliability, making them ideal for strategic installations around the world for the provision of base load and critical standby power.

The 4000 Series features include: -

Conventional bedplate and crank design for robustness and reliability.

Flat deck cylinder block design in superior vermicular spherodial iron for greater strength.

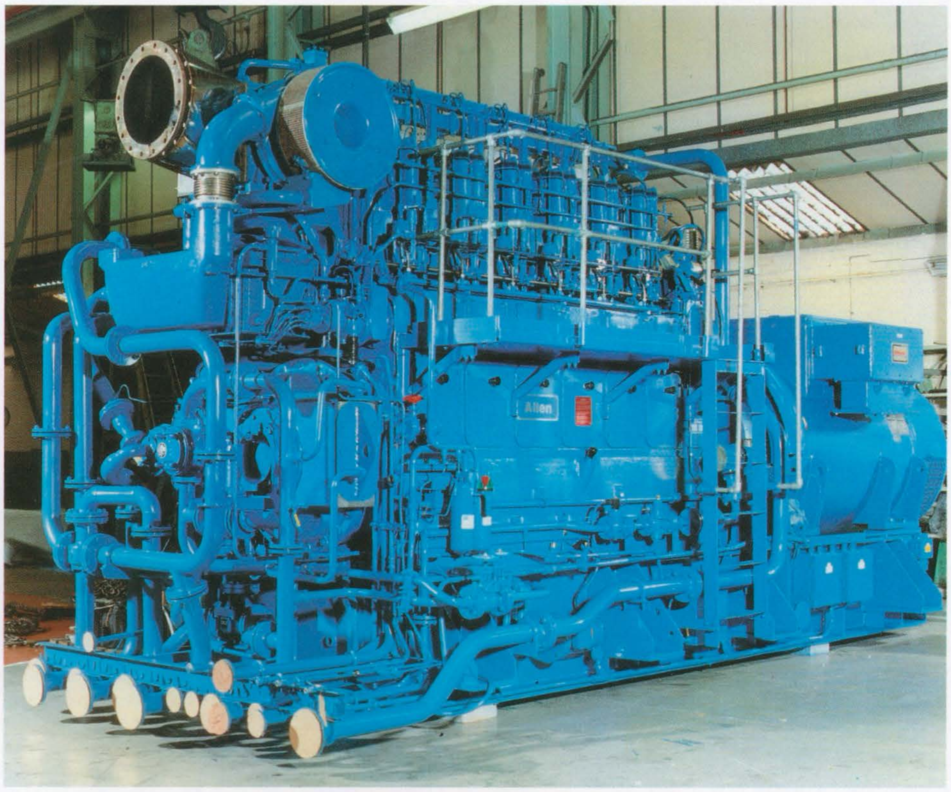
Two stage inter-cooling to improve efficiency, whilst maximising heat recovery for CHP systems.

High-grade SG iron single piece pistons crankcase in high strength spheroidal iron for heavy-duty reliability.

Technically advanced composite S.G.iron pistons with steel crowns, for reliable operations at high pressures.

Individual unit injectors providing high fuel injection pressures and good combustion characteristics, resulting in excellent fuel economy.

Low parts count for simplified maintenance with long overhaul periods.



Allen 2000 Series for Thames Water sewage works.

(oil cooled), for reliable operation on heavy grade fuels.

Whereas, the 3000 Series sets new standards for modern medium speed diesels engines with its advanced power to weight and power to space ratios. It is one of the most advanced, compact and powerful engines of its type in the world. It has an engine speed of 720 - 1000 r/min, Mean Piston Speed of 10.0 m/s at 1000 r/min and a B.M.E.P. of 23 bar. It is one of the most cost-effective ranges of engines available as it has low capital cost, excellent fuel economy and long periods between overhauls.

The 3000 Series features include: -

Under slung die-forged crank with

There were many of our members' lubrication products evident around the works both metalworking fluids and diesel engine oils. It was good to see our industry's technology was helping Allen Diesels manufacture their products and especially helping towards creating new export opportunities and aiding in the design of new engines. I have no doubt we shall want to re-visit Allen Diesels very soon.

Rod Parker

LUBE-TECH

ENGINE COOLING CONCENTRATE..

In common with automotive lubricants, antifreeze formulations have been subjected to a progressive development in order to meet the changing requirements in terms of operation conditions and materials of construction. Higher engine temperatures resulting from higher specific power outputs and the use of turbochargers, improved aerodynamics resulting in lower radiator aperture areas, widespread use of aluminium alloys, longer service intervals, environmental controls which ban the use of certain ingredients, have all increased the stress on the coolant. All of these conditions and restrictions are familiar to formulators of crankcase oils.

Antifreeze formulations were originally based upon alcohols such as methanol and ethanol, and these are in fact still used in certain regions of the world, and in some low price formulations. The main problems associated with the use of alcohols are excessive volatility and toxicity.

The market generally moved to adopt ethylene glycol as the main ingredient, which, although more expensive, was less toxic and less volatile.

The very much more expensive propylene glycol is now being increasingly used, as this has a number of advantages over ethylene glycol, being even less toxic and less volatile.

Apart from the fluid base, however, the main distinguishing features between antifreezes are the corrosion inhibitors. A typical antifreeze formulation would be:

Glycols (Monoethylene or Monopropylene glycol)	93-96%
Inhibitors	2-5%
Water	1-2%
Antifoam/Dye	0.01%

(The presence of a small amount of water helps to solubilise the inhibitors and prevents freezing of the concentrate during very cold storage)

Antifreeze formulations are expected to provide much more than to merely prevent the coolant from Freezing. They must primarily:

Depress the freezing point of the coolant by the required amount.

As temperature is decreased, liquids undergo either one of two distinct behaviours; true freezing where the liquid crystallises, or supercooling, where the viscosity of the liquid increases to such an extent that it will not flow. At higher concentrations of glycols, e.g. over 35% in the case of propylene glycol, such solutions exhibit only supercooling behaviour and are therefore safe from burst damage. At lower concentrations, crystallisation can occur, and, since the solution then expands, burst damage can occur. The problem is most likely to occur when a vehicle is first used on a cold morning, i.e. when the thermostat is still closed, the engine not having achieved operating temperature. The cold air passing through the radiator will rapidly chill the coolant, resulting in crystallisation and possible rupture of the radiator elements if the concentration of glycol is too low.

They must also:

Inhibit corrosion of or not degrade any material likely to come into contact with the antifreeze, including steel, copper, aluminium alloys, solder, cast iron, brass, plastics, rubber, etc.

All coolants will dissolve metals to some extent, the rate of attack will depend upon a number of factors, including the composition of the make-up water, the composition of the base fluid used, and the composition of the corrosion inhibitor package. Early corrosion inhibitors packages contained e.g. triethanolamine phosphate, sodium nitrite and sodium benzoate, but more recent formulations can include sodium metasilicate, sodium nitrate, disodium tetraborate and copper and brass passivators such as benzotriazole or tolyltriazole, sodium and ammonium molybdate, and, more recently sodium salts of dicarboxylic acids.

Inhibit cavitation.

Cavitation at high coolant pump speeds can seriously impede proper circulation of the coolant, and to such an extent that the engine can overheat due to lack of coolant flow. (Older readers may recall the disastrous failure of the works Jaguars at Le Mans in the 1950's when all three retired with overheating problems caused by pump cavitation, when they had previously been expected to win). Erosion of the impeller blades can still occur even if the effects of cavitation are not sufficient to interfere with the coolant flow. The physical characteristics of the coolant must be such so as to inhibit the formation of bubbles at the surface of the pump impeller blades, which is the primary cause of cavitation.

Have good heat transfer.

Good heat transfer is essential in any cooling agent. The factors affecting heat transfer in a coolant include thermal conductivity, and to a lesser extent, boiling point, vapour pressure, density, viscosity, thermal expansion coefficient, and specific heat.

Thermal conductivity is the measure of heat transport through a material. The thermal conductivities of glycols decrease with increasing temperature, whereas that for water follows a bell-shaped curve reaching a maximum at 126.7 degree C. In practice, the two factors approximately cancel out. In the case of, e.g. propylene glycol solutions of 50% in water, the thermal conductivity is almost unchanged over the range 0 to 120 degree C.

Unlike the alcohols, the glycols have lower vapour pressures than water, and do not therefore vaporise as readily. Cooling systems are normally sealed, and are pressurised to operate at between 7 and 18 psig in order to raise the boiling point of the coolant.

A 50% propylene glycol solution boils at 106 degree C at atmospheric pressure, and at 125 degree C at 15 psig.

However, since the specific heat of water is higher than any of the alcohols or glycols, the use of antifreeze coolants reduces the capacity of the coolant to transfer heat.

A measure which is often used in heat transfer calculations is the Prandtl Number (Npr), which may be expressed as

Npr = Specific Heat of Fluid * Fluid Viscosity/Fluid Density

Since the Prandtl Number is dimensionless, it is important to use the proper units when calculating its value.

Be compatible with rubber and paintwork.

Many problems have arisen in the past when motorists have misguidedly used antifreezes intended for engine coolants as screenwash. Damage to paintwork and to the windscreen seals occurred as a result.

Although more recent antifreezes are far kinder to rubber and paintwork, it is still not regarded as acceptable practice.

Have low toxicity

Accidental deaths from imbibing antifreeze solutions do still tragically occur among children, in fact it is considered that drinking antifreeze solutions is the most common cause of poisoning of domestic animals, one spoonful being sufficient to kill a cat. Ethylene glycol solutions are particularly hazardous, since they are toxic yet are quite sweet to the taste. Some formulations contain an additive 'Bitrex,' which imparts such a degree of bitterness to the solution that it is impossible to drink.

Be non-flammable

Early antifreeze solutions containing high proportions of alcohols were

'ANTIFREEZE'

flammable, and could constitute a hazard. Those containing glycols are much less hazardous in this respect.

Be stable.

The coolant must be chemically and physically stable over time. Corrosion inhibitors lose effectiveness with age since the alkaline nature of the coolant becomes progressively neutralised by acids resulting from attack of the metals. When the alkaline buffer is exhausted, attack on

the metals becomes much more rapid up to the point where corrosion at the weak points begins causing damage. Tests for antifreeze strength to monitor antifreeze performance do not measure the degree of residual anti-corrosion performance, therefore it is common practice to recommend changing ethylene glycol based products every two years and propylene glycol based products every four years. Dye indicators are also invariably added which change colour at certain pH levels and can provide a visual indication of when the reserve alkalinity has reached lower levels than desirable. Over the last few years, coolants are being used in the initial fill of new cars, which are reputed to last the life of the vehicle. Although undoubtedly superior in performance to the traditional formulations, the introduction of these new practices, the main object being to reduce servicing and running costs are not always in the interests of obtaining optimum vehicle life.

Be non-foaming

The development of foam in the coolant reduces the density and the specific heat of the coolant, therefore reducing its ability to conduct heat. In extreme cases, this can result in excessive loss of coolant, overheating and possible engine damage.

Antifreeze Standards

The British Standards Institution originally produced three standards to cover the majority of applications.

These were:

BS 3150 - recommended for light alloy construction engines

BS 3151 - recommended for other engines except aircraft

BS 3512 - recommended for engines of ferrous construction

These standards were used from the 1950's until the mid-1970's, when changes in operating conditions and materials of construction rendered them obsolete. Further work resulted in a new standard BS 5117 and an interim Test DD3 of 1977 finally resulted in a completely new standard, BS 6580: 1985, which met the requirements of the previous 3150, 3151 and 3152.

Chemical/Physical properties		
Performance		
	Corrosion	Glassware tests
		Simulated service tests
		Recirculating rig tests
	Freezing Point	
	Cavitation	Ultrasonic
	Erosion	Waterpump tests
	Foaming	Shake tests
		Air flow
		Hot and cold conditions
	OEM in-house tests	Compatibility with other materials
		Toxicity
		Electrochemical tests
		Engine tests
		Fleet trials
		Specific recipe requirements and restrictions

However, this standard was itself modified by incorporating an improved aluminium corrosion test, subsequently becoming BS 6580: 1992. This standard has for some years been accepted as the universal quality standard for automotive antifreeze and coolants.

However, OEMs have subsequently developed their own coolants, and imposed their own specifications and requirements, which in many cases go beyond the requirements of the BS 6580.

The basic elements of an OEM specification could include:

With increasing emphasis on environmental considerations, biodegradability is becoming increasingly important. Such coolants are normally based on monopropylene glycol containing sodium salts of dicarboxylic acids.

David Margaroni

LUBE-TECH

Industrial Lubrication & Tribology

The bi-monthly magazine, Industrial Lubrication & Tribology, is already well-known to a number of members. It is a highly regarded academic publication with a worldwide circulation, which also includes much in the way of commercially useful information on products and services available to the lubricants industry. The magazine has been continually developed and expanded over the years, and now offers a complete information service, subscribers being able to access current and archive material via the Internet. It was first established 50 years ago, under the name of Scientific Lubrication. Since then, editorship has changed several times, the predecessor to the current editor being Bernal Osborne, who many will remember as being the one-time editor of 'Motorcycling'. The current editor, Bill Wilson, an engineering graduate from Aberdeen University, has seen service with C.A.Parsons, manufacturers of steam turbines, with Sir H.G.Parsons, and as a R.E.M.E officer in Germany, before spending time with the Glacier metal company at Kilmarnock and London. He subsequently joined Leeds University as a senior engineer, then moved to Shamban Europa Bearings at Sheffield. He took over editorship of Industrial Lubrication & Tribology in 1989.

Recently he announced his wish to retire, and the search commenced for a new editor, a number of possible candidates being identified. However, following negotiations between the MCB University Press and the British Lubricants Federation it was agreed that there were a number of benefits to both organisations if the editorial role were to be transferred to the BLF. The BLF has access to the technical expertise and literature sources in the relevant areas covered by the journal. The income generated from the contract would be sufficient to fund the BLF's editorial activities without affecting other services. The magazine and the current BLF publication 'LUBE' would play complementary roles, with the LUBE magazine concentrating on issues of general interest, whilst Industrial Lubrication & Tribology would concentrate on technical issues in a degree of depth inappropriate to LUBE. The MCB Press would be assured of continuity of editorial service for the duration of the contract. Whilst the contract would be placed with the BLF, the nominal role of the editor would be taken over by David Margaroni, Technical Officer for the BLF.

Following a successful conclusion to the negotiations, it was agreed that the BLF would commence the editing of the journal with effect from the second issue in 1998.

The Following is a list of the main articles featured in Industrial Lubrication & Tribology during 1997 (Volume 49)

Number 1 January/February
Modern two-stroke engine lubrication
Conventional two-stroke engine lubrication
Pump protection and repair
Pretzel oven carbon bearings

Number 2 march/April
Counterface surfaces for redial seals
Crambe oil - a potential new hydraulic oil and quenchant

Number 3May/June
Oil Ageing - drain period in a petrol engine

Number 4 July/August
Lubricant growth forecasts
Used oil reclamation processes

Number 5 September/October
Tribological characterisation of composite powder metallurgy valve train components for heavy-duty diesel engines under starved or unlubricated conditions.

Number 6 November/December
Asbestos-free jointing products
New low cost Ferrofluidic sealing challenges the mechanical seal

Many of the articles highlighted above describe the subject area in such detail that they may be used as a useful source of reference to industrialists and students alike. In addition, each issue contains regular features which cover areas such as product reviews, new products and materials, industry round-ups, conferences and meeting reports, publication reviews, tribology reports, people in the industry, forthcoming events, etc. In addition, subscribers to the full journal service can access current and archive material via the Internet. In short, Industrial Lubrication & Tribology is one of the leading journals in the field of lubrication and will be of interest to many BLF members.