Correspondence on "Fuel Features Related to Operating Experiences in Motor Ships Using Low Cost Fuels"

After the publication of the February 1955 TRANSACTIONS containing the paper, and discussion thereon, by H. F. Jones, M.C., F.Inst.Pet., D. Royle, B.Sc.(Eng.) (Associate Member), and R. G. Sayer, B.Sc.(Eng.) (Associate Member), two additional contributions to the discussion were received, from Messrs. G. Aue and W. McLaughlin (Member). These are printed below, together wth the authors' reply to the points raised.

MR. G. AUE thought that the authors were to be congratulated on their very thorough work containing many interesting results. A noteworthy fact was that, whilst on Diesel fuel the wear rate usually decreased with the age of the liner, it did not do so in the vessels reviewed. This might be explained by the general deterioration of the engine conditions due to the accumulated liner wear or, as in Vessel A, by the rising sulphur content of the fuel, a trend which was very pronounced in the last few years.

Analysing the findings of the paper more closely it must be confessed that the conception of the details of the wear mechanism was still not sufficiently complete for a reasonable prediction of wear rates from the fuel analysis. The generally recognized principle that higher sulphur and ash contents led to higher wear was confirmed by the authors, but there were, sometimes, exceptions to this rule. This was the case, for instance, in the period around 5,000 hours in Vessel A, when it was running on a fuel of higher ash content whilst still showing a definite kink in the wear curve indicating a lower wear rate. A few experiments conducted at Winterthur several years ago also seemed to confirm the fact that it was not the percentage of sulphur nor the ash content only which determined the amount of wear, but showed that there must be some other factors or combinations of factors which still required further investigation.

Concerning the use of a detergent oil as in Vessel B, it was also experienced up to some time ago* that special oils, including detergent and even high-additive oils, did not bring any improvement. These original heavy-duty oils were developed for small engines, where there was a copious lubricating oil supply to the piston rings, and in these engines these oils behaved well. In large engines, however, the amount of cylinder oil was so scanty and conditions as to temperature and deformation were so different that heavy-duty oils first had to be improved to meet the requirements of this service. Several cases were known where application of heavy-duty oils in place of straight mineral oils definitely improved conditions as far as wear and fouling were concerned, although it was not possible to generalize this experience as yet. On the other hand some developments now seemed to be taking place in the lubricating oil field which definitely reduced liner wear, as cited in the "Motor Ship", January 1955†.

It was interesting to note that the authors recommended water washing of the crankcase oil as a means to prevent corrosion. This practice was in former times generally recommended but was discontinued some seven years ago in order to prevent the danger of corrosion. An explanation of this fact by the authors would be appreciated.

To facilitate the use of fuels of a higher specific gravity than 0·985, the authors proposed to make the water seal of the centrifuge with salt water. This rendered the interphase position between fuel and sealing water more stable but naturally did not improve the purifying effect of the centrifuge‡. This practice had been considered and sometimes recommended but it constituted a complication of the centrifuge service and included the danger of fuel losses in case of fresh water entering the centrifuge.

It was considered that the centrifuging temperature in the vessels reviewed by the authors was rather on the low side and the reasons for this temperature limitation should be explained.

MR. W. MCLAUGHLIN (Member) wished before discussing the paper proper, to consider the authors' statements under "The Position of the Motor Ship in World Commerce", which were open to question; they stated that there were no developments in view which would lead to the steam turbine becoming generally competitive with the Diesel engine for power units under 5,000 s.h.p. However, there were two developments which could be quoted, namely, the single cylinder steam turbine installation, and the free piston gas generator installation, which had used residual fuel on trials.

Again, the authors stated that the two-stroke type of oil engine would become competitive with the steam turbine for single-screw vessels up to 15,000 s.h.p. Were the authors visualizing geared Diesel installations when they felt that the two-stroke oil engine would offer the steam turbine serious competition when supplying 15,000 s.h.p. to a single screw? The power per cylinder of, say, the Doxford engine might be increased by about 33 per cent by supercharging. This would mean that the direct drive engine developing about 15,000 s.h.p. at, say, peak revolution per minute of 120 would have about eight cylinders if such an arrangement could be dynamically balanced satisfactorily. (With supercharging the rate of wear would be made greater due to the high brake m.e.p.) At a more conservative rating of 110 r.p.m. and with increased cylinder bore the number of cylinders would again be about eight. This would result in increased length of engine room with consequential reduction in valuable cargo carrying and earning space and the statistician would require to take cognizance of this when producing a balance sheet for both systems. It would appear that the smaller bore high-speed engine, with a higher degree of supercharging, geared, and with either electric or hydraulic slip couplings, would approach closest to the authors' hopes.

Referring specifically to the paper it was observed that Vessels A, B, C and D were all powered by Doxford opposed piston two-stroke engines and it was interesting to know that other builders obtained fuel consumption of the order of 0·370lb. per s.h.p. per hr.; why was the oil fuel injection pressure of 4,400lb. per sq. in. carried on Vessel A?

In Table IV it was noted that specific gravity was quoted

* Kilchenmann, W. 1953. "New Designs of Large Two-stroke Marine Diesel Engines". Trans.I.Mar.E., Vol. 65, p. 137.

† Jan. 1955. "Reduction of Cylinder Wear when Operating on Boiler Oil". "The Motor Ship", No. 418, Vol. XXXV, p. 425.

‡ Brunner, A. 1954. "Centrifuging Tests with Heavy Fuel Oil". Sulzer Technical Review, No. 2.

as 0·935; after heating to 190 deg. F. at the main engine fuel pump suction, should the specific gravity not be changed by about 130 (0·0004) = 0·052? When discussing comparative fuel consumptions on page 40 (February 1955 TRANSACTIONS), the authors quoted a figure of 3·0 per cent higher specific fuel consumption when using residue fuel; was the fuel used in raising the fuel temperature (from 60 deg. to 190 deg. F.) taken into consideration in this estimate?

Regarding engine cleanliness and wear, the particulars of the burning of the fuel bunkered at London in July 1951 made interesting reading, particularly the resetting of the fuel cam; was there no bearing trouble after this change? Was the alteration in cylinder maximum pressure measured?

It was observed that the point of maximum wear was about 10 inches from the centre of the combustion chamber. No doubt this was caused by angularity of the connecting rod inducing maximum side pressure on the cylinder liner at this point.

Were these surface roughnesses measured by a Talysurf Recorder or by direct gauge measurement? It was unfortunate the authors did not plot ring breakage on a base of increase of liner wear. It was possible that ring condition could be a function of liner wear and increased side slap resulting from increased wear.

AUTHORS' REPLIES

MR. AUE'S contribution raised a number of interesting points and the authors agreed that the many factors responsible for liner wear rates made the problem very complex and it was practically impossible to segregate the effect of each individual feature. The tests at Winterthur confirmed the authors' conclusion that other factors besides fuel features, either individually or combined, had an important bearing on liner wear rates and Mr. Haug's reference* to not loading the engines to more than 80 per cent of normal output was pertinent.

Mr. Aue's remarks about the use of detergent oils which had been developed primarily for service in small high-speed Diesel engines, not giving a consistent improvement when used as a cylinder oil in reducing the wear rates and deposit formations found in marine Diesel engines, were in general agreement with the authors' conclusions. Mr. Aue would see from Mr. Jackson's contribution† that water-washing of crankcase oil was still practised by many operators. In cases where crankshaft corrosion had occurred, the crankcase oil had been restored to a condition satisfactory for further service by efficient water washing to remove all traces of mineral acidity.

The fuels on board the vessels were usually centrifuged at temperatures of 180 deg. F. which, considering the viscosity and flash points, was not on the low side and in close agreement with the conclusions reached by Mr. A. Brunner in an article entitled "Centrifuging Tests with Heavy Fuel Oil" (Sulzer Technical Review, 1954). When the engines were on test at the builder's works, the authors were only present as guests and consequently the centrifuging temperature quoted in the paper of 165-175 deg. F. was fixed by the engine manufacturer, possibly in consultation with the shipowner.

Mr. McLaughlin commented in some detail on whether the marine Diesel engine was competitive with other types of prime movers for all ranges of power up to 15,000 s.h.p., as suggested by the authors. Mr. W. Kilchenmann, in his paper (Trans.I.Mar.E., Vol. LXV, p. 137) had dismissed the use of Diesel electric drives or free piston gas generator installations in the interests of low cost and simplicity. There were numerous references in the literature to two-stroke type Diesel engines of up to 15,000 shaft horsepower for single-screw vessels. Further information should be available in the papers to be presented at the International Internal Combustion Engine Congress at The Hague in May 1955. The authors did not agree that liner wear rates would necessarily increase in supercharged engines due to the fact that the higher b.m.e.p. was not associated with a reduction in the amount of excess air available. Mr. van Asperen had expressed the opinion that the continuous availability of the required combustion air excess in the cylinder, apart from the necessary amount of scavenging air, should be watched in connexion with the factors influencing liner wear rates.

The authors could offer no explanation as to why the fuel injection pressure of 4,400lb. per sq. in. was used during the test bed trials on marine Diesel fuel of the engine for Vessel A. As mentioned previously, the authors had no part in deciding what operating conditions should be used on the builder's test bed. Mr. McLaughlin raised a query about the specific gravity of the fuel quoted in Table IV, and his deductions were correct if the specific gravities had been determined at 60 deg. F. and 190 deg. F. in each case. In point of fact, the specific gravities were determined at 60 deg. F. on all the samples as indicated in the paper. No correction was made to the specific fuel consumed when using residual fuel to account for the extra fuel used in heating the fuel up to 190 deg. F. Mr. van Asperen, in his contribution‡, had given some useful information on this subject in Fig. 16.

No bearing troubles were experienced after advancing the period of fuel injection on Vessel A. The maximum cylinder pressure was increased although no directly comparable data were available. The maximum pressures did not exceed the figures mentioned by Mr. Jackson of 600/640lb. per sq. in. and, therefore, the possibility of bearing failure was very remote. The maximum liner wear occurred in nearly all cases at a point coincident with the position of the top ring on the pistons at their inner dead centre. Other methods of distributing the cylinder oil over the ring zone and improving load bearing characteristics of the cylinder oil, might reduce the variations in wear rates obtained at various datum points in the liner. The liners were measured by an internal micrometer. There was no doubt that ring breakage was more pronounced with the increase in liner wear, and the graph suggested by Mr. McLaughlin could be plotted from Fig. 4 and Table IX for Vessel A and Fig. 9 and Table XIII for Vessel B.

* Trans.I.Mar.E., Vol. LXVII (No. 2), p. 67.
† Trans.I.Mar.E., Vol. LXVII (No. 2), p. 64.
‡ Trans.I.Mar.E., Vol. LXVII (No. 2), p. 59.