FUEL PROBLEMS IN WARTIME

The following is an extract of an address given by ENGINEER VICE-ADMIRAL SIR JOHN KINGCOME, K.C.B., *to the Fuel Luncheon Club in London on the 20th December*, 1945.

With the U-boat menace and the immediate institution of the convoy system, it was essential to ensure that fuel supplies should be re-arranged to ensure the shortest sea routes. Pre-war, much of the fuel for British warships came from the sterling areas ; in 1939, most of the fuel had to come to Britain from America.

Persian fuels were still available in the Mediterranean and East Indies, but at a later date even the passage of tankers through the Mediterranean became impossible, and all Western Mediterranean supplies also came from America. The major supplies came from Trinidad, Venezuela and East American ports and the quality of the fuel was not quite up to pre-war standards. Moreover, with the increased demands for aviation gasoline a greater degree of cracking was carried out at the American refineries, and the standard of the fuel fell progressively.

It is an ill wind that brings no benefit to someone : these fuels contained more vanadium oxides, and due to the need for this material by British steel manufacturers, arrangements were made to save the ash from naval and merchant ships and send it ashore, where the vanadium was extracted and passed to the steel manufacturers. I believe the greatest amount of vanadium thus obtained was eight tons from the Navy and 20 tons from the Merchant Service in 1943, and although these figures may not appear impressive the material came at a time when it was in extremely short supply and any contribution was vitally important. The higher figure obtained from merchant ships was chiefly due to the higher percentage of heavy residual ash-containing fuels used in these ships.

Problems of combustion and emulsification

In warships, weight and space is of vital importance, and naval boilers are more highly forced than those in the Merchant Navy or in shore practice. Moreover, the essential need to avoid making smoke for operational reasons, has necessitated the development of special burning equipment for naval boilers. These have been developed and perfected over a number of years at the Admiralty Fuel Experimental Station at Haslar. Early in the war, troubles began to be experienced owing to the higher asphalt content in the fuels we were receiving, and research was started immediately to overcome these difficulties. We have now developed an improved equipment capable of handling the lower grade fuels now being supplied.

Anyone experienced in burning oil fuel will know that the admission of water to a fuel tank involves the risk of fires being extinguished, generally at the most critical moments. Early in the war, we started having trouble owing to leakage of sea water into our fuel tanks, due to the straining of hull structures resulting from ships being driven at high speed under adverse conditions. Furthermore, it is imperative in many ships to admit sea water to fuel tanks in order to maintain stability, thus increasing the risks of water contamination and emulsions.

Early experience in the war indicated that the wartime quality of fuel was very prone to the formation of permanent emulsions which could not be broken by heating. In one instance a cruiser ballasted a partly-filled fuel tank with sea water and then proceeded to sea in atrocious weather with the result that the emulsion so formed had to be removed from the tank by hand with shovels.

These problems were largely solved by the provision of settling and sullage tanks, and by issuing special instructions to the Fleet on the best method of handling fuel and sea water in fuel tanks which required ballasting.

Research has also been carried out at Haslar on the various conditions and qualities of fuels liable to promote emulsions and the possible use of chemical additives with a view to inhibiting the formation of emulsions, or to assist in breaking down emulsions already formed. A certain amount of success has been obtained in this direction and the research is still continuing.

Compatibility of fuels and a common U.S.-U.K. specification

Prior to the war the U.S. Navy had experienced some difficulty from deposition of sludge in storage tanks and excessive preheater fouling, due to incompatibility of mixtures of fuels from certain sources. To overcome these difficulties, stability and compatibility tests were included in the U.S. Navy fuel specifications. At the request of the Americans the stability test was included in the Admiralty fuel specification, although our experience had not demonstrated the necessity for such a test.

For the war against Japan it was necessary to include in shipments of oil to the Pacific theatre of operations large quantities of Persian fuel, as well as supplies from the Netherland West Indies and U.S. West Coast production. Tests showed that Admiralty grade Persian fuel was incompatible with U.S. West Coast fuels, particularly those from certain refineries which were very deeply cracked and an extensive compatibility survey was undertaken. To facilitate this investigation, reference fuels representing the extremes of U.S. East and West Coast and Gulf production were established.

With some modification to the refinery procedure at Abadan it was found possible to produce a fuel which would be fully compatible with all U.S. production but the supply of this fuel was insufficient to meet requirements, in spite of the shorter haul from Abadan to the South Western Pacific area. By diverting some of the most deeply cracked fuels of Californian origin from the Pacific theatre to other areas, a blend of one part of the special Abadan production with three parts of normal Abadan Admiralty grade fuel proved to be sufficiently compatible with all the U.S. reference fuels for practical purposes and this blend was shipped to the Pacific theatre and Australia, the balance of Abadan production being absorbed in the East Indies theatre and other areas where it was unlikely to be mixed with fuels of Californian origin.

Much consideration was given to the evolution of a common specification for fuel for the U.S. and British Navies, but full agreement on this question was never reached largely owing to the great complexity of the compatibility problem. Whilst it is probable that the achievement of complete compatibility of all residual fuels suitable for use in warships without unduly restricting supplies is impossible, the evolution of a common specification which would provide complete compatibility of fuel mixtures in two or more zones appears possible and further investigation on these lines is desirable.

Buoyant rubber hose solves Pacific refuelling problem

The need for fuelling ships at sea had been realised before the war and two systems had been developed. The primary one was called the trough method, the two ships steaming side by side, the supplying ship, usually the larger, passing a hose across to the receiving ship. The alternative plan was called the stirrup method, and was mainly used in harbour when weather conditions prevented the fuelling tanker and the receiving ship lying side by side ; in this system the feeding ship lay directly ahead or astern of the receiving ship. In earlier years of the war, many destroyers were fuelled by the capital ships of the fleet. It requires good seamanship to carry out the operation expeditiously.

When the war spread to the Pacific theatre, necessitating prolonged periods at sea, it became necessary not only for the smaller ships to be refuelled more frequently, but for the bigger ships to be fuelled as well.

Our tankers had not been designed for such service and, although the trough method could be employed satisfactorily under moderate weather conditions, a new method had to be devised to ensure the practicability of fuelling under adverse conditions. This was achieved through the development, by British hose manufacturers, of buoyant flexible rubber hoses to replace the stirrup method and the fitting out of our tankers accordingly. This method proved successful within the limiting pumping capacity of existing tankers and of the receiving capacity of ships being fuelled. It will, of course, be appreciated that under operational conditions, with attendant risk of attack by underwater craft and from the air, it is vital that the highest possible fuelling rates be achieved and we are now actively engaged in embodying, so far as possible, in all classes of ships and attendant tankers, such modifications as are necessary to achieve this. In addition, provision is being made for the transfer of all other types of fuel necessitated by modern conditions of warfare.

Diesel fuel and petrol

It is satisfactory to note that in all the numerous types of Diesel-engined vessels, including converted merchant ships, submarines, minesweepers, escort vessels and landing craft, no difficulty was experienced with the quality of Diesel fuel supplied either by the Admiralty or United States. The fuel was in all cases a high-grade distillate fuel having a Diesel Index of about 53 or Cetane Number of not less than 50 and, apart from a few isolated instances of trouble with water or dirt contamination, the fuel gave complete satisfaction in all the various types of engines.

Towards the end of the war it became essential to simplify the storage and handling of petrol supplies used in the various combined operations and for this purpose a common grade of leaded petrol having an octane number of 80 was employed.

As is well known the introduction of appreciable quantities of T.E.L. (in this case up to 4.5 c.c. per gall.) gives rise to maintenance difficulties in engines which have not been specially designed to take a leaded fuel. Many of the smaller engines used in motor boats and landing craft came into this category and it was necessary to issue special instructions to meet the situation. The use of unleaded fuel was maintained as long as circumstances permitted and engines were adjusted as far as possible to take the higher octane fuel. In general it may be said that the introduction of this fuel did not lead to any major difficulties although it did involve more attention to the care and maintenance of engines.