THE INTRODUCTION OF OIL FUEL

BY

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Though most accounts of the period up to the first World War mention the introduction of oil fuel, few spell out the advantages and none describe the problems which the Royal Navy's engineers[1] had to overcome in leading the way. There were obvious advantages such as ease of embarkation and stowage, supply to the boilers (and hence reduction in the number of stokers) but the disadvantages of limited supply, high cost and, initially, poorer evaporation seemed more important. Coal formed an important element in the protection of many ships[2]. Two aspects which would today be seen as among the advantages of oil were, initially, quite the opposite; the greater calorific value of oil, 19,000 BTU/lb compared with 14,500 for the best Welsh coal, could not be realized due to incomplete combustion which led to early oil burning ships being very smoky. Up to the late 1890s the Navy was content to carry out a few experiments and monitor developments elsewhere.

By 1898 the Great Eastern railway was achieving some success using Holden burners and an experimental installation was fitted in the destroyer *Surly* (FIG. 1) using both Holden and Rusden & Eeles burners. Trials in 1898–99 were very disappointing as only about 50% of the full evaporation could be obtained before dense clouds of black smoke were formed and the evaporation per pound of fuel was only 8.8lbs compared with 10.7lbs using coal. Further trials in 1901 with improved burners from both companies were only a little more successful.

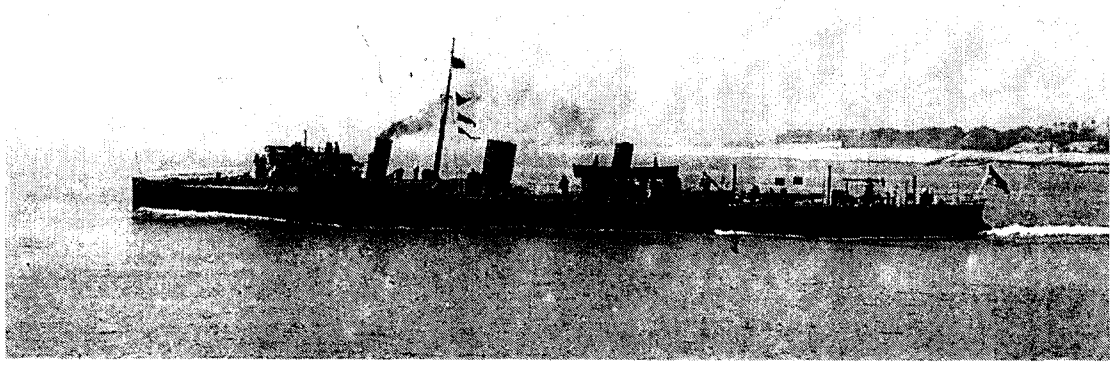

FIG. 1—HMS 'SURLY'

However, more priority was given to development and a number of boilers[3] were installed within Devonport Dockyard for trials of combustion equipment. During 1902 tests were carried out with the same types of burner as those in *Surly* and these were modified to give better combustion. Better results were achieved and three ships were modified to burn oil in some of their boilers. The battleships *Mars* and *Hannibal* had two of their eight boilers converted whilst another burnt oil in conjunction with coal. The cruiser *Bedford* had her forward boilers, about a quarter of the total, modified for oil burning.

During 1902 further trials were carried out in *Surly* with both the Kermode and the Orde systems of burning. The former used heated, compressed air to spray the fuel and was reasonably successful giving an evaporation of 12.2lbs of water per pound of oil at 91% full power. The Orde system used superheated steam to vaporise and spray the oil and was less successful.

In the same year a small experimental plant[4] was constructed in the Haslar Gunboat yard, next to Froude's ship tank.[5] There was an experimental brick furnace and two small watertube boilers.[6] The mixing of air with the oil spray was greatly improved using a slotted cone nozzle and high rates of combustion were possible with excellent economy and without clouds of smoke. By 1903, the training of engineer officers and ratings was extended to cover oil burning.

Also in 1903, two boilers of the battleship *Sultan* were converted to burn oil with various types of coal, including bitumen and anthracite. As a result, the experimental oil only boilers in *Mars*, *Hannibal* and *Bedford* were altered to mixed fuel. There were more trials at Haslar[7] which were not very successful and a modified Kermode system was tried in *Surly* which was rather better but these were abandoned with the success of the simpler 'pressure' system. In this the oil was forced through a special nozzle, without the complication of steam or compressed air, and mixed with air from the slotted cone.

This was tried in *Surly* in 1902 and in her sister, *Spiteful*, the following year. Further tests in *Sultan* and at Devonport went well and in 1904 it was decided to fit all battleships and cruisers to burn oil as an auxiliary to coal and the 1905 destroyers were designed for oil only. Secret patents were taken out by J MELROSE[8] on behalf of the Admiralty covering the main features of the system. Five new boilers[9] were installed at Haslar and when they were operational the Devonport test site was closed. Trials in *Surly* and *Sultan* continued.

Between September 1904 and January 1905 *Spiteful* using oil only was compared with her coal burning sister *Peterel*; some of the results are shown below:

	Spiteful		*Peterel*	
	Speed, kts	Tons oil/hr	Speed, kts	Tons coal/hr
Two boilers. Max power obtainable by Ship's Staff.	22.4	2.17	20.6	2.262
Portsmouth-Plymouth, Two boilers.	21.8	2.52	19.5	2.47
Round Isle of Wight, Two boilers.	22.3	2.7	21.4	2.5
As above, one boiler, tubes not swept	18.9	1.28	19.0	1.97

More important; *Spiteful* needed only three men in the boiler room against six for *Peterel*. A closed trunk system of forced draught, tried both ashore and in *Surely* during 1905, was found less convenient than the closed stokehold system since the sprayers and cones were less accessible. *Mars* and *Hannibal* were changed—again—from steam spraying to the pressure system and several other ships[10] were fitted in the same way to burn oil over coal with satisfactory results. Three engineer officers were appointed to the Fleet in November 1905 for 'special duties in connection with oil fuel'.

The first of the 1905 coastal destroyers, known as the 'oily wads', completed in 1906 and tests of their boilers went well, the average evaporation being 14.58lbs of water per pound of oil. Once at sea, a number of teething problems became apparent, notably rapid burning of the air cones. There was also excessive smoke when lighting up with cold oil. Work at Haslar, backed by trials in *Surly*, gradually overcame these problems. The first oiling at sea took place in 1906; the battleship *Victorious* towed a tanker, the tow rope supporting the oil hose.[11]

Improvements in the fittings for oil burning enabled those ships fitted for mixed fuel to burn oil only though, when doing so, power was limited to 60%. Development continued and the first formal instructions for using oil fuel were issued in February 1908 and revised in August 1910. There were still minor problems; transfer of thick, cold oil from railway trucks was aided by bleeding compressed air into the tank. Fire fighting was tried in 1908 with the conclusion that plenty of sea water was the best answer. Experiments were carried out to determine the conditions under which oil floating on the sea could be ignited.

There was a boiler explosion in *Britannia* on 29 April 1908 whilst she was burning oil over coal. Tests at Haslar showed that the cause was lack of water and that oil burning had nothing to do with it.

Rather reluctantly, the 16 *Beagles* of the 1908 programme were ordered as coal burners since there was insufficient oil available at supply depots. Their evaporation rate was only 9.8lbs of water per pound of coal compared with 14.6–15.2 achieved by oil burning ships. Oil was now accepted and the three special duty officers were removed at the end of 1908. By 1911 there were sufficient bunkering ports to meet the likely needs of the Fleet.

In 1908 it was decided that the maximum viscosity which could be accepted was 10,000 seconds measured at 32°F on a Redwood viscometer so that oil could be pumped when cold. A new air tube tried in TB 1 in 1909 proved satisfactory and its use was extended, becoming universal in 1911. In 1910 the Commander-in-Chief of the Home Fleet asked that all restrictions on the use of oil be removed as:

> 'Oil can be more easily and rapidly replenished (but with little labour) than coal, and its extended use economizes the coal and so saves the large amount of time and labour entailed in firing and coal trimming at sea and in coaling in harbour. The use of oil fuel also materially reduces the smoke when burning coal, and its continuous use practically eliminates the dense smoke formed when first putting on oil fuel and when suddenly increasing speed.'

For destroyers, the use of oil greatly increases the power developed from a given size of boiler room and fuel consumption is much less. The coal burning *Beagle* is compared with the oil burning *Defender* of the same power and similar capability in the following table.

	Beagle	*Defender*
	Coal	Oil
Boiler surface, sq ft	26,000	19,000
Boiler room Weights, tons	187	142
Boiler room Length, ft	92	61
Total machinery weight, tons	345	300
Ship Length, ft	270	240
Fuel weight, tons	225	175
Endurance, actual miles*	2200 @ 15	2600 @ 13
Engine and boiler room complement	58	24
Speed, actual, kts (Nominal 27)	27.2	28.5
Cost, £	106,000	83,000

The *Beagle* was designed for 1500 miles at 15 and the *Defender* for 2,000 at 13 (Equivalent to 1500 at 15).

1. My thanks are due to successive editors of the *Journal of Naval Engineering* for providing material on which this article is based.
2. Two feet of coal were equivalent to one inch of steel and full bunkers, even if flooded, preserved much of the buoyancy and stability. ATTWOOD.
3. A Normand (as in *Blonde*), a Belleville and cylindrical, together with two more cylindrical boilers from *Bonaventure*.
4. Best known as the Admiralty Fuel Experimental Station, AFES.
5. Admiralty Experimental Works, AEW.
6. Pinnace type; one White-Forster, one Mumford.
7. Clarkson & Chapel and May burning systems.
8. James MELROSE, Chief Inspector of Machinery, assisted by ENGINEER COMMANDER George FRYER.
9. Babcock & Wilcox, Yarrow large tube, Belleville, Yarrow small tube and Thornycroft small tube.
10. *Prince George, Argyll, Black Prince, Duke of Edinburgh* and *King Edward VII.*
11. A photograph appears in the advertisement section of Janes 1914.
12. A coastal destroyer renumbered.