CONFIDENTIAL

GERMAN PETROLEUM INDUSTRY

HAMBURG DISTRICT

REPORT No.11

CHEMISCH - PHYSIKALISCHE VERSUCHS - ANSTALT der MARINE

DÄNISCH-NIENHOF. (KIEL-DIETRICHSDORF).

Reported By

MR. E.H. BOOMER - Can. Min. of Supply

on behalf of the

BRITISH MINISTRY OF FUEL & POWER

AND THE

U.S. TECHNICAL INDUSTRIAL INTELLIGENCE COMMITTEE

JUNE, 1945

C.I.O.S. Target No.30

FUELS AND LUBRICANTS

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE

G-2 Division, S.H.A.E.F. (Rear) APO.413

TABLE OF CONTENTS

CHEMISCH - PHYSIKALISCHE VERSUCHS - ANSTALT DER MARINE

DÄNISCH - NIENHOF

SECTION 1. Conclusions

Two types of low pour point lubricants of satisfactory viscosity characteristics were developed for use in torpedo tubes and torpedo driving mechanisms. One of these, for electric driven trackless torpedos, had a specific gravity greater than sea-water.

Test methods for fuels and lubricants were developed by Dip. Ing. Jentzsch and his work on spontaneous ignition temperatures leading to the development a characteristic quantity, the "priming value" of oils is important. These quantities have been adopted as a standard specification in German Naval fuels and lubricants.

Flame-thrower fuels using gasoline as a base (and flame-throwers) were developed. Coal tar and synthetic resin provided by I.G. Farbenindustrie were used as thickening agents. The fuel was adopted officially but did not get into production.

SECTION 2. Historical

This research institute dealt almost entirely before the war with pure mathematics, physics and chemistry. German Naval research organizations were concentrated there during the war until ultimately, all naval research excepting Radar was carried out at or direct from the Versuchs-Anstalt.

SECTION 3. Description of Versuchs-Anstalt work

The investigations at the Versuchs-Anstalt covered a very broad field involving mathematics, physics and chemistry and, to some extent, equipment. The present investigation was concerned only with lubricants and fuels, particularly the former. Copies were obtained of documents of interest. All documents at the Versuchs-Anstalt are available and copying facilities exist.

(a) Torpedo lubricants

A lubricant for standard torpedos running on decalin was developed to meet naval specifications. The specifications were such

that only a mixture would satisfy them. A second oil of similar specifications, excepting that the specific gravity had to be 1.1 or more in order that it should sink in sea-water, was developed for use with the trackless, electric torpedo, ET 42. These oils had the following compositions and properties:

Standard		Notes
25 Rape oil 75 Neats foot oil	15%	The phosphate was used for lubricating value only and paraflow as pour point depressor. The spindle oil lowered the pour point and viscosity. The solvent refined lubricating oil used had a viscosity of 6.5E/50°C. and low pour point.
Blown rape oil	3%	
Tricresyl phosphate	10	
Paraflow (I.G.)	3	
Spindle oil	29	
Solvent refined lubricating oil	40	

Sp.Gr.20°C., 0.970 Flash point 160°C. +
Pour point -50°C. Neutralization No 0.04
Viscosity, 12 to 14 E/20°C.
3.1 to 3.7 E/50°C.
Corrosion, nil

Trackless

Rape oil or neats foot oil, Mineral oil Paraflow	60 to 75%	The oil used was similar to the standard oil less the phosphate. The mineral oil component was treated to -50°C. pour point.
Clophen A-60	25 to 40%	Clopen A-60 is a neutral, Chlorinated hydrocarbon of 1.6 gravity and supplied by I.G. Farbenindustrie.

Sp. Gr. 20°C., 1.1 +
Pour point -30 to -35°C.
Viscosity 6 to 7 E/50°C.

The above lubricants were manufactured by Harmesen, Kiel and Rhenania-Ossag, Hamburg. The oils were given performance tests by use of a brake machine and the actual torpedo mechanism.

(b) Diesel fuel for high speed submarine and surface vessel motors

The performance of diesel fuels for submarines and high speed surface craft was studied and a specification developed. It was as follows :

Sp. Gr. 20°C.,		0.84 to 0.88
Colour		4 to 7 (Ostwald scale)
Viscosity		1.2 to 1.4 E/20°C.
Flash point		80°C.
Pensky-Martin		65°C or more
Aniline point		60°C (not routine)
B.Pt. (Engler)		
	1.B.Pt.	200°C.
	75% over	300°C.
	Average B.Pt.	300°C. or less
	End point	360°C.
Sulfur		0.3% maximum
Conradson carbon		0.5% or less
Pour point		-10°C.
Cetane number		45 (to July, 1943)
		39 (1943 to date)

(The average boiling point is the sum of the 5 to 95% points by tens, divided by 10).

(c) Spontaneous ignition temperatures and "priming value" for fuels and lubricants

This work is an old development, principally by Dip. Ing. Jentzsch, that led to the adoption of characteristic functions of the ignition behaviour of fuels and lubricants as specifications by the German Navy. Early work is covered in articles appearing in "Oel und Kohle" No.3, 1934 and "Angewandte Chemie" page 593, volume 45) 1932.

Documents dealing with the subject collected by the investigators were :

1. The Jentzsch Priming Value Tester
2. Normblatter zum Zündwert-Verfahren.

3. Vorschriften für die Pflege der schmierstoffe sowie der heizöle und der flüssigen Kraftstoffe. 1938, revised to June 1940. (Kriegsmarine).

The last document listed contains specifications and test methods for naval lubricants, fuel oils and diesel oils including the "Zündwert" or "priming value" tests. Jentzsch work is of interest in two respects, namely, the unique and convenient test methods and apparatus and the value of the spontaneous ignition temperature as a property of fuel oils and lubricants. The ignition qualities of oils as expressed in the "priming value" are of importance particularly with oils where sources are synthetic or the by-products of coal distillation.

(d) Flame-thrower fuels

The Versuchs-Anstalt were concerned with the development of flame-thrower fuels which did not use rubber, natural or synthetic, or soaps as thickening agents. This work produced the type of fuel used by the Army and Navy which consisted of gasoline, coal tar oil and a synthetic resin. The final work at the Versuchs-Anstalt led to the adoption by the Navy of the following fuel:

Gasoline	70%
Tar oil	20%
Resin	10%

The synthetic resin (Quellemasse) was of unknown composition and was provided by I.G. Farbenindustrie. Samples of the earlier fuel and the resin had been obtained before the surrender. The only significant difference between the earlier fuel and the above fuel lay in a change of the resin content from 5 to 10%. The resin is probably of coumarone type but may be phenol-formaldehyde.

The ignition qualities of the fuel were good. In the winter months, an addition of carbon disulfide in amounts up to 10% eliminated ignition

troubles. The effective range of the fuel in regular flame-throwers was 100 to 150 metres and the spread at the target, 10 to 15 metres. There was no or only a very short rod to the jet.

Studies were carried out on the addition of substances improving flammability, heat generated and raising the flame temperature. The addition of aluminum powder reached a high degree of development in experimental flame-throwers. A rise of several hundred degrees in flame temperature and a change in colour to white resulted.

The chief production centre of the gasoline-tar-oil-resin fuel was Buch-Chemie, Goppinger near Stuttgart.

(e) Synthetic lubricants

The manufacture of synthetic lubricants by the condensation of chlorinated paraffins with naphthalene or similar aromatic hydrocarbons in the presence of activated aluminum is described in D.R. Patent 1200/1943, The paraffin hydrocarbons were obtained from Fischer-Tropsch oils. The reaction was carried out with or without an inert solvent medium depending on the quality of oil desired. Condensation at 100°C. in a heavy naphtha medium yields an oil as follows:

Sp. Gr. 20°C.,	0.915
Conradson carbon,	0.52%
Viscosity	7°E/20°C. 1.2E/50°C.
Polhöhe	1.83

Condensation at 200°C. with no medium produced an oil as follows:

Sp. Gr. 20°C.,	0.9208

Conradson carbon,	0.64%
Viscosity,	16.9E/50
Polhöhe	1.88

The patent claims good viscosity characteristics and improved resistance to coking in such lubricating oils.

(f) Lubricants, water soluble, non-corrosive and low pour-point.

The manufacture of synthetic lubricants containing no hydrocarbons but of good quality and mixible with water is described in D.R. Patent 560/1943. The raw materials used are di- and tri-ethanolamines and unsaturated, high molecular weight, fatty acids, such as oleic acid ricinoleic acid and linoleic acid. The application was primarily as torpedo lubricants, the material being compatible with water, alcohols and hydrocarbons. A mixture of soaps is obtained by the reaction of the amine mixture with a fatty acid at 40-50°C. and converted to an ester at 150-250°C. over zinc dust. Proportions of reactants are adjusted to yield a neutral or slightly alkaline product.

The documents referred to in this report have been deposited with C.I.O.S. Secretariat.

Personnel Interrogated

Dr. H. Meyer.
Dr. H. Eckert.
Dip.Ing. Jentzsch.

Date of Visit & Party

19th May 1945.

Mr. C.H. Barton	(Brit.)	Mr. Paul K. Kuhne	(U.S.)
" W.H. Thomas	(Brit.)	" Donald S.Fraser	"
" V. Haensel	(U.S.)	" E.H.Boomer	(Can.)