FUEL FOR HEAVY-OIL ENGINES.

A BULLETIN recently issued by the U.S. Bureau of Mines consists of a paper dealing with heavy oil as a fuel for internal-combustion engines. The writer, Mr. Irving C. Allen, enlarges upon the varieties of liquid fuels, viz., gas oil, coal tar and tar oils, lignite tars, wood tars, seep oils and animal oils, and also upon the use of alcohols. The heavy-oil engine, its advantages over the steam and explosion engine for marine use, its maintenance cost and fuel consumption are fully described, and the various uses to which this type of engine may be satisfactorily consigned are enumerated. An important part of the subject, specifications for fuels and lubricants, is also exhaustively dealt with.

Concerning the desirable properties of fuel for the heavy-oil engine the writer has this to say:—

In selecting a fuel for this engine its composition as affecting combustion is most important. For proper combustion the fuel should be mobile and volatile, clean, and free from water, solid particles, and grit. In general the specific gravity of an oil rises directly as the vapor density. The boiling point and the amount of air necessary for combustion vary inversely with the volatility, and the greater the volatility of the fuel the better the ignition and combustion. The benzene-ring bodies, or benzol, seem to be more difficult to break up than the paraffin-chain bodies, and the latter have a better diffusibility than the former. They are, therefore, more active and seem to give better results in combustion, though for this same reason they are more dangerous. The calorific value of biuminous tars in general is lower than that of lignite tars or petroleum products. Petroleum benzines require approximately 40 volumes of air, whereas the heavy petroleum products require approximately 100 volumes of air for complete combustion.

Petroleum, gas oils, and lignite tar oils readily lend themselves to gasification and they leave practically no residue, giving them peculiar value in an oil engine. Anthracene and creosote oils gasify fairly well. Paraffin-chain bodies, in general, gasify very readily and are suitable for heavy-oil engines. Benzene-ring bodies, however, volatilize more difficultly. They volatilize regularly and do not have the explosive tendency to be noted in the several kinds of petroleum products, which gives the latter the value peculiar to oil engines. An oil, to give best results in a heavy-oil engine, should on heating show a tendency to volatilize suddenly at some given temperature and not to give off vapors regularly and uniformly, that is, distil with the rise in temperature. To this tendency to sudden volatilization or explosion, in contradistinction to regular volatilization or uniform distillation, is due the value as a fuel in the heavy-oil engine (unlike the explosion engine fitted with carburetor and igniter where the time of combustion is so short).

Lignite tar oils and bituminous tar oils mixed with 25 per cent. anthracene give good results in a heavy-oil engine. In general, in a good paraffin oil, the ratio of hydrogen to carbon, as shown by analysis, should be 10 to 15, and in bituminous tar oils the ratio should be about 10 to 12.5.

If an oil be heavy, with a very low content of "flashy" constituents, it should be enlivened by having mixed with it before admission into the cylinder about 2 per cent. of gaseous oil, such as the "gas oil" previously mentioned.

One gram of gasoline of specific gravity 0.71 to 0.73 requires approximately 15 grams of air for theoretically complete combustion, and under working conditions from 19 to 23 grams, whereas 1 gram of denatured ethyl alcohol, 90 per cent., requires theoretically 8 grams, and under working conditions from 9.5 grams to 11.5 grams. That is, under normal working conditions denatured alcohol requires about half the weight of air that gasoline requires; 25 to 50 per cent. excess of air, however, is necessary in both cases for best results; or, stated in heat units, denatured alcohol, 94 per cent. by volume, develops 5,833 calories per gram, whereas gasoline of specific gravity 0.71 to 0.73 develops 10,611 calories. Therefore the power developed by denatured alcohol and by gasoline is approximately 10 to 18 in favor of the gasoline. The difference in ignition temperature, a matter of prime importance in the Diesel engine, is also greatly in favor of the gasoline, because an explosive mixture of alcohol vapor and air can be compressed to over twice as high a pressure (180 pounds per square inch) as can an explosive mixture of gasoline vapor and air (70 pounds per square inch) before self-ignition takes place. Although explosion engines are hard to start with alcohol and are uncertain with variable loads, an explosion engine properly designed and regulated will run as well with alcohol as with gasoline; but less cooling water is required for the engine cylinders with alcohol than with gasoline.

Use of Water in the Cylinder.—It is believed that an auxiliary nozzle could be advantageously used to inject a small quantity of water into the combustion cylinder simultaneously with the fuel. The nozzle must be removed as far as practicable from the fuel nozzle, however, so as not to dampen the ignition of the oil by the steam thereby generated. During ordinary running the cylinders are continuously superheated and must be cooled by water circulating externally. This circulating water cools the cylinder; carries away considerable heat, and thereby causes a direct loss of fuel value. The water injected will generate steam or power by absorbing a portion of the surcharge of heat and converting it into power, and will at the same time reduce, at least in part the necessity for externally cooling the cylinders and thereby losing some heat. This principle has been practically developed by James Hargreaves in his internal-combustion engines, and might be applied, so far as practicable, to eliminating the explosion pound of internal-combustion engines in general. That an engine so fed with water will run more quietly and smoothly has been demonstrated by Strong in his gasoline-alcohol tests. Even as low as 50 per cent. alcohol and water has been burned by him in an explosion engine.

Relative Calorific Values of Some Fuels.—The calorific values of the chemically pure fundamental bodies found in liquid fuels is given below for the purposes of comparison:—

Heat of Combustion of Pure Liquids.

Substance	Specific gravity	Average Calories per gram
	0°.C	
Methyl (wood) alcohol, CH_3OH....liquid....	0.810	5,314
Ethyl (wine) alcohol, C_2H_5OH.....liquid....	.791	7,107
Hexane (paraffin), C_6H_{14}...... ..liquid....	.677	11,603
Benzene, C_6H_6 ....liquid....	.899	10,001
	15°.C	
Commercial gasoline	.710-.730	11,368
Commercial kerosene	790-.800	11,050
Crude California asphaltic petroleums:		
Coalinga (average of 53 samples)	.9462	10,501
Coalinga (average of 62 samples)	.9498	10,404
McKittrick (average of 26 samples)	.9566	10,282
Midway (average of 29 samples)........	.9570	10,341
Kern (average of 40 samples)	.9645	10,307
Sunset (average of 25 samples)	.9701	10,266
Average of asphaltic petroleums	.9574	10,350