

B-119 - ADIK 3199

Short Report No. 412 on
Gasoline-water emulsions.

Summary

This is a description of an emulsifying agent Emulgator EM 18, which was developed for B 4 - water emulsions. It is produced from the esters of di-carboxylic acids, and is used in a proportion of 2.5% of the total emulsion. The emulsion is quite fluid, to a certain extent non-inflammable, and easy to produce. It has a storage time of 6 days.

One can hardly expect of an emulsion which consists half of water that it should resist cold below -20°C .

Engine tests are not available.

Object of the investigations.

The firm of Daimler Benz A.G. approached the Technical Test Station with a request to produce emulsions of B 4 and water in the ratio 50:50, and to find a special emulsifying agent which if used in small quantities, would impart a long storage time to the emulsion. These emulsions are to be injected into the blower to cool the boost air.

General Remarks.

It has always been a problem of the utmost difficulty to produce gasoline - water emulsions which have long storage times if a small amount of emulsifier is added. This is due mainly to the nature of the two substances, one being a hydrocarbon of low density and low melting point and the other an inorganic liquid of high specific gravity. The marked difference in density of the two components, and also the mobility of the hydrocarbon molecules, make great demands on a substance which, after all, has to hold the two components together. In the above problem it is necessary to be quite clear whether it is required to produce an emulsion of a hydrocarbon in water or of water in a hydrocarbon. Both are emulsions, but require different emulsifying agents for their stability. We decided in favour of an emulsion of a hydrocarbon in water, the hydrocarbon representing the inner phase, and being in suspension in the emulsion as minute particles, stabilised by the emulsifying agent.

The problem of making emulsions stable is nothing else than a struggle against gravity and buoyancy, which always tend to cause the particles of the denser liquid to collect at the bottom, and those of the lighter liquid to collect at the top. The sole purpose of the emulsifying agent is to anchor the particles of the two components together, and to arrest the tendency to separated. For this purpose, it is necessary for the emulsifying agent to be partially soluble in both liquids. Therefore, its molecule must contain groups which favour solubility in gasoline, and also such as favour solubility in water.

Commercial emulsifying agents.

An attempt was first made to use the customary commercial emulsifying agent and to test them in the above capacity. The primary requirements are always that the volume used shall be small and that the liquid shall be sufficiently thin. As was to be expected out of the great range tried only three commercial products conformed more or less to these requirements, namely Spermin-Oil, Ammonium Oleate, and Soromin S.G. The first two were excluded on the grounds of the difficulty of obtaining the raw material as well as poor stability at elevated temperatures. It was impossible to keep an emulsion stable with Soromin for longer than 24 hours.

Emulsifier F.M. 18

We were therefore compelled to develop a new emulsifying agent for producing B 4 - water emulsions in the ratio of 50/50. This meant that it was necessary to look for an organic compound which could be changed in such a way that it was soluble in both gasoline and water. After carrying out several series of development tests to this end, we found the required preparation in the esters of di-carboxylic acids.

The product F.M. 18 is soluble in both gasoline and water. It is solid, and constructed like a soap, and like soap it has no melting point, but decomposes on heating. The colour of the present crude product is yellowish-brown. At present it is being produced as a solid. But to obtain better solubility in B 4 it is proposed to produce F.M. 18 as a paste, which will be a viscous fluid even at low temperatures. The best procedure is to dissolve the present product in B 4 at 40°C, by adding a concentrated solution of the product previously prepared in pure benzene. This preliminary solution could be dispensed with if the substance was in the form of a paste.

Production of the emulsion

The simplest possible method was chosen. The emulsifying agent is dissolved in gasoline at 40°C, and the mixture then added to the water, which is at a temperature of about 50°-60°, and briskly stirred by hand. The emulsion then forms immediately as a white milk. The following is the prescription for 4 litres of 50/50 emulsion: Dissolve 100 grammes of dry emulsifying agent in 200 cc of pure benzene, and then make up with 2 litres of B 4. Then add 2.2 litres of water at 50°C, and stir vigorously.

Properties of the Emulsion

The cold blueish-white emulsion does not foam and is sufficiently fluid. It is not stable below - 20°C. Developments along these lines must be the subject of a future series of tests with regard to flash point is, however, remarkable that the prepared emulsion can be ignited with a match at normal temperature, because gasoline vapour has collected on the surface owing to the vapour pressure of the B 4. When this vapour has burned away, the emulsion does not burn any more, because the gasoline drops are enveloped in water. Emulsion atomised by an injection nozzle is not ignited by a flame or sparking plug. How far the emulsion is to be considered safe against firing, is a question which in any case must be determined by tests.

Storage time and optimum concentration

The storage time, compared with that of commercial emulsifiers, must be considered good. It is 6 days for a 5% concentration of emulsifying agent calculated on the basis of the gasoline volume, which is 2 $\frac{1}{2}$ % based on the total volume of liquid. These figures only apply for the impure emulsifying agent at present, since there were special reasons why it was impossible to think of purifying and isolating these substances, which are highly surface-active. It is probable that by good purification and blending, e.g. using super-sonic waves, the optimum concentration can be lowered and the storage time raised.

Investigations regarding increase in power, consumption, and formation of deposits have not been made yet. They will be made in due course in the R4W single cylinder engine.