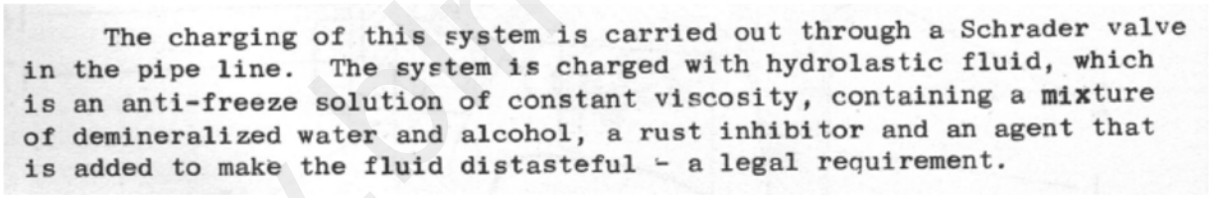
“The Viscosity of Hydrolastic Fluid”

By Tony Cripps

Have you ever wondered what the viscosity of hydrolastic fluid might be? Having some expertise in this area, I thought I would therefore conduct some experiments on what is purported to be the original formula of hydrolastic fluid and compare with ethanol and water.

Hydrolastic fluid is available from a manufacturer in Australia (Anglomoil) in 20L containers. Anglomoil claim to have been the original supplier to BMC. According to the engineer at Anglomoil, their fluid does not contain alcohol (ethanol) as such (although it does contain ethylene glycol, which is an alcohol but not the drinking kind). One can imagine the tax payable (as did BMC) if ethanol were to be used. He also advises that it contains another ingredient to impart the desired viscosity to the mixture (which is supported by the results to be presented here).

According to the official BMC service literature, hydrolastic fluid contains a lubricity additive to overcome a squeak from the valve inside the hydrolastic unit and the literature lists several different part numbers corresponding to different concentrations of the lubricity additive – the more additive, the firmer the ride. The following excerpt is from the Austin 1800 Service Training Notes TP765.



The charging of this system is carried out through a Schrader valve in the pipe line. The system is charged with hydrolastic fluid, which is an anti-freeze solution of constant viscosity, containing a mixture of demineralized water and alcohol, a rust inhibitor and an agent that is added to make the fluid distasteful - a legal requirement.

The Hydrolastic system was first introduced on the Morris 1100 range, and during development of this vehicle, Australian BMC Engineer Reg Fulford visited UK to find out what where the consequences for the introduction of this car in Australia.

As part of his stay in UK, he visited Alex Moulton. In Reg’s personal diary of the event, he records the discussion he had with Moulton about the system. For the most part, they discussed how the factory, and the service people, would set the system up. Moulton favoured a pressure reading over a height setting, but Fulford preferred the height setting because he felt that any pressure gauge in a dealership was unlikely to be accurate.

With respect to the fluid, Fulford reports: “He pointed out that we should be able to reduce the alcohol content of the fluid for our climate. I said I would discuss this with Brown.“ – the implication being that the alcohol content was purely for antifreeze purposes.

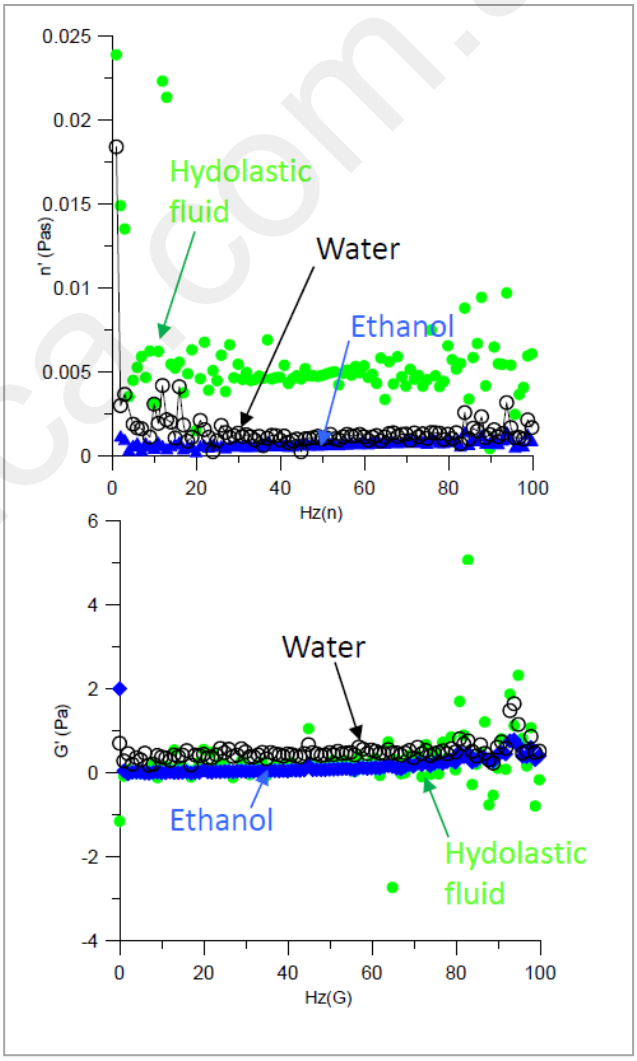
Fulford records that “Moulton was opposed to us doing independent ride work in Australia other than by having modified displacers sent out for trial. He was worried that mistakes and confusion could result. He would also be opposed to changing anything in the valving other

than the bleed due to the amount of work that had gone into achieving the present valve design and the complications of changing it. Alec Moulton is a great salesman for his suspension, but also candidly admitted most of its shortcomings".

For the purposes of this article, three fluids were tested in an instrument designed to measure absolute values of viscosity and elasticity, or shear modulus. To understand the significance of the readings, it is necessary to know a little but about these physical properties.

In solid mechanics, we are mainly interested in the elastic modulus of material, as well as other properties such as yield strength hardness and fracture toughness strength, and hardness. In fluid mechanics, it is the viscosity, or "resistance to flow" that is of most interest. However, many materials are placed somewhere in between being solid and liquid and are often referred to as being "visco-elastic".

A good example of a purely viscous material is water. When you pour out some water, it flows and takes the shape of its container. Compare this with something like Vegemite or cottage cheese. This material also flows (if you deform it with your butter knife), but it has "body" to it. It will sit there, an elastic quivering mass, unless it is deformed.



It is the Shear Modulus G that quantifies the elastic component of the material response and the Viscosity n that quantifies the viscous response. Water theoretically has G = 0 and a viscosity *n* = 1 mPas at room temperature. These properties often change with temperature, and also the rate of deformation. For example, manufacturers of paint arrange things so that paint is easy to brush (low viscosity when the shear rate is high) but has a high viscosity when it is left alone (so that it doesn't sag and cause runs). Now to our hydrolastic fluid.

The graphs here show the viscosity *n* and shear modulus G on the vertical axis against frequency of deformation on the horizontal axis. Note that hydrolastic fluid has a higher viscosity than water, which in turn has a higher viscosity than ethanol. For the shear modulus, hydrolastic fluid behaves very much like the other fluids which are all close to zero.

There was not time to conduct these tests at different temperatures, but the results do show that the shear rate (Hz) does not influence the properties very significantly and so the characteristics of our suspension are likely to be the same over bumpy roads and smooth roads.

So, what does all this mean for us? Hydrolastic fluid is not simply a mixture of water and alcohol as evidenced by the significantly higher value of viscosity throughout the frequency range. It is the lubricity additive that makes the difference here (as pointed out by the Anglomoil engineer) and is why the fluids with the high concentration of additive give a harder ride since the fluid does not flow from front to rear as easily as would water. For the Anglomoil product, the fluid does indeed feel quite oily when rubbed between the fingers.

For hot climates, water with a little antifreeze is probably OK – but certainly do not use brake fluid or any other kind of oil lest the rubber components become degraded.

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