microComponents

TechNote

How viscosity influences the mp6-hyb and mp6-liq performance

The flow and pressure performance of the mp6-hyb and mp6-liq are influenced by the viscosity of the pumping fluid.
With water the mp6-liq has its optimal frequency – where the flow rate and the pressure generation are at maximum – at approximately 150 Hz[1]. The optimal frequency changes when liquids of other viscosities are pumped. As gases have much lower viscosities than water, the frequency can be quite high (see "ApplicationNote - Air" for more details). High viscous liquids will require lower frequencies. As a rule of thumb: The higher the viscosity the lower the pump frequency has to be.

Water-glycerin mixtures were prepared to be able to present some general change in pump performance with higher viscosities. The highest viscosity that was tested was 120 mPas; although higher viscosities are possible the flow rate will be lower. Therefore it depends on the application and the customer demand if the pump performance with even lower viscosities is still of interest, as priming the pump with such a liquid will take considerable time.

The mixtures, the corresponding optimal frequencies and other data are listed below in Figure 1. It has to be remarked that viscosity is affected by temperature, in these experiments the environmental temperature was 20 to 21°C. Most viscous liquids can be considered to decrease its viscosity with rising temperature, take motor oils as an example.

Viscosity [mPas]	Glycerin [w%]	Optimal frequency [Hz]	Achievable flow rate SRS; [µl/min]	Achievable flow rate rectangular; [µl/min]
10	59.05	50 to 60	2392	2764
20	68.92	~40	1334	1503
50	78.4	15-25	571	666
100	84.58	10-15	375	398
120	85.77	10	275	325

Figure 1

These results represent mean values over three standard mp6-hyb and mp6-liq pumps; this means they have the same exemplary tolerance, i.e. ±15%.

[1] The 150 Hz is an approximate value due to the ±15% exemplary tolerance of the pump. Therefore quality control and test data are based on 100 Hz as the pump tolerance is much smaller then.

In Figure 2 below the flow curves are presented for SRS and rectangular driving signal of the mp6-hyb. Although we recommend using the SRS signal when pumping liquids due to possible cavitation effects that may result in gas bubble generation, it is possible to use the rectangular signal too. It depends on the liquid if cavitation will result in gas bubbles that decrease the pump performance, however with these lower viscosity liquids it wasn't observed. That means, as long as no gas bubbles appear, the rectangular signal will give a bit more flow rate and pressure than the SRS signal.

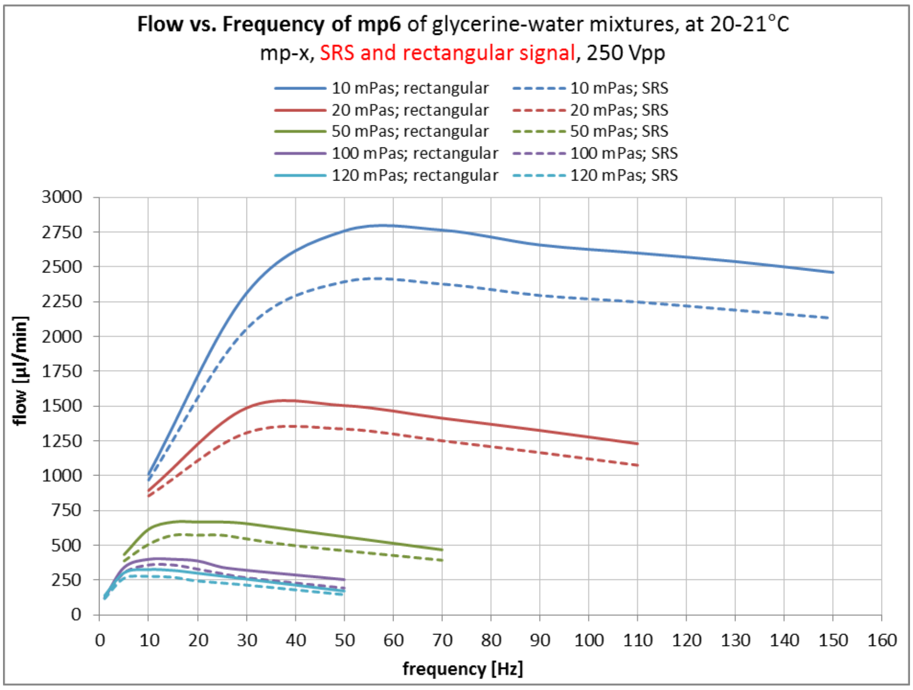

Figure 2

The pressure generation of the mp6 is in general a bit higher for viscous liquids than with water. The viscosity prevents the liquid to flow back easily which adds to the pressure built up. However the same effect will also delay the pressure built up in general, this means although the maximal possible pressure is a bit higher it will take longer to actually reach it. With the water-glycerin mixtures it was possible to achieve ~575 mbar with the SRS signal and ~617 mbar with the rectangular signal. The higher the viscosity the longer it took to reach that level, as an example; the 120 mbar needed more than ten minutes to increase from 600 to 617 mbar. Although the experimental setup with flexible tubing (the Tygon tubing mp-t) has its influence here as the tubing expands with pressure, the same happens when measuring water but maximal pressure is gained much faster.

For priming an empty mp6 with viscous liquids the low frequencies are not reasonable. If the pump cannot be filled otherwise – syringe or gravity induced flow- the pump should be controlled with a high frequency to pump air, i.e. frequency up to 300 Hz or more. Once the liquid enters the pump, the sound of the pump changes abruptly, the frequency can be turned down. This method was used in the experiments mentioned above. Once the sound changed the frequency was lowered and with the glycerin-water mixtures the pump did prime perfectly due to the wetting behavior of the liquid.

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