TechNote

How viscosity influence the mp6's flow and pressure rate

The flow and pressure performance of the mp6 is influenced by the viscosity of the pumping fluid. For water the resonance frequency of the mp6, this is the frequency at which the maximum flow rate can be achieved, is 150 Hz. The maximum achievable flow rate is 7 ml/min. For lower viscous media as gases this frequency is shifted into the kHz range and no resonance point has been defined. Therefore as outgoing inspection frequency 300 Hz has been defined and the maximum flow rate at this point is 18 ml/min. A general information on the behavior of the mp6 when pumping gas is summarized in the application note 'Operating Micropumps with Air'. For higher viscosities the resonance point is shifted to lower frequencies and the maximal achievable flow rate is decreasing depending on the viscosity. The maximum viscosity levels that can be handled are typically in the order of 100 mPas.

In order to get an insight into the viscosity behavior measurements with water glycerin mixtures have been carried out. See the table on the right for viscosity orientation. All percentage values refer to the weight percentage of glycerin in the mixture. Density for glycerin was set at 1,26 g/cm^3. A temperature variance of ± 1°C is granted. All measurements were performed with the optimal driving parameters for the mp6, amplitude of 250 Vpp with an SRS-signal form with the mp-x driving electronics.

Temperature 20°C	Viscosity [mPa*s]
DI-water	1,00
20% glycerin	1,76
40% glycerin	3,72
60% glycerin	10,8

As a first step the viscosity depending resonance frequency has been determined for maximum flow and pressure performance. The table below summarizes the results. It can be seen that the pressure is more prone to changes of viscosity than the flow rate.

	Maximum Flow rate	Maximum Pressure
DI-water	150 Hz	150 Hz
20% glycerin	130 Hz	150 Hz
40% glycerin	110 Hz	70 Hz
60% glycerin	70 Hz	30 Hz

The viscosity has a great impact on the flow rate. For example the 60% mixture is far below the pure DI-Water by a factor of 4. Changing the frequency influences mostly the low viscosity liquids's flow rate, which starts with a linear relation at small frequencies till a certain point where the graph flattens and reaches its maximum. The flow rate starts falling after that.

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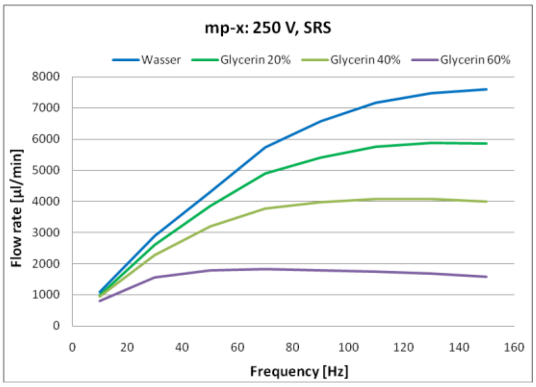
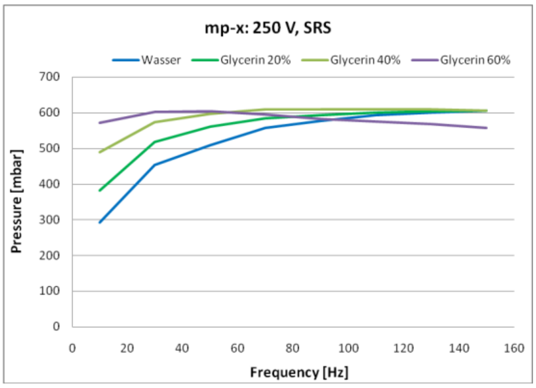
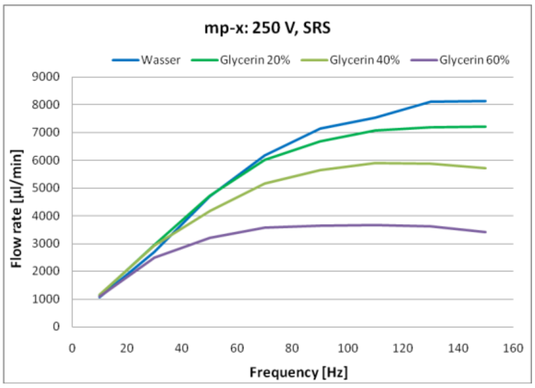
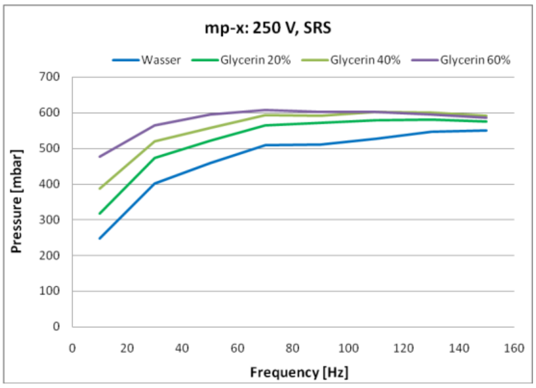


The viscosity has no influence on the maximum pressure. Higher viscosity liquids reach maximum pressure at a smaller frequency, but the overall maximum is 600 mbar for all liquids. As in the flow rate the performance decreases after the optimal frequency which is very low for the 60% mixture, for example.



All tests have been carried out at room temperature. With increasing temperature the viscosity is reduced resulting in higher flow rates. Therefore again the resonance frequency is shifted to a higher optimal frequency. The pressure behavior starts to decrease for the 60% glycerin mixture. In general it should also be considered that heating liquids could generate bubbles from dissolved gas that can decrease the overall performance of the pump. At temperatures of 70°C the overall pump performance is decreasing as this is the temperature limit for use of the pump. As an example the flow and pressure curves for 55°C are shown:





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