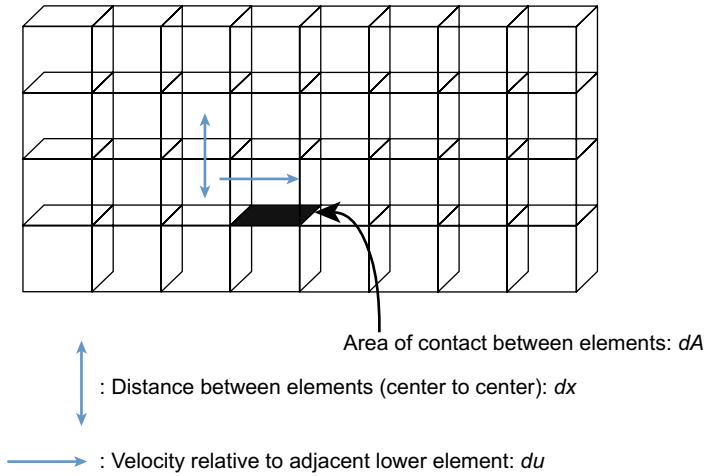

Figure 9.1 A volume element moving relative to a lower volume element with relative velocity equal to *du*.

Table 9.1 Viscosities of different fluids in mPa s

Fluid	Viscosity (mPa s)	Fluid	Viscosity (mPa s)
Air at room temperature	0.02	Motor oil SAE 10 at 20 °C	65
Acetone at 20 °C	0.33	Motor oil SAE 40 at 20 °C	319
Water at 20 °C	1.0	Castor oil at 26.9 °C	650
Ethanol at 25 °C	1.1	Dark Canadian maple syrup at 25 °C	1028
Mercury at 26.9 °C	1.5	Glycerol at 20 °C	1410
Kerosene at 26.9 °C	1.6	Honey at room temperature	10,000–20,000
Linseed oil at 26.9 °C	33	Peanut butter at room temperature	250,000
Corn oil at 25 °C	51	Window putty at room temperature	$>5\times10^{6}$
Olive oil at 25 °C	63	Pitch at 25 °C	2.3×10^{11}

is to measure the viscosity at different velocity gradients (dv/x) and determine if the viscosity changes. Orientation of the molecules at high velocity gradients will result in a decrease in frictional force and hence lower viscosity. This behavior is often referred to a shear thinning, and was observed to happen for an IgG_1 mAb (Figure 6.3) (Liu, Nguyen, Andya, & Shire, 2005).

The viscosity of a protein/mAbs solution is dependent on the temperature of the solution, concentration, shape, and molecular weight of the macromolecule as well as the interactions between the molecules. At a particular temperature the viscosity