Calculating the Bulk Modulus of a Fluid

ThermophyiscalData:-Property will compute the properties of fluids; these properties include density, enthalpy, viscosity and more.

However, some properties are not computable out-of-the box; these include the isothermal bulk modulus a fluid. Bulk modulus is defined as

$$K = \rho \frac{dP}{d\rho}$$

So to compute the bulk modulus we need to calculate the

- fluid density
- and the numeric derivative of pressure with respect to density (at constant temperature).

This procedure accepts a temperature, pressure and fluid, and calculates the bulk modulus. Numerical derivatives are computed with fdiff.

> *restart* :

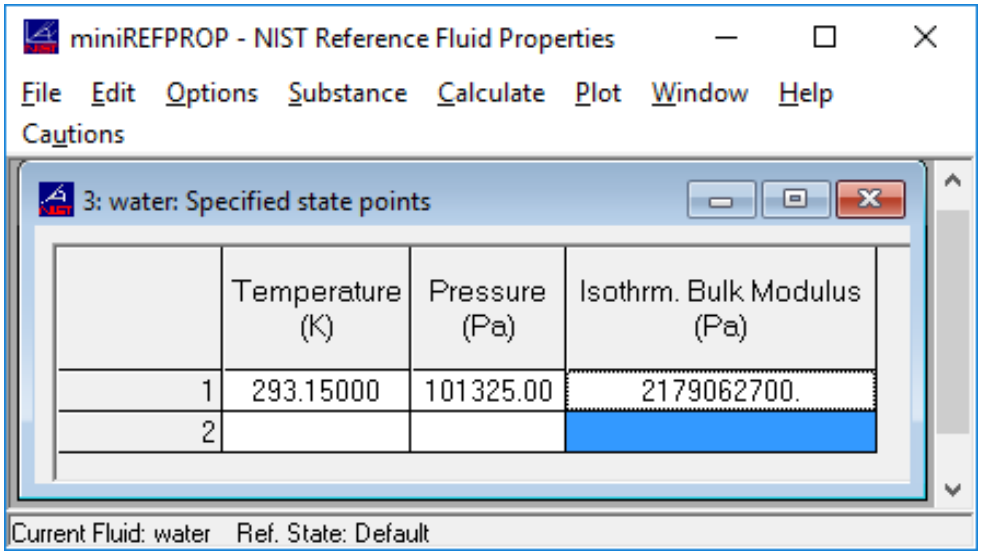
```
BulkModulus := proc(temp, press, fluid)

   local rho:
   uses ThermophysicalData:

   rho := Property(density, temperature = temp,
                   pressure = press, fluid);
   return rho*fdiff(Property(P, density = D,
                  temperature = temp, fluid), D = rho);

end proc:
```

Hence the bulk modulus of water at 20°C and 1 atm is

> *BulkModulus*(293.15, 101325, *water*)

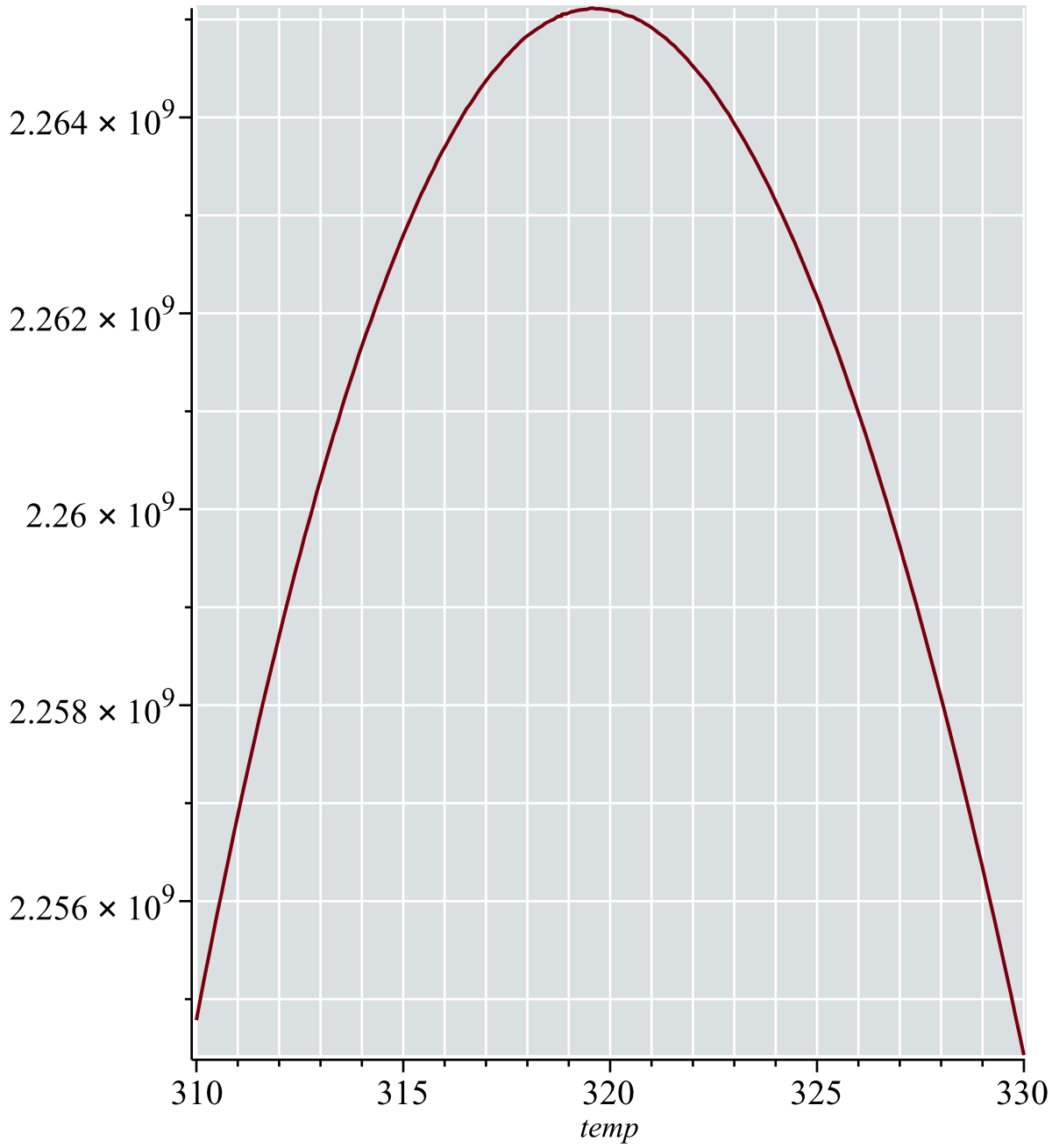
$$2.17905765310^{9} \quad \textbf{(1)}$$

This value closely matches that given by miniREFPROP , as illustrated in the screengrab below



This plot demonstrates that the bulk modulus of water is at a maximum when the temperature is about 320 K

> *plot*('*BulkModulus*'(*temp*, 101325, *water*) , *temp* = 310 ..330, background = ColorTools:-Color("RGB", [218 / 255, 223 / 255, 225 / 255]) , axis = [gridlines = [color = ColorTools:-Color("RGB", [1, 1, 1])]], *size* = [800, 500])


2.264 × 10^9
2.262 × 10^9
2.26 × 10^9
2.258 × 10^9
2.256 × 10^9
310
315
320
325
330
temp

>