What is the specific internal energy of compressed liquid water at 3.0 MPa and 60 °C?

SOLUTION:
For this case, there is no table entry for either 3.0 MPa or 60 °C so we must linearly interpolate with respect to both temperature and pressure (called <u>bilinear interpolation</u>),

$$u_{2.5\text{ MPa},60\text{ °C}} - u_{2.5\text{ MPa},40\text{ °C}} = \left(\frac{u_{2.5\text{ MPa},80\text{ °C}} - u_{2.5\text{ MPa},40\text{ °C}}}{T_{2.5\text{ MPa},80\text{ °C}} - T_{2.5\text{ MPa},40\text{ °C}}}\right)\left(T_{2.5\text{ MPa},60\text{ °C}} - T_{2.5\text{ MPa},40\text{ °C}}\right), \quad (1)$$

$$u_{5.0\text{ MPa},60\text{ °C}} - u_{5.0\text{ MPa},40\text{ °C}} = \left(\frac{u_{5.0\text{ MPa},80\text{ °C}} - u_{5.0\text{ MPa},40\text{ °C}}}{T_{5.0\text{ MPa},80\text{ °C}} - T_{5.0\text{ MPa},40\text{ °C}}}\right)\left(T_{5.0\text{ MPa},60\text{ °C}} - T_{5.0\text{ MPa},40\text{ °C}}\right),$$

$$u_{3.0\text{ MPa},60\text{ °C}} - u_{2.5\text{ MPa},60\text{ °C}} = \left(\frac{u_{5.0\text{ MPa},60\text{ °C}} - u_{2.5\text{ MPa},60\text{ °C}}}{p_{5.0\text{ MPa},60\text{ °C}} - p_{2.5\text{ MPa},60\text{ °C}}}\right)\left(p_{3.0\text{ MPa},60\text{ °C}} - p_{2.5\text{ MPa},60\text{ °C}}\right),$$

where,

$u_{2.5\text{ MPa, 40 °C}}$ = 167.25 kJ/kg
$u_{2.5\text{ MPa, 80 °C}}$ = 334.29 kJ/kg
$u_{5.0\text{ MPa, 40 °C}}$ = 166.95 kJ/kg
$u_{5.0\text{ MPa, 80 °C}}$ = 333.72 kJ/kg
$T_{2.5\text{ MPa, 40 °C}}$ = $T_{5.0\text{ MPa, 40 °C}}$ = 40 °C
$T_{2.5\text{ MPa, 60 °C}}$ = $T_{5.0\text{ MPa, 60 °C}}$ = 60 °C
$T_{2.5\text{ MPa, 80 °C}}$ = $T_{5.0\text{ MPa, 80 °C}}$ = 80 °C
$p_{2.5\text{ MPa, 60 °C}}$ = 2.5 MPa
$p_{3.0\text{ MPa, 60 °C}}$ = 3.0 MPa
$p_{5.0\text{ MPa, 60 °C}}$ = 5.0 MPa

$\Rightarrow u_{2.5\text{ MPa, 60 °C}} = 250.77$ kJ/kg, $u_{5.0\text{ MPa, 60 °C}} = 250.34$ kJ/kg $\Rightarrow$ $\boxed{\upsilon_{3.0\text{ MPa, 60 °C}} = 250.68\text{ kJ/kg}}$

Note that the same result would be achieved if we interpolated first with respect to pressure and then with respect to temperature.

TABLE A-5

Properties of Compressed Liquid Water

T °C	$v \times 10^3$ m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	$v \times 10^3$ m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K
	p = 25 bar = 2.5 MPa (T_{sat} = 223.99°C)				p = 50 bar = 5.0 MPa (T_{sat} = 263.99°C)			
20	1.0006	83.80	86.30	.2961	.9995	83.65	88.65	.2956
40	1.0067	167.25	169.77	.5715	1.0056	166.95	171.97	.5705
80	1.0280	334.29	336.86	1.0737	1.0268	333.72	338.85	1.0720
100	1.0423	418.24	420.85	1.3050	1.0410	417.52	422.72	1.3030
140	1.0784	587.82	590.52	1.7369	1.0768	586.76	592.15	1.7343
180	1.1261	761.16	763.97	2.1375	1.1240	759.63	765.25	2.1341
200	1.1555	849.9	852.8	2.3294	1.1530	848.1	853.9	2.3255
220	1.1898	940.7	943.7	2.5174	1.1866	938.4	944.4	2.5128
Sat.	1.1973	959.1	962.1	2.5546	1.2859	1147.8	1154.2	2.9202

Pressure Conversions:
1 bar = 0.1 MPa
= 10^2 kPa

H_2O

(Table from Moran et al., 7th ed.)