How does boiling point change with pressure?

Education in Chemistry
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On the International Space Station (ISS) the crew's urine is processed through a distillation process called vapour compression distillation. This system uses a vacuum pump that sucks out air, lowering the pressure and therefore dropping the boiling point of the water inside.

In this activity you will investigate how the boiling point of water changes with absolute pressure and determine the vacuum needed in order that the water can be distilled on the ISS without the need for a heat source.

1. The table gives the boiling point of water at different pressures.

Plot the data on graph paper.

Draw a line of best fit.

Absolute pressure in mmHg	Boiling point of water in °C
0	0
15	18
25	27
55	40
100	52
200	67
355	80
500	89
760	100
827	102
931	106
1034	109
1241	114

Data taken from www.engineeringtoolbox.com

2. Describe the trend shown by the data.

3. The average temperature on the ISS is approximately 24°C.

a. State the absolute pressure at which the boiling point of water is 24°C.

b. Calculate the vacuum that must therefore be applied to distil the water from the crew's urine without the need for a heat source.

vacuum applied in mmHg = 760 mmHg – absolute pressure in mmHg

Answers

1. Suitable graph drawn (x-axis: Absolute pressure in mmHg; y-axis: Boiling point of water in °C) and curve of best fit drawn.

2. As the pressure increases the boiling point of water increases.

The relationship is non-linear with the change in boiling point increasing dramatically with small increases in pressure at low pressure, but the effect becoming smaller as the pressure increases. For example, an increase in pressure from 100 to 200 mmHg results in an increase in the boiling point of water of 15°C (from 52°C to 67°C) whereas an increase in pressure from 800 to 900 mmHg only increases the boiling point of water by 3°C (from 102°C to 105°C).

3. a. approx. 23 mmHg

b Vacuum = 760 mmHg – 23 mmHg = 737 mmHg