Three devices

Energy contained in geothermal water that is heated deep underground can be used in a number of devices that require heat.

Locate and open the interactive learning object, *Using geothermal energy*. Select **Start** and explore features of the desalinator before answering the questions below.

Part 1: Desalinator

1. Describe what happens to geothermal water as it flows through the desalinator.

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2. Describe what happens to seawater as it passes from the evaporator through the condenser.

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3. Explain how latent heat is utilised in the desalinator.

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4. Why can geothermal water at a temperature less than 100 °C vaporise seawater? Explain your answer.

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5. Explain the physics behind a design feature that boosts the efficiency of the desalinator.

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6. Why are water droplets removed from steam coming from the evaporator?

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7. Concentrated brine is returned to the sea after water has been extracted in the evaporator. Why is the composition of seawater near the desalination plant carefully monitored?

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8. Estimate the quantity of energy required by a desalinator that produces 130 million litres of fresh water each day, if seawater boils at 70 °C due to reduced operating pressure.

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Part 2: Refrigerator

A refrigerator uses the latent heat of vaporisation of a refrigerant liquid to produce a cooling effect. The refrigerant is usually a gas that can be liquefied easily when subjected to high pressures in the compressor. Modern refrigerators use tetrafluoroethane (HFC-134a) as the refrigerant. This has taken the place of harmful chlorofluorocarbons (CFCs) used in older refrigerators.

Select **Next** in the interactive learning object, *Using geothermal energy*, and explore the features of the refrigerator before answering the questions below.

9. What changes do refrigerant particles experience as they: (a) enter the compressor; and (b) pass into the space beyond the expansion valve?

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10. Explain energy changes that lead to changes in temperature as refrigerant particles: (a) enter the compressor; and (b) pass into the space beyond the expansion valve?

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11. Would a gas such as nitrogen be suitable as a refrigerant? Explain your answer.

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12. What is the main advantage of using a gas such as tetrafluoroethane as the refrigerant?

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13. Explain the role of latent heat in the absorption of heat from food stored in a refrigerator cabinet.

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14. Where does energy to drive the compressor come from?

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15. Why is it not possible to cool down a kitchen by leaving the refrigerator door open?

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Part 3: Chiller

The chiller produces a cooling effect in a different way to a refrigerator. The refrigerant in the chiller is water in a lithium bromide solution. Water is separated from the lithium bromide solution in the **condenser** unit, and recombined with lithium bromide solution in the **absorber**. Lithium bromide solution readily absorbs water, even when water is in the vapour phase, to produce a partial vacuum.

Select **Next** in the interactive learning object, *Using geothermal energy,* and explore the structure and operation of the chiller before answering the questions below.

16. How does warm geothermal water contribute to the overall operation of a chiller?

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17. Briefly explain the function of the generator.

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18. The generator and condenser operate simultaneously in a low-pressure region. How does the low-pressure region assist in vaporisation of water from the dilute lithium bromide solution?

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19. Why is water separated from the lithium bromide solution?

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20. How does spraying water from the condenser over water pipes in the evaporator produce a chilling effect?

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21. Why is it necessary to keep the evaporator chamber at a very low pressure (0.8 mPa)?

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22. Briefly explain the function of the evaporator.

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23. How does the water-absorbing property of lithium bromide solution help in operation of the chiller?

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24. Why is cold water from the cooling tower circuit used in the absorber chamber?

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25. Briefly explain the function of the absorber.

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26. Explain why the generator and condenser units are paired within one pressure chamber, and the evaporator and absorber units are paired within another pressure chamber.

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27. The cooling towers for the chiller are similar to those used in conventional power stations. Describe similarities in operation of cooling towers in both situations.

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28. The chiller relies upon the concept of latent heat of vaporisation for its operation. At which stage(s) in the cycle does the concept contribute directly to the process? Explain your answer.

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29. Briefly explain the function of the condenser.

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30. Some chillers use steam instead of warm geothermal water. Would you expect the efficiency of the chiller to be greater, less or the same compared to using warm water? Explain your answer.

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