

Ammonia: Questions

1. This question is about the Haber process.

(a) The list gives substances used or produced during the process.

air ammonia carbon dioxide iron natural gas
potassium carbonate (alkali) water

Use substances from this list to answer the following questions.

(i) What are the three raw materials used in this process?

_____ [1]

(ii) Name a by-product of the process.

_____ [1]

(iii) What could be used to remove this by-product from the mixture of gases?

_____ [1]

(iv) What is the name of the catalyst used in the Haber process?

_____ [1]

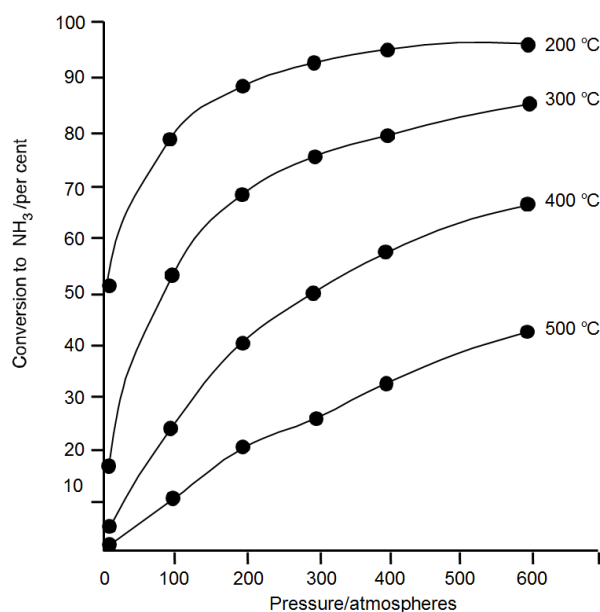


Figure: The equilibrium conversion to ammonia under different conditions.

(b) The graph shows the yield of ammonia produced at equilibrium under different conditions of temperature and pressure.

(i) If the conditions are 200 atmospheres and 425 °C, what yield of ammonia is obtained at equilibrium?

_____ [1]

(ii) In practice, the yield obtained in the plant under these conditions is 15%. Suggest why this is so.

_____ [1]

(iii) What would be the effect on the yield of ammonia of increasing the pressure?

_____ [1]

(iv) Suggest why the process is not operated at even higher pressures.

_____ [1]

(v) What would be the effect on the yield of ammonia of decreasing the temperature?

_____ [1]

(vi) Suggest why the process is not operated at even lower temperatures.

_____ [1]

(c) Ammonia is removed from the mixture of ammonia, nitrogen and hydrogen gases. The table gives the boiling points of the three gases at atmospheric pressure.

Gas	Boiling point/°C
Nitrogen	-196
Hydrogen	-253
Ammonia	-33

(i) Use these data to explain how ammonia can be removed from the mixture of gases at atmospheric pressure.

_____ [1]

(ii) The boiling points of these gases are higher at higher pressure. Use your knowledge of particles to explain this.

_____ [2]

(iii) Some of the ammonia is distributed as liquid ammonia by road using tankers.

Suggest an advantage of distributing ammonia as a liquid rather than as a gas. Use your knowledge of particles in your answer.

_____ [2]

(d) The air contains noble gases such as argon. What happens to these noble gases during the process?

_____ [1]