Prior to the turn of the century, farming was restricted due to lack of fertilizer. All fertilizer was animal (manure) base. It was in such high demand the ships were sent to the bird colonies of the coast of Chile to "mine" bird guano built up over hundreds of years.


Fritz Haber, a German chemist, looked into making ammonia from atmospheric nitrogen (called fixing nitrogen). Ammonia (NH₃) is then easily converted to nitrates (NO₃⁻ compounds) which is fertilizer.

The Haber process reaction:

\[
4 \text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g}) + 92 \text{kJ}
\]

Let's see if you can replicate Haber's solution to making ammonia:

29 (a) In order to get the highest yield of NH₃, should you use high or low pressure?

\[\text{Pressure} \rightarrow \text{products (} \uparrow \text{NH}_3)\]

(b) In order to get the highest yield of NH₃, should you use high or low temperature?

\[\text{Low Temp} \rightarrow \text{products (} \uparrow \text{NH}_3)\]

(c) In order to have the fastest reaction rate, should you use high or low temperature?

\[\text{High Temp} \rightarrow \text{fast R.H.}\]
(d) Look at your answers to (a) and (b), what problem exists? Suggest a suitable compromise to solve this problem.

\[ \begin{align*}
0^\circ \text{C} & \quad \text{Low Temp} \rightarrow \text{max. yield NH}_3 \\
100^\circ \text{C} & \quad \text{High Temp} \rightarrow \text{max. reaction rate}
\end{align*} \]

\( \rightarrow 500^\circ \text{C} \) compromise

(e) What else might be done to speed up the reaction rate? Industry uses iron oxide from ground up old cars for this purpose.

\[ \begin{align*}
\uparrow \text{R.R.} \quad \downarrow \text{catalyst!}
\end{align*} \]

As a result of this process cheap and effective fertilizer was and is being made. It is due to this fertilizer that the production of food has gone way up and of course so has human population.

On another note:

Nitrites can also be used to make very effective explosives. In fact WW I was prolonged because both sides had access to more powerful explosives (shells, bombs, bullets etc) than ever before. Nitrites are still used to make some types of explosives! @