The Haber process

MAGS Hey. I'm Mags and this is Cal. Cal.

CAL Hey, you can't hurry a good reaction. This episode Mags has made a video about ammonia and the Haber process. I need to get ready for my hot date.

MAGS I think you need a 'Cal process' to make you ready. Here's my video. Comb your hair.

CAL I have.

MAGS You'd find ammonia in my hair, because it's in hair dye, and also fertilisers, cleaning fluids, even explosives. So how's ammonia produced, I hear you ask.

Molecules of nitrogen, which comes from the air, and hydrogen, are mixed in a reaction called the Haber process. And it's a reversible reaction, so the arrows go in both directions.

Our Auntie Trish works at a factory making ammonia for fertilisers. It's a growth industry. Because fertiliser grows things. Check it out…

Wow, this looks expensive.

TRISH Yup, this factory spends a lot of money, especially on the energy bill.

The energy cost goes up if we use a higher temperature. Environmental factors also need to be considered.

The two main factors affecting the chemical reaction here are temperature, and pressure.

MAGS So, heat up the nitrogen and hydrogen, increase the pressure, then…

TRISH Molecules move faster, and collide more, then it's 'ammonia o'clock'.

MAGS Is that an actual time?

TRISH — No. We also speed up the reaction with a catalyst – with the Haber process, that's iron. We need to replace the iron over time as it gets poisoned.

Now, the forward reaction in the Haber process is exothermic. Which means…

MAGS — …if it's too hot the ammonia turns back to hydrogen and nitrogen.

TRISH — Exactly. The reaction's a two-way street, and we're now reversing. Away from Ammonia-ville, which before you ask, is not an actual place.

MAGS — And if the temperature's too low, the rate of reaction will also be low?

TRISH — Making the process longer and more costly. So we want a compromise temperature, between 350°C and 450°C. Low enough for a good yield of ammonia, but high enough for a fast reaction rate. Unreacted hydrogen and nitrogen go back through the system for another try.

A really high pressure will increase the energy costs too, but too low and the reaction will be slow. So the compromise pressure we use is between 150 and 200 atmospheres.

MAGS — Fair play, Auntie Trish. You'd better get back to work. Don't want you under pressure.

CAL — So, temperature and pressure need to be at the optimum rate to keep production as economical as possible.

MAGS — Yeah. Speaking of which, if you want to get a reaction, put yourself under less pressure, and stay cool.