Nitric Acid: Teacher Notes

Catalyst gauzes

Each catalyst gauze is worth several thousand pounds. The gauzes are supported inside the burner on a steel mesh.

Catalyst recovery

Small amounts of catalyst metals are carried from the burner. These are valuable, and precautions are taken to remove them from the gas stream and recycle them along with the spent catalyst gauze.

Equilibria

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \quad \Delta H = -115 \text{ kJ mol}^{-1}$$

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \quad \Delta H = -58 \text{ kJ mol}^{-1}$$

Ideally the positions of both these equilibria should be as far to the right as possible. This can be achieved by:

- Cooling them. Since both reactions give out heat as they go from left to right, cooling the reaction mixtures displaces the equilibria to the right (as predicted by Le Chatelier's principle).
- Increasing the pressure. Since both reactions have fewer molecules of gas on the right, increasing the pressure displaces them to the right (as predicted by Le Chatelier's principle).

So the gases emerging from the burner (which contain excess air) are cooled and, on some plants, compressed further. The heat energy recovered is used to raise steam.

Bleaching the acid

After absorption, the nitric acid is green/brown due to the presence of dissolved nitrogen dioxide and dinitrogen tetraoxide. The green/brown acid passes down a bleaching tower as a current of air passes upwards. This removes the nitrogen oxides to leave colourless acid. The mixture of air and nitrogen oxides is passed back to the absorption tower for reaction with water to make more nitric acid.

Waste gases

Most of the gas discharged from the stack is nitrogen containing small amounts of nitrogen oxides (NO_x) which is mainly in the form of nitrogen dioxide, as nitrogen monoxide reacts with oxygen:

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$$

The amount discharged is monitored by the plant and reported to the Environment Agency. Typically, it is less than 120 parts per million (ppm) of NO_x.