Longford - the Normal Process and the Accident Sequence

(Text from Appendix to Hopkins, A. "Lessons from Longford; the Esso Gas Plant Explosion", CCH, 2000)

This appendix provides a more coherent description of the normal process and the accident sequence than is provided in the text. It is nevertheless a simplified version designed for non-technical readers. Those wanting more detail are referred to the report of the Royal Commission.

The normal process

The Longford complex consists of three gas plants and a crude stabilisation plant. These four plants are interconnected, as the processing of gas produces some liquids which are then further processed in the crude stabilisation plant. Similarly, the processing of crude oil in the stabilisation plant produces some gas which is then fed to the gas plants for final processing before sale.

The gas coming ashore from the Bass Strait platforms contains significant amounts of hydrocarbon liquids (condensate) and water. In order to meet the specified quality for sales gas, it is necessary to process the gas to remove all the water and most of the liquifiable components (LPG), and also to remove hydrogen sulphide, a noxious gas present in very small quantities.

The liquids arriving at Longford in the gas stream are removed in a system of large pipes called slugcatchers and all traces of water and hydrogen sulphide are then removed by so-called molecular sieves which preferentially extract these compounds from the gas stream. The LPG components then have to be removed.

Gas plant 1 uses a refrigerated lean oil absorption process for this purpose, so-called because lean oil (a light oil similar to aviation kerosene) is circulated at low temperature over trays in a tower, called an absorber, to extract the LPG components from the gas stream which is passing up the tower. The lean oil is enriched by the LPG which it extracts and is then called rich oil. The processed gas from the top of the tower is piped away for sale and the cold, rich oil leaves the absorber and is heated by passing through several heat exchangers before being distilled to recover the LPG as a marketable product. Having had the LPG components stripped from it, the rich oil becomes lean oil and is circulated back through the system of heat exchangers to return to the absorber as cold, lean oil.

Because the gas entering the absorber is refrigerated, some of the LPG components in it are condensed and this condensate is removed from the gas stream in a separate compartment on the bottom of the absorber before the gas passes up into the main part of the absorber.

The accident sequence

The night before the accident there had been a larger than usual flow of liquids into the plant from offshore. The result was a build-up of the level of condensate in the absorber. The volume of condensate could be controlled to some extent by raising its temperature. However an automatic valve which controlled the temperature, known as TRC3B, was not working properly and operators were using a manual by-pass valve. For reasons discussed in the text, they did not keep the temperature high enough and the build up of condensate continued. The outflow through the condensate outlet was too great for the downstream reprocessing so the outflow rate was automatically reduced. The level of condensate in the absorber tower then rose so high that it went off scale, that is, beyond the point where operators could monitor it. In fact it rose to the point where it overflowed into the rich oil stream.

The presence of condensate in the rich oil stream caused the rich oil to become much colder than normal. This caused an upset in processing equipment downstream which in turn led to an automatic shutdown of pumps which maintained the lean oil flow.

Operators were unable to restart these pumps and they remained shutdown for hours.

Because the circulation of warm lean oil had stopped, two of the heat exchangers became abnormally cold and a thick layer of frost formed on their exterior pipework. The temperature dropped below the design limit and the metal in one exchanger contracted to the point that it began to leak oil onto the ground. Unsuccessful attempts were made to fix this leak by tightening certain bolts. Operators decided to stop the flow into GP1 at this point to try to deal with the situation. This stopped any further flow of cold condensate within the plant. But operators did not depressurise the plant. Rather, they decided to try again to restart the pumps to rewarm the heat exchanger. This was a critical error. The metal in the vessel by this time was so cold that it was brittle and it needed time to thaw out before being rewarmed. Operators succeeded in restarting the pumps and the reintroduction of warm liquid caused fracturing and catastrophic failure of one of the heat exchangers. A large quantity of volatile liquid and gas escaped and was ignited by a nearby ignition source.

See illustrations overleaf

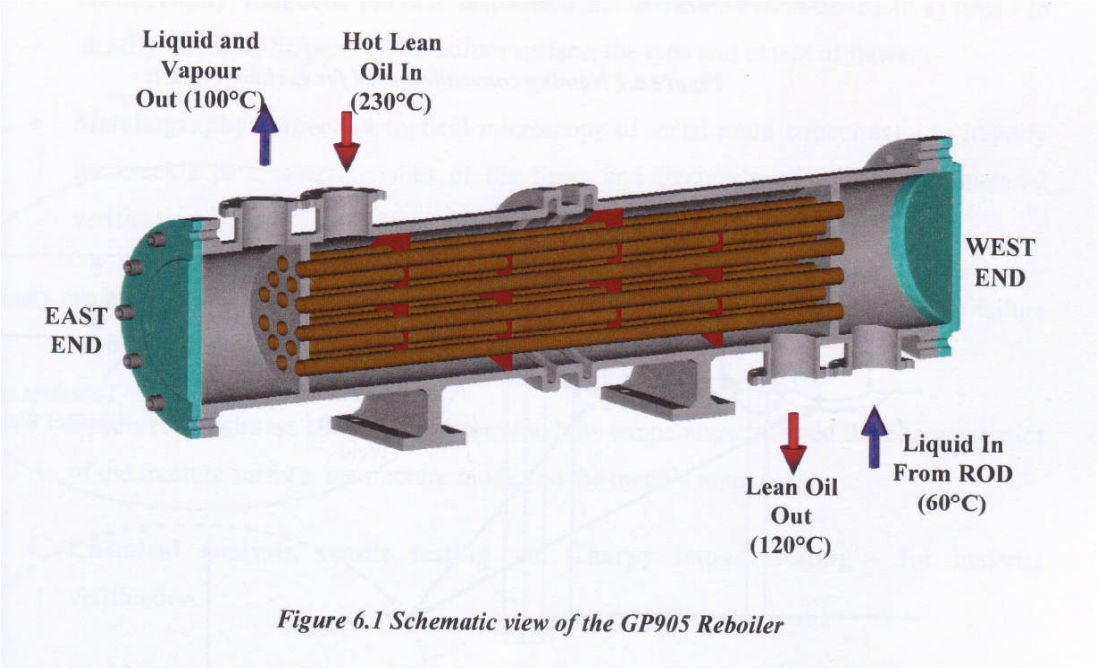

Figure 6.1 Schematic view of the GP905 Reboiler

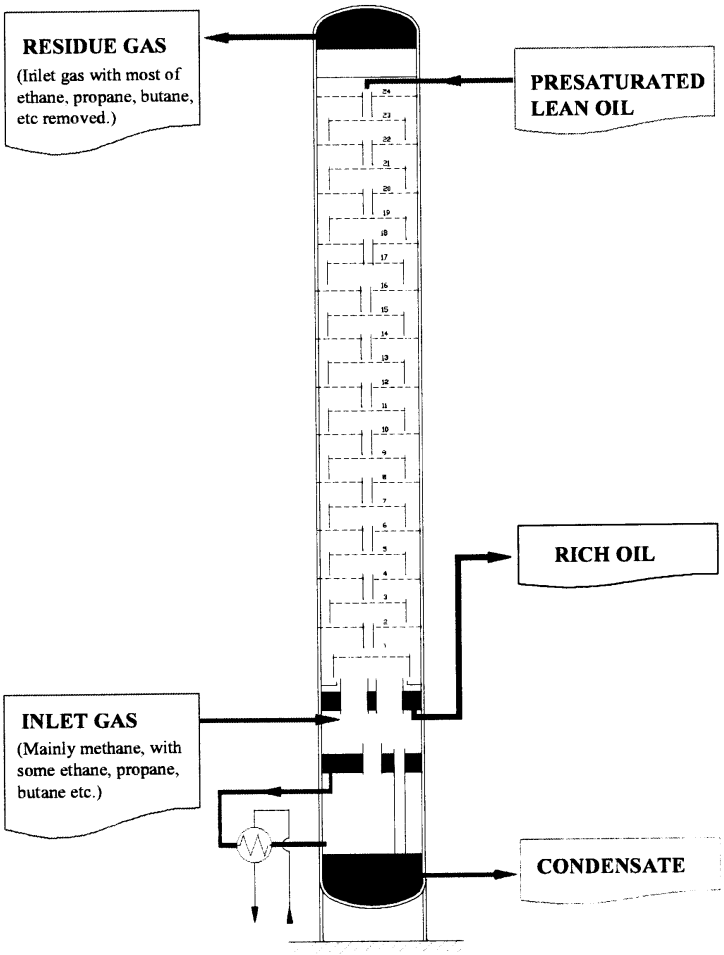

Figure 2.5 Schematic diagram of an absorber

Illustrations from Dawson, D.M. and Brooks, B.J. “The Esso Longford Gas Plant Accident: Report of the Longford Royal Commission”, Victorian Government, 1999.