Reactor, Boiler & Auxiliaries - Course 133

ANNULUS GAS SYSTEM

The purpose of the annulus gas system is to provide thermal insulation between the hot coolant channels and the relatively cool calandria tubes and surrounding moderator, to reduce heat losses from the channels.

At Pickering, for example, the amount of heat actually lost from the channels to the moderator is about 2.6 MW(th).

Important operating features of the gas annulus system will then be to:

(a) prevent corrosion of coolant tubes, calandria tubes and garter spring spacers.

(b) maintain low radiation fields in the gas system.

(c) provide an indication of leaking calandria or pressure tubes.

CHOICE OF GAS

CANDU units use three different gases for this system. (Helium is not among the choices because of its high thermal conductivity and high cost.)

Air

NPD and Douglas Point both use air in the annular space which forms part of the vault air circulating system. This is effectively a closed loop system but the large vault volume results in some air leakage so provision is made to exhaust the equivalent in leakage out through the stack. Disadvantages of the use of air are the radiation fields in the system from A-41 and the possibility of corrosion with the presence of oxygen, nitrogen and water vapour. Water vapour is kept to a minimum by vault air driers.

Nitrogen

Pickering uses nitrogen which avoids the corrosion and radiation problems mentioned above. The system is now separate from the vault circulation system and forms its own closed circulating system, which has the advantage of retaining any leaking D_2O within its own system.

Carbon Dioxide

At Bruce and in the 600 MW(e) units CO_2 rather than N_2 is used. The reasons are the possibility of forming corrosive nitric acid in a wet annulus and the C-14 hazard. However, Pickering does not appear to have had a nitric acid problem even after experiencing leaking tubes in 74/75. The C-14 hazard also does not seem to have caused any concern. With CO_2 there is still a potential corrosion problem if it contains above 0.01% O_2, however.

SYSTEM EQUIPMENT

A simplified flow diagram of a typical closed system is shown in Figure 1. Gas flows through the annuli, via inlet and outlet headers through heat exchanger HX1, which cools down the hot outlet gas from ~230°C to ~70°C, to minimize heat damage to the concrete walls conducting the gas piping. HX2 then cools the gas down to ambient temperatures.

A moisture separator MS1 at this heat exchanger outlet provides an indication of the amount of moisture (leakage) in the system. Two 100% compressors then circulate the gas from this point through HX3, which removes compression heat in the gas. The gas then passes through a drier and a filter (to trap any escaping desiccant from the drier) before entering the inlet header to form a closed system.

Gas addition will be from a filling station typically close to the inlet header and overpressure relief will be provided by rupture discs in the headers.

ASSIGNMENT

1. What would be the effect on the gas annulus system of:

   (a) a leaking pressure tube?

   (b) a leaking calandria tube?

2. What steps would be taken to prevent the build up of high radiation fields in the gas annulus system?

D. Winfield

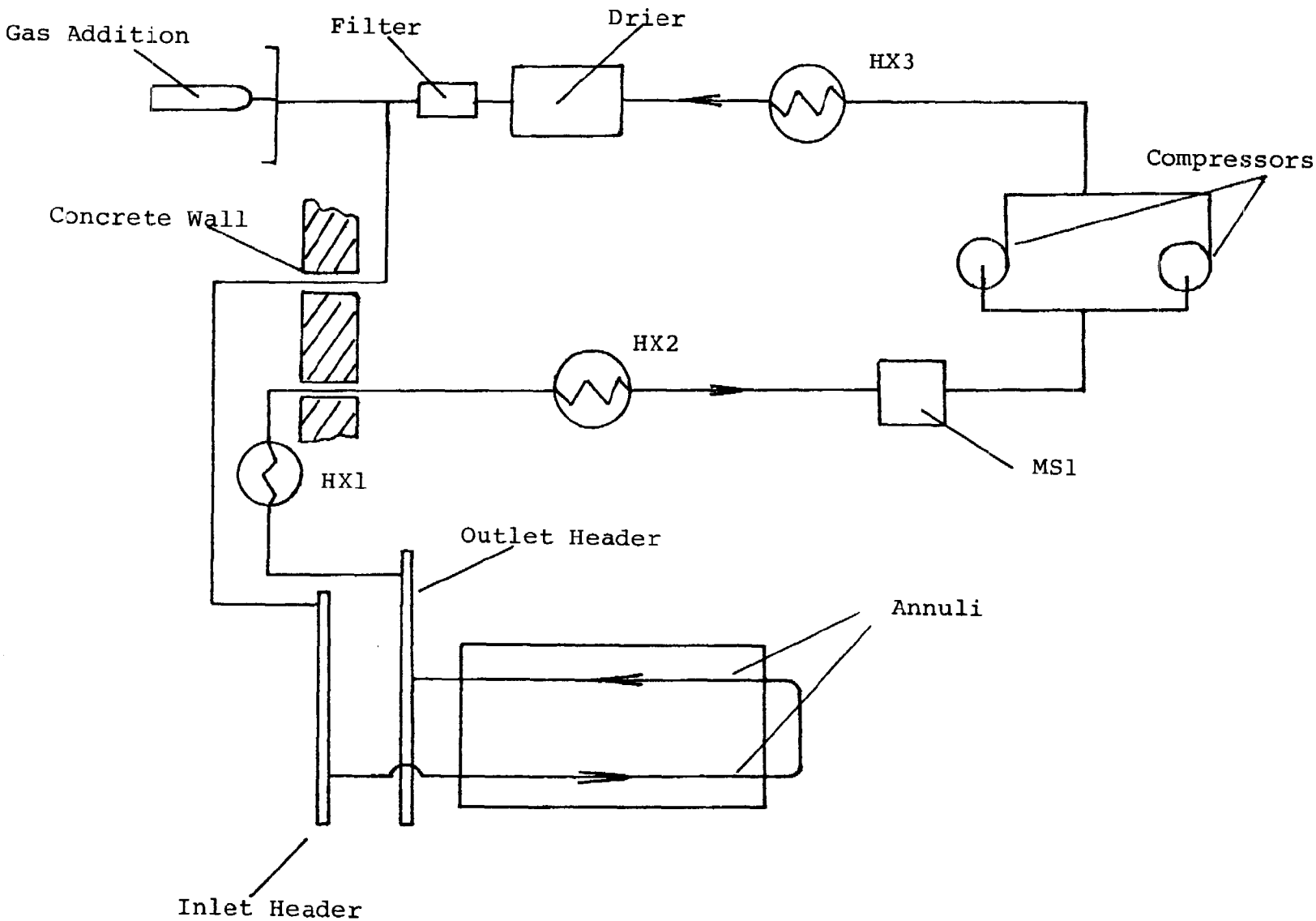

Figure 1: Simplified Gas Annulus System