The Use of Radioactive Sources in Troubleshooting Gas Plant Problems

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Introduction

Liquid carry over in gas treatment facilities can cause major problems in operating gas re-compression trains, gas dehydration systems, and gas sweetening plants. Carry over can be either light in the form of either condensate droplets or oil droplets; or heavy carry over in the form of foam. In addition, with gas condensate operation, retrograde liquid carry over can often influence the operation of the gas treatment plant. All forms of carry over can cause operation problems to a certain degree or another, including damage to compressor seals as well as mechanical damage to the metal parts of the compressor. In addition, gas plant carry over will cause production limitations in the plant.

Poor performance of gas dehydration can be caused by either poor design of the dehydration tower or the poor design of the facilities upstream of the dehydration system. Similar problems can be experienced with the operation of the Sweetening plants.

There are different techniques in identifying and resolving issues associated to gas plant operational problems caused by carry over or poor design of treatment vessels. Among these techniques are modelling, gathering plant data, and gas and liquid sampling. However, it has been demonstrated that the online monitoring of a system where flow behaviour within the pipe work and vessels are assessed and measured, a picture can be established on the real cause of a problem in the form of graphical plots.

This paper will address the online techniques used in trouble shooting carry over problems, to distinguish between the condensate carry over from retrograde condensate as well as determining the flow characteristic of the gas and condensate in process vessels. Consequently, the data generated from these studies together with other evaluation programmes were used to optimise and improve the overall operation of the production facilities.

Type of Radioactive Measurements Technique

Basically there are two basic radioactive measurement techniques, which have been utilised in the industry in assessing carry over, flow behaviour and conditions within the separators. These are based on:

1. Sealed sources which can be used to scan vessels and pipe systems. This technique if applied correctly will provide an internal picture of the conditions within the vessel or the pipe work. This can be in the form of level irregularities, change of flow characteristic, in term of slugging of carry over. The principle of the measurement is based on the Gamma radiation penetrating the metal and any other media inside the metal surface. The level of radiation intensity penetrated through the media will be a function of the density of the media as described in the following equation:

$$I = I_O e^{-rmx}$$

Using the information from the scan, a plot is generated from the measurement and the conditions of the system can be established on the conditions of the system. A typical scan of the glycol contactor with the data generated is illustrated in **Figure 1**.

2. Unsealed sources in the form of radioactive tracers, which can be used to assess carry over, flow regimes and calculating the retention time in the vessels. Radioactive tracers can be either aqueous phase suitable for the water phase, organic tracer suitable for the condensate and gas phase. A typical radioactive study for measuring the retention time in the system is illustrated in **Figure 2**.

Applications for the Sealed Sources in a gas plant

Sealed sources have been used in a number of applications in the gas condensate systems. Some of the applications are:

1. Scanning pipe system in order to determine the level of liquid slugging
2. Changes in the liquid and gas density was used in pipe scan in order to determine the level of carry over from upstream scrubbers
3. Change in liquid gas density was measured to determine poor distribution in split flow systems.
4. Vessel scan was used to determine actual liquid levels in gas condensate separators and scrubbers.
5. Vessel scan was used to determine the level of foam and conditions inside glycol and amine contactors.
6. Vessel scan was used in order to determine the level of icing in cold separator operated below $-30^{O}C$.
7. Scan of lines in order to measure the level of hydrate formation in the lines.

The above applications have been used successfully in determining gas plant problems and consequently the required corrective actions were taken in order to optimise the operation of the plant.

In most cases, the vessel scan as illustrated in **Figure 3** will provide data plotted in a graphical form. The plot will clearly show changes in the density, which is indirectly, reflect on the gas and liquid distribution and demonstrated in **Figures 4A and 4B**. Hydrate detection is used to establish the level and position of hydrate in the pipeline as illustrated in **Figure 5**.

Application of the Unsealed sources in a gas plant

Unsealed sources have been used in gas condensate production facilities in order to determine mal distribution, flow regimes and identify carry over of liquid in the gas phase or gas carry under in the liquid phase. Some of the applications are:

1. Flow regimes and distribution of the different phases in the Glycol and amine contactors.

2. Carry over in condensate stabilising train.
3. Carry over and formation of liquid retrograde in gas plant
4. Gas carry under in process stabilising train
5. Performance of different internal devices, by means of establishing the flow regime within the separators
6. Determine the retention time of different phases in the separator.

Radioactive tracer injection normally applied and monitored through out the gas plant, as illustrated in **Figure 6**.

Both sealed radioactive sources and radioactive tracers have been used in the process. Each technique has its own benefits and limitations. In some cases conventional and other alternative techniques can not be used as effective in determining both qualitatively and semi quantitatively the level of carry over in gas condensate system.

The interpretation of the data is critical in gaining the full benefit of any study. In general, the data can be quantified to a certain degree if a known base line and reference points are established. This was proven to be very challenging task, but with careful planning, a base line and reference point readings can be established.

Figure 1: Vessel scan of the Glycol contactor and the interpretation of the data

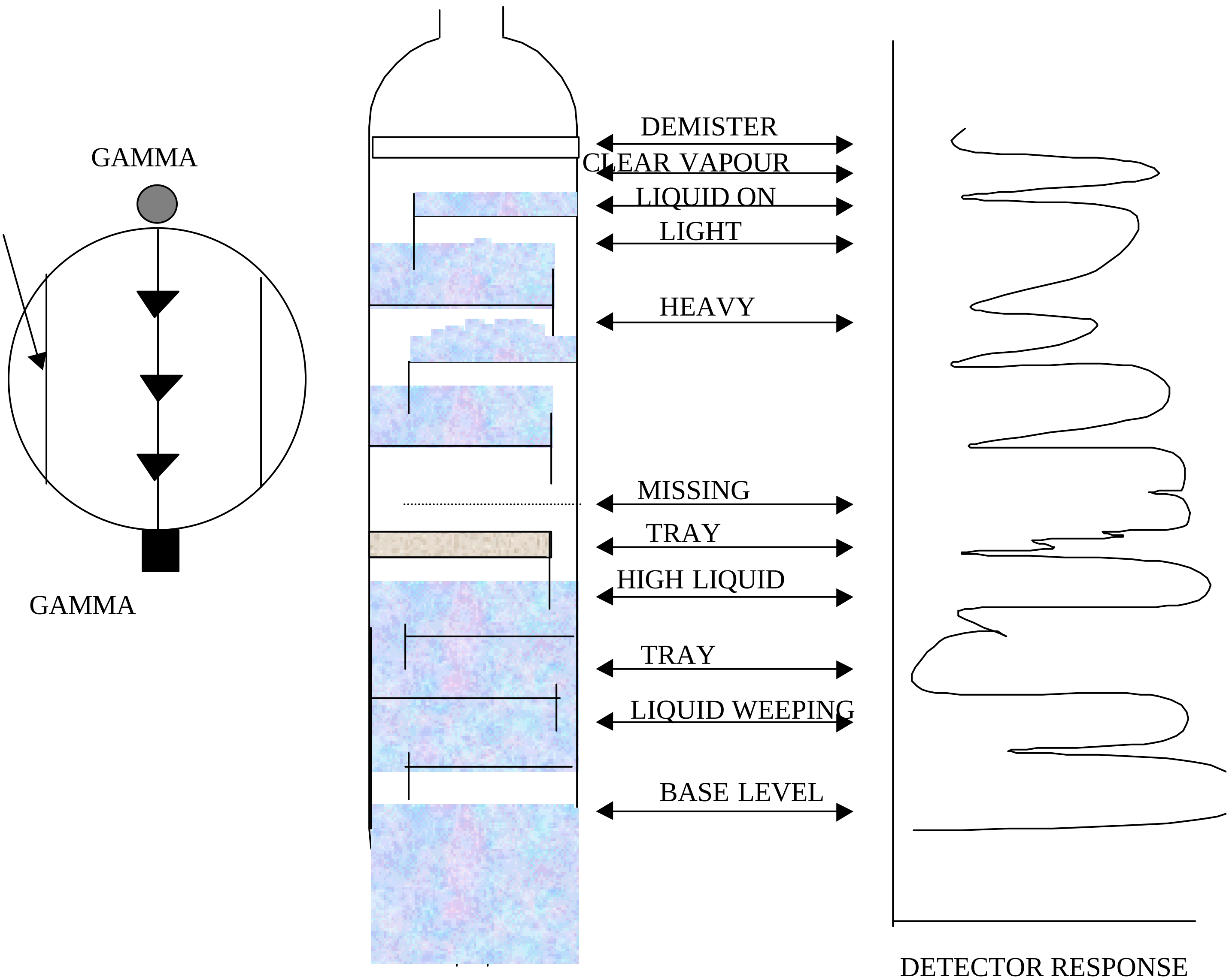

Figure 2: Radioactive tracer applied in process system in order to establish flow regimes, carry over and retention time

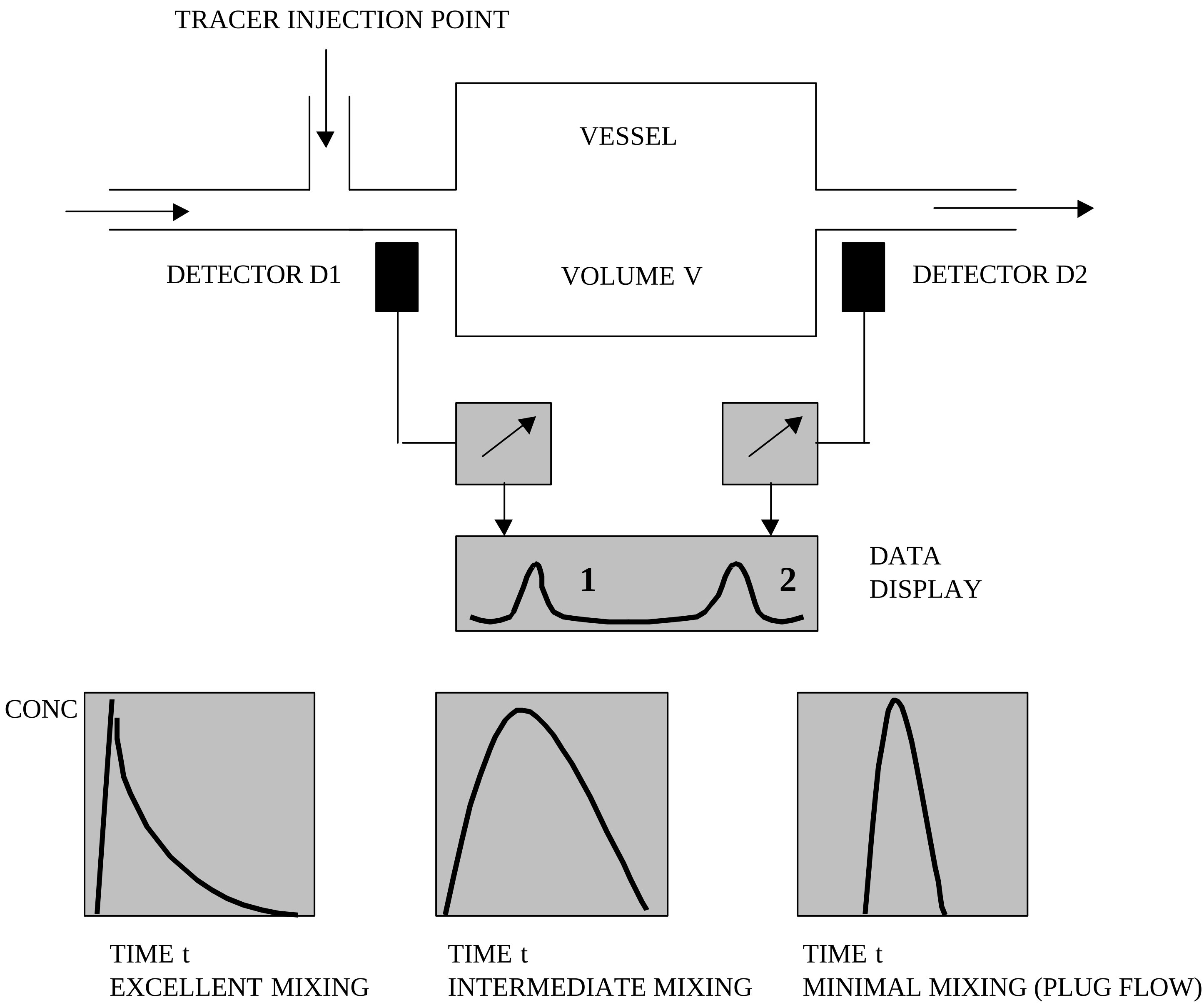

Figure 3: Typical scan configuration for vessels or pipe line

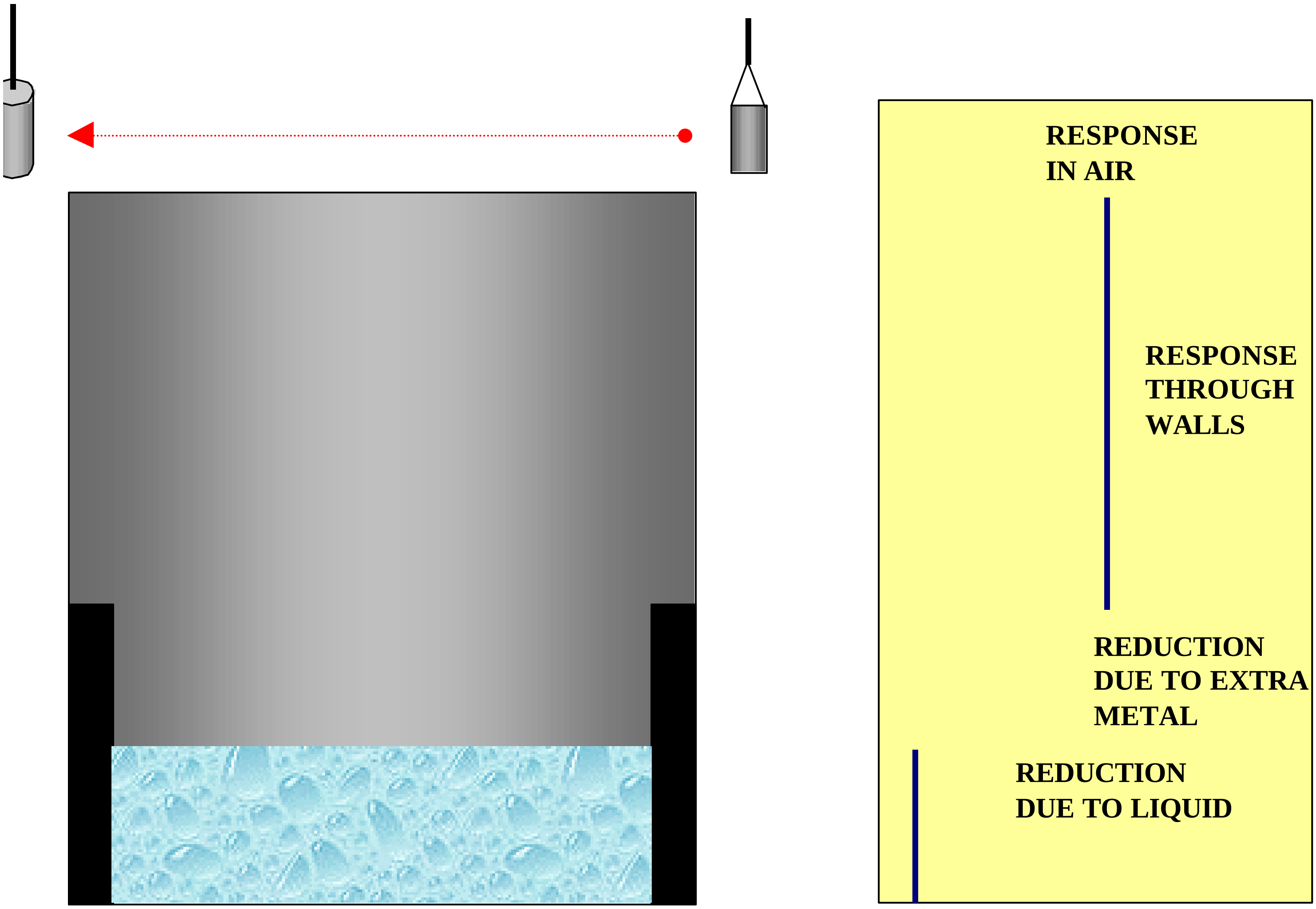

Figure 4A; The plot generated from a vessel scan which then can be interpret to liquid and foam levels

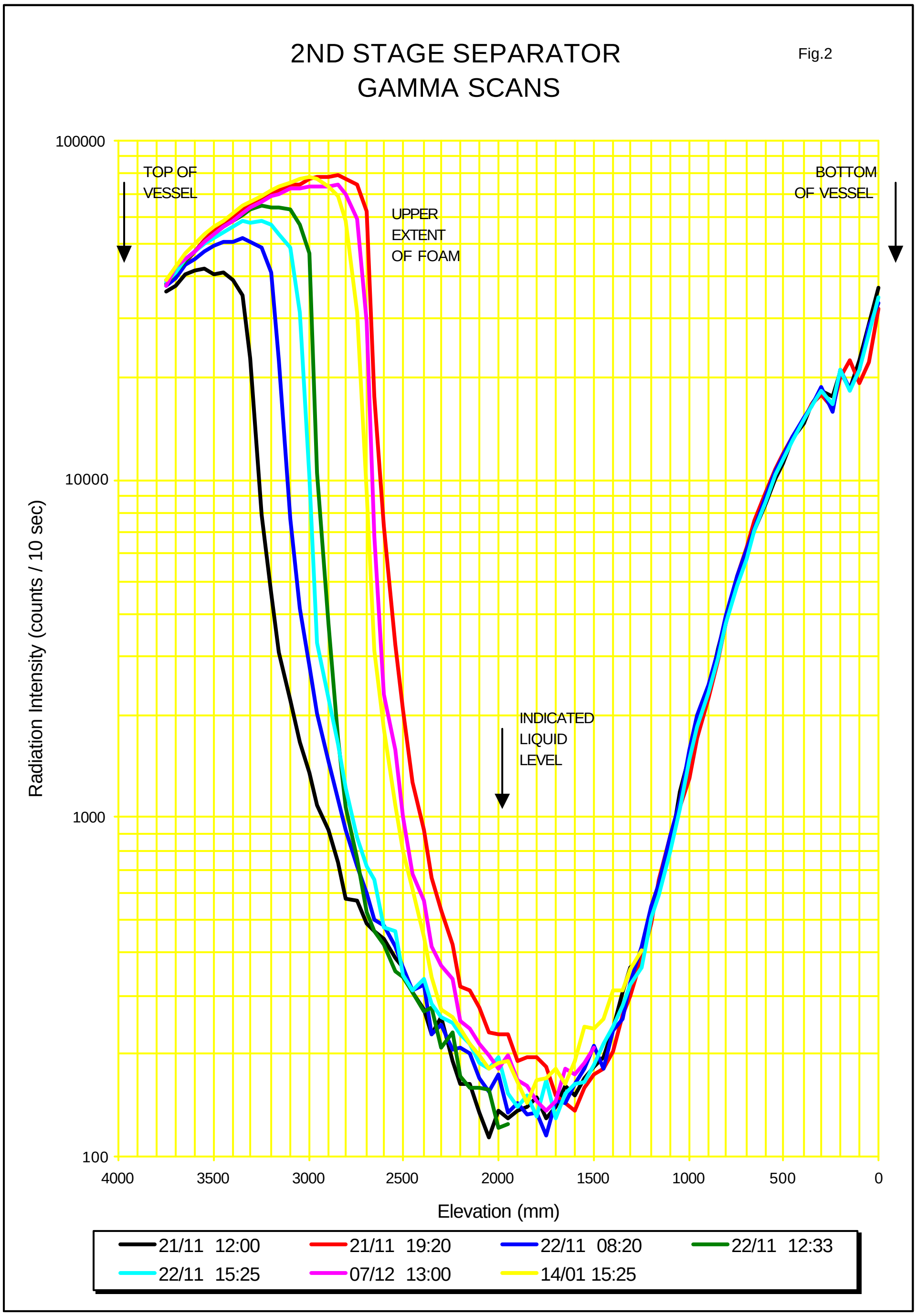

Figure 4B: The Profile established from Vessel Scan

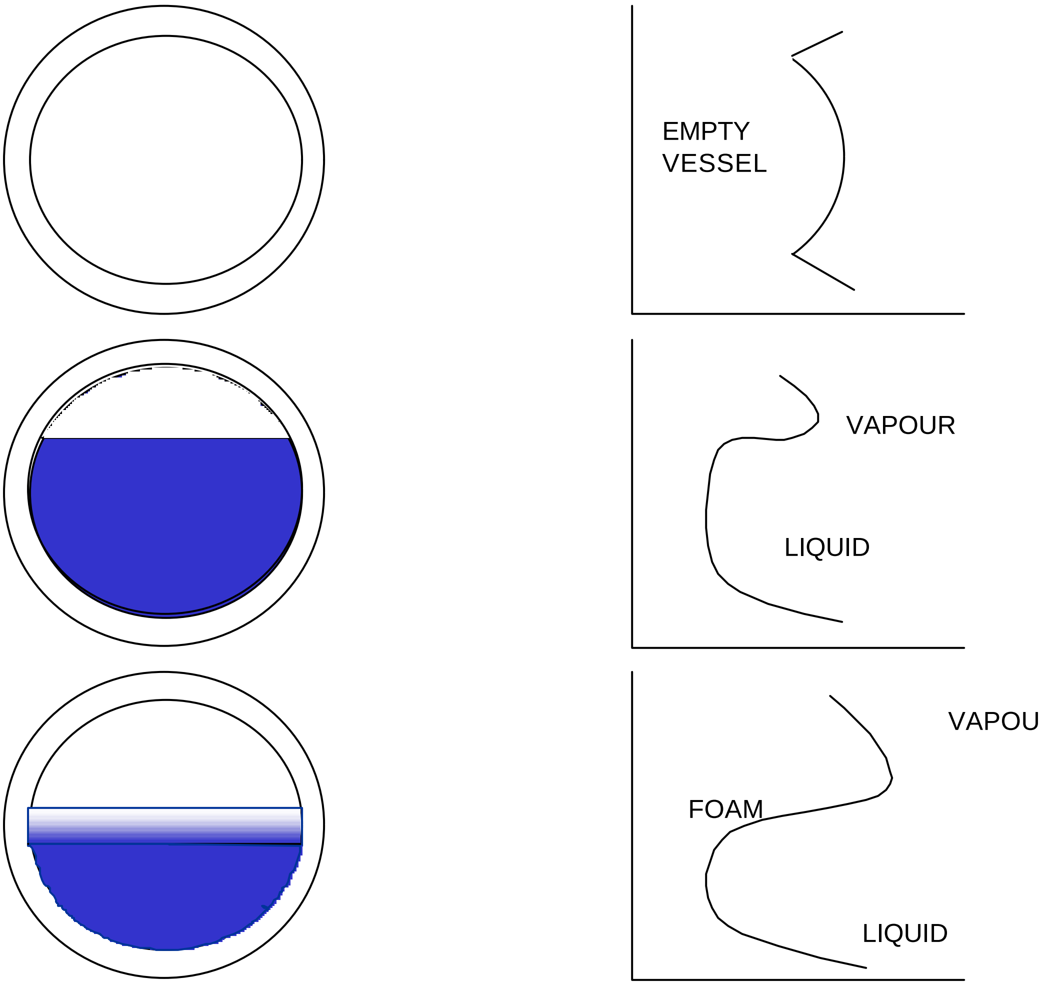

Figure 5: Detection as a function of density in the pipeline

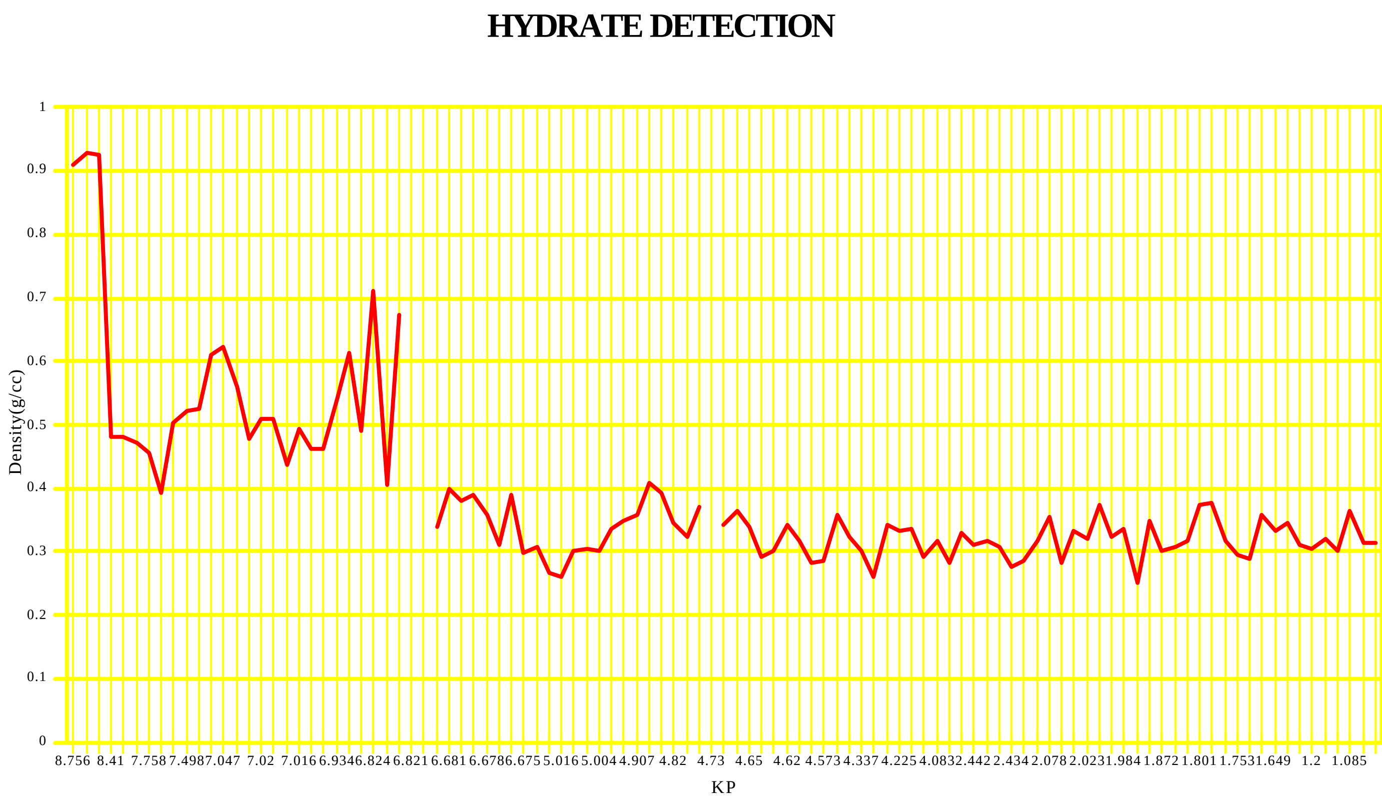

Figure 6: Typical arrangements for applying radio active tracer in gas plant