TECHNICAL NOTE

RADIOTRACER INJECTOR: AN INDUSTRIAL APPLICATION (RIIA)

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ABSTRACT

The radiotracer injector is meant for transferring liquid radiotracer in the system for industrial radiotracer application with minimal radiation exposure to the operator. The motivation of its invention is coming from the experience of the workers who are very concern about the radiation safety while handling with the radioactive source. The idea ensuring the operation while handling the radioactive source is fast and safe without interrupting the efficiency and efficacy of the process. Thus, semi automated device assisting with pneumatic technology is applied for its invention.

ABSTRAK

Penyuntik radiopengesan ialah dimaksudkan kerana memindahkan cecair radiopengesan dalam sistem itu untuk penggunaan radiosurihan perindustrian dengan dedahan sinaran minimum bagi pengendali. Motivasi ciptaannya datang dari pengalaman pekerja-pekerja yang amat bimbang tentang keselamatan sinaran manakala mengendalikan dengan sumber radioaktif. Idea memastikan operasi ketika mengendali sumber radioaktif cepat dan selamat tanpa menyampuk kecekapan dan kemujaraban proses. Oleh itu, separuh peranti berautomasi membantu dengan teknologi pneumatik memohon ciptaannya.

Keywords: radiotracer injector, radiation exposure, safety

INTRODUCTION

Radiotracer technology has been applied in industry for quite a decade and it has been proven to be the best tool in dealing with troubleshooting of plant deficiencies and malfunctions while in operation (Hills 2001). Flow measurement, leak testing, measurement of homogenous mixing efficiency in batch or continuous process and retention time distribution (RTD) studies are among the most widely used applications in chemical and petrochemical industries using radiotracer technology. Figure 1 shows the principle of radiotracer whereas detection probes are mounted at selected locations at the inlet and outlet of the processing vessel. They are shielded by lead collimators to protect them from the natural background and other parasite radiation which may come from around. If needed, detectors are protected from heat (for temperature higher than 60-70^{0}C) by placing aluminum plate between the detector and reactor walls (Radiotracer app in Industry 2004).

Radiotracer technology is one of the many beneficial applications of ionizing radiation that is used around the world. To ensure that persons are protected from the harmful effects of radiation, such application must comply with the international Basic Safety Standards (BSS) or equivalent national regulations (IAEA 2001).

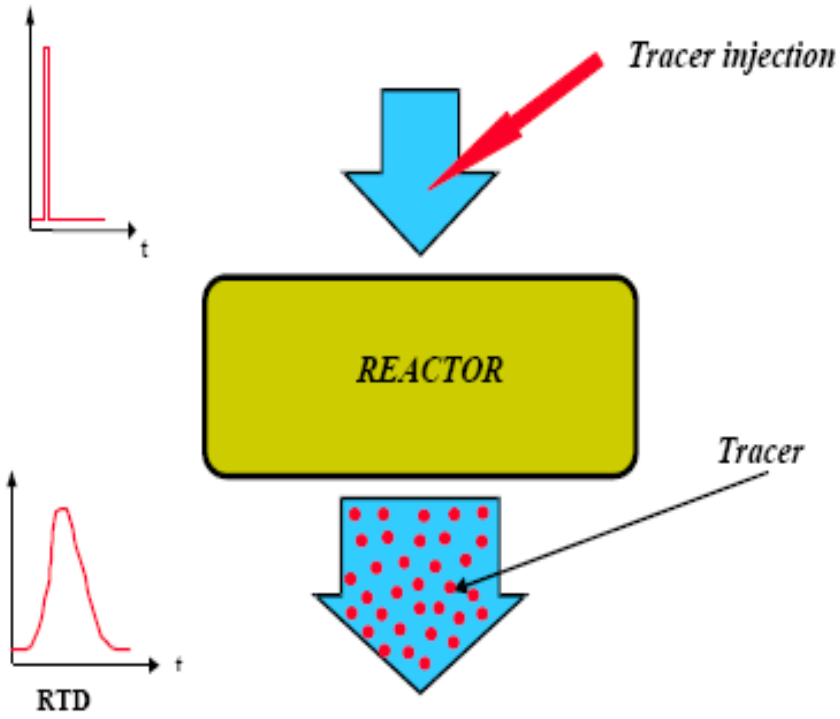


Figure 1 Tracer principle

Thus, due to that reason, it is the duty of Plant Assessment Technology team under Industrial Technology Division to come out with a design called Radiotracer Injector-An Industrial Application (RIIA). RIIA can easily facilitate the operators to work safely in handling and preparing the high activity unsealed source. It is mobile and can secure the radiated target and to reduce radiation exposure to the operators, plant personnel and public.

For conducting a radiotracer investigation, various requirements need to be met before starting the actual test. Experience has shown that good cross-sectional mixing may require as many as 100 pipe diameters to be achieved. It is often not possible to inject the tracer at such a distance upstream of the measurement section. Therefore, it is required to reduce that length by using appropriate tracer injection techniques and devices (IAEA 2008). Some type of injectors which are commonly used in order to obtain the homogenous of mixing between radiotracer and the medium of interests are multiple orifice injectors, high velocity jets and vortex generators. Injection systems are generally home-made, built and adapted for specific applications. They vary considerably in design from the simplest (a syringe or a reservoir with a peristaltic pump) to the most complex (devices for remote injection into pressure vessels). This system injects the radiotracer as a pulse (Dirac type) signal into the flow under investigation. It is worth noting that other types of injection (continuous flow rate, sinusoidal and random) can be of great interest in the understanding of certain complex processes. Nevertheless, most industrial processes can be perfectly characterized using the above proposed injection device, provided that the time duration of the injected signal is about a hundredth the mean residence time (MRT) of the flow studied (Radiotracer app in Industry 2004).

TECHNOLOGICAL DEVELOPMENT

Firstly, a multipurpose device for pulse injection is presented. This injection device, shown in Figure 2, is constructed so as to be usable in any multiphase flow either in liquid or gaseous pipelines. The radiotracer injector is meant for transferring liquid radiotracer in the system for industrial radiotracer application where the minimal contact with radiation can minimize the amount of radiation absorbed by the radiation workers. Table 1 shows the control specification of the RIIA.

Table 1. Control specification of the RIIA

Type	Electro-pneumatic
Input Supply	230 / 240 V AC, 4A
Operating voltage	24V DC, 1A
Compressed air supply	3 to 12 Bar
Injection flowrate	Max. 1900 l/min

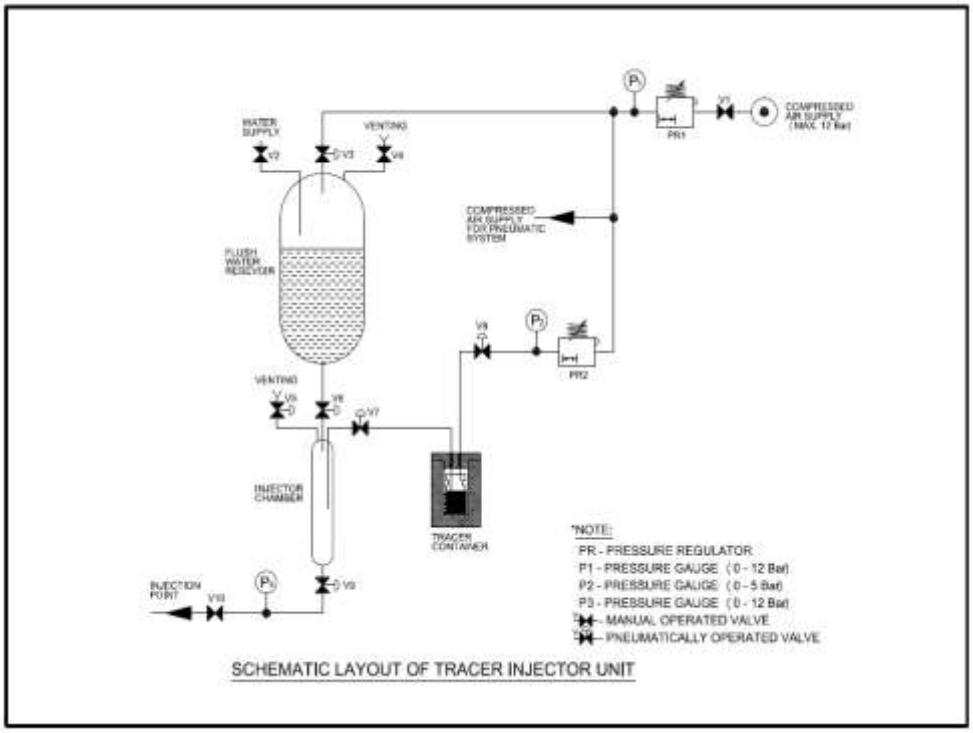


Figure 2. Schematic diagram of Radiotracer Injector-An Industrial Application (RIIA)

The radiotracer injector comprising of: an injector panel; tracer container and control panel (Figure 3-5). An injector panel consists of set three pressure gauges wherein the bottom pressure indicate the actual pressure in the system, the middle is for the indicator for the pneumatic and the top is to adjust the pressure with respect to the bottom gauge respectively.; water column is to contain the water up to 350ml and tracer column is to contain the radiotracer up to 50ml; The injector also has four main inlets and one outlet; Inlet 1- filling up the water to the water column, inlet 2- supplying of compressed air at permissible pressure which is less or equal to 12 bar only; inlet 3- to supply pressure pneumatically at 0.4 bar , inlet 4 is for tracer loading and finally outlet for tracer injection. It also has four manual and six pneumatic valves in order to control the flow of liquid and air respectively. This injector responds to the system pneumatically.

Tracer container is a closed vessel having two independent tubes for liquid tracer and pressure line tubes respectively.

The control panel is having four buttons. Button 1-is the main switch; button2-tracer loading button, button3-injector warm-up button and button 4- tracer injector button.

STANDARD OPERATING PROCEDURE

1- It is the aim of this invention:

(i) To develop an alternative and safe system for low pressure industrial radiotracer injection; and

(ii) To develop novel sample loading and injection methods that offers minimal radiation exposure compared to the conventional method.

2- The water vessel should be filled up with 350ml water in order to flush out the radiotracer completely later. The injector should be attached to sufficient compressed air in order for the system to respond pneumatically. The permissible pressure for compressed air is 12 bar and the pressure gauge at the middle should indicate 0.4bar in order for it to operate well. The shielded radiotracer container which having two tubes will be connected to the inlet 3 and 4 for loading tracer to the tracer column and supplying pressure to the container respectively. Once valve at the outlet is opened, the gauge at the bottom will indicate the actual pressure of the process pipeline of interest whereas the gauge at the top will be adjusted 2-3 times higher than the actual pressure.

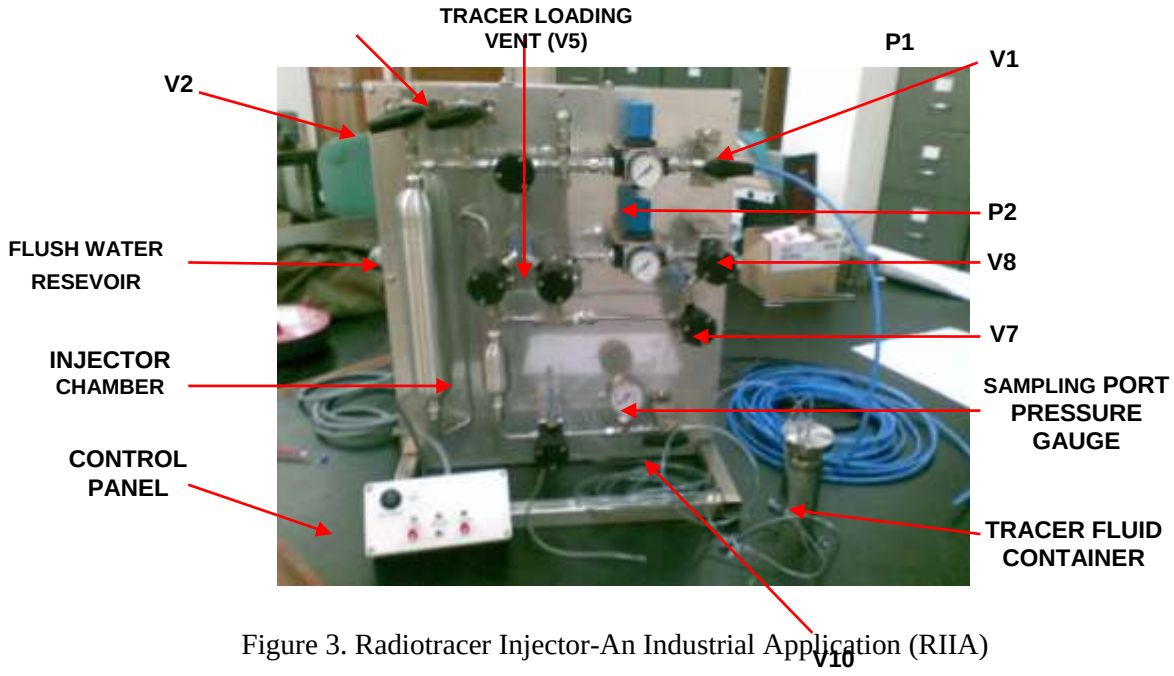


Figure 3. Radiotracer Injector-An Industrial Application (RIIA)

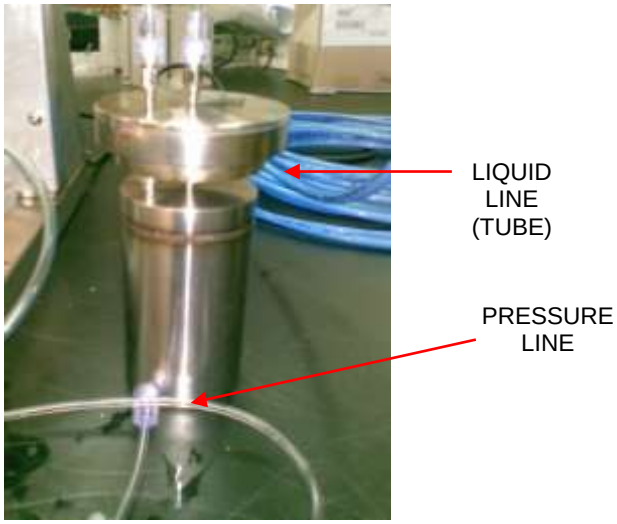


Figure 4. Tracer container



Figure 5. Control panel

3- The control panel should be connected to the main supply and the red light will flash when the main switch is pressed at 1 and light off when press at 0. Prior to injection, the operator will be 2-3 meter away from the injector system. Tracer loading button will be turned on in order to load the radiotracer from the tracer container to the tracer column at the injector panel. At this point, the corresponded valves will be

opened pneumatically. The loading time of the tracer corresponds to the amount of tracer in the tracer container. Experimentally, 1 minute is required to load 50ml of liquid. Compressed air will pass through pressure line tube at the tracer container, and forcing the tracer liquid to flow through another tube and flow into the tracer column at the injector panel.

4- Prior to tracer injection to the pipeline of interest, the warm-up button should be turned on for a few second. Pressure will be build up inside water column and tracer column for injecting process. Pressing the tracer inject button will flush the tracer with water from the water vessel until the process complete.

SUMMARY

The Radiotracer Injector-An Industrial Application (RIIA) has been tested at the multiphase flow rig at the EVF building for flow measurement study. It has been proven that its usage is very practical, fast and safe to the workers.

ACKNOWLEDGEMENT

The authors would like to acknowledge the support and assistance from Plant Assessment Technology (PAT) and Prototye and Design Center (PDC). The research is funded by NM-R&D-10-1

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