

### 1.3. Transfer lines

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One goal of the session was to define the problems associated with transfer lines to and from targets and within the radiochemistry environment. Another goal was to make people aware of these facts and to demonstrate the advantages of tuned transport to obtain high specific activity radiolabeled gases.

What is already known?

The predominant choices for lines are stainless steel (316), Teflon or polyethylene. Stainless steel is the preferred material unless corrosion is a problem. Teflon lines suffer from radiation damage and will deteriorate with time when in prolonged contact with positron radiation. The Teflon weakens, becomes brittle and ruptures. Polyethylene is good from a radiation standpoint but has poorer temperature characteristics. Many standard sizes of Teflon and polyethylene are available ( producer: AIN Plastics, 21270 West Eight Mile Road, Southfield, MI 48075, USA ) for typical diameters and wall thicknesses.

The best quality materials are required to minimize radiochemical and radionuclidic contaminants. This applies to tubing, valves, regulators and connectors. When in doubt, keep to stainless steel (SS). Oil contamination has been a problem with some SS lines. Careful cleaning is required. Target gas contamination has been and continues to be a problem. Sources of contamination result from leaks in valves, seals and connections and deterioration of transfer line components including regulators, valves and gaskets. Residual gas in refilled cylinders has contributed to impurities. Swagelok, Skinner, Parker continue to be the vendors of choice for connectors, valves, etc. For best performance, however, adhere to manufacturers recommendations for installation and use.

For the most reliable service, use a particular transfer line for a particular target material. Use of a single line for  $^{18}\text{F}$  and  $^{15}\text{O}$  has led to serious problems which in documented cases resulted in total deterioration of the transfer line.

Tuned pipelines for  $^{15}\text{O}$  transport have been developed and implemented at several institutions. Tuned systems are critical for delivery of high specific activity in useful volumes for short-lived radionuclides. The advantage of a tuned system is that it provides equal activity in lower volumes of gas with less beam on target over a conventional untuned system, all things being equal. Hence, by reducing beam current on target, foil lifetime is increased, cyclotron activation is reduced and, when enriched target gases are used, target gases are not wasted. Succinctly, better target efficiency is achieved. Personnel exposure is minimized by matching production rate to the clinical use ( physiological demand by patient ) and reducing transfer line volume. Tuned systems are appropriate for all short-lived gases but particularly for  $^{81\text{m}}\text{Kr}$ ,  $^{15}\text{O}$  and  $^{11}\text{C}$ . A tuned system may also be used as a simple impedance to deliver gases at a specified rate without the need of a metering valve. Table 1 describes a tuned condition for  $^{15}\text{O}$  transport over several different distances.

What must be done?

Targetry, chemistry and clinical delivery systems should be critically reviewed to determine if a tuned system is appropriate for a particular application. Increasing clinical demands for PET radiopharmaceuticals will begin to tax even the best equipped laboratories. Tuned transfer systems decrease wasteful overproduction of short-lived PET nuclides and improve radionuclide production efficiency.

Table 1  
Characteristics of gasline transport systems \*

Tube Length [m]	Tube Dia. [cm]	Pressure [psia]	Flow [l/min]	Transport time [sec]	Activity recovered
1.0	0.15	15	0.9	0.15	43 %
	0.32	15	5.6	0.05	6 %
	0.64	15	62.0	0.01	0.5 %
50.0	0.15	17	0.2	39.0	66 %
	0.32	15	0.3	45.0	51 %
	0.64	15	1.2	36.0	19 %
500.0	0.15	60	0.7	226.0	11 %
	0.32	32	1.0	213.0	8 %
	0.64	20	2.8	189.0	4 %

Tuned condition for optimized Transport \*

Tube Length [m]	Tube Dia. [cm]	Pressure [psia]	Flow [l/min]	Transport time [sec]	Activity recovered
1.0	0.056	16.5	0.11	0.14	85 %
50.0	0.097	24.5	0.12	24.0	71 %
500.0	0.056	71.0	0.63	227.0	11 %

\* Calculated for  $^{14}\text{N}(\text{d},\text{n})^{15}\text{O}$  reaction.  
Target volume = 35 cm<sup>3</sup> and filling volume = 1000 cm<sup>3</sup>

The utmost care must be taken to insure all transfer line components are clean and leak free. At all costs, contaminants should not be allowed to enter the system. Routine checks by gas chromatography should be performed to determine if leakage is a problem or deterioration of transfer line components is present. Do not get lazy and remember, garbage in will result in garbage out!

The use of polyethylene or stainless steel lines for transfer system is preferred. The lifetime of these lines should be considered when planning a new system. Multiple back up lines should be included in the design to insure long term reliability.

As liquid targets become more widely used, the same care and concerns will have to be taken into account to optimize production schemes and make transfer systems more efficient. This is especially critical for  $^{18}\text{O}(p,n)^{18}\text{F}$  production and other enriched target systems.

## References

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