RADIOACTIVE ISOTOPE PRODUCTION WITH BABY CYCLOTRON AND RADIOACTIVE ISOTOPE PROCESSING SYSTEM

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Ultra compact medicall cyclotron (Baby Cyclotron) has been developed by J.S.W. to produce of short-lived nuclides such as carbon-11, nitrogen-13, oxygen-15, and fluorine-18 for nuclear medicine. Prototype was already constructed and is operating at National Nakano Chest Hospital for clinical diagnosis. Commercial cyclotron is also accomplished, which has ability to accelerate 10MeV of proton and 7MeV of deuteron with 50$\mu$A of beam current.

We succeeded to produce enough amount of radioactive isotopes by using Baby Cyclotron and newly developed radioactive isotope processing system. The nuclides (carbon-11, nitrogen-13, oxygen-15, fluorine-18) which are produced by Baby Cyclotron are converted semi-automatically to suitable chemical forms for clinical use by the radioactive isotope processing system. This system controls each chemical process by sequence program to make short chemical processing time. Fig.1 shows the graphic panel of this system.

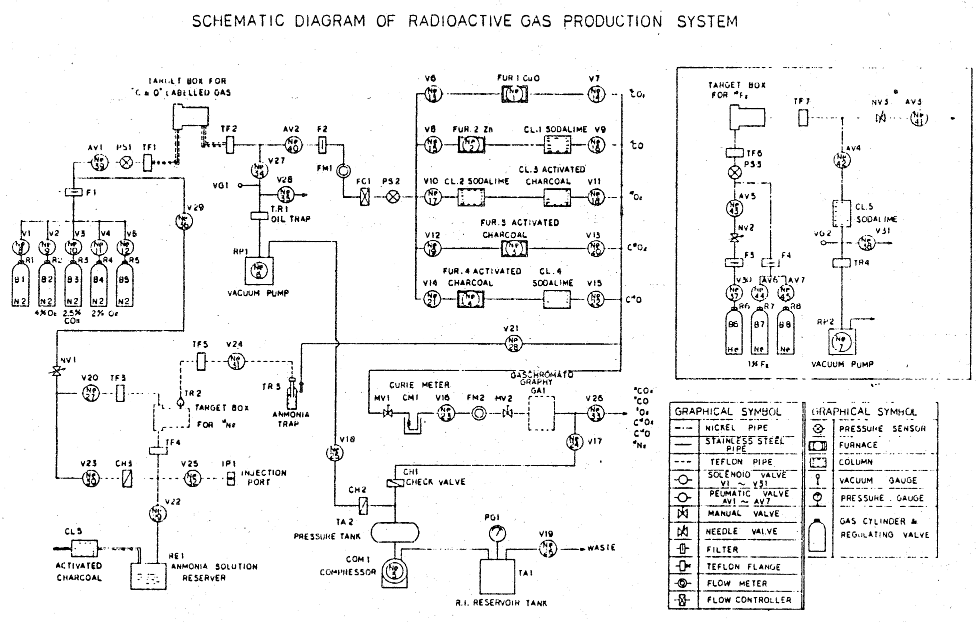


Fig.1 Graphic panel of radioactive isotope processing system

Chemical compounds shown in Table 1 are obtained by pressing four push buttons in sequence

Table 1. Produced nuclides and their chemical compounds

| Nuclide | Chemical compound | Target Material | Nuclear Reaction |
|---|---|---|---|
| $^{11}C$ | $^{11}CO_2$ | $N_2$ gas | $^{14}N(p,\alpha)^{11}C$ |
| | $^{11}CO$ | | |
| $^{13}N$ | $^{13}N_2$ | Ammonia solution | $^{16}O(p,\alpha)^{13}N$ |
| | $^{13}NOx-$ | Distilled water | |
| $^{15}O$ | $^{15}O_2$ | $O_2$ in $N_2$ gas | $^{14}N(d,n)^{15}O$ |
| | $C^{15}O_2$ | $CO_2$ in $N_2$ gas | |
| | $C^{15}O$ | $O_2$ in $N_2$ gas | |
| $^{18}F$ | $^{18}F_2$ | $F_2$ in Ne gas | $^{20}Ne(d,\alpha)^{18}F$ |

These compounds are recovered such pure forms as to apply to clinical diagnosis.

As an example $^{11}CO_2$ is obtained from $^{11}CO_2$ and $^{11}CO$ mixture by passing through CuO reagent heated at 700°C. Table 2 shows examples of the radioactive isotope production test with Baby Cyclotron and the radioactive isotope processing system.

Table 2. Results of radioactive isope production test (example)

| Chemical Form | Incident Energy | Beam Current | Bombardment Time | Yield | Purity |
|---|---|---|---|---|---|
| $^{11}CO_2$ | P:9.5MeV | 50μA | 60 min. | 1200mCi | > 99.9 |
| $^{13}NOx^-$ | P:9.5MeV | 50μA | 40 min. | 270mCi | - |
| $C^{15}O_2$ | d:5.9MeV | 50μA | 20 min. | 1300mCi | > 98 |
| $^{18}F_2$ | d:5.7MeV | 50μA | 240 min. | 300mCi | > 80 |

Yield and purity are usable to clinical diagnosis. It shows that Baby Cyclotron has enough ability to produce radioactive isotopes for clinical diagnosis.

We are, at present, developing several automated synthesis systems of organic compounds labeled by short-lived radioactive isotopes.