VOLUME REDUCTION OF LIQUID RADWASTES CONTAINING CITRIC ACID

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High volumes of contaminated liquids are generated when items at nuclear fuel cycle areas are decontaminated. Citric acid is commonly used as decontamination agent because is less aggressive for metals than nitric or sulphuric acids. Depending on the activity level of the solutions due to the presence of radionuclides, the liquids should be treated as radwastes and its high volumes could be reduced[1,2]. For this purpose a solar-electric evaporator of natural circulation type was constructed that allows the evaporation of 0.25 m^3 per week, with a volume reduction factor of about 10.

The evaporator body is made of polypropylene sheets, 10 mm thick. Its geometry follows a prismatic form as shown in Figure 1. The cap is made of a transparent glass which allows the sun light absorption.

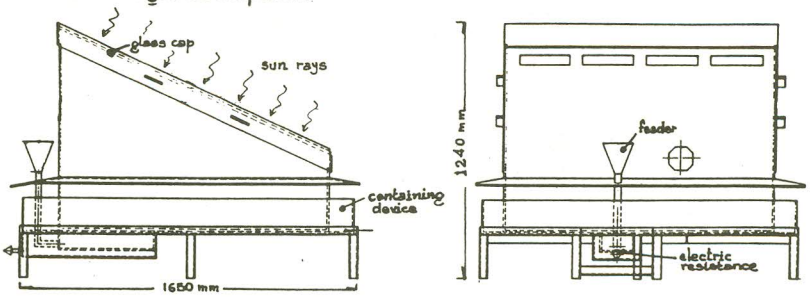

Fig.1. Schematic design of the solar-electric evaporator.

Below the evaporation device an electric resistance, covered with a teflon cap, is installed and used when solar heat is insufficient to evaporate the solutions. A ventilator is used to force the water vapor to leave the evaporation camera to the environment. The feed is made manually through a funnel. The volume of the solution under evaporation is controlled by a level indicator. A thermostat, that controls the lower evaporation temperature switches on the electric resistance when sun light is no more effective for heating purposes.

Under the evaporator there is a contention device made of inox metal sheet - 4.5 mm thick, to collect liquids in case of accidental leakage occurences.

Decontamination liquids at one of IPEN areas have mainly high concentration of citric acid, about 7 $g.L^{-1}$, metallic ions as F^{-} , Ni^{+} , Cu^{2+} , Fe^{2+} , Al^{3+} , U_{nat} and decaying elements, ^{234}Th and ^{234}Pa. Saline concentrations do not exceed 5 $g.L^{-1}$ and the evaporation effciency is not disturbed.

After the decontamination process the remaining liquids are analysed at the radiochemistry laboratory and than can be evaporated. The first evaporation load is 250 L which is the maximum capacity of the evaporator. During the evaporation process the feed is maintained at approximately 50 L per day.

The temperature inside the evaporation camera is reasonably stable, about 50 ± $5^{0}C$. When solar beam intensity is high, mainly during spring and summer times, the evaporation process is accelerated and the electric expenses are reduced by 40 %.

Water vapor is free from radioactive contaminants and the evaporation process has a decontamination factor of about 10^{4}. The limiting factor can be the crystallization of dissolved salts at the cooler points of the evaporation camera if higher salts content is observed. The sludge, obtained after the evaporation is neutralized with lime and is chemically stable and homogeneous. Depending of its activity it can be encapsulated in metal drums directly, mixed with cement matrix or stored for further treatment[3,4].

If nitric or sulphuric acids are used for decontamination purposes the remaining solutions should be evaporated with care to forbid evaporator working life reduction. From the exposed matter it can be pointed out that:

- the solar-electric evaporator can be used for acid liquids volume reduction;
- it can save about 40% of the energy expenses at high intensity solar times;
- when solar heating is inadequate mainly in rainy days, winter and autumm times electric energy must be used;
- volume reduction factor is about 10 and higher liquid volumes could be evaporated by constructing a battery of the same kind evaporators;
- polypropylene in comparison with other plastics shows a good performance at high temperatures and especially a better resistance against acids and solvents;
- sludges removal is made by a simple opening of the glass cap;
- the construction price was determined as about US$ 900.00 per unit.

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