Significant aerosol increase is observed at 60°C in particular. More particles of smaller size are observed for the higher temperature.
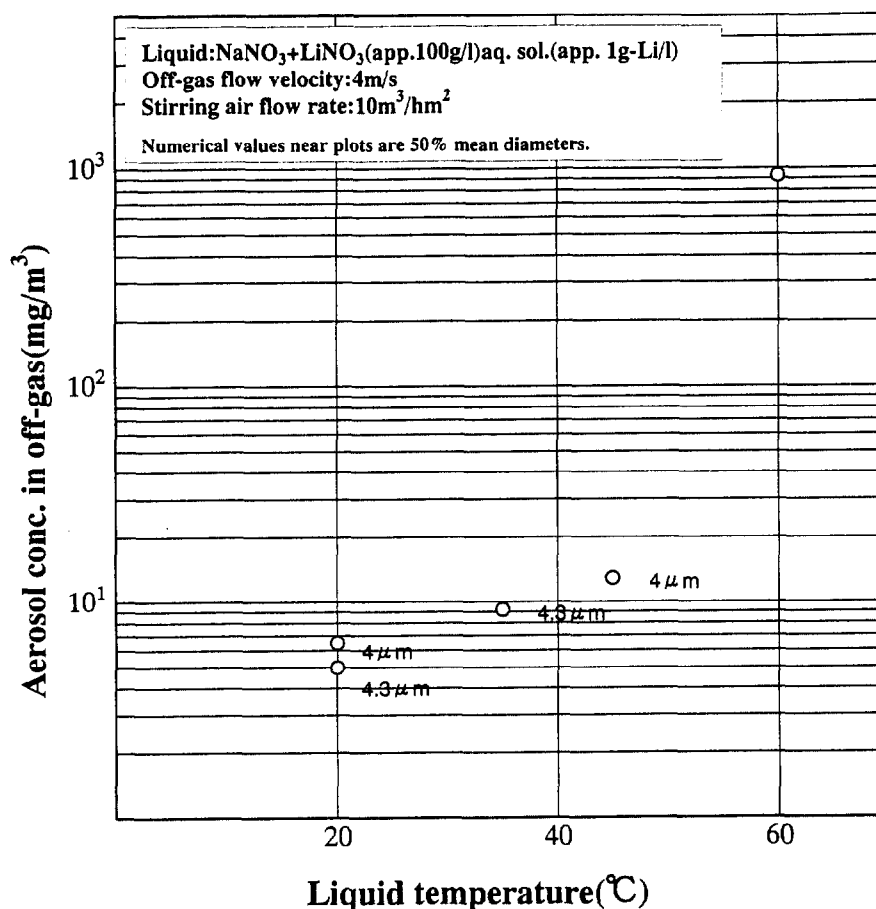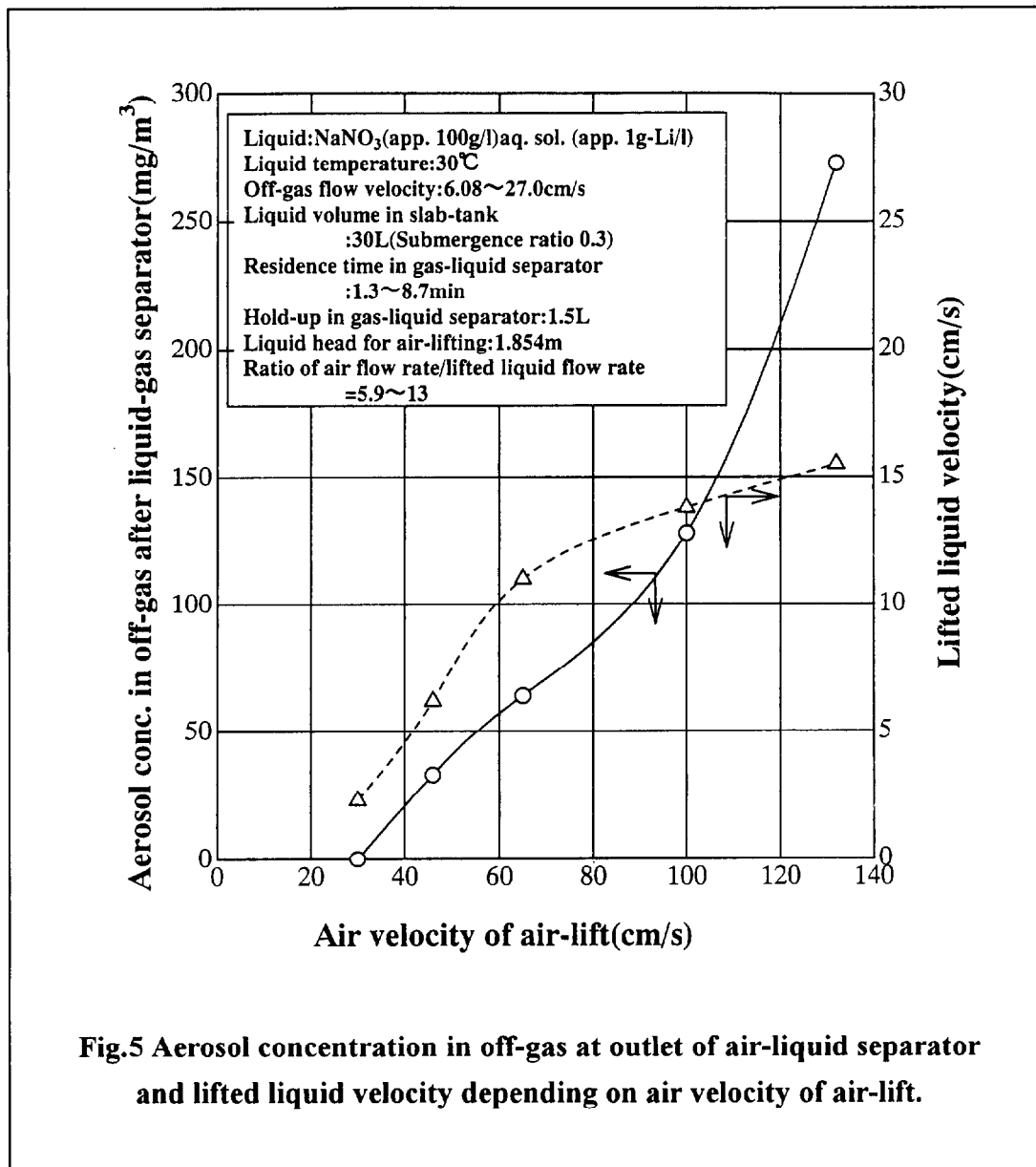


**Fig.4 Aerosol concentration in off-gas depending on liquid temperature.**

Air-lift Operation

Characteristics of air-lift depends on submergence ratio. Submergence ratio is defined as the ratio of depth of air-lift submergence beneath free surface to total head of lifting liquid. Air-lift was operated by adjusting submergence ratio at 0.3 by keeping app. 30L solution volume in slab-tank. Solution was recycled through air-liquid separator and pot to slab-tank. Diameter of air-lifting pipe is 12.7 mm. Aerosol sampling was carried out for 5 hours on vent pipe from air-liquid separator.

Aerosol concentration in off-gas from air-liquid separator are related to linear velocity of air in air-lifting pipe, as shown in **Fig.5**. Lifted liquid velocity is also shown in the figure. Aerosol concentrations are roughly proportional to air velocity. And it is observed that aerosol concentrations are in the range from a few to several hundreds mg/m$^3$ in this experimental range. Air-liquid separator

actually has no function to remove aerosol from off-gas. Demister should be applied to reduce aerosol migration to the downstream of off-gas from air-liquid separator.

Liquid:NaNO₃(app. 100g/l)aq. sol. (app. 1g-Li/l)
Liquid temperature:30℃
Off-gas flow velocity:6.08～27.0cm/s
Liquid volume in slab-tank
　　　　　:30L(Submergence ratio 0.3)
Residence time in gas-liquid separator
　　　　　:1.3～8.7min
Hold-up in gas-liquid separator:1.5L
Liquid head for air-lifting:1.854m
Ratio of air flow rate/lifted liquid flow rate
　　　　　=5.9～13

**Fig.5 Aerosol concentration in off-gas at outlet of air-liquid separator and lifted liquid velocity depending on air velocity of air-lift.**

Evaporation

Evaporation of solution in slab-tank was carried out at the evaporation rate in the range from 1.4 to 7 L/h. Standard evaporation rate is assumed to be 10% liquid volume in one hour, this rate corresponds to 3 L/h in this experiment. Evaporation rate was controlled by heater output and measured by condensate level increase in pot. Inner pressure of slab-tank was adjusted in the range of app. -80 to -200 mmH₂O by exhaustive blower operation. Off-gas flow velocity was adjusted at 4 m/s at off-gas outlet of condenser by controlling carrier air which sweeps the volume above free surface in

slab-tank. Aerosol sample was collected at the off-gas outlet of condenser for one hour.

Aerosol concentration and migration rate to outlet of condenser are related to evaporation rate, as shown in **Fig.6**. Dependence of aerosol migration rate on evaporation rate is not apparently clear in this experiment. Aerosol concentrations are observed in the range from 2 to 7 mg/m$^3$ in off-gas. Hourly migration ratios are calculated in the range from $6.2 \times 10^{-4}$ to $1.7 \times 10^{-3}$. Hourly migration ratios are defined by the ratio of migration rate to outlet of condenser divided by total amount of solution in slab-tank.



**Fig.6 Aerosol concentration in off-gas and aerosol migration rate to the outlet of condenser, depending on evaporation rate.**
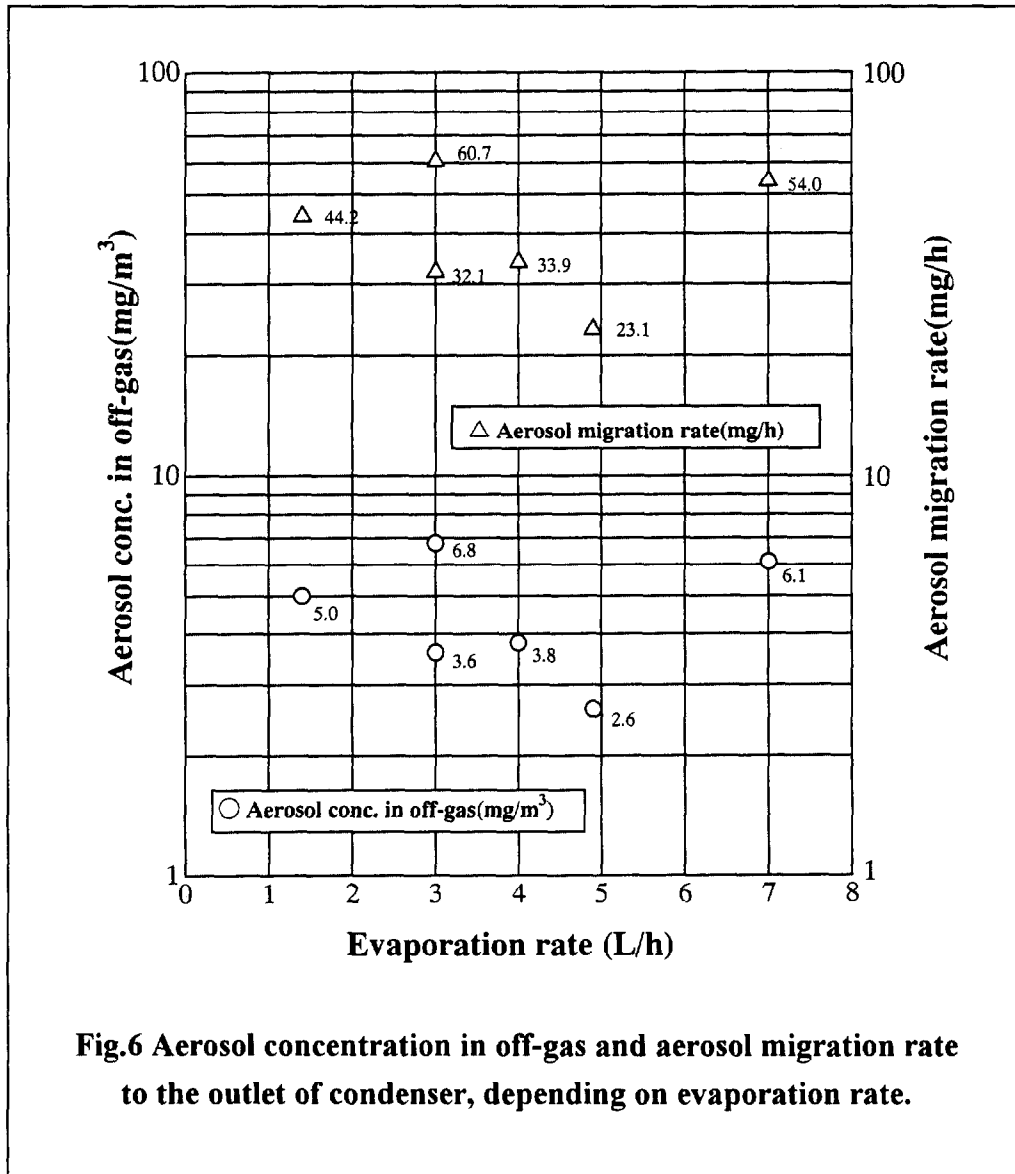
IV. Conclusion

Aerosols in off-gas are measured at outlet of vessel under various operation condition using

simulated nitrate solutions to understand the behavior of non-volatile radioactive elements under normal operation of reprocessing. Experimental results show the following conclusions.

(1) Aerosol concentrations in off-gas at outlet of vessel are observed in the range from a few to 20 mg/m$^3$ in the range of off-gas flow rate 2 to 10 m/s, stirring air flow rate up to 50 m$^3$/hm$^2$, liquid temperature 20 to 45 ℃. Aerosol concentration of less than 10 mg/m$^3$ is observed at stirring air rate less than 30 m$^3$/hm$^2$ for 350 g/L NaNO$_3$+LiNO$_3$-3M nitric acid solution.

(2) Decrease of liquid surface tension by adding trace amount of TBP increases aerosol concentration in off-gas by 2 to 5 times that of nitrate solution without organic additives.

(3) Aerosol concentrations in off-gas from air-liquid separator are observed in the range from a few to several hundreds mg/m$^3$. Aerosol removal should be applied to reduce aerosol migration to the downstream of off-gas from air-liquid separator.

(4) Aerosol concentrations in off-gas from condenser of vessel under evaporation operation are observed in the range less than 10 mg/m$^3$.

Acknowledgements

References

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(4) JNFS R-91-001(1991).

## DISCUSSION

**DORMAN:** One would expect fairly rapid evaporation of some of the aerosols so size would depend markedly on position of sampling. Did you carry out size measurements at more than one point?

**FUJINE:** Yes, we measured the aerosol sizes at different points, namely, different distances less than 2 m from the vessel in which aerosols are generated. Average sizes of aerosols observed were not different markedly. Regarding evaporation, we made measurements on the size distribution of aerosols in humidified and non-humidified carrier air. Aerosols in humidified air consist of smaller sizes than those in non-humidified air. However, the difference is not big, approximately 10%. Sampling point was just at the outlet of the vessel. I think the non-humidified air was partially humidified to some extent in our experiment.