# Effect of soil sampling thickness on starting time of salt crystal production

○ Xi Man Liu[1], Hiroaki Terasaki[2], Masahiro Kusama[3] and Teruyuki Fukuhara[4]

[1]Student member of JSCE, Master course student, University of Fukui
[2]Member of JSCE, Postdoctoral fellow, University of Fukui
[3] Student member of JSCE, Master course student, University of Fukui
[4]Member of JSCE, Dr. of Eng., professor, University of Fukui

## 1. Introduction

In order to prevent or control soil salinization, we need to better understand the moisture and salt movement in soils under drying process. Although there is some past research that measured the salt concentration near the soil surface, few past research had examined the influence of sample thickness on the salt concentration of the soil surface (surface salt concentration) as well as the salt concentration profile accompanied by the salt crystallization. Our experiments[1)] showed that the accuracy of the surface salt concentration is sensitively affected by the sample thickness. The appropriate sampling thickness, therefore, should be explored to make a better prediction model for the salt concentration near the soil surface.

This study aims at providing beneficial information on the effect of the sampling thickness on the starting time of salt crystal production.

## 2. Experimental apparatus and procedure

**Fig. 1** shows the schematic view of the experimental apparatus, which consists of four soil rings made of vinyl chloride with 0.075m in diameter, a heat lamp (250W), a microscope with magnification ×50–200 and an electric balance with a minimum reading of 0.01g. The experiment was conducted in a temperature and humidity controlled room. The experimental procedure is as follows:

(1) Chao soil was packed in a ring with the dry bulk density of 1550kg/m$^3$.
(2) The soil ring was filled with saline water with the salt concentration of 80kg/m$^3$.
(3) Radioactive energy from the heat lamp was emitted from a height of 0.3m above the soil surface. The evaporation flux was calculated from the time decrement of the weight measured with the electric balance. The salt crystals were detected with a microscope every 5minutes.
(4) The experiment was continued for 16hours until the soil in the column was completely dry.
(5) The above experiment was repeated by changing the soil ring height, $H_r$ (=3, 5, 7 and 10mm).

## 3. Results and discussions

### 3.1 Salt crystallization process

**Fig. 2** shows the growth of salt crystals on the soil surface in the soil ring with a thickness of 7mm and enlarged views of the salt crust. Initiation of salt crystal production was observed at elapsed time of 32minutes. The soil surface was wet at that moment. Finally the soil surface became dry

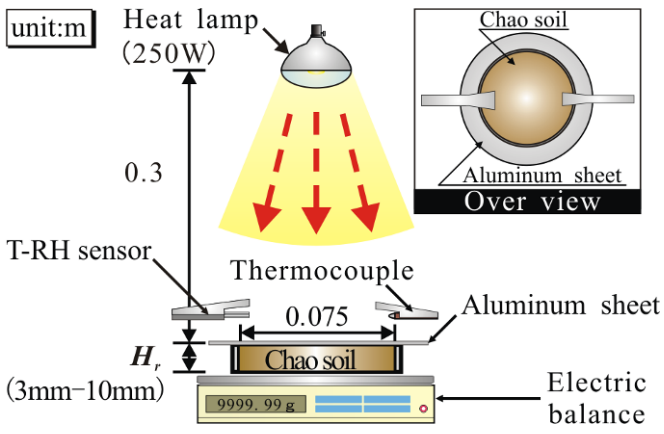


Fig. 1 Schematic view of experimental apparatus

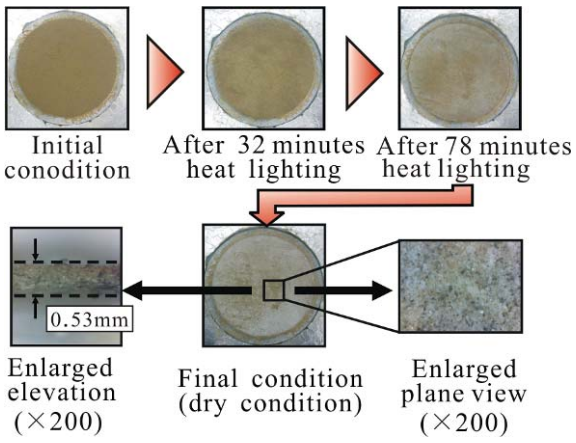


Fig. 2 Growth of salt crystals on the soil surface

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Contact address: Environmental heat and hydraulics Laboratory, University of Fukui, 3-9-1 Bunkyo, Fukui 910-8507, Japan.
Tel: 0776-27-8595, Fax: 0776-27-8746, E-mail: maria_1027@163.com

and was wholly covered with the salt crystals as shown in Fig. 2. The average height of the salt crust was 0.53mm.

### 3.2 Evaporation

**Fig. 3** shows the time variation in evaporation per unit soil surface area $E_v$ (kg/m$^2$/s). $E_v$ began to decrease gradually from the first stage of the experiment. Subsequently, $E_v$ decreased obviously at the elapsed time shown by arrows in **Fig. 3** because of the desiccation of the soil surface.

### 3.3 Salt concentration and crystallization

**Fig. 4** shows the time variation in average salt concentration of the soil surface layer, $C_{ave}$ ($= M_{salt}/(V_{water} - \sum E_v)$) and the saturation density of salt, $C_{sat}$ (=371kg/m$^3$, 60℃). **Fig. 4** also shows the starting time of the salt crystal production, $t_{crystal}$, by visual confirmation. The value of $t_{crystal}$ ranged 15 to 40 minutes as shown in the enlarged view for $0 \leqq t \leqq 0.8$hr. The value of $C_{ave}$ increased nonlinearly with time for every experimental case. The salt saturation time, $t_{sat}$, i.e. the elapsed time when $C_{ave}$ reached $C_{sat}$ ranged 1.0 to 5.8 hours and became large as $H_r$ increased.

**Fig. 5** shows the change in a time lag between $t_{sat}$ and $t_{crystal}$, $\Delta t$ ($=t_{sat} - t_{crystal}$) in association with $H_r$. Since a salt crystals is produced in a saturated solution of salt, $t_{crystal}$ should be larger than $t_{sat}$. $\Delta t$, therefore, can be used to evaluate the degree of error (precision) in measurement of the salt concentration of the soil surface. The value of $\Delta t$ increased linearly with the increase in $H_r$ and the relationship was regressed as: $\Delta t = 0.61 H_r - 1.19$.

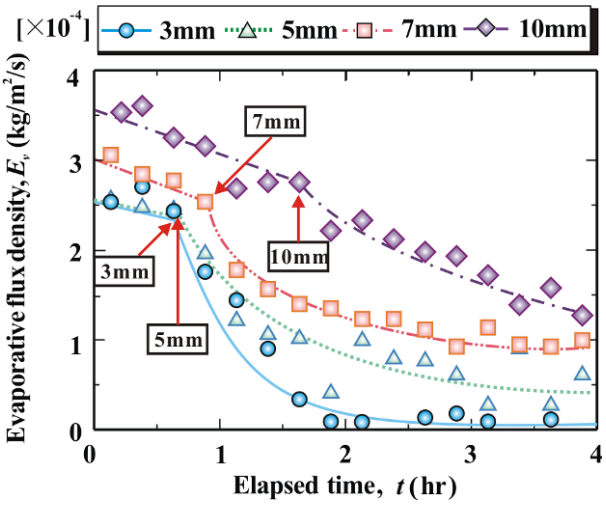


**Fig. 3 Time variation in evaporative flux density**

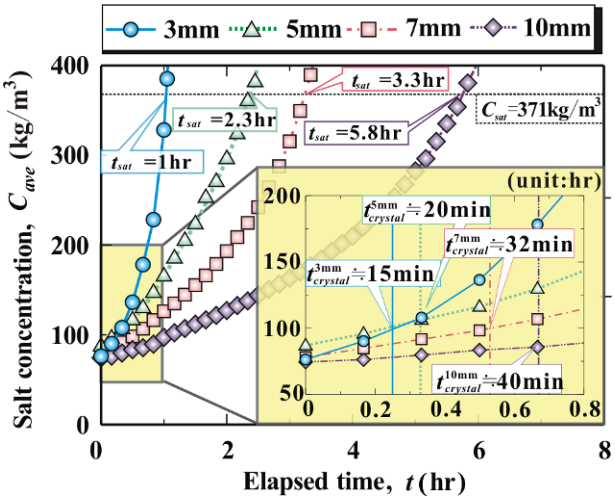


**Fig. 4 Time variation in salt concentration and starting time of salt crystal production**

| $H_c$ | $t_{sat}$ | $t_{crystal}$ | $\Delta t$ |
|---|---|---|---|
| mm | hr:min | hr:min | hr:min |
| 10 | 5:48 | 0:42 | 5:06 |
| 7 | 3:18 | 0:32 | 2:46 |
| 5 | 2:18 | 0:20 | 1:58 |
| 3 | 1:02 | 0:15 | 0:47 |

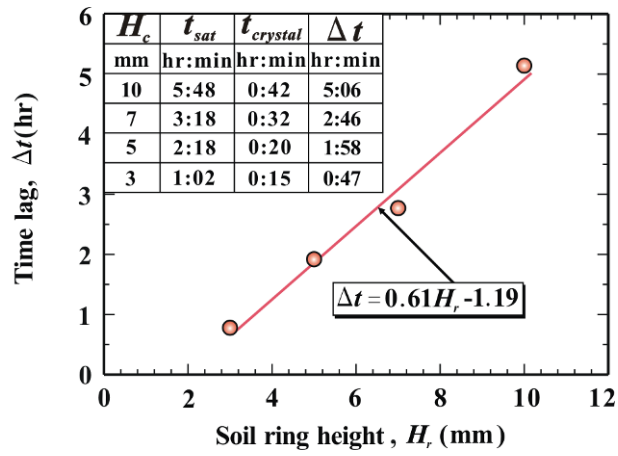


**Fig. 5 Time lag between starting time of salt crystal production and saturation time in association with soil ring height**

## 4. Conclusions

We examined the effect of the thickness of soil sampling near the soil surface on the salt concentration of the soil surface using Chao soil and four different thin soil rings. It was found that the judgement accuracy of the starting time salt crystallization gets worse with the increase in the ring height, i.e. soil sampling thickness.

## Reference

1)Yuan Wang, Hiroaki Terasaki, Takuto Kido, Teruyuki Fukuhara: Measurement of salt concentration on the soil surface by the water absorption method, 64th Annual Journal of Civil Engineering, JSCE, Ⅱ–153, pp. 305-306, 2009.

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