Sea Salt Deposition on the Canister Surface of Concrete Cask

(This work has been carried out under the contract with Minister of Economy, Trade and Industry of the Japanese Government.)

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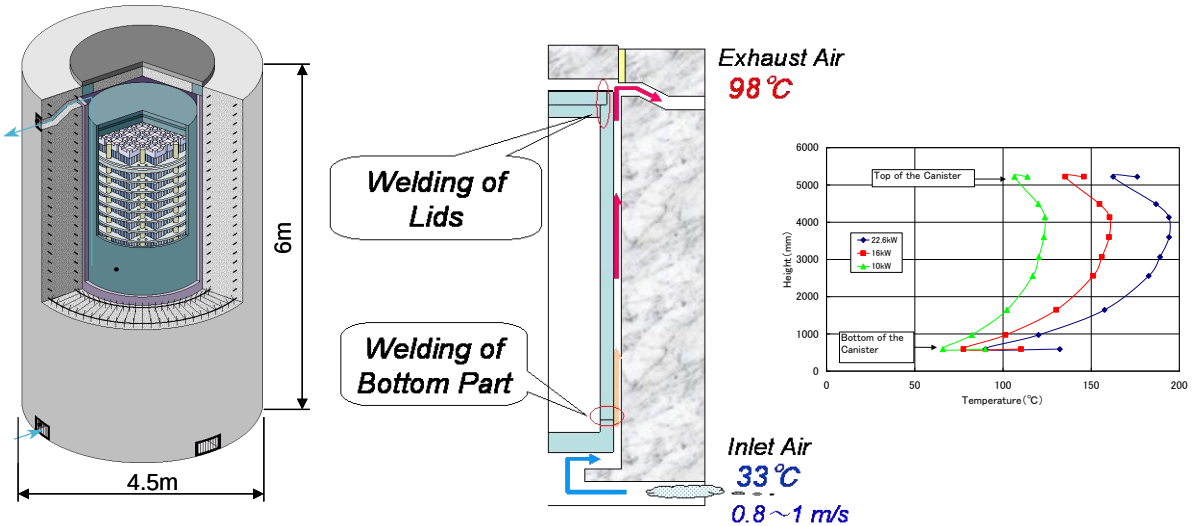
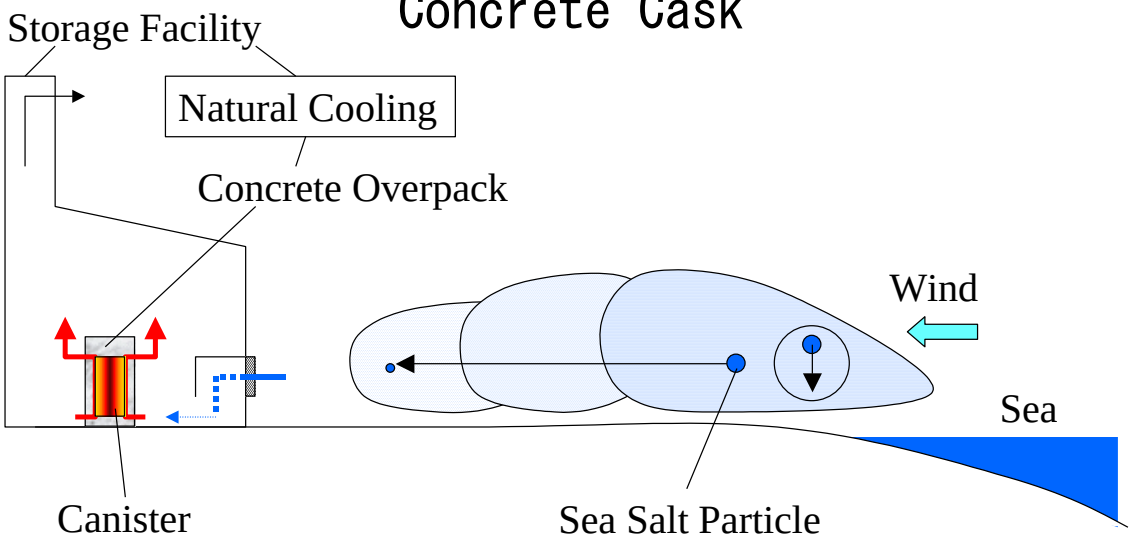
ISSF2010 in CRIEPI (Komae)

Background

Location of nuclear power plants in Japan

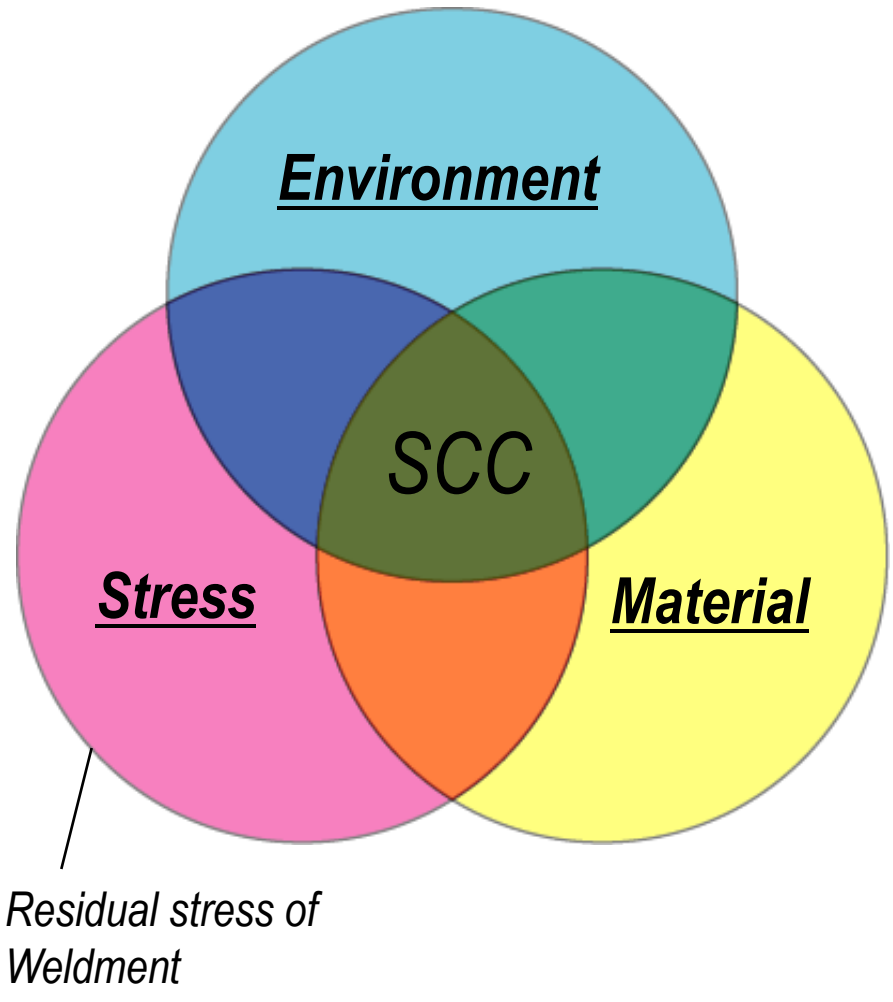


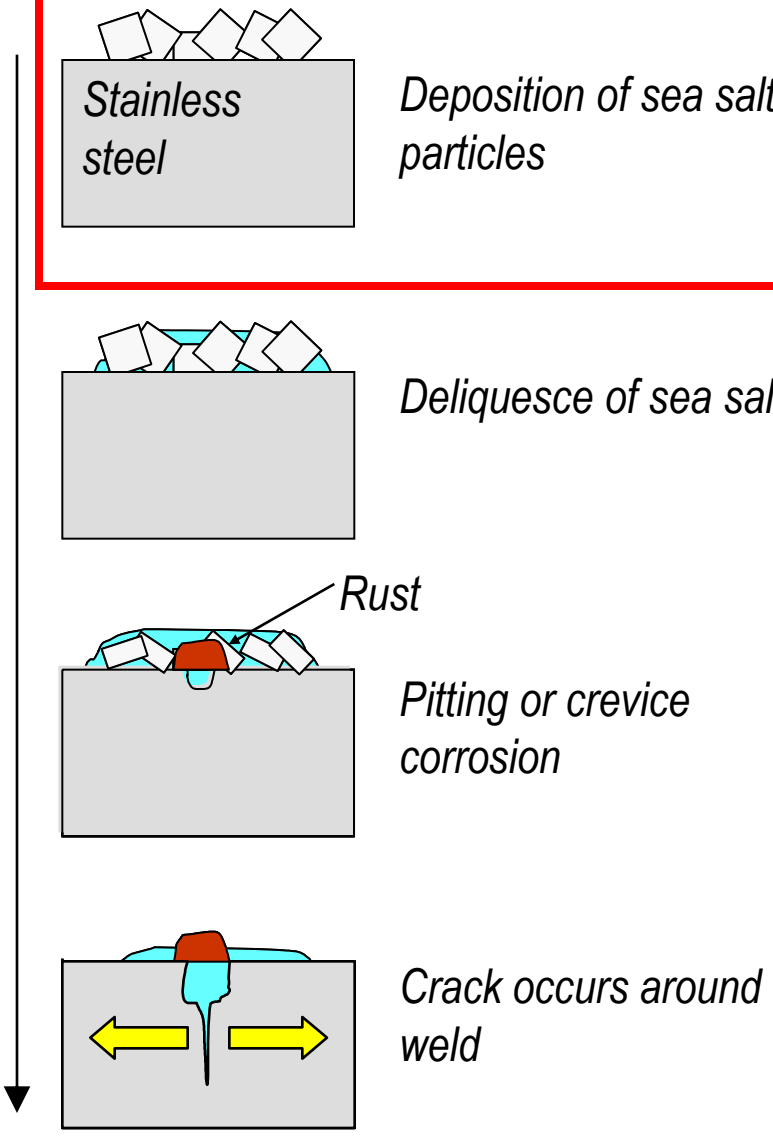
Concrete Cask



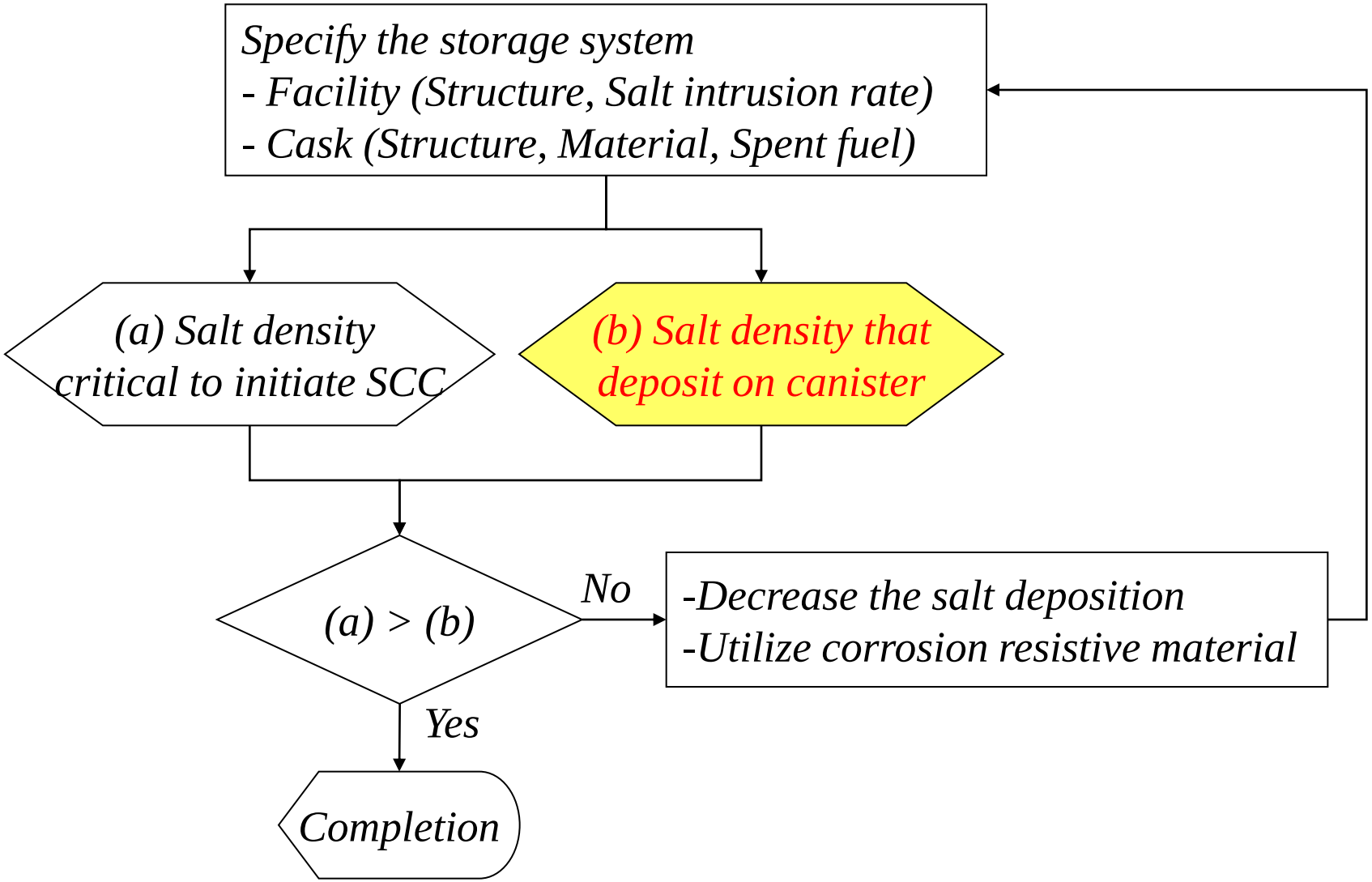
Transport of the sea salt particle

Stress Corrosion Cracking





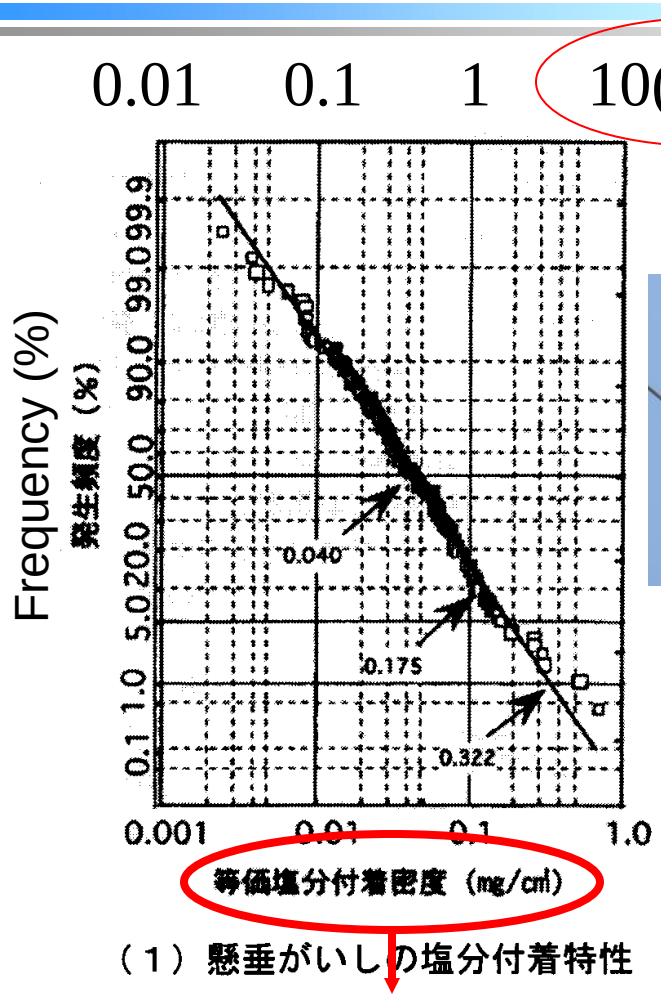
Design Assessment



Objectives

- To Evaluate the amount of deposition on the canister surface during the interim storage
- To obtain the experimental data of the deposition on the metal surface

State of the Art

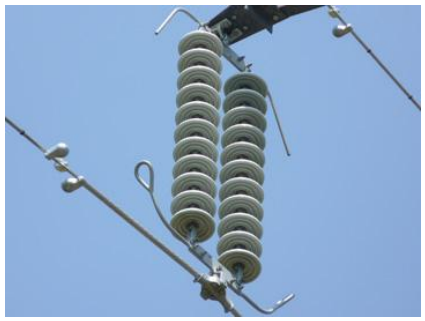


（１）懸垂がいしの塩分付着特性

Equivalent Salt Deposit Density (mg/cm²)

CRIEPI in Yokosuka

（Distance from the seashore 50m）



Insulator

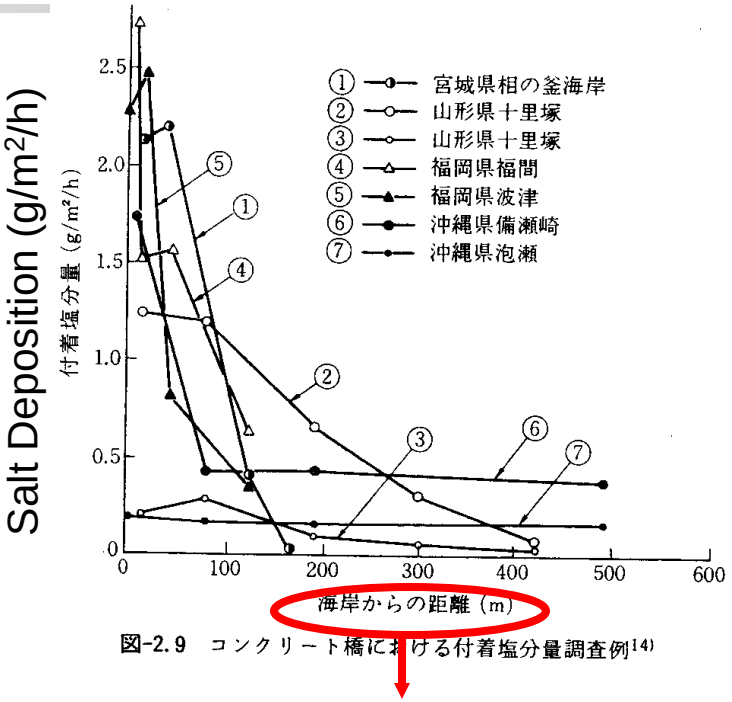
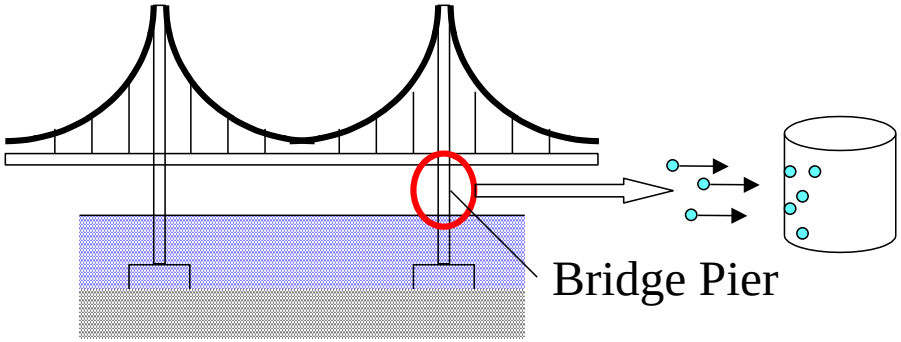


図-2.9 コンクリート橋における付着塩分量調査例[14]

Distance from the sea (m)

Measurement Data of Salt Deposition on the bridge piers



State of the Art

1 mdd=1 mg/dm^2/day=0.1 g/m^2/day

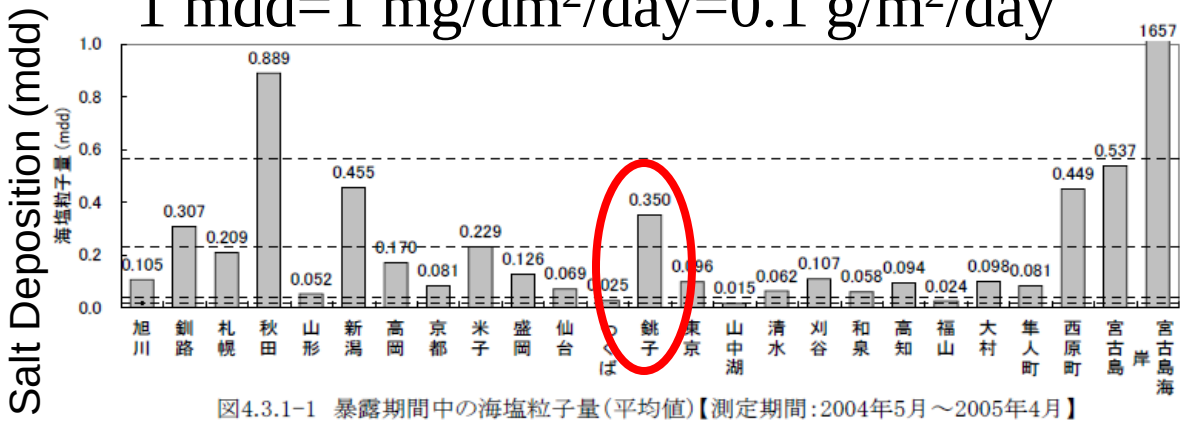
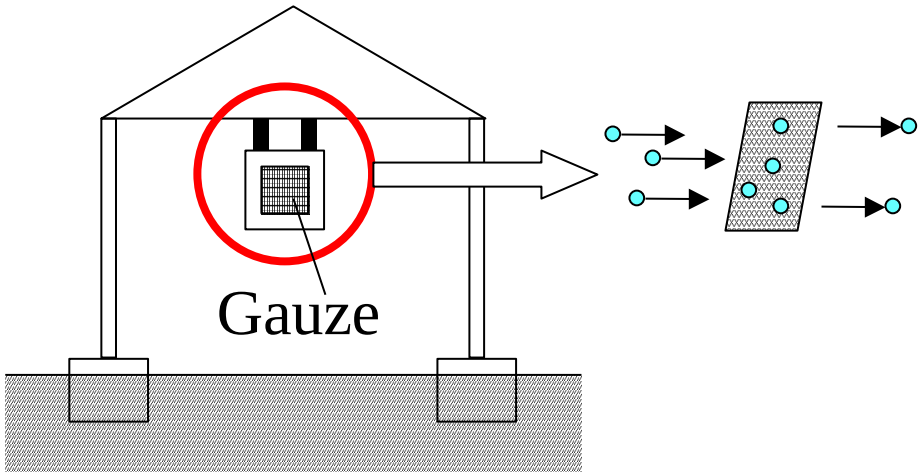
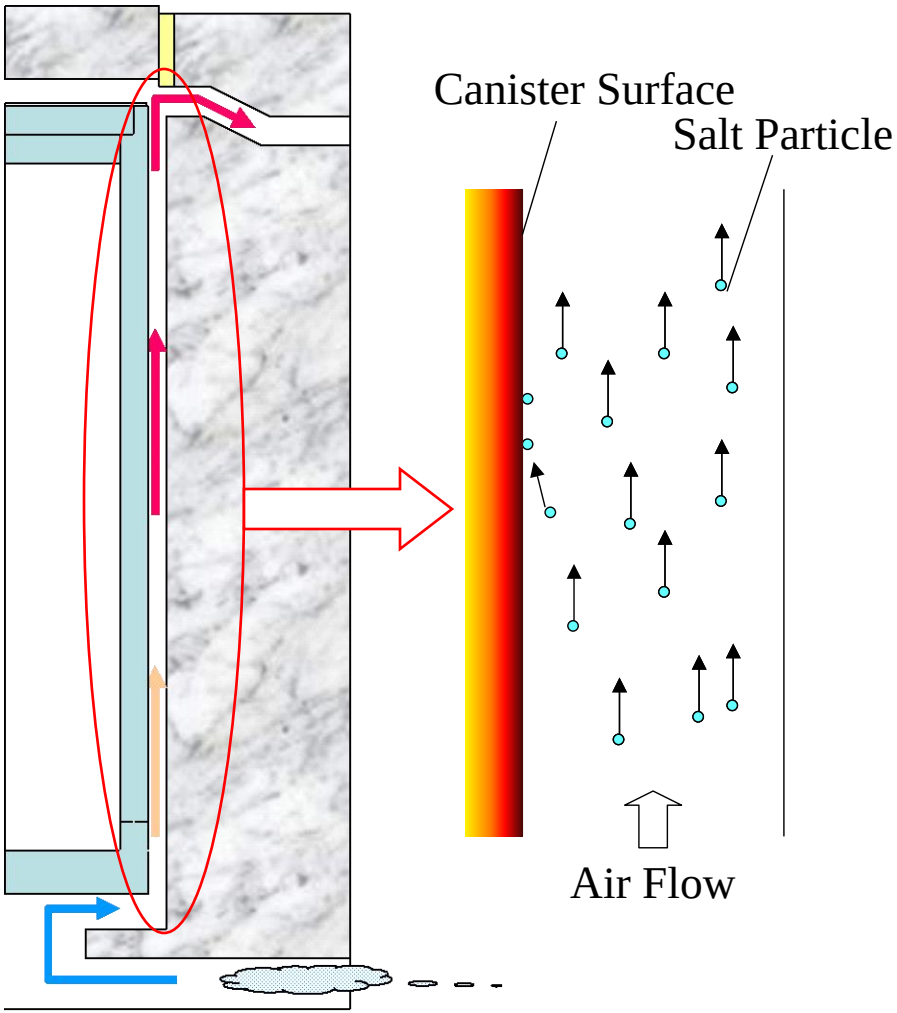


図4.3.1-1　暴露期間中の海塩粒子量(平均値)【測定期間:2004年5月～2005年4月】

Measurement Data of Salt Deposition by Gauze Method (May 2004- April 2005)



Difference between the state of the art and this study



(1) The temperature of the canister surface is hot.

(2) The surface of the deposition is vertical.

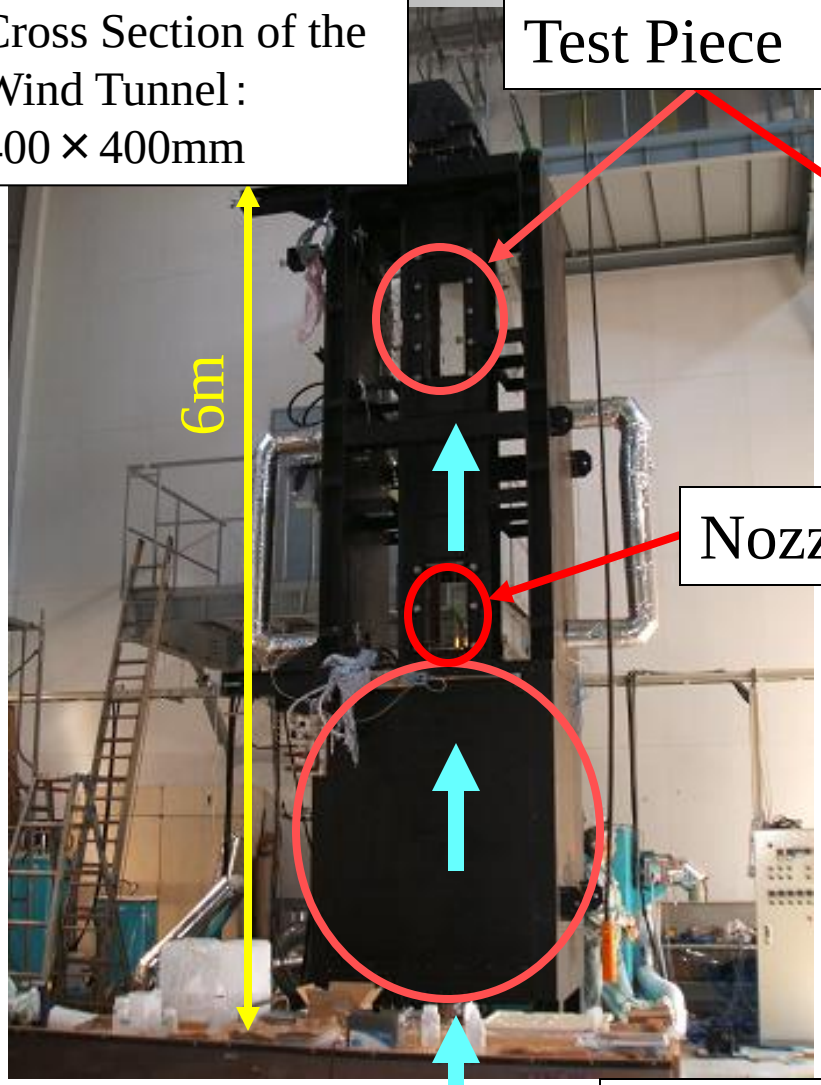
(3) The cooling air including the sea salt particles goes upward in parallel with the canister surface.

(4) The concrete cask is placed in a building and the canister surface is not exposed to wind and rain.

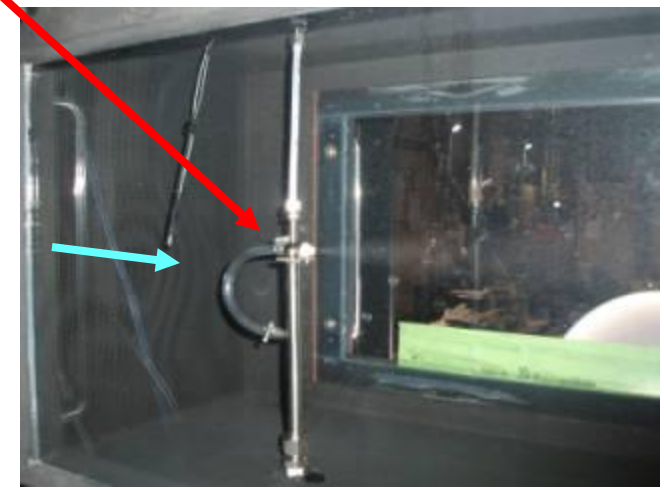
(5) Because the radiation dose is very high near the canister surface and the gap between the canister surface and the concrete container is very narrow, it is difficult to measure the amount of the deposition and check the surface condition.

Chloride Deposition Velocity Test (Test equipment)

Cross Section of the Wind Tunnel : 400 × 400mm

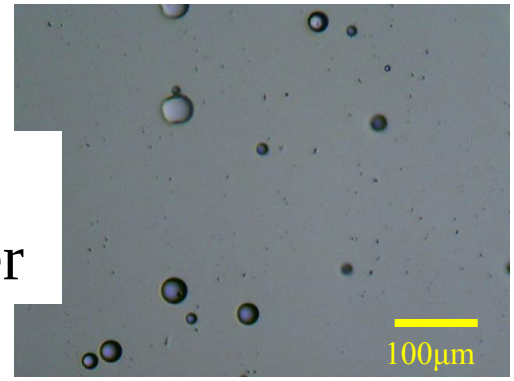


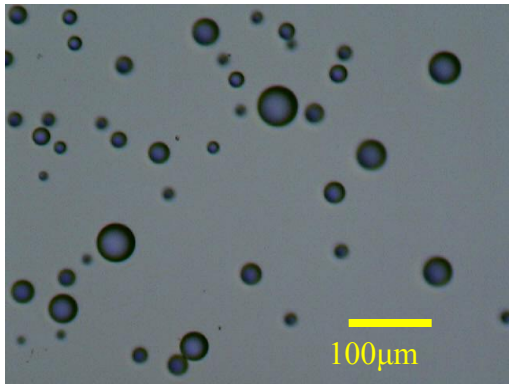
Size of the Piece : 75 × 75 × 2mm
Number: 10

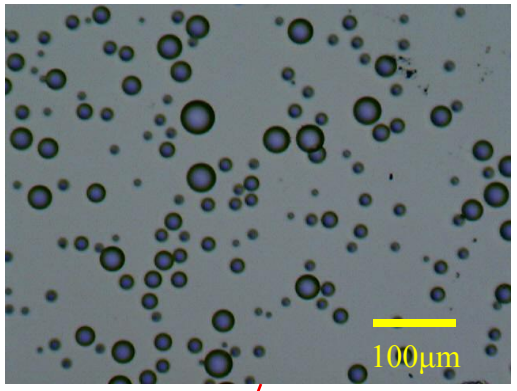


Particle Observation in the Wind Tunnel (Immersion Method)

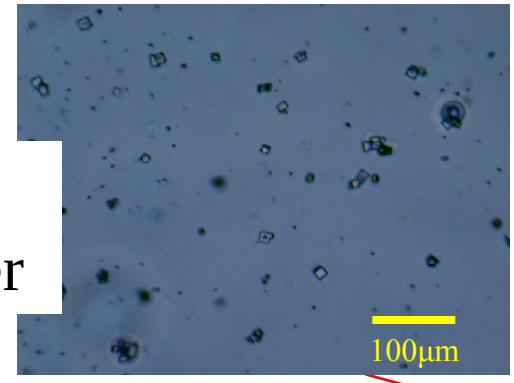
Pure Water

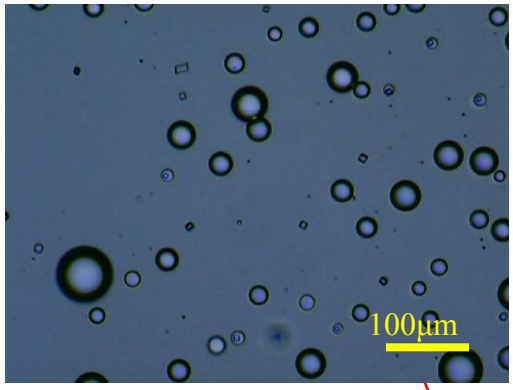


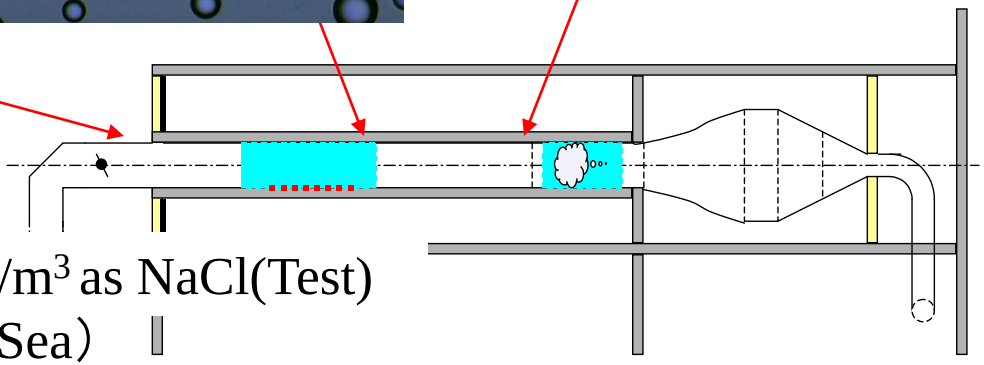




Salt Water



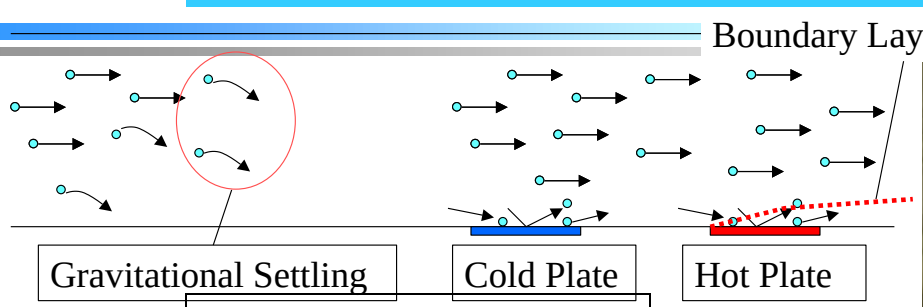


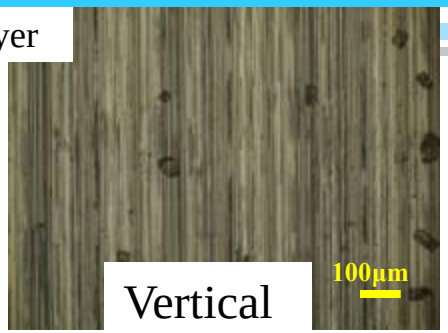


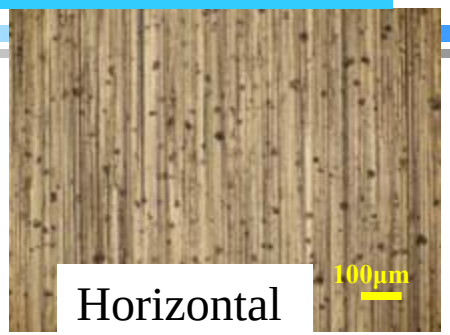
Size of Salt Particle : 31μm (Test)
～30μm (Measurement near the Sea)

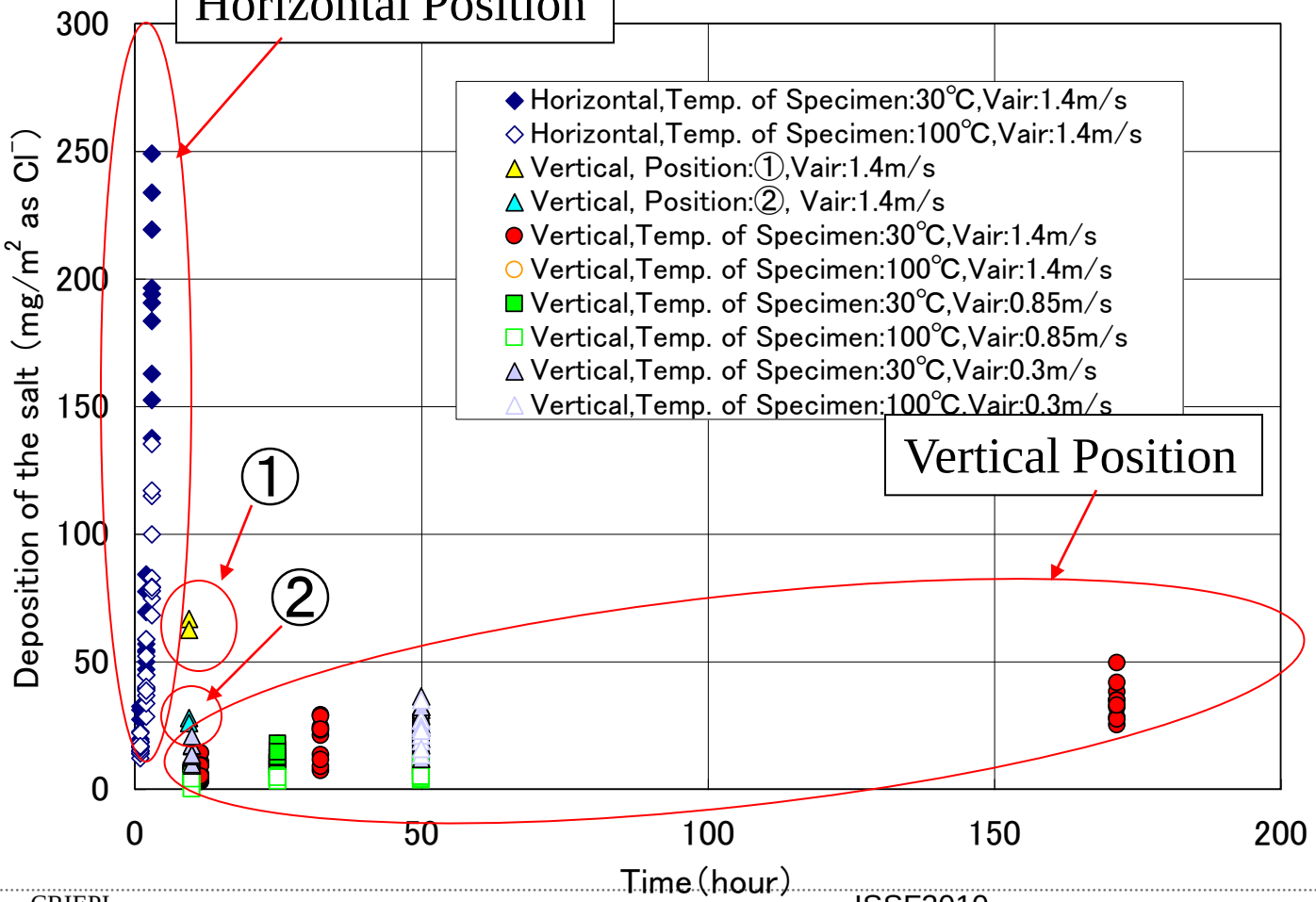
Salt Concentration in the Air : ～16mg/m^3 as NaCl(Test)
～60μg/m^3 (Measurement near the Sea)

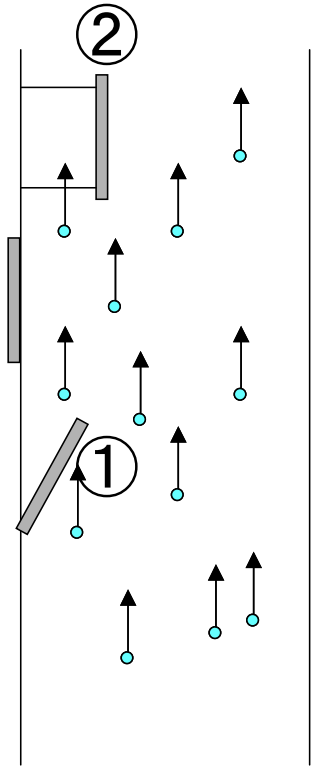
Result of Chloride Deposition Velocity Test (1)



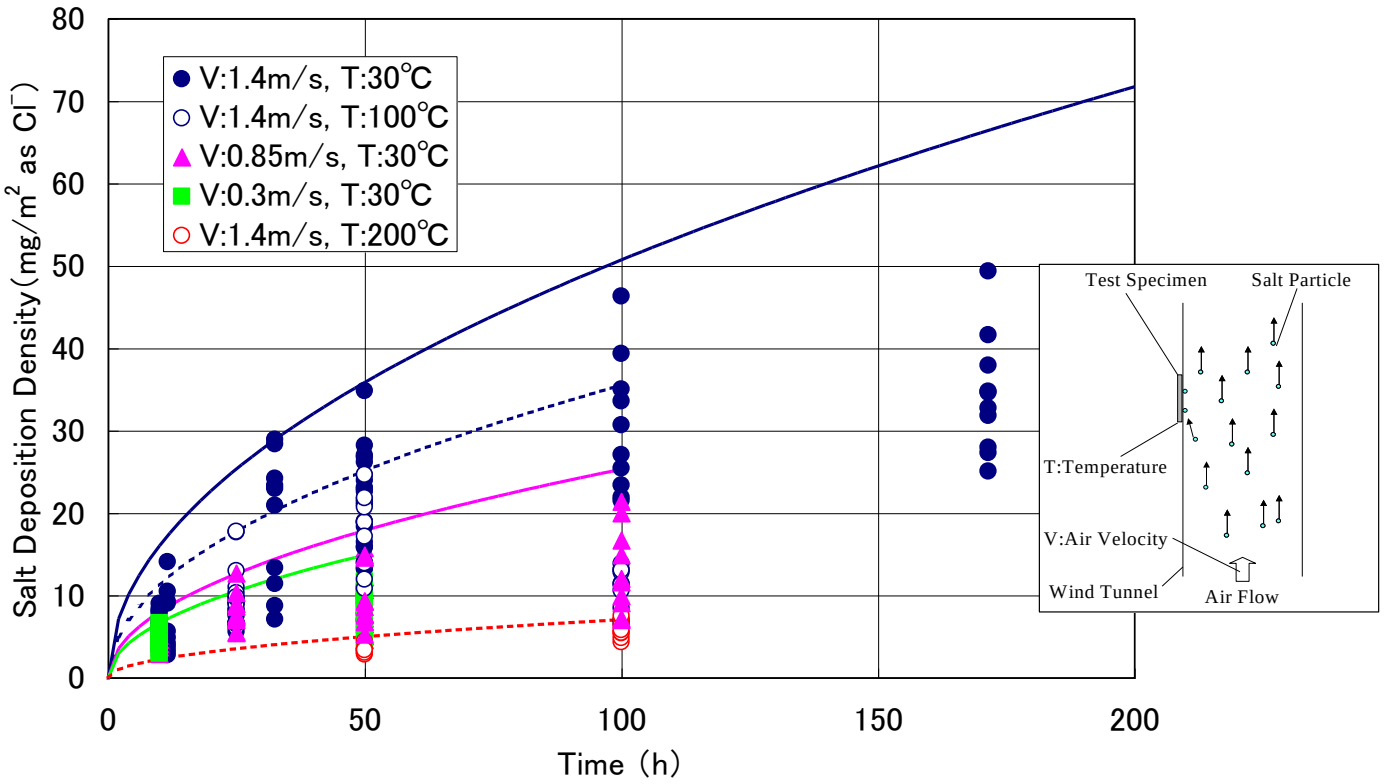








Result of Chloride Deposition Velocity Test (2)



Effect of the Temperature of the Specimen

Q_{200}: Deposition of the Salt at 200℃
Q_{100}: Deposition of the Salt at 100℃
Q_{30} : Deposition of the Salt at 30℃

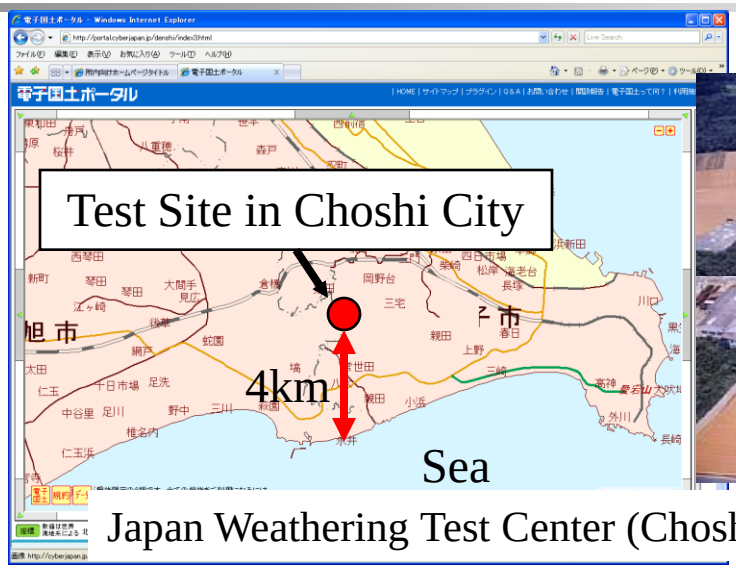
$$Q_{200} < Q_{100} < Q_{30}$$

Effect of the Air Velocity

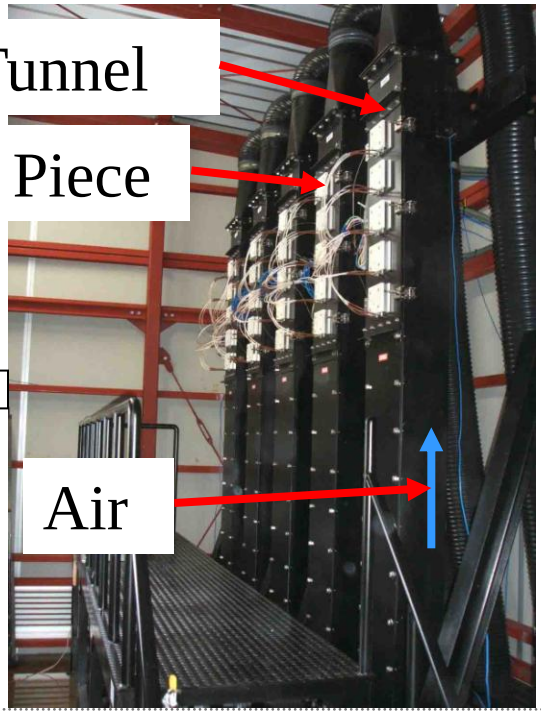
$Q_{1.4}$: Deposition of the Salt at 1.4m/s
$Q_{0.85}$: Deposition of the Salt at 0.85m/s
$Q_{0.3}$: Deposition of the Salt at 0.3m/s

$$Q_{0.3} < Q_{0.85} < Q_{1.4}$$

Test Equipment for the Field Test in Choshi

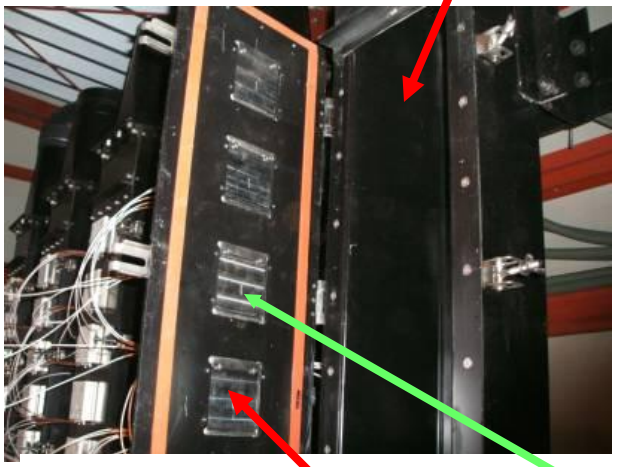


Japan Weathering Test Center (Choshi Site)



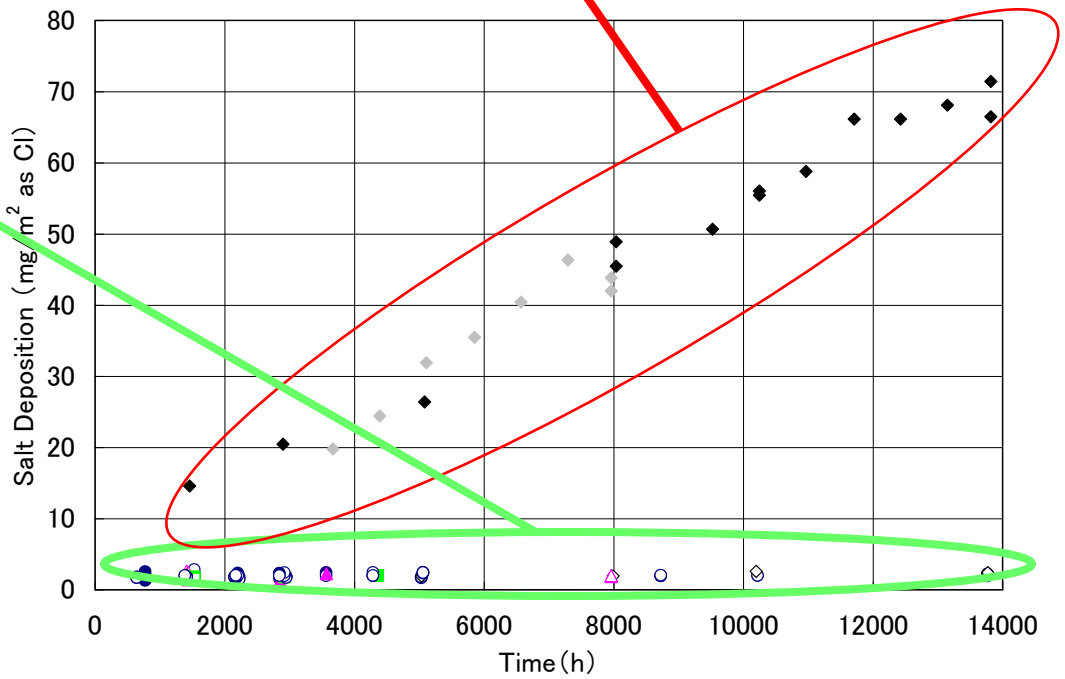
Test Equipment for the Field Test in Choshi

Wind Tunnel

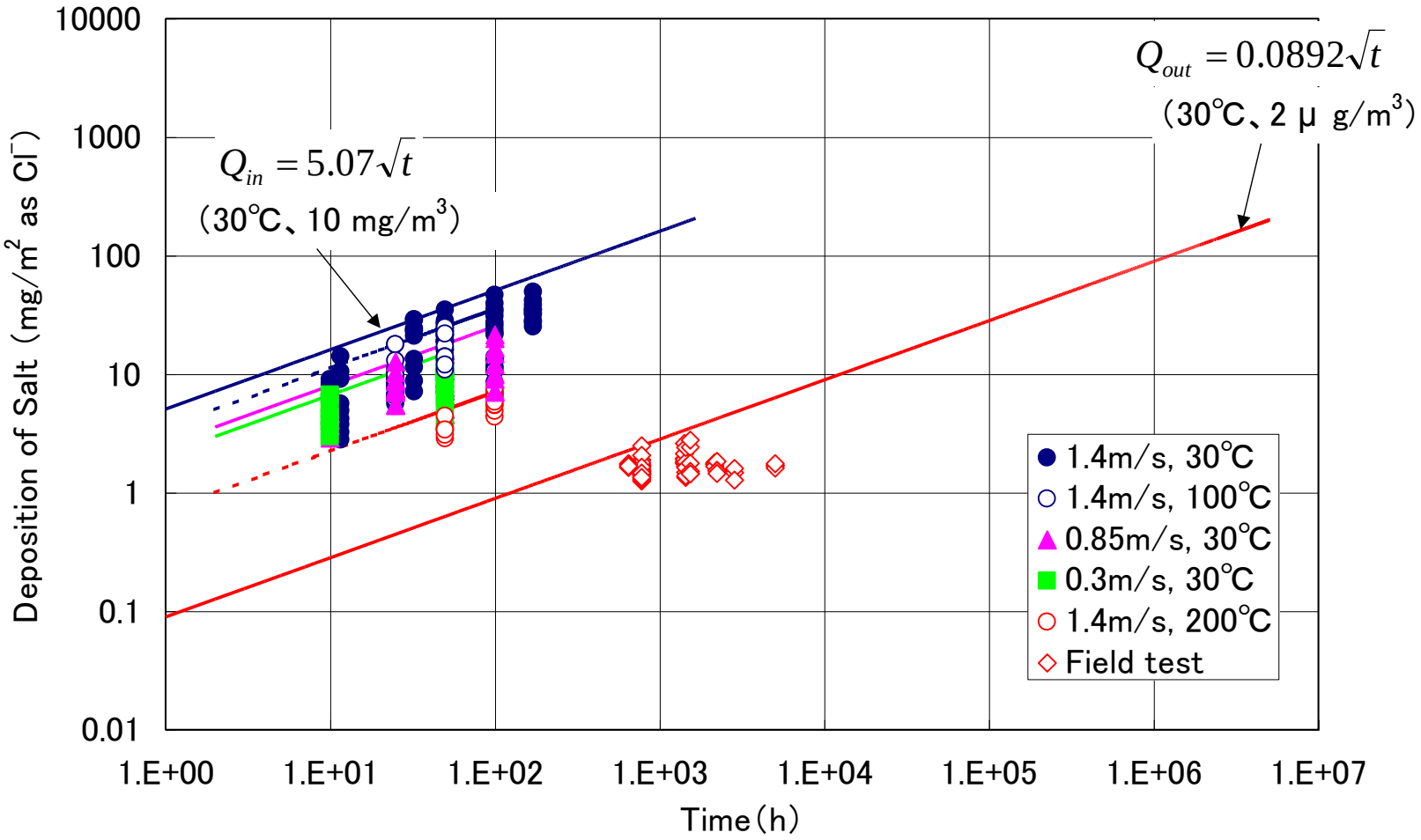


Test Piece with Heater

Air Inlet of Test House

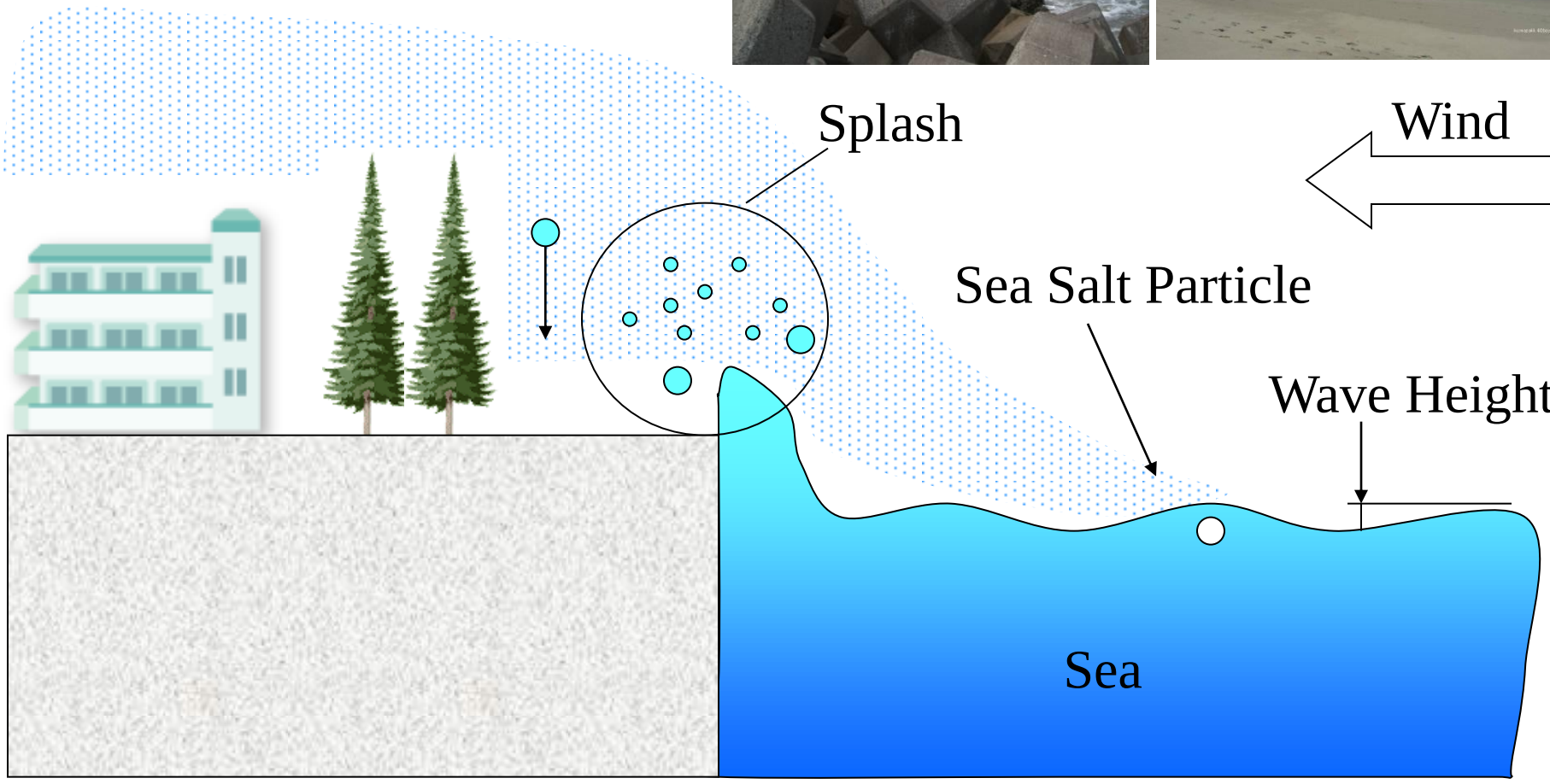


Test Equipment for the Field Test in Choshi

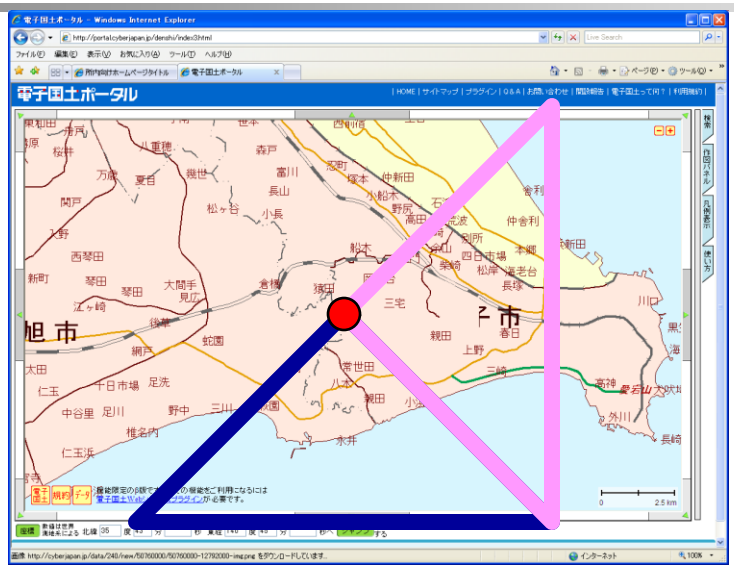


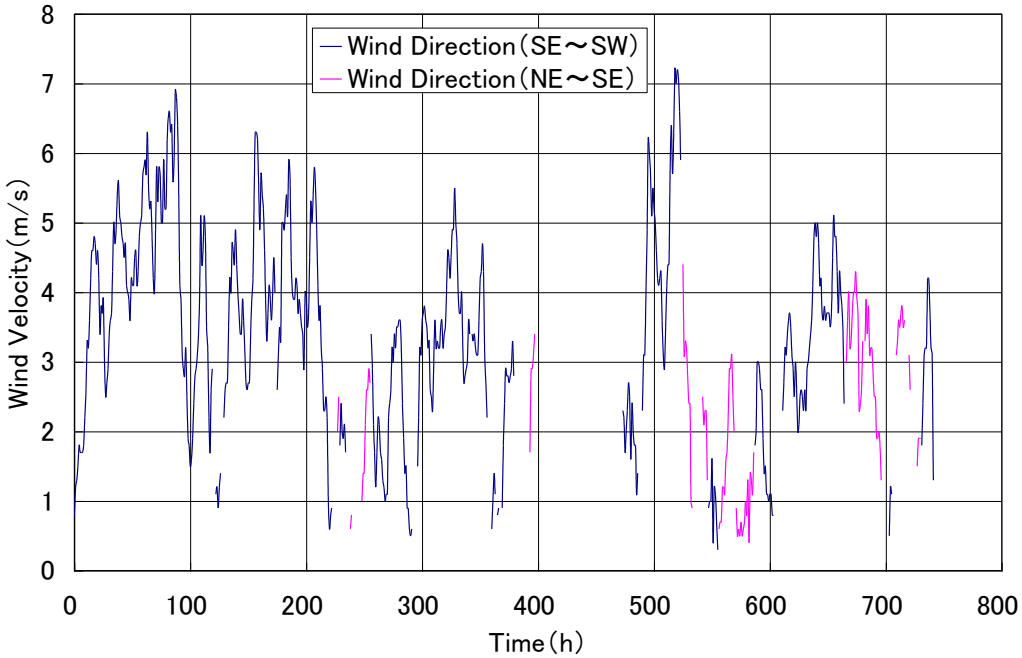
Comparison between Laboratory data and Field Data

Transport Phenomena of Sea Salt Particle in Nature



Concentration of Sea Salt in Air



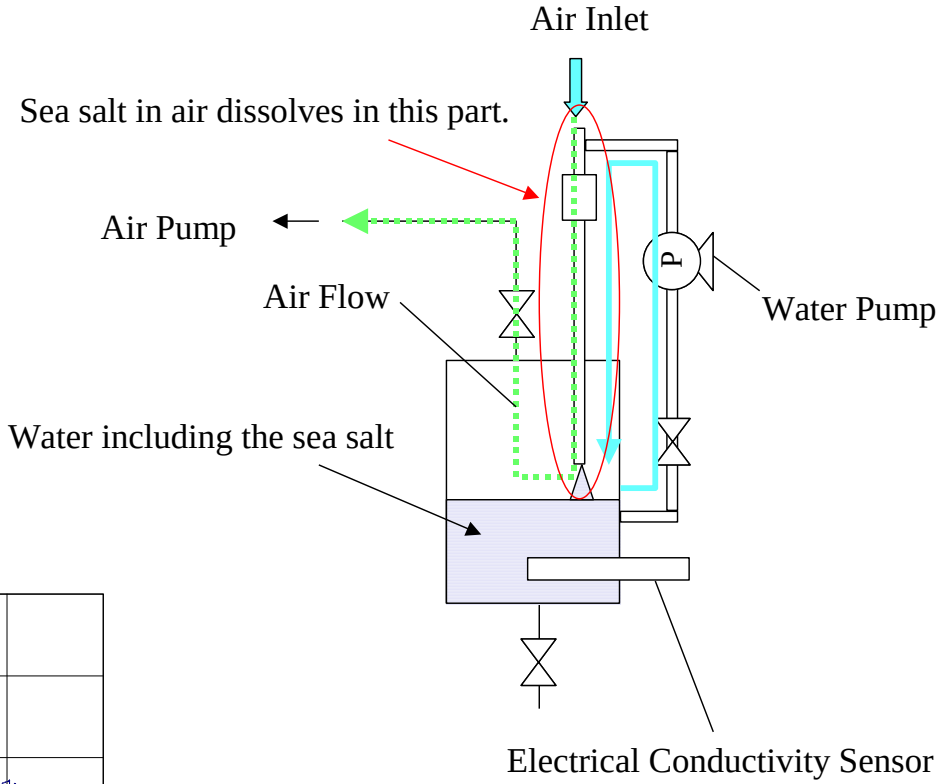


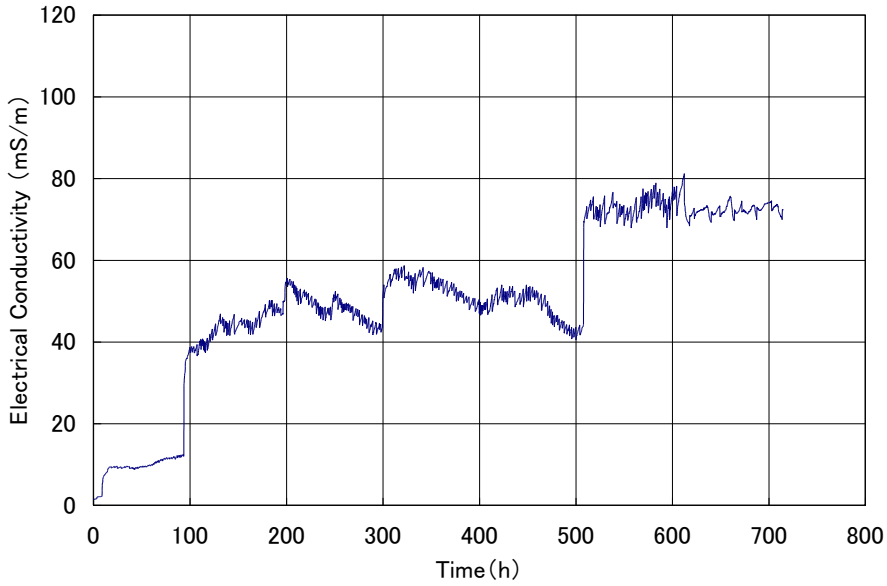
Measurement Data of the Deposition by Gauze Method:
13.1 mdd as NaCl (Average of August)

⇩

This is not the concentration of sea salt in air.

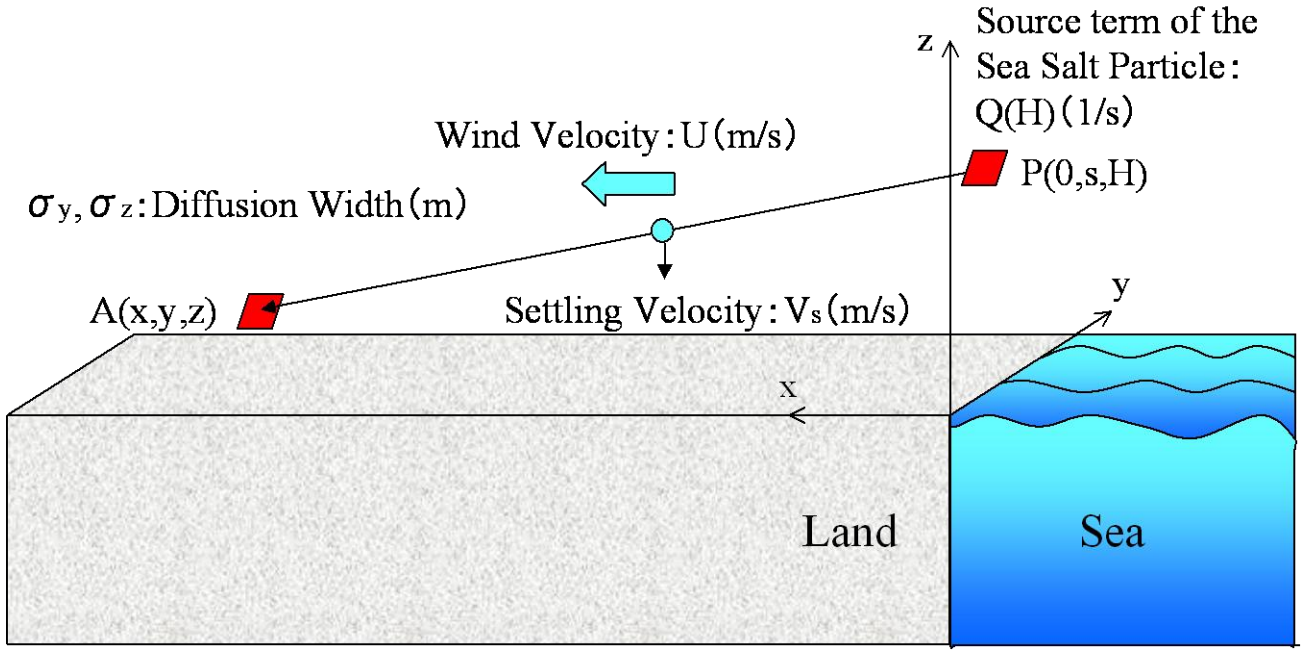
Development of Measurement Device





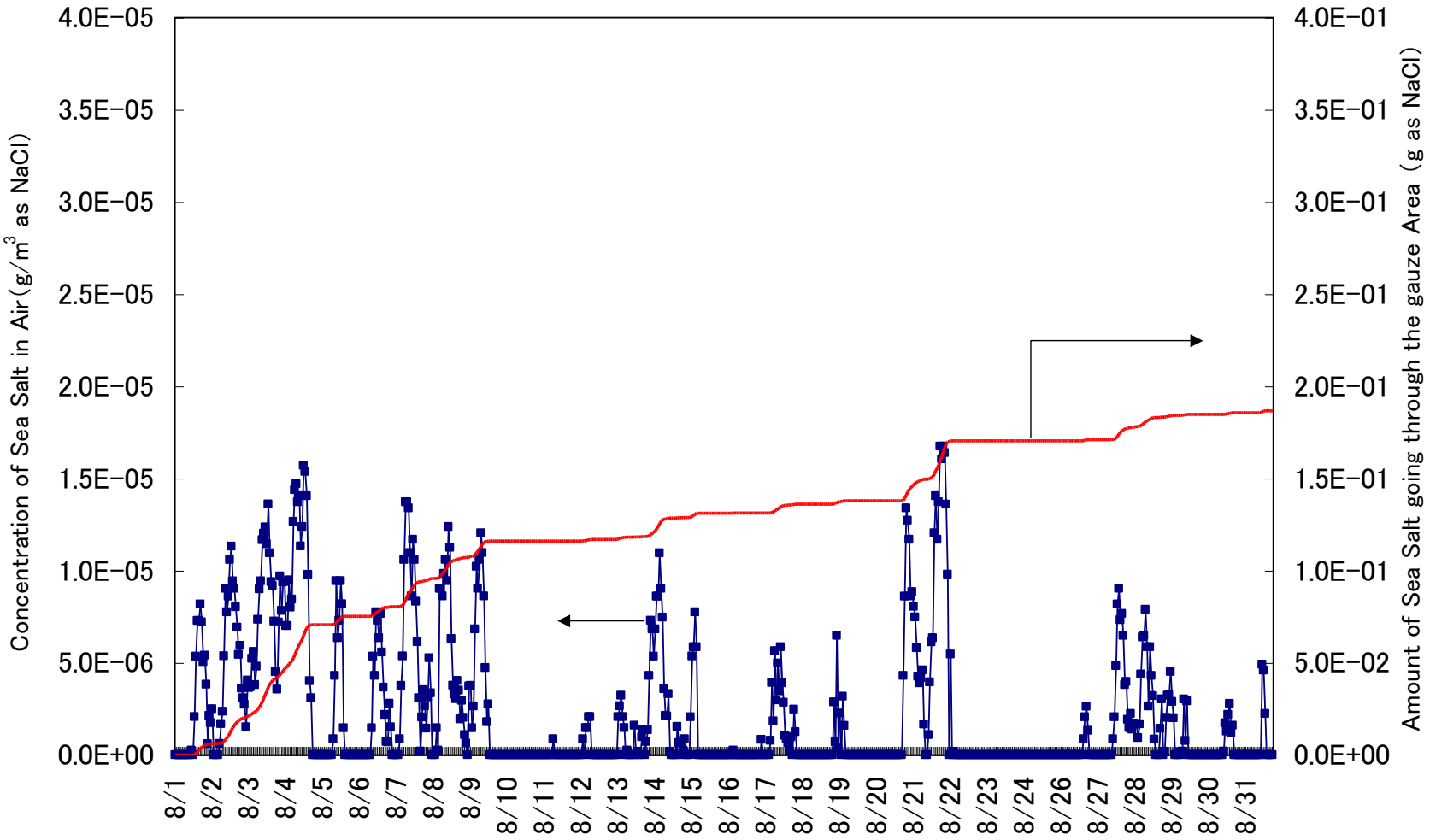
Calculation Method of Concentration of Sea Salt in Air

$$C'(x,y,z,s,H)=\frac{Q(H)}{2\pi U\sigma_y\sigma_z}\exp\left\{-\frac{(y-s)^2}{2\sigma_y{}^2}\right\}\times\left[\exp\left\{-\frac{\left(H-z-V_s\frac{x}{U}\right)^2}{2\sigma_z{}^2}\right\}+\exp\left\{-\frac{\left(H+z-V_s\frac{x}{U}\right)^2}{2\sigma_z{}^2}\right\}\right]$$



	Diameter (μ m)	Number Density θ 0 (1/m³)
Size1	4.06	1.61×10^{5}
Size2	5.96	9.02×10^{4}
Size3	8.75	4.88×10^{4}
Size4	12.8	2.64×10^{4}
Size5	18.9	2.20×10^{4}
Size6	27.7	2.88×10^{4}
Size7	40.6	4.00×10^{4}

Example of the Calculation Result



Summary

- We obtained the experimental data concerning the amount of deposition on the metal surface in the laboratory and field test.
- To evaluate the amount of deposition on the canister surface during the interim storage, it is necessary to know the concentration of sea salt in air. We developed the measurement device and the calculation method.