

10.3 Investigation of atmospheric diffusion

New factories are being built the environmental impact on the atmosphere of each factory needs to be evaluated accurately. Or, the atmospheric environment needs to be improved in industrial areas where many factories are located. To satisfy these requirements field research must be done on the environment and diffusion in these areas. A field study is necessary, especially, when the object area lies over complex terrains, or weather characteristics which are disadvantageous to preserving the atmospheric environment.

Research is divided into a meteorological condition research to grasp the situation of the field of diffusion and an environmental investigation which examines the environmental concentration and condition of the diffusion.

10.3.1 Meteorological conditions investigation

Investigation of the meteorological condition of an object area acquires not only the data used to diffusion simulation, but also the general characteristics of the atmospheric on the diffusion that in the area. The items for field for diffusion measurement are as follows:

- ① The hourly wind direction and velocity at ground level
- ② The hourly solar radiation and net radiation
- ③ The temperature and the vertical distribution of the temperature
- ④ The atmospheric turbulence
- ⑤ The wind's direction and velocity vertical distribution and velocity

The wind direction and velocity at ground level are measured by either a windmill type anemometer or a ultra-sonic anemometer. It is desirable to have a density of one observation site with a 5-kilometer radius, or at least several sites in the whole area. The height of the measurement equipment should be more than 10 meters above the ground and in a location where there is no influence from buildings and trees, etc. An ultra-sonic anemometer set on a pole is shown in photo.10.3.1.

The solar radiation and the net radiation are necessary to estimate the degree of atmospheric stability and the development of the mixing layer or the ground inversion layer. The equipment is installed in an open place with no shade and, if possible, on grassland. A net radiometer is shown in Photo.10.3.2.

Temperature and vertical temperature distribution near the surface of the ground are necessary, to make clear the conditions of the mixing layer and the inversion layer as well as the meteorological conditions and to use diffusion model. The ground level temperature is measured with a thermometer housed in an instrument shelter installed on the grassland. To measure a continuous vertical temperature distribution, a thermometer is installed in a building such as a tower or a chimney. The thermometer used is usually a ventilated platinum wire thermometer. In areas where towers or chimney cannot be used to measure the vertical temperature distribution continuously, a remote measurement method such as a radio sonde can be used (Photo.10.3.3).

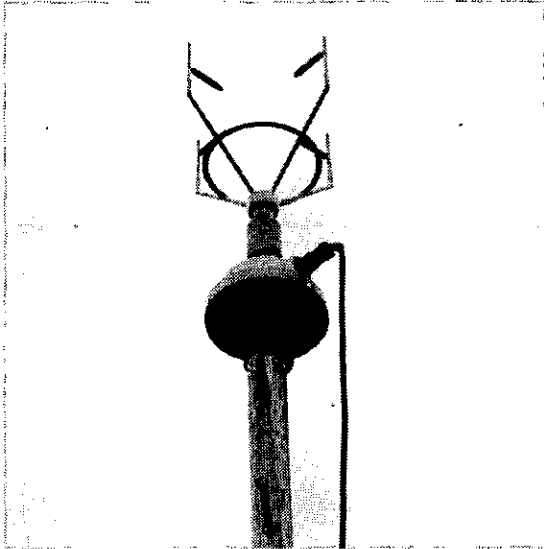


Photo.10.3.1 An ultra-sonic anemometer

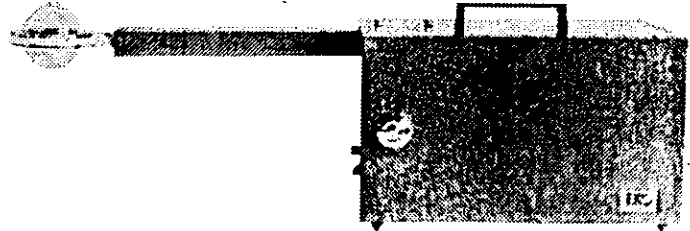


Photo.10.3.2 A net radiometer

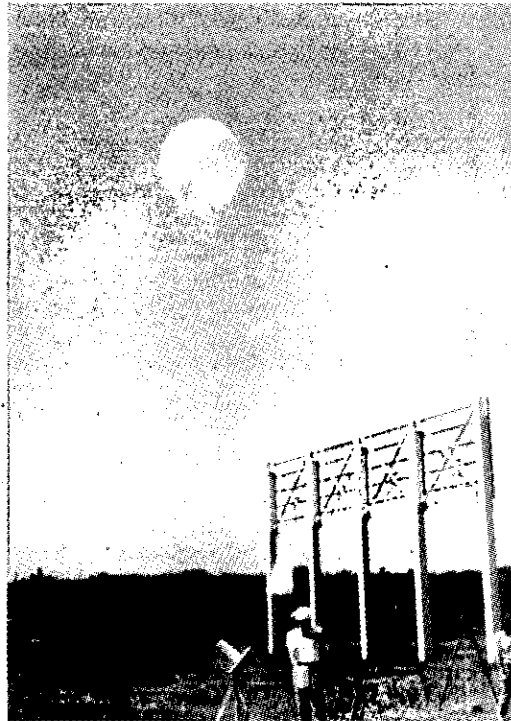


Photo.10.3.3 A radio sonde

Turbulence in the atmosphere is necessary to introduce the influences on diffusion by the terrain or structures (This word covers buildings, towers and other man-made artifacts. The word "constructions" doesn't usually pertain to buildings). An ultra-sonic anemometer is installed on a tower 20 meters or higher off the ground and it measures the two components of turbulence of horizontal direction and vertical direction.

The vertical distribution of the wind direction and velocity is necessary information to deal with diffusion from

high sources such as tall stacks. Wind direction/velocity meters and an ultra-sonic anemometers are mounted on high towers and chimney to continuously measure the vertical distribution of the wind direction and velocity. Where towers and chimney can not be used, remote methods can be utilized such as the pilot balloon method which tracks balloons released by theodolites and, also, the Rawin sonde can be used.

10.3.2 Investigation of the diffusion condition

Research into the diffusion condition of pollutants discharged from chimney among others is expensive and needs much manpower, but they are very important. The first is to measure the diffusion distribution of pollutants from existing industrial areas and the areas where the emission sources already exist. A tracer gas diffusion experiment is conducted to make clear the influence from specific sources in an area where the emission source is not operating yet and an area where many emission sources exist. In the tracer gas experiment, a material which has a low background concentration and highly sensitive to analysis is released instead of pollutants and is collected on the downwind side for analysis in a sampling network which has been arranged in an arc. As tracer material, sulfur hexa-fluoride (SF_6) and fluorocarbon 13B1 (CBrF_3), and so on, were used from the past but these chemicals are the greenhouse gases and their use is becoming impossible.

Fig.10.3.1 is an example of a diffusion concentration profile on the ground which was acquired by a tracer gas experiment using sulfur hexa-fluoride. The release height was 147 meters, and the emission duration and sampling time were both about one hour. The tracer material was collected by the sampler which was arranged in a half arc and analyzed, and an contour distribution of concentration was made. By these data the maximum concentration, the distance from the source point, the plume width and so on are acquired, and they are related to the meteorological condition and analyzed.

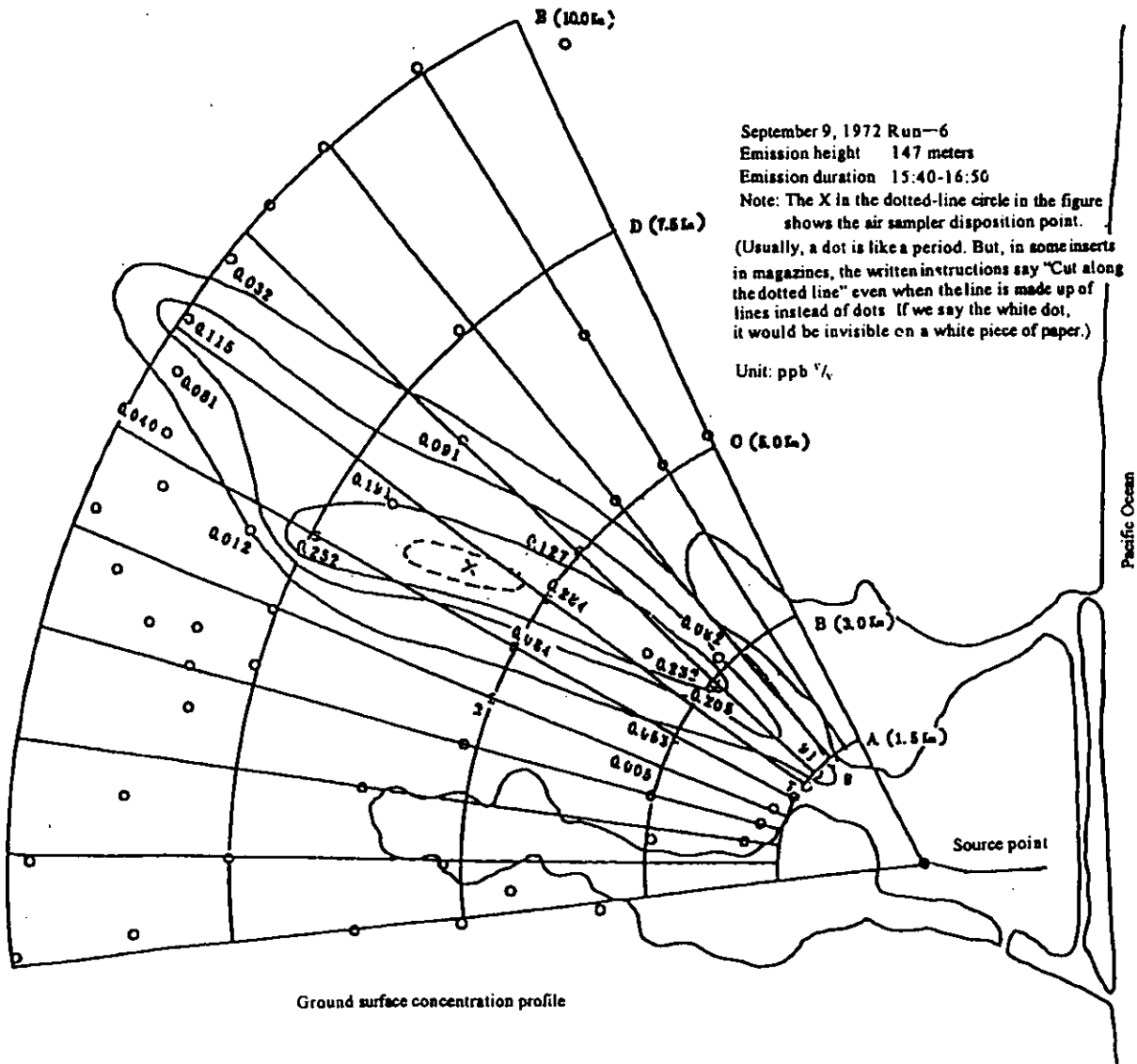


Fig.10.3.1 Ground surface concentration profile acquired by a tracer diffusion experiment