VI INTERNATIONAL
SAUNA CONGRESS
HELSINKI
15.–17.8.1974

ISBN 951-95328-0-3

Vammala 1976. Vammalan Kirjapaino Oy.

SAUNA STUDIES

Papers read at the VI International Sauna Congress in Helsinki on August 15—17, 1974.

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HELSINKI 1976

THE IONS IN SAUNA AIR

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Introduction

It has been well known for a long time that air contains both positive and negative ions. The influence of the ions in the air has been studied in many investigations (1, 2, 3). It has been shown that the ions are capable of inducing measurable and reproducible physiological changes in a variety of living forms. Investigations of the ions in the air started at Tampere University of Technology at the end of 1973. The aim of this work was to study the ions in sauna air in connection with the investigations of ions in the air in different working and living spaces.

Measuring conditions in the sauna are quite difficult and therefore these experiments provided a challenging opportunity of testing our system. There has been some discussion (4) about the ion distribution in sauna air, but no measurements have been published so far.

Experimental

Fig. 1. is the block diagram of the system which was used in ion measurements. The detectors were constructed at Tampere University of Technology. They were similar in principle to detectors which have been used widely elsewhere (5, 6). The detector consists of a cylindrical capacitor and an electric field persists between the electrodes. When air containing ions flows through the capacitor, the electric field affects the path of an ion.

Depending on the air flow and the electric field, ions are either

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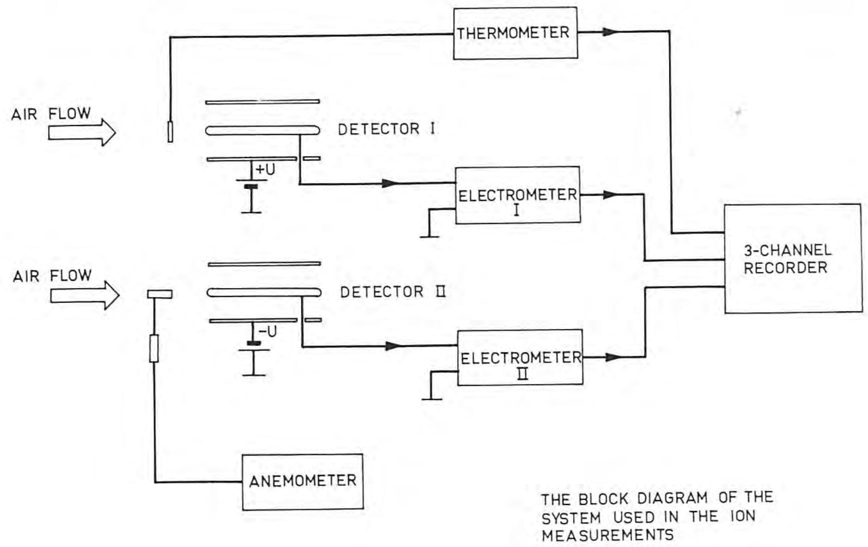

Fig. 1. The block diagram of the system used in the ion measurements.

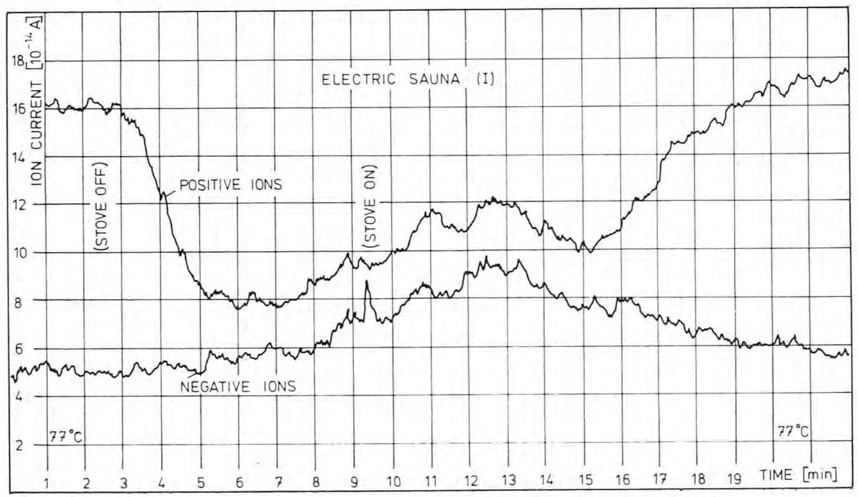

Fig. 2. The effect of an electric stove (*kiuas*) on the ion current in the sauna. When the resistances of the stove were glowing the density of positive ions was much higher than the density of negative ions.

captured or they pass through the capacitor. In this connection we define the critical mobility k_g which can be obtained from the dimensions of the apparatus and the test conditions. For a cylindrical capacitor of radii R and r and lenght L we obtain the expression

$$(1) \quad k_g = M \frac{\ln R/r}{2\pi L U}, \ (7)$$

where M is the quantity of air sucked through the capacitor in cm^3/sec. and U is the voltage between the electrodes. All ions with mobility

$$(2) \quad k = \frac{v}{E} \geq k_g$$

will be observed, whereas of the ions with mobilities $k < k_g$ only the fraction k/k_g is captured. In expression (2) v is the drift velocity of the ion and E is electric field.

In our measurements the air flow was 1.4 litres per sec. and the voltage $\pm$ 30 V. The critical mobility in our measurement was $0.45 \frac{cm^2}{Vs}$. The ion current was measured with commercial electrometers. We had two similar detectors in parallel so that we could measure simultaneously both negative and positive ions. The experimental conditions were kept the same for both detectors except that the voltages were opposite. The current of positive and negative ions as well as the temperature of the air were recorded with a 3-channel recorder.

Measurements

Two different electric saunas, one continuous-heating and one smoke sauna, were studied. Both were located quite close to one another and were in regular use. Both saunas were typical and commonly used in Finland. In our measurements the critical mobility was $0.45 \frac{cm^2}{Vs}$, so that we observed basically small ions. The amount of such ions in normal air varied from 300—500 per cm^3. In some

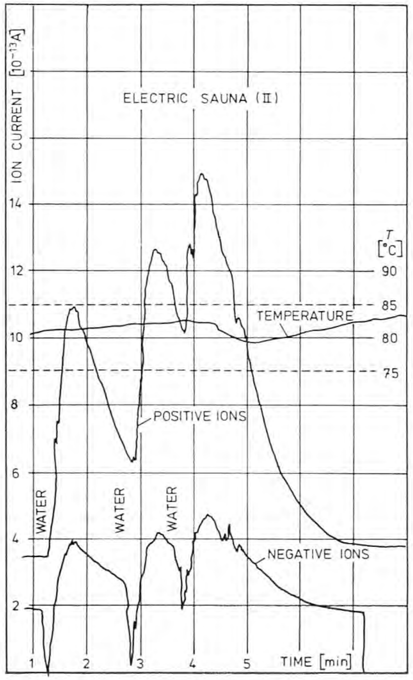

Fig. 3. When water (löyly) was thrown on the stones in the electric stove the increase of both negative and positive ions was large. However in the tested sauna the increase of positive ions was much larger than the increase of negative ions.

cases in the sauna, when water was thrown on the stove, the number of small ions observed was as high as 6,000/cm^3.

Electric sauna

A large increase in positive ions was observed when the electric stove was on and the resistances were glowing. Positive ions are produced when air flows through the stove. This

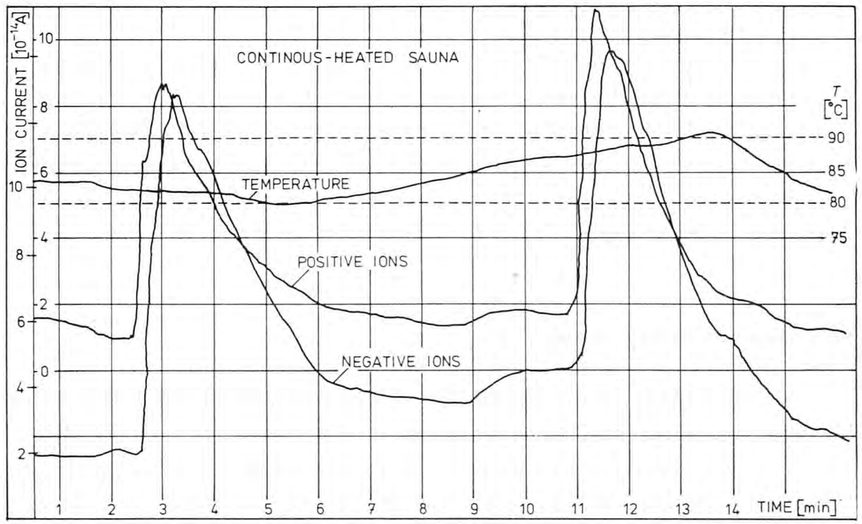

Fig. 4. The situtation in a continuous-heating sauna when water was thrown on the stove.

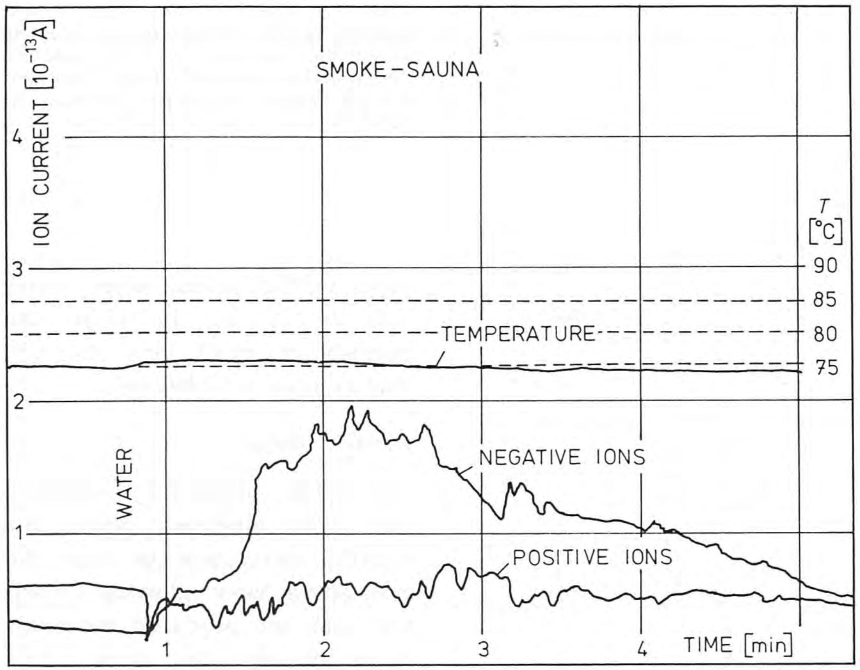

Fig. 5. In the smoke sauna the number of small negative ions increased markedly when small amounts of water were thrown on the stove.

phenomenon could be easily tested in the laboratory. The ion distribution of a glowing wire has been measured earlier (8). When water was thrown on the stove the number of both negative and positive ions increased strongly. The number of positive ions, however, increased more sharply.

Continuous-heating sauna

No big changes in the numbers of positive and negative ions could be observed when the stove was heated. The stove was made of iron and had only 10—20 kg of stones. The metal was not glowing during the measurements. When water was thrown on the stones the density of both positive and negative ions increased markedly. When the stove is heated properly the increase in negative ions is larger.

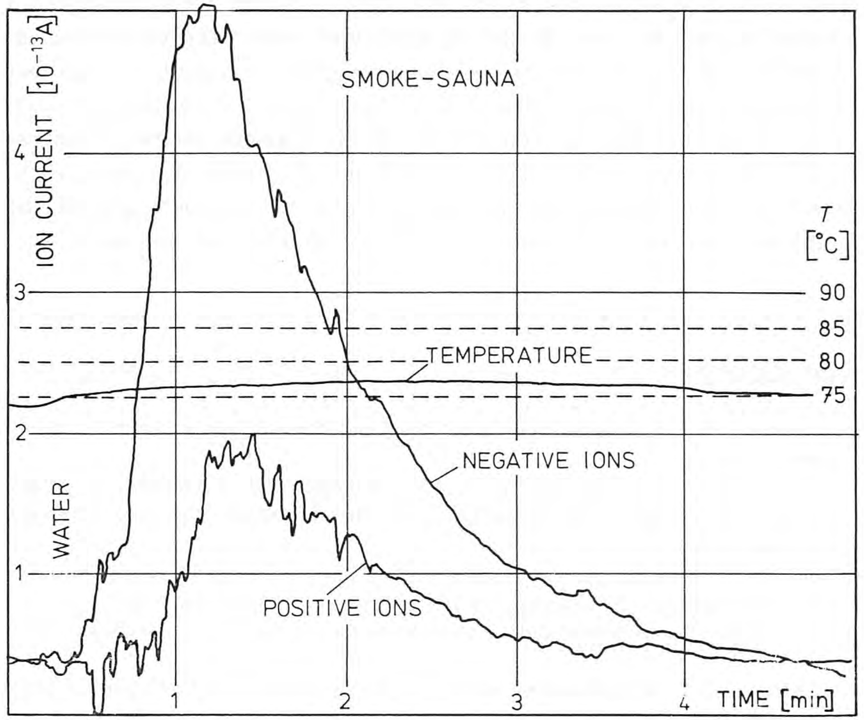

Fig. 6. When a larger amount of water was thrown on the stove in the smoke sauna a clear increase in positive ions also was observed, but the number of negative ions increased much more.

Smoke sauna

In the smoke sauna the number of negative ions per cu.cm. increased strongly when water was thrown on the stove. Very few positive ions were produced when small amounts of water were thrown. When water was thrown in larger amounts, also the number of positive ions increased but not as much as the number of negative ions.

Conclusion

The ion distribution of sauna air depends on the stove (*kiuas*), how it is heated, how it is built and what kind of materials are used. The *kiuas* is the heart of the sauna (9). The glowing metal produces a surplus of positive ions. In the smoke sauna, where the *kiuas* is made of stones and usually only very few metal parts are used, the number of negative ions is much greater than the number of positive ions. It seems to us that the ion distribution of air depends on the temperature of the stones in the *kiuas*. Further investigations are required in which the ion distribution is followed and the temperature of the stones is recorded at the same time. These studies are in progress.

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