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Characteristics of Water Veil and Verification of its Healing Effect by Visualization of Mind

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***Abstract*:** A very thin water veil like a thin transparent sheet of vinyl has been produced by shaping a double-disk nozzle in such a way to accelerate the water flow inside the nozzle. Comparison of the simulated shape of the water veil with that of the experiment shows that they are almost identical. Human mind can be refreshed and relaxed by being inside of this water veil. In this paper, the application of water veil to healing mind and body is examined. The analysis of the brain wave data using the emotion spectrum analysis method (ESAM) elicited that the water veil is very useful to recover freshness and effective in healing mind and body.

***Keywords*:** water veil, healing, computer simulation, visualization of mind, brain wave.

1. Introduction

Shaping a double-disk nozzle in such a way to accelerate the water flow inside the nozzle has produced a thin water veil like a thin transparent sheet of vinyl. A computer simulation of this radial flow is performed using the balancing equation of gravitational force, surface tension, inertia force and air resistance. About a small size water veil, the computer simulation was performed using this equation and compared with the experiment (Nakayama et al., 1996). This device is useful for an interior display.

An effect of this water veil is to clean the surrounding air and to supply humidity. Minus ions produced from the veil by Lenerd effect are considered to be effective for stimulating metabolism and promoting blood circulation. In other words, it is also effective for health, beauty and prevention of aging. It is considered that human mind can be refreshed and relaxed by being inside of this water veil.

In this paper, the numerical analysis and experiment are performed and the characteristics are made clear about a large water veil. And then, how this water veil works on healing mind and body is examined. Human emotion can be expressed numerically by measuring brain waves, and this new method is called ESAM (Musha et al., 1997; Musha et al., 2000). Using this method, human brain waves are measured before and after entering the water veil, the emotion analysis is made and the verification of the healing effect of the water veil is performed.

2. Water Veil

2.1 Numerical Analysis

As shown in Fig.1, the outlet point of the double-disk nozzle is taken as an origin of the coordinate axes. The vertical axis is the z-axis (positive in downward direction) and the horizontal axis is the x-axis. The parameter T denotes the surface tension, p the pressure difference between inside and outside of water veil, Q the volumetric flow rate, u_0 the outlet velocity from the nozzle, ρ the density of water and g the gravitational acceleration.

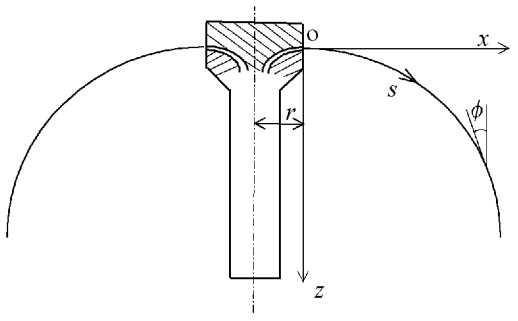

Fig. 1. Coordinate system.

Now, considering the surface tension T is constant, and neglecting the air resistance, the velocity of water u at an arbitrary position is given by,

$$u^2 = u_0{}^2 + 2gz \tag{1}$$

Putting the inclination of the water veil surface to the vertical axis as ϕ, the thickness of water veil at an arbitrary point as t, the radius of curvature as r_c and the radius of the double-disk nozzle as r, the following equation is obtained from balancing of the surface tension, pressure, gravitational force and inertia force:

$$\frac{2T}{r_c} + \frac{2T\cos\phi}{r+x} - p + g\rho t\sin\phi - \frac{u^2\rho t}{r_c} = 0 \tag{2}$$

continuity equation is given as,

$$Q = 2\pi(r+x)ut \tag{3}$$

Equations (1) and (2) can be made dimensionless using the following equations.

$$X = \frac{x}{L},\quad Z = \frac{z}{L},\quad S = \frac{s}{L},\quad R = \frac{r}{L} \quad \text{here} \quad \frac{1}{L} = \frac{4\pi T}{\rho Q u_0} \tag{4}$$

$$U = \frac{u}{u_0} \tag{5}$$

Here, s is the film arc length cutting by the meridian measured from the original point and r is the radius of the double-disk nozzle. Substituting Eqs. (4) and (5) into Eq. (1),

$$U^2 = 1 + 2\beta Z \tag{6}$$

here $\beta = \dfrac{g\rho Q}{4\pi u_0 T}$

From $\dfrac{1}{r_c} = -\dfrac{d\phi}{ds}$, $\sin\phi = \dfrac{dX}{dS}$, Eqs. (3), (4) and (5), Equation (2) becomes

$$-\sin\phi\frac{d\phi}{dx}\left(1 - \frac{U}{R+X}\right) + \frac{\cos\phi}{R+X} - \alpha + \beta\frac{\sin\phi}{(R+X)U} = 0 \tag{7}$$

here $\alpha = \dfrac{\rho u_0 Qp}{8\pi T^2}$

Giving the initial condition $\phi = \phi_0$, $X = Z = S = 0$ to Eq. (7), the computer simulation was performed using Runge-Kutta method.

2.2 Experimental Apparatus

2.2.1 Small size water veil

The experimental apparatus is shown in Fig. 2. The outside diameter of the double-disk nozzle is 5 cm and the height is 17 cm. The water from a pump is supplied to the nozzle through the differential pressure flow meter. The shape of the nozzle is designed to produce an accelerated flow. By adjusting the pressure control valve and changing the discharge, the outlet clearance and the outlet flow rate that form a most attractive water veil shape are obtained.

Milk was poured into the water tank to get 0.1% water solution of milk for the purpose of making the reflecting laser light. By cutting the water veil using the laser light sheet, the thickness and shape of the water veil are obtained.

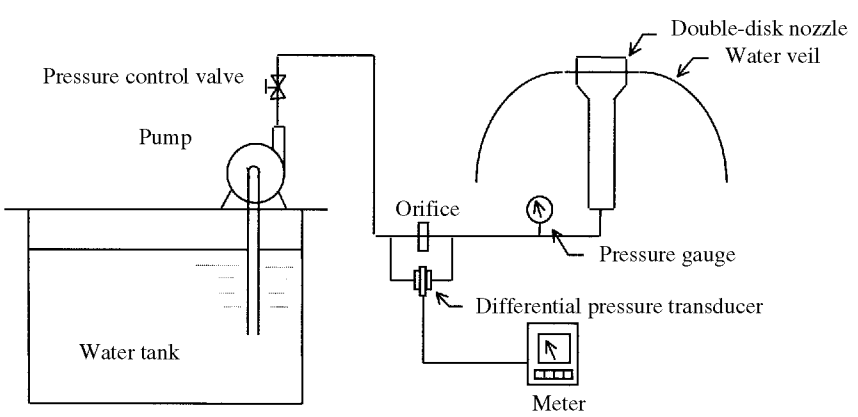

Fig. 2. Testing apparatus.

2.2.2 Large size water veil

The experimental apparatus is shown in Fig. 3. The outside diameter of the nozzle is 160 cm and the height is 100 cm. The water from a pump is supplied to the nozzle through a damper tank and an ultrasonic flowmeter. The outlet clearance and the outlet flow quantity that produce a most attractive water veil shape and flow quantity are obtained by changing the rotational speed of the pump and hence changing the discharge.

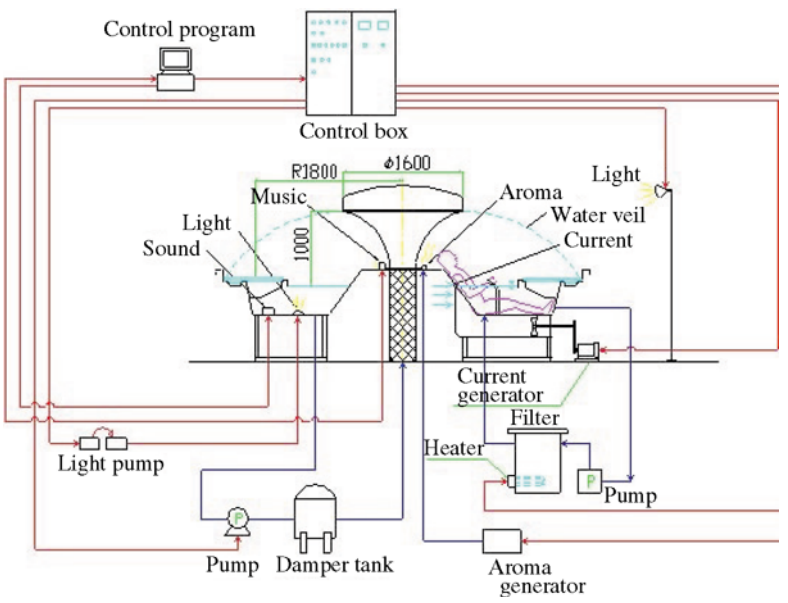

Fig. 3. Mind and body care system using water veil.

2.3 Computational and Experimental Results

2.3.1 Small size water veil

A result of the visualization experiment on the film of the water veil is shown in Fig. 4. According to this photograph, the thickness t is found to be 1.2 mm. In this case, the flow quantity Q is 1.8×10^{-4} m^3/s, so the outlet velocity becomes 0.97 m/s. The value of ϕ at the outlet is 110°.

Using the values obtained from the experiment and putting $p = 0$ Pa, the theoretical analysis is carried out and the result is shown in Fig. 5. It is clear that the numerical results agree well with the experimental values. The compact type for interior decoration is shown in Fig. 6.

Fig. 4. Visualized result of water veil.

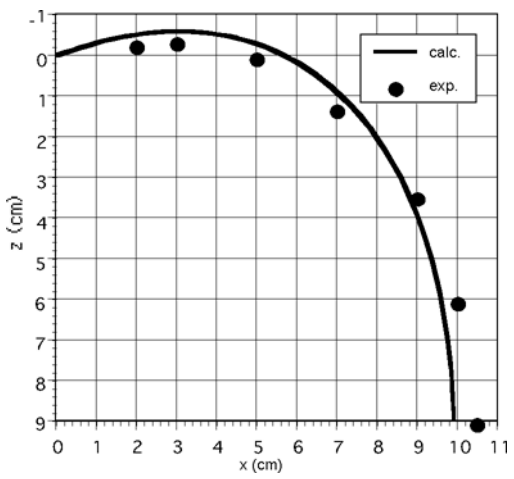

Fig. 5. Result of calculation and experiment.

2.3.2 Large size water veil

In this experiment, the outlet clearance of the nozzle is approximately 1 mm and the volumetric flow rate Q is 0.033 m^3/s. The value of ϕ at the outlet is 110°. The photograph of the water veil taken from the side is shown in Fig. 7. From this photograph, the shape of the veil is measured.

The number of negative ions generated by Lenerd effect is about 15,000 ions/cm^3 near the water veil.

From these results described above, the utilization of the water veil is considered effective in healing human mind.

Fig. 6. Small size water veil.

Fig. 7. Water veil for healing.

3. Visualization of Mind

3.1 Brain Waves

A cross-section of the cerebral cortex is shown in Fig. 8. From the close inspection of the cerebral cortex, the nervous cells called neuron are found packed in the surface layer of a few mm thickness. This part is called gray matter. The layer under the gray matter appears comparatively white, consisting of axons, and hence it is called white matter. The electric voltage inside the neuron is kept at minus 60-90 mV relative to the outside part, in other words, "the cell is polarized". If the neuron receives electrical signals from other neurons and is polarized (is excited), an electric current impulse is emitted in the connecting axons. A mass electric current thus generated is in the vertical direction to the cortical surface. After passing through the skull, it reaches the scalp where the electric potential distribution is produced. This is the brain wave.

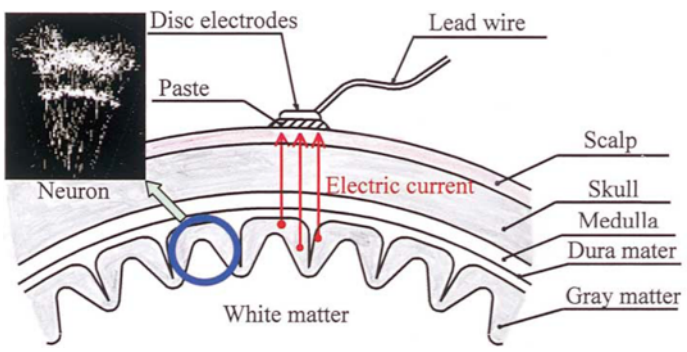

Fig. 8. Section of cerebral cortex.

3.2 Measuring Method of Brain Wave

The 11 disk electrodes are attached on the scalp according to the International 10-20 Standard. A reference electrode is attached on the right earlobe. The experimental set-up for measuring brain wave is shown in Fig. 9.

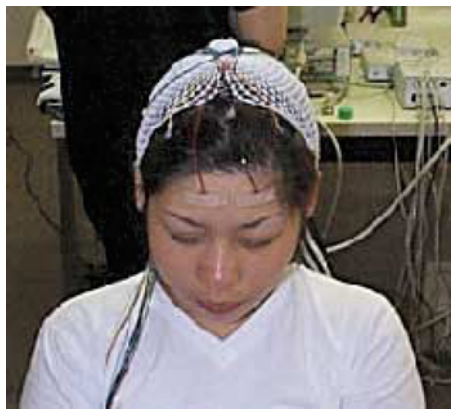

Fig. 9. Measuring the state of brain wave.

3.3 Frequency of Brain Wave

The brain wave in the frequency range of 4-8 Hz is called θ wave, 8-13 Hz is known as α wave and 13-35 Hz is called β wave. θ wave is produced while falling into a doze and flashing of mind. Concentration of mind, meditation and relaxation produce α wave. β wave is generated by nervous tension and worries.

3.4 Numerical Expression of State of Mind

Human emotional state is manifested as correlations among the brain wave signals. The cross-correlation of brain waves measured at two points on the scalp is considered. For example, putting the electric potential recorded with jth and kth electrodes as $X_j(t)$, $X_k(t)$, the cross-correlation coefficient is defined as $\langle X_j(t)X_k(t)\rangle \Big/ \sqrt{\langle X_j(t)^2\rangle \langle X_k(t)^2\rangle}$. The symbol $\langle\ \rangle$ represents the mean value of some interval over a given time span (5 sec in the present case). 45 different cross-correlation coefficients [${}_{10}C_2 = 45$] can be selected from 10 electrodes.

Using three frequency bands of the brain wave, 135 values of the cross-correlation coefficient y_1, y_2, y_3, ····· y_{135} can be obtained.

The levels of 4 indices representing stress, joy, depression and relaxation, are given by z_1, z_2, z_3, z_4, respectively, and these levels are expressed respectively by the following equations.

$$\left.\begin{aligned} z_1 &= c_{1,1}y_1 + c_{1,2}y_2 + \cdots\cdots\cdots\cdots + c_{1,135}y_{135} \\ z_2 &= c_{2,1}y_1 + c_{2,2}y_2 + \cdots\cdots\cdots\cdots + c_{2,135}y_{135} \\ z_3 &= c_{3,1}y_1 + c_{3,2}y_2 + \cdots\cdots\cdots\cdots + c_{3,135}y_{135} \\ z_4 &= c_{4,1}y_1 + c_{4,2}y_2 + \cdots\cdots\cdots\cdots + c_{4,135}y_{135} \end{aligned}\right\} \quad (8)$$

The total number of coefficients is now $135 \times 4 = 540$.

Several people who have received a training to control their emotion are requested to put themselves in each of those four pure emotional states. Now, if these are independent and hence orthogonal, the emotional state in general is expressed as a combination of these four elementary states. This technique is named as Emotion Spectrum Analysis Method (ESAM). Based on this assumption, the coefficients of Eq. (8) can be determined by setting the coefficients as those in Eq. (9).

$$\left.\begin{aligned} &\text{Stress} && : z_1 = 1, z_2 = 0, z_3 = 0, z_4 = 0 \\ &\text{Joy} && : z_1 = 0, z_2 = 1, z_3 = 0, z_4 = 0 \\ &\text{Depression} && : z_1 = 0, z_2 = 0, z_3 = 1, z_4 = 0 \\ &\text{Relaxation} && : z_1 = 0, z_2 = 0, z_3 = 0, z_4 = 1 \end{aligned}\right\} \quad (9)$$

Using these coefficients, values of z_1~z_4 can be obtained by inputting the 135 values of the cross-correlation coefficient measured in an arbitrary individual.

The present research was conducted using ESAM. Figure 10 shows the measuring system.

Fig. 10. Brain wave measuring system.

4. Application of Water Veil to Healing

4.1 Mind and Body Healing System Using a Water Veil

The healing system is shown in Fig. 3. The size of the water veil is the same as the one in Fig. 7. Bathtub is placed in the closed space inside the water veil. Colored light is projected from outside of the veil to inside, and the light through the water film is seen fluctuating from inside. Inside the water veil, colored light is projected from the base of a bathtub, and healing music and aroma are added. Furthermore, the running water is placed on the back of each person. Figure 11 shows the scene of the healing test in the water veil.

Fig. 11. Healing test inside a water veil.

4.2 Experiments and Results

The number of experimenters is 8. The brain waves are measured before entering the water veil. Having stayed inside the water veil for 10 minutes, they come out of the water veil, and the brain waves are again measured. The example of these results is shown in Fig. 12. From these signals of brain waves, ESAM characterizes the features of stress, joy, depression and relaxation. The state of mind is expressed as a combination of these four independent states of mind. The results measured by this method are shown in Fig. 13.

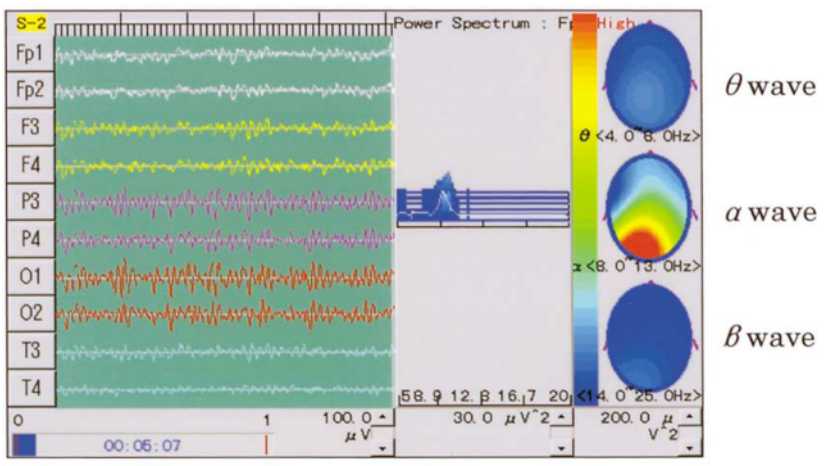

Fig. 12. Brain waves of 10 parts of head and θ, α and β waves.

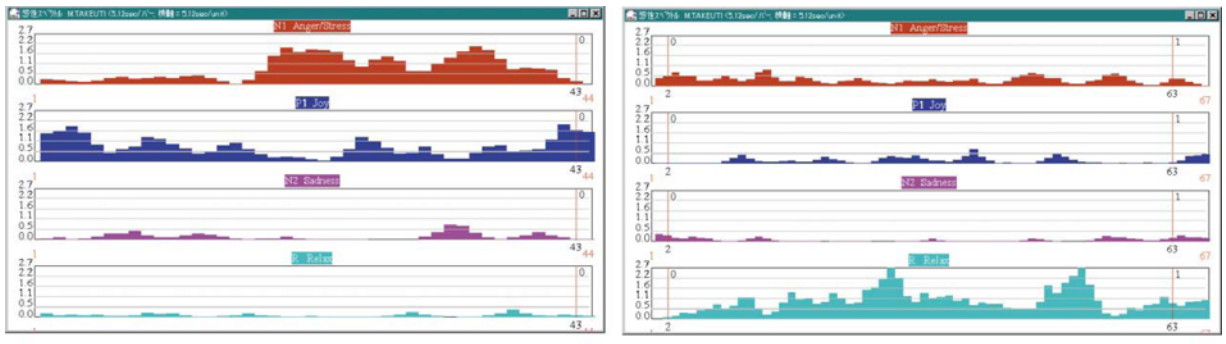

Fig. 13. Comparison of brain waves before and after experiment of water veil.

Before bathing, the values corresponding to stress are large and those corresponding to relaxation are small. However, after a bath, the values for stress become small and those for relaxation become large. The 6 out of 8 experimenters show the same results.

4.3 Future Prospects

People today are living in a stressful society. Symptoms related to stress started to increase. Appropriate treatments are required to remove such accumulated stress, but in the modern society, especially in large cities, it is not easy to do so. The space surrounded by a thin water film, called the water veil, is made, and the light, aroma, music and pleasant stimulus of the running water on the surface of the skin are generated in this space synthetically. By increasing α wave in the brain, a model is produced for a system for relaxation. The present system is designed for the health industry, preventive medical industry as well as the healing industry.

5. Conclusion

1) The computational results of the newly developed water veil almost agreed with the experimental results.
2) The comfortable space filled with minus ions is constructed inside the water veil and this space is found to be effective in healing of mind.
3) If the light, aroma, music and also pleasant stimulus of running water on the surface of the skin are added, it is shown that the healing effect increases further.

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Author Profile

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Toshimitsu Musha: He received his Ph.D. degree in physics in 1954 from the University of Tokyo. He worked at the Electric Communication Laboratory of NTT, Research Laboratory of Electronics of MIT (USA), RCA Tokyo Laboratory and Tokyo Institute of Technology, where his work was related with 1/*f* fluctuations ubiquitously observed in nature. Through many biological experiments he found that biological rhythm is in principle subject to 1/*f* fluctuations; because 1/*f* fluctuations create comfortable sensation. After retirement from Tokyo Institute of Technology in 1992 he established two research laboratories, Brain Functions Laboratory and Institute of Fluctuation Phenomena.