水産大学校大型回流水槽の特性

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Characteristics of the Circulating Water Tank of National Fisheries University

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We investigated the characteristics of the circulating water tank of National Fisheries University focusing on the velocity distribution of the flow. Dimensions of the observation channel of the tank are 6 m in length, 2.2 m in width, 1.2 m in height. We divided the observation channel into five sections in the direction of flow. We made the center of the channel "section B". The following characteristics were clarified:

1) The current in this tank hardly changes against time and shows high stability.
2) The current of the central area of each section is widely uniform, even though the current near the wall is relatively faster and near the glass is slower.
3) There is no torsion of the flow.
4) The mean velocity (Vm) of section B is representative of the velocity at the central measurement point.
5) Vm is also calculated from the panel velocity (Vp), which is indicated on the panel, with the following expression. $Vm = 1.075 \cdot Vp - 0.64$
6) The characteristics of the water tank are not influenced by temperature of 9~31℃.
7) There has been no marked temporal change of the characteristics of the water tank, at least over the last three years.

Key words : circulating water tank, water tunnel, velocity distribution, characteristic of water tunnel

1. Introduction

The circulating water tank of National Fisheries University is used to investigate the dynamics of and improvements to fishing gear, i.e., trawl, set net, otter board, and other fish culture facilities[1,2]. The present tank was built in March, 1996. It is a horizontal circulating type tank with one impeller. Dimensions of the whole tank are 13.6 m in length, 5.1 m in width, 1.9 m in height with a water capacity of 50m^3. Dimensions of the observation channel are 6 m in length, 2.2 m in width, 1.2 m in height, where we are able to generate the maximum velocity of steady flow 1.2 m/s by a remote controlled operator. A performance test was carried out when they set up the tank at their manufacturing plant before fixing it up at the university. The result was that the deviation of the velocity distribution of the flow was within 4%. This indicated that there might be a fairly uniform flow in the tank. However a detailed performance test has not been carried out after fixing the tank up at the university. Moreover, in the performance test the velocity distribution of the flow aforementioned was measured only at the center section of the observation channel. The velocity distribution of the flow through the upper stream to the downstream of the channel although has not been examined. Furthermore, the current stability has not been investigated. As a characteristic of the circulating tank for an experiment, the current stability is necessary to be uniform. Therefore we decided to investigate the characteristics of the circulating tank formally focusing on the velocity distribution of the flow through the upper stream to the downstream of the channel.

Besides, the water temperature in the tank varies a lot through a year. Although the density of water varies little with temperature, the coefficient of kinematic viscosity decreases a lot in proportion to the temperature rise. For example, the density of water is 0.9997g/cm^3 at 10 ℃ and 0.9957g/cm^3 at 30 ℃[3]. On the other hand, the coefficient of kinematic viscosity of water is 1.310×10^2cm^2/s at 10 ℃

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and $0.803 \times 10^2 cm^2/s$ at 30 ℃. However we were unable to find any references which examine the relation between water temperature and the characteristics of a tank[4,5]. Therefore we also decided to investigate the characteristics of the circulating tank considering the variation of water temperature.

2. Experimental method

We divided the observation channel into five sections in the direction of flow in order to investigate the velocity distribution. We made the center of the channel as "section B". We also made the section, which is 75 cm up to section B, "section A", and "section C, D, E" which are downstream to each other at intervals of 75 cm. Figure 1 shows an outline of the tank and placement of sections.

We set measurement points at intervals of 10 cm in the horizontal and vertical directions at each section. As the width of the channel is 220 cm and the depth is 120 cm, the number of the measurement points amounts to 231 ($=21 \times 11$) for each section.

We used a current meter (CM-1 SX, Dentan Co.; the diameter of a propeller protection ring is 53 mm) to measure the velocity. We also measured the velocity using the method of moving averages of 20 sec., which is programmed in the current meter. The current meter was attached to the bottom of a stay of a traverser, which was mounted over the tank and moved horizontally and vertically under the control of a computer.

The current of the tank is controlled at a control panel. The velocity value is indicated on the panel in proportion to the revolution of the impeller, since they previously investigated the relation between the impeller revolution and the mean velocity at the center section when they carried out the performance test at the manufacturing plant. In this paper, we call the velocity value "panel velocity: Vp" and made it a criterion of the velocity setting.

First, we measured the velocity distribution of the flow of section B at four speed level: $Vp=0.164$, 0.303, 0.432, and 0.598 m/s. Next, we also measured the velocity distribution of section A, C, D, and E at one speed level: $Vp=0.432$ m/s to examine the difference of the velocity distribution of each section.

On the other hand, for experiments using a circulating tank, the current stability is one of the important factors such as the uniformity. It takes about 100 minutes to carry out the measurement of the velocity distribution at one speed level at one section. If the velocity at one measuring point varied, it is difficult to measure the accurate velocity distribution. Therefore we checked the velocity change owing to time to determine the current stability.

The water temperature of this tank changes from

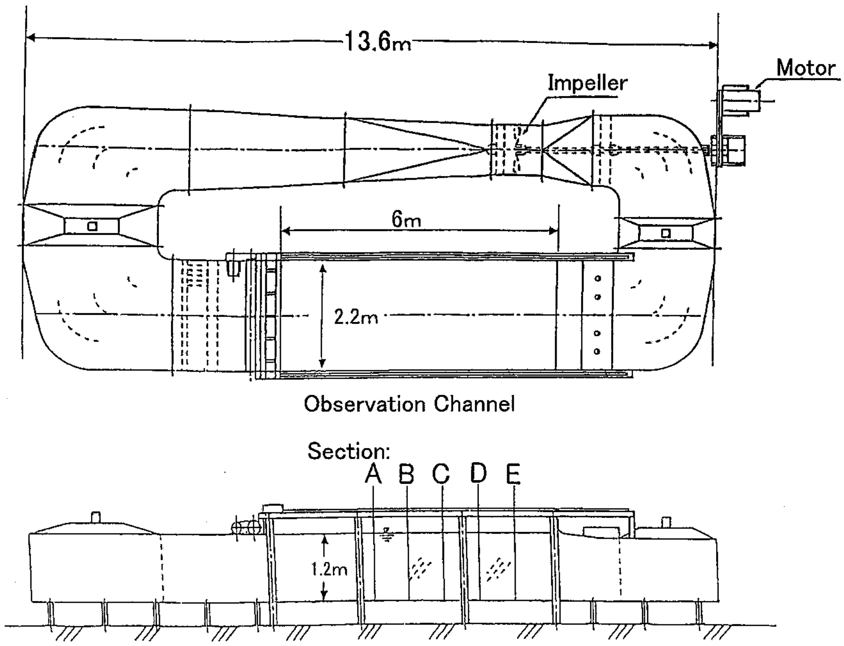

Fig. 1. Diagrammatic illustration and outline dimensions of the circulating water tank.

thirty-odd ℃ in July or August to several ℃ in January or February. As the first measurement was carried out at the beginning of August, under high temperature conditions as thirty-odd ℃, the need of checking the characteristics of the tank under different water temperatures was clearly necessary. Then we carried out the measurement of velocity at 231 measurement points of section B at the end of September, middle of November, and beginning of January. At the measurement at the end of September and middle of November, we measured the velocity at four speed levels : $Vp = 0.164$, 0.303, 0.432, and 0.598 m/s the same as the first measurement. At the measurement at the beginning of January, we measured at three speed levels: $Vp = 0.232$, 0.369, and 0.516 m/s. Furthermore in order to check the temporal change, three years after the first measurement; at the beginning of October in 2004, we measured the velocity distribution at section B and compared the results. Moreover we investigated the relation between the inverter frequency and impeller revolution and panel velocity under changing the frequency at the end of September and the beginning of January.

3. Results and discussion

3.1 Current stability

Result of measurements about current stability is shown in Fig. 2. In the figure, velocity values were obtained by setting the current meter at the center of section B (60 cm under the surface, 110 cm from the channel wall) and measuring for 30 consecutive minutes at 20-second intervals at $Vp = 0.432$ m/s. At first, we started to measure for 100 consecutive minutes since it took about 100 minutes to measure the velocity distribution of each section. However, as the current stability was recognized in full, we stopped measuring after 30 minutes. As the figure shows, velocity values change little and periodic fluctuations were seldom seen during the 30 minutes. That is, the current in this tank hardly changes against time and shows highly stability.

3.2 Velocity distribution of the flow of B section at each speed level

Result of measurements about velocity distribution of the flow of section B at each speed level is shown in Table 1. Speed levels of section B are as follows; $Vp = 0.164$, 0.303, 0.432, 0.598 m/s. Result of each speed level is shown as (a) ~ (d) respectively in the table. The table shows the result of measurements when we observed the section from the downstream of the channel and each value was measured using the method of moving averages of 20 sec. As the table shows, we numbered the measurement points as follows : Px= 1 ~21 from the glass in the horizontal direction, Py = 1 ~11 from the surface in the vertical direction, in order to show the position of each measurement point. Therefore the center of the section is shown as follows, (Px, Py) = (11, 6): We made the mean value of the velocity of 231 points mean velocity (Vm) and showed it on the table with standard deviation ($S.D.$) for each section. And we also showed the coefficient of variation c ($c = S.D. \div Vm$) in the table. When we set a model fishing gear in the tank, we will be able to get the actual velocity acting on the model by averaging the velocities of the area occupied by the

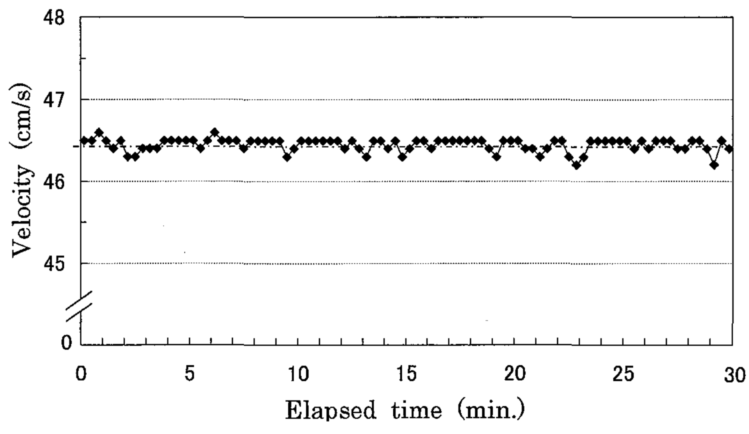

Fig. 2 Current stability measured at the center of section B. ($Vp = 0.432$m/s)

Table. 1. Velocity distribution of flow of section B at four speed levels.

Glass Side

(a) $Vp = 0.164$ m/s $Vm = 17.29$ $S.D. = 0.552$ $c = 0.0319$ (unit : cm/s)

Py \ Px	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	16.9	17.2	17.0	16.8	17.3	17.6	17.3	17.4	17.0	17.1	17.3	17.4	17.1	17.5	17.8	17.7	17.9	18.4	19.1	18.0	17.3
2	16.5	16.6	16.9	17.3	17.3	17.1	16.7	16.9	17.3	16.8	16.6	16.6	17.4	17.0	17.4	18.3	17.9	18.1	18.3	17.6	17.2
3	16.6	16.9	16.6	16.4	16.9	17.6	17.1	16.9	17.1	16.9	16.9	16.9	16.6	16.6	17.1	17.2	17.3	17.9	18.3	17.6	17.3
4	16.6	16.9	16.6	16.9	16.8	17.3	17.3	17.3	17.0	17.3	17.2	17.1	16.9	17.0	17.5	17.3	17.3	18.0	18.0	17.6	17.6
5	16.9	16.9	16.9	16.9	16.7	17.3	17.0	17.0	17.0	17.3	17.3	17.3	17.0	17.0	17.3	17.6	17.7	18.0	18.1	18.4	17.6
6	17.1	17.4	17.1	16.9	16.6	17.3	17.1	17.2	16.6	17.5	17.4	17.4	17.6	17.5	17.3	18.0	18.0	18.2	18.5	18.5	18.2
7	17.0	17.3	16.6	16.6	16.5	16.9	16.9	17.0	16.6	17.5	17.3	17.5	17.3	17.3	17.0	17.7	17.6	17.6	18.0	18.3	18.0
8	16.6	17.3	16.6	16.5	16.6	17.2	16.9	17.0	16.9	17.3	17.1	17.0	16.9	17.0	17.6	17.5	17.5	17.7	17.7	18.0	17.1
9	17.1	17.0	17.0	16.6	16.6	16.9	16.9	17.3	17.0	17.0	17.0	17.3	17.0	17.1	17.6	17.1	17.5	18.4	18.0	18.3	17.3
10	17.1	16.9	17.0	16.6	16.6	17.0	17.3	17.0	16.8	17.0	17.0	17.1	17.0	17.3	17.8	17.5	17.6	18.8	19.3	18.4	17.6
11	16.6	16.8	17.0	16.6	16.9	17.3	17.3	17.0	16.9	17.3	16.6	15.8	17.6	17.6	17.7	17.8	18.0	18.5	19.2	19.0	18.0

(b) $Vp = 0.303$ m/s $Vm = 31.57$ $S.D. = 0.897$ $c = 0.0284$ (unit : cm/s)

Py \ Px	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	30.8	31.3	31.2	30.8	31.9	32.5	32.2	32.2	31.2	31.5	32.2	32.6	32.1	32.0	33.6	32.7	33.4	33.7	33.4	31.9	31.5
2	30.0	30.4	30.1	30.9	30.9	31.4	31.6	31.4	30.5	31.2	31.6	30.7	30.7	30.5	32.3	31.3	31.7	33.4	32.7	32.1	30.0
3	30.7	30.8	30.4	30.1	31.9	32.3	31.2	30.8	31.4	31.2	31.2	31.2	30.7	30.5	32.0	31.6	31.6	33.2	32.7	31.5	31.8
4	30.5	30.8	30.0	30.9	30.2	31.2	31.2	32.0	31.1	31.4	30.9	31.0	31.2	31.0	32.2	32.1	31.6	32.7	32.2	31.9	31.8
5	31.2	31.2	30.7	31.2	30.5	31.9	31.5	31.7	31.0	31.9	31.5	31.5	31.2	31.5	31.9	32.3	32.4	32.3	33.2	33.0	33.1
6	31.5	31.9	31.5	30.9	30.1	31.2	31.2	31.5	30.1	31.5	31.6	31.5	31.9	31.5	31.9	32.3	32.7	33.0	33.2	32.5	32.5
7	31.6	31.9	31.2	30.8	30.2	31.5	31.5	31.4	30.4	31.9	31.6	32.2	31.9	31.4	31.2	32.0	32.2	31.6	32.7	32.7	31.9
8	30.5	31.4	30.5	30.1	30.5	31.5	30.9	31.2	30.5	31.4	31.2	31.5	30.9	30.8	31.9	31.9	31.5	31.8	31.9	31.9	31.2
9	31.6	31.2	31.0	30.2	30.6	31.2	31.1	31.5	31.2	31.2	30.7	31.7	31.2	31.2	31.9	31.0	31.5	33.0	33.4	32.3	30.9
10	31.2	30.9	30.9	30.5	30.4	31.2	31.5	31.2	30.5	31.2	31.2	31.2	31.2	31.2	31.5	31.5	31.7	34.1	34.3	33.0	31.2
11	30.5	30.9	31.2	30.5	31.2	31.9	31.9	31.4	31.9	31.9	31.5	30.1	32.2	32.6	32.1	33.8	33.4	33.8	35.7	34.1	31.5

(c) $Vp = 0.432$ m/s $Vm = 47.31$ $S.D. = 1.226$ $c = 0.0259$ (unit : cm/s)

Water Surface

Py \ Px	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	47.6	47.2	47.0	47.2	48.3	49.0	48.3	49.0	47.3	47.6	48.7	49.0	48.3	48.3	50.2	49.5	50.5	50.5	50.2	48.4	47.6
2	47.6	45.8	45.4	46.7	46.8	47.2	48.0	47.5	46.3	47.3	47.8	46.5	46.1	46.1	48.3	47.3	48.0	50.0	49.0	47.6	44.8
3	45.8	46.1	45.4	46.0	46.9	48.9	47.5	46.5	46.9	47.3	46.5	46.5	46.1	45.8	47.6	48.0	47.8	49.8	49.7	48.7	46.4
4	46.2	45.8	44.8	46.3	45.8	47.2	46.8	48.3	46.4	47.5	46.1	46.2	46.2	46.7	48.4	48.2	48.0	49.0	48.7	48.4	48.0
5	46.5	46.0	45.8	46.9	45.8	47.6	47.6	47.7	46.5	47.6	47.2	47.2	46.8	47.2	48.0	48.3	48.3	48.7	49.0	49.2	49.0
6	46.9	47.2	46.9	46.9	45.6	46.7	46.8	47.6	45.5	47.5	47.2	47.2	47.5	46.8	48.7	48.3	48.5	49.4	49.0	48.8	49.0
7	46.7	47.5	46.5	46.5	45.8	46.9	47.2	47.2	45.8	48.0	47.2	48.0	48.0	47.0	47.0	47.8	47.6	47.0	48.7	48.3	47.2
8	46.0	47.1	46.1	45.4	45.8	47.5	46.5	46.7	45.8	46.9	46.8	47.6	46.1	46.1	47.4	47.7	46.9	48.3	48.2	47.8	46.1
9	46.9	46.1	46.5	45.0	45.8	46.8	46.1	47.2	46.7	46.5	45.8	47.2	46.9	46.5	48.0	46.5	47.2	49.3	49.8	47.6	46.0
10	46.8	45.8	45.8	45.6	45.5	46.5	46.8	46.8	46.0	46.3	46.3	46.1	46.8	46.7	47.7	47.2	47.5	49.7	50.0	48.3	46.0
11	46.0	46.5	46.9	45.8	46.5	47.2	47.2	46.8	47.5	46.8	45.8	45.3	48.7	48.3	48.3	49.1	48.9	50.2	51.6	50.0	47.2

Wall Side

(d) $Vp = 0.598$ m/s $Vm = 63.42$ $S.D. = 1.558$ $c = 0.0246$ (unit : cm/s)

Py \ Px	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	64.1	62.9	62.7	63.2	64.8	65.1	65.0	65.5	63.6	63.6	64.8	65.5	64.8	64.3	66.7	65.9	67.3	67.2	67.7	64.4	63.9
2	64.5	62.2	61.0	62.9	62.8	63.7	64.4	63.6	62.2	63.3	64.3	62.2	61.5	61.4	64.8	62.9	63.8	66.3	66.6	63.8	60.8
3	61.8	62.9	60.8	61.5	63.0	66.0	63.6	62.9	63.3	64.1	63.0	62.7	62.6	61.3	64.0	64.1	64.4	65.8	66.3	64.9	61.0
4	62.9	62.2	60.8	62.6	61.8	63.5	63.3	64.8	62.6	63.6	62.2	62.2	62.6	62.6	64.6	64.1	64.4	65.5	65.1	64.5	63.9
5	62.6	62.6	62.1	63.6	61.8	64.0	63.4	64.5	62.7	64.0	63.2	63.3	62.2	63.3	64.6	64.8	64.5	65.2	66.0	65.5	65.3
6	62.6	62.9	62.3	62.8	61.0	62.4	63.0	64.1	61.1	63.7	63.4	63.6	63.2	63.1	65.2	64.8	64.4	65.7	66.2	65.5	64.8
7	62.3	62.4	61.3	62.2	60.8	63.5	63.6	63.3	61.5	64.4	63.0	64.4	63.7	63.3	62.9	63.6	63.6	64.0	64.8	64.6	63.2
8	62.3	62.6	61.6	61.1	60.7	63.7	62.6	62.8	61.6	63.3	62.6	63.6	62.2	62.1	63.7	64.1	63.3	64.6	65.0	63.6	61.8
9	62.6	61.4	62.6	60.2	61.9	62.7	62.1	63.8	62.6	62.6	61.3	63.6	62.9	62.2	64.4	62.5	62.8	64.8	66.6	62.9	61.1
10	62.2	60.6	61.1	61.4	61.1	62.6	62.8	62.8	61.6	62.6	61.6	62.2	62.6	63.0	64.2	62.3	63.3	65.8	67.4	63.7	62.6
11	61.8	62.1	62.3	60.9	61.9	63.3	63.0	62.9	63.3	63.8	62.1	61.4	65.8	65.6	65.2	66.6	66.3	65.5	69.0	67.0	64.0

Tank Bottom

model. Result of measurements about velocity distribution of the flow of other sections and in the other months are omitted due to limitation of space.

Result of measurements about velocity distribution of the flow of section B at each speed level is shown in Fig. 3 based on Table 1. The figure is distinguished by using different colors as follows; first, we divided the difference between the velocity of each measurement point and the mean velocity by the mean velocity and multiplied it by 100, that is, showed it as the % variation of the mean velocity for the 231 points. Next, we classified the velocity distribution into five stages in relation to the % variation of the mean velocity. Hereby, we can visually investigate the velocity distribution of the flow. Blue indicates that it is faster than mean velocity, red indicates it is slower.

From Fig. 3, it is clear that the current near the wall is faster and near the glass is slower in common in all four speed levels. In other words, the current inside the circular tank is faster and outside is slower. This might be a characteristic of horizontal circulating tanks. However, the areas, where distinct differences of flow are seen, are near the surface and the bottom near the wall in common with four speed levels. These areas are not in use in practical experiments in the circulating water tank. The central area of the section, which is in use in practical experiments, is relatively uniform through the four speed levels. Therefore, velocity distribution of the flow of section B hardly differs by speed levels and the flow of the central area of the section is uniform.

3.3 Velocity distribution of the flow of each section

Result of measurements about velocity distribution of the flow of sections A～E at Vp=0.432 m/s is shown in Fig. 4. The figure is distinguished by using different colors as in 3.2. By comparing the five charts of each section, we can investigate the velocity distribution of the flow through the upper stream to the downstream of the observation channel. In common with five charts, A～E, it shows a tendency like section B as described in 3.2. Therefore, it is considered that the velocity distribution of the flow does not differ by the position of the observation channel and there is no torsion of the flow.

3.4 Vertical and horizontal variation of the velocity distribution of the flow

We investigated the general characteristics about the velocity distribution of the flow of each section in 3.3. Here, we investigated the vertical and horizontal variation of the velocity distribution of the flow of each section in order to compare the difference between each section in detail.

(1) Vertical variation of the velocity distribution of the flow

Figure 5 shows the vertical variation of the velocity distribution of the flow of sections A～E, using five lines. In the figure, we set five measurement points horizontally at equal intervals. These are at Px= 3, 7, 11, 15, and 19, which are in line from the glass side to the wall side. Viewing each polygonal line of the velocity distribution of the flow, it is a characteristic that section A is slow at Px =15, which is a little near to the wall from the center. It is also a characteristic that section E is a little slow at Px = 3, which is near to the glass. Furthermore, focusing on the area near the surface, section E, which is the most downstream section, is generally a little slow. It might be considered that it is caused by the effect of the end of the observation channel. That is, as shown in Fig. 1, the surface of the observation channel is a free surface, but it is not a free surface any more at the end of the observation channel.

However, these characteristics can be said since we read the magnified velocity scale, a transverse axis, in the figure. If we read the velocity scale with the full range, from 0 to 60 cm/s which is the range of the velocity, it is considered that the velocity distribution of the flow has little difference among the sections A～E like the result of 3 - 3. And the velocity distribution of the flow in the vertical direction that is in the direction of depth of water only shows minimal differences.

On the other hand, as the result of 3.2, the surface area is fast for all sections. The glass side is slow, the wall side is fast.

(2) Horizontal variation of the velocity distribution of the flow

Figure 6 shows the horizontal variation of the velocity

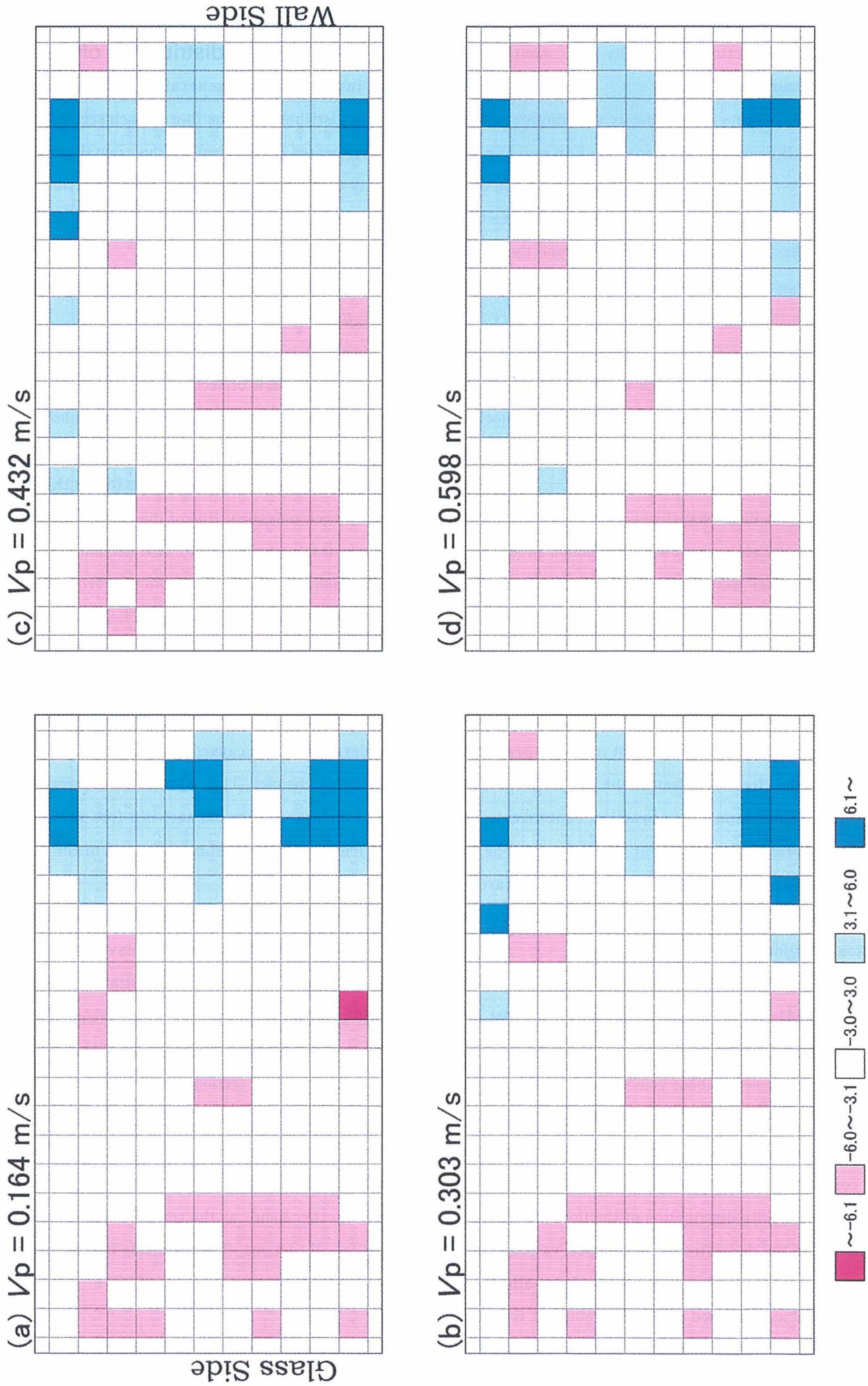

Fig. 3. The velocity distribution of flow for four velocity stages at section B.

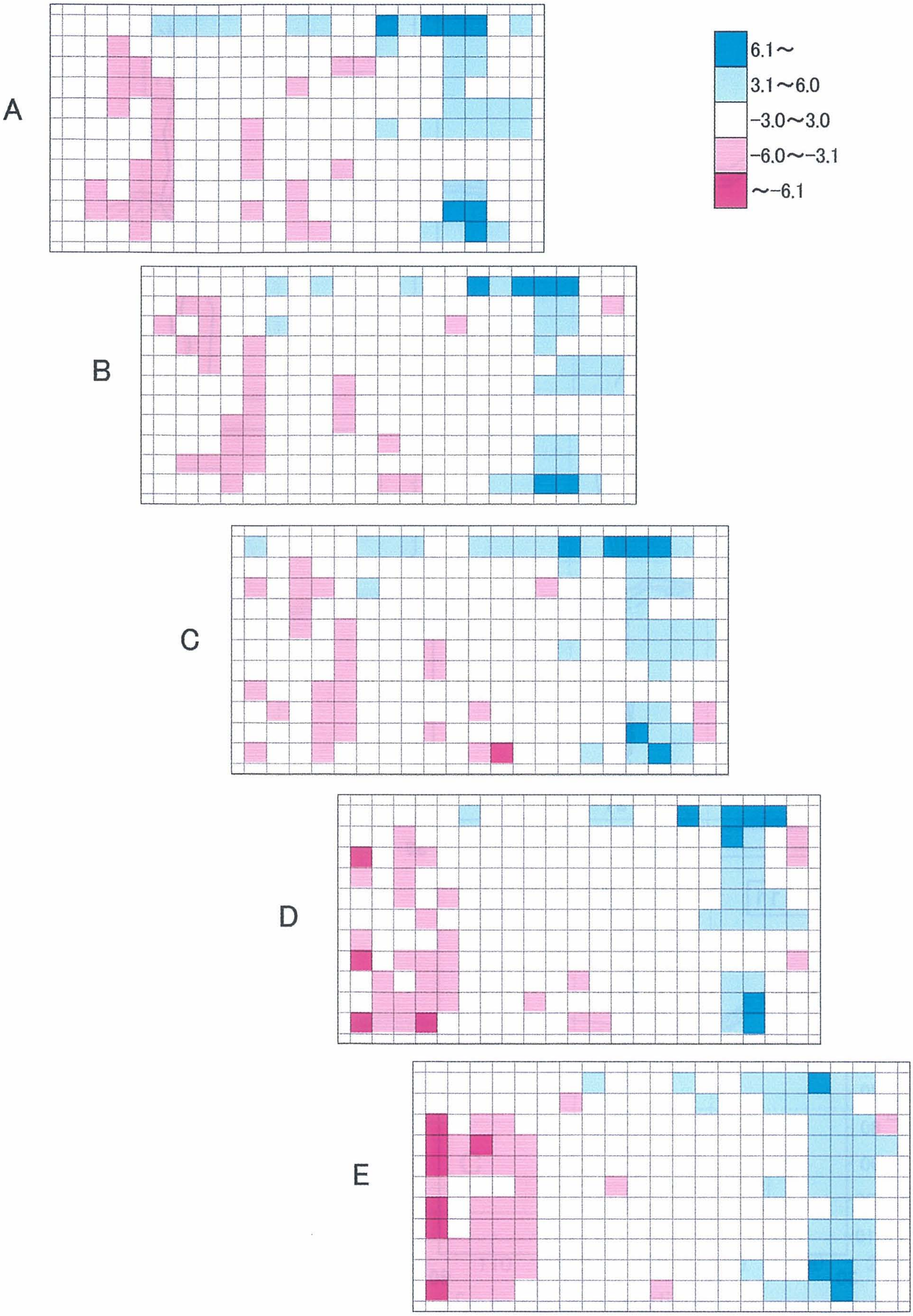

Fig. 4. The velocity distribution of flow at sections A～E : V_p=0.432m/s.

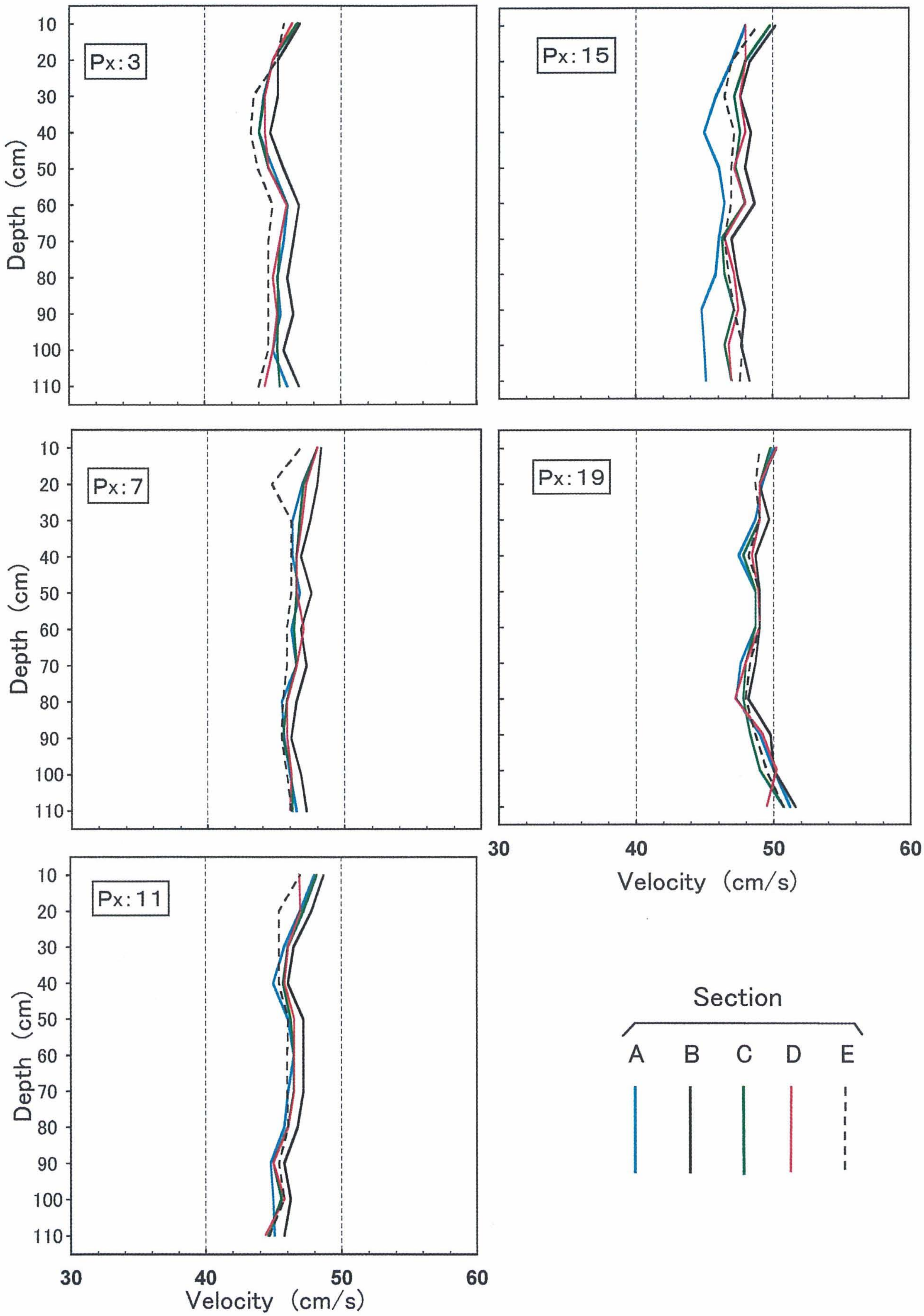

Fig. 5 . The vertical variation of the velocity distribution of flow at Px : 3 , 7 , 11, 15, 19 (section A~E).

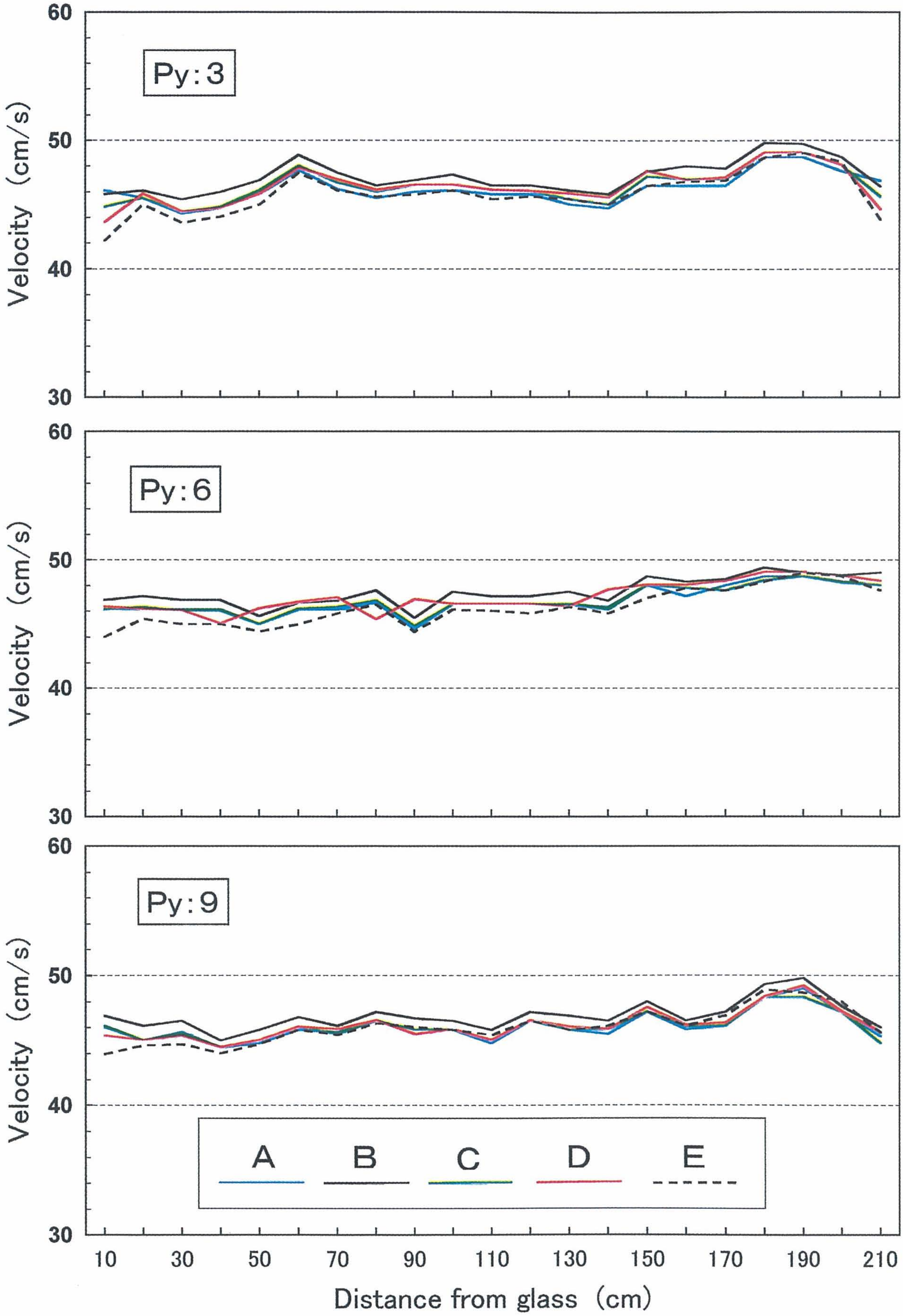

Fig. 6. The horizontal variation of the velocity distribution of flow at Py : 3, 6, 9 (section A~E).

distribution of the flow of sections A～E, using five lines. In the figure, we set three measurement points vertically at equal intervals at Py= 3 , 6 , and 9 , which are in line from the surface to the bottom. Differently from Fig. 5 , a vertical axis indicates the velocity and a transverse axis indicates the distance from the glass. Viewing each polygonal line of the velocity distribution of the flow, it is a characteristic that section E is slightly slower near the glass. For all sections, the area near the wall, 30～40 cm from the wall, is faster. However, especially the central area is uniform in all sections and depths.

3.5 Relationship between central velocity and mean velocity

As shown in Fig. 3 , it is clarified that the velocity distribution of the flow of the central area of the section is uniform. Then we investigated the relation between the mean velocity (Vm) and the central velocity (Vc), which is the velocity at the central measurement point: (11, 6) of section B. We show the result in Fig. 7. As Fig. 7 shows, it is clarified that the mean velocity is linearly proportional to the central velocity. The regression coefficient of the straight line indicates 1.0. This means the mean velocity of section B is representative of the velocity at the central measurement point.

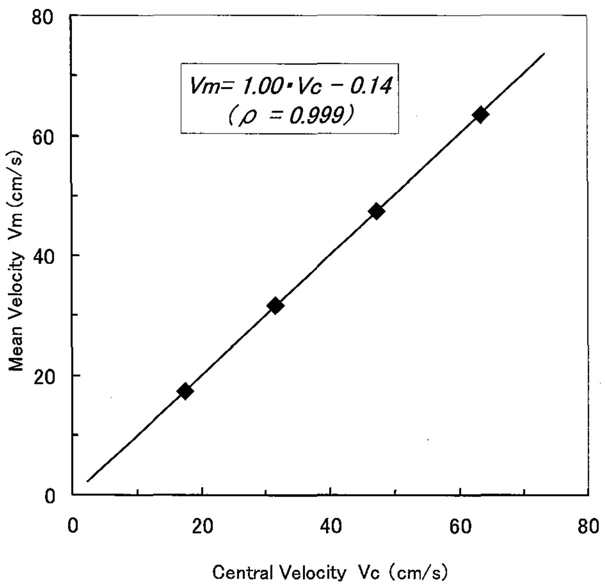

Fig. 7 . Relationship between central velocity and mean velocity.

3.6 Relationship between impeller revolution and mean velocity under different water temperatures

Relationship between impeller revolution and mean velocity under different water temperatures is shown in Fig. 8 . It is a result of the measurement of the velocity of section B under different water temperatures : 30.7, 24.7, 15.9, and 9.2 ℃. Four steps of temperature are shown by four different kinds of marks, which are all on a straight line. Therefore, the relationship between impeller revolution and mean velocity is not influenced by temperature.

3.7 Relationship between inverter frequency and impeller revolution under different water temperatures

Result of measurements about inverter frequency (Fi) and impeller revolution (Ri) under 25.0 and 9.4 ℃ is shown in Fig. 9 . Two steps of temperature are shown by two different kinds of marks, which are all on a straight line. Therefore, also the relationship between inverter frequency and impeller revolution is not influenced by temperature.

3.8 Relationship between panel velocity and mean velocity

Since it has been definitely shown by 3.6 and 3.7 that the characteristics of the circulating tank are not influenced by temperature, we made a graph about the relationship be-

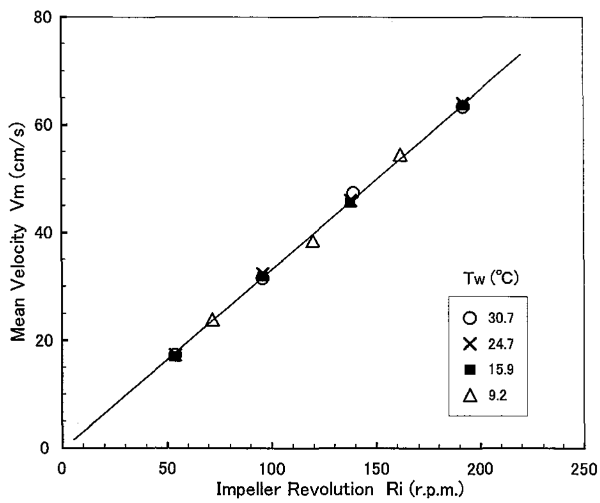

Fig. 8 . Relationship between impeller revolution and mean velocity under different water temperatures.

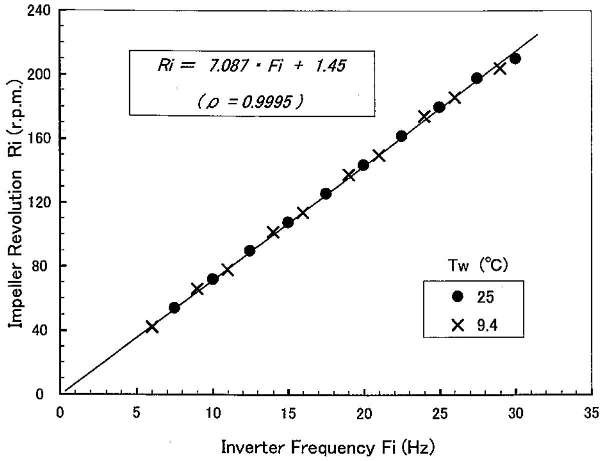

Fig. 9 . Relationship between inverter frequency and impeller revolution under different water temperatures.

tween panel velocity and mean velocity of section B under four steps of water temperature. The result is shown in Fig.10. An expression of the regression line deduced from the figure is shown as below. It is considered that the expression shows the relationship between panel velocity and mean velocity of this tank regardless of the water temperature.

$$Vm = 1.075 \cdot Vp - 0.64 \quad (\rho = 0.9997)$$

Vm : mean velocity Vp : panel velocity

ρ : a coefficient of correlation

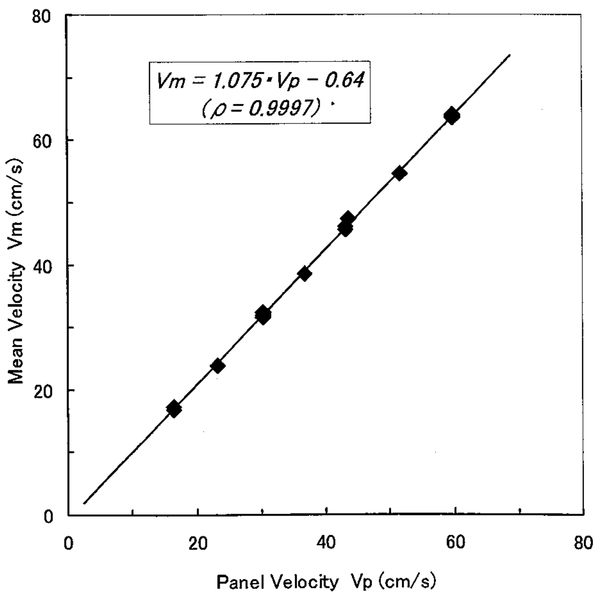

Fig.10. Relationship between panel velocity and mean velocity.

3.9 Temporal change of the characteristics of the water tank (Relationship between impeller revolution and mean velocity)

In order to see the temporal change of the characteristics of the water tank, we measured the velocity distribution of the flow of section B at the beginning of October in 2004 and compared it with the result measured three years before, as detailed above in 3.6. The result of the comparison is shown in Fig.11. The figure, namely, showed the relation between impeller revolution and mean velocity of 2001 and 2004. It is clear that the mean velocity is proportional to impeller revolution in both years. Then we drew regression lines for the results of 2001 and 2004. The expressions are as follows.

$$2001: Vm = 0.3373 \cdot Ri - 0.78 \quad (\rho = 0.9994)$$

$$2004: Vm = 0.3329 \cdot Ri - 2.12 \quad (\rho = 0.9998)$$

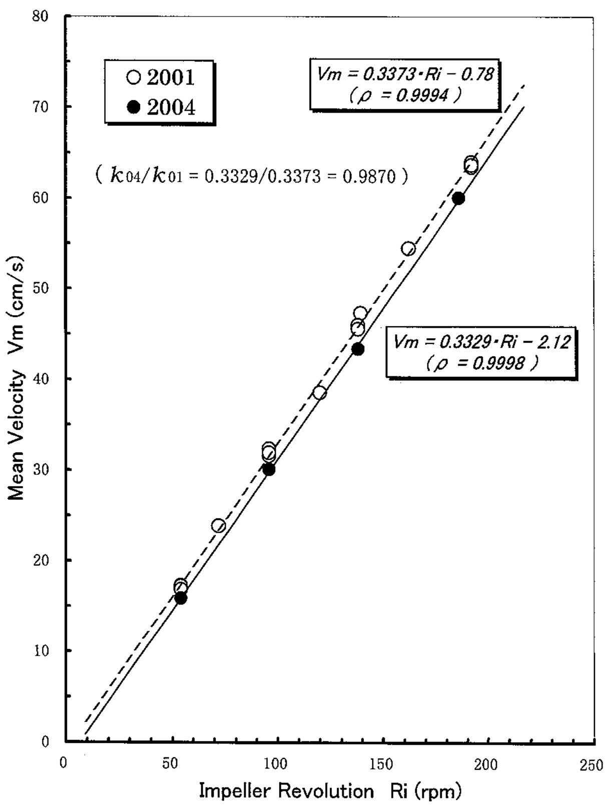

Fig.11. Temporal change of the characteristics of the water tank. (Relationship between impeller revolution and mean velocity).

Even though there is a slight difference in the intercept of the two lines, the difference in the inclination is less than 1.3 %, that is, there is little difference as far as the inclination. Furthermore, the result of the measurement of the velocity distribution of the flow in 2004 showed the wall side is relatively faster and the glass side is slower for the four levels of speed just like the result in 2001. Therefore we concluded that there has been no marked temporal change of the characteristics of the water tank, at least over the last three years.

4. Conclusion

As the characteristics of the water tank of National Fisheries University, it is clarified as follows.

1) The current in this tank hardly changes against time and shows high stability.
2) The current of the central area of the each section is widely uniform, even though the current near the wall is relatively faster and near the glass is slower.
3) There is no difference of the velocity distribution of the flow in different speed levels.
4) The velocity distribution of the flow does not differ by the position of the observation channel and there is no torsion of the flow.
5) The mean velocity (Vm) of section B is representative of the velocity at the central measurement point.
6) Vm is also calculated from the panel velocity (Vp), which is indicated on the panel, with the following expression. $Vm = 1.075 \cdot Vp - 0.64$
7) The characteristics of the water tank are not influenced by temperature of 9 ~31 ℃.
8) There has been no marked temporal change of the characteristics of the water tank, at least over the last three years.

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水産大学校大型回流水槽の特性

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水産大学校大型回流水槽観測部（長さ6m，幅2.2m，水深1.2m）を流れ方向に5つの断面に区切り，流速分布を中心に水槽特性を調べた。その結果，以下のことが明らかになった。①水槽の流れには時間による変動がなく，非常に高い安定性がある。②ガラス面側の流速が遅く壁側が速いが，中央部付近は比較的広範囲にわたって乱れも小さく，均一な流れである。③流れにねじれはみられない。④観測部中央断面（B断面）の平均流速値は同断面の中央流速値で代表できる。⑤同平均流速値は制御盤指示流速値から変換式によって算出される。⑥9～31℃の水温変化による水槽特性の違いはみられない。⑦少なくとも3年間の水槽特性の経年変化はない。