Chapter VI

DISCUSSION

The overall oxygen transfer rate constant values were found to be affected by many factors. It would be advantageous to discuss them separately as follows.

Rotation of rotor in revolutions per minute

The values of overall oxygen transfer rate constant for 20°C ($K_{La(20)}$) obtained in this research are shown in Tables 1,2 and 3. It was found that, at law speeds(under 60 RPM), Rectangular Rotor NO 1 gave the highest $K_{La(20)}$ apparently because Rectangular Rotor NO 1 had the biggest rotor blades. A larger amount of water could be thrown into the air while Rectangular Rotor NO 2 and Rectangular Rotor NO 3 could get only a small amount of water into the air. In the higher speed range, however, Rectangular Rotor NO 3 gave the highest overall oxygen transfer rate constant because Rectangular Rotor NO 3 had a small sharp blade so that a larger amount of small droplets could be thrown into the air and a larger number of small bubbles were introduced into the ditch. Pasveer,(1953) noted some years ago in his work with Kessener brushes that foaming in the immediate vicinity of the brush was responsible for practically all of the aeration-process foam around the brush which may represent a large surface of water in a small space.

Figures 7,8 and 9 show the variation in overall oxygen transfer rate constnat for 20°C with the speed of rotation. Overall oxygen transfer rate constant for 20°C was found to increase as the speed of rotation increases. The increase in $K_{La(20)}$ of Rectangular Rotor NO 1 from speed 30 to 45 RPM was better than from speed 45 to 60 RPM. The increase in overall oxygen transfer rate constant of Rectangular Rotor NO 2 from speed 30 to 80 RPM was found to be higher than from 80 to 100 RPM. The increase in overall oxygen transfer rate constant of Rectangular Rotor NO 3 from speed 45 to 80 RPM is more rapid than from speed 80 to 120 RPM. Thus overall oxygen transfer rate constant increases with increase in speed.

In Figure 10 the variations in overall oxygen transfer rate constants with speed of rotation at a specified depth of immersion of rotor blade of the three rotors are shown. It would appear that Rectangular Rotor NO 3 would be the best of the rotors studied if the overall oxygen transfer rate constant(K_{La}) is used as a criterion.

Depth of immersion of rotor blade

Figures 11, 12 and 13 show the variations in the overall oxygen transfer rate constants and depth of immersion at any indicated rotor speeds. The increase in overall oxygen transfer rate constants of Rectangular Rotor NO 1 from 5 cm. to 7.5 cm. of immersion of rotor blade is gradual when compared with Rectangular Rotor NO 2 and Rectangular Rotor NO 3. At 10 cm. immersion of rotor blade and high speed (120 RPM) the overall oxygen transfer rate constant increased rapidly in the case of Rectangular Rotor NO 3. It can be concluded therefore that the overall oxygen transfer rate constant for 20°C

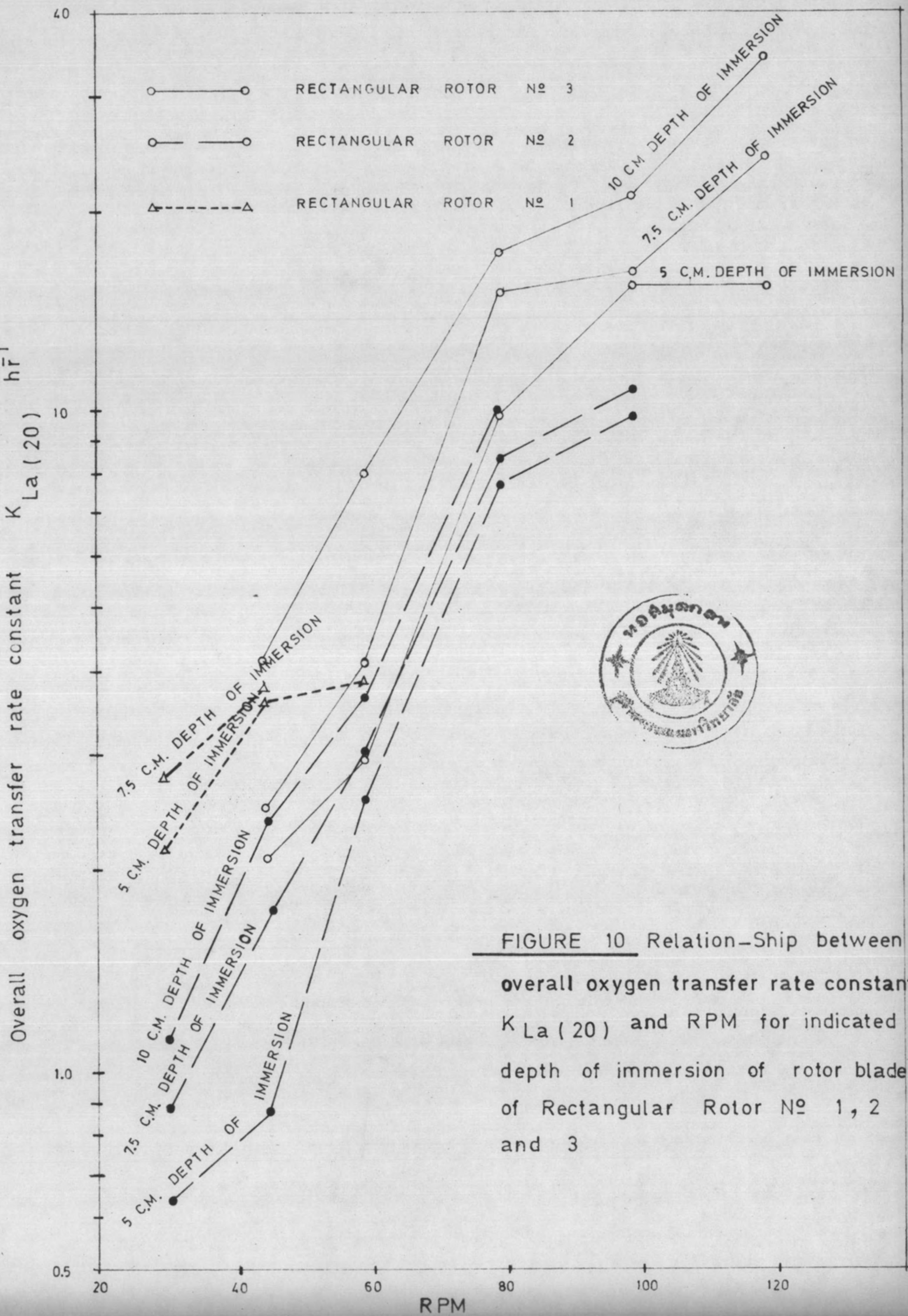

FIGURE 10 Relation-Ship between overall oxygen transfer rate constant $K_{La(20)}$ and RPM for indicated depth of immersion of rotor blade of Rectangular Rotor № 1, 2 and 3

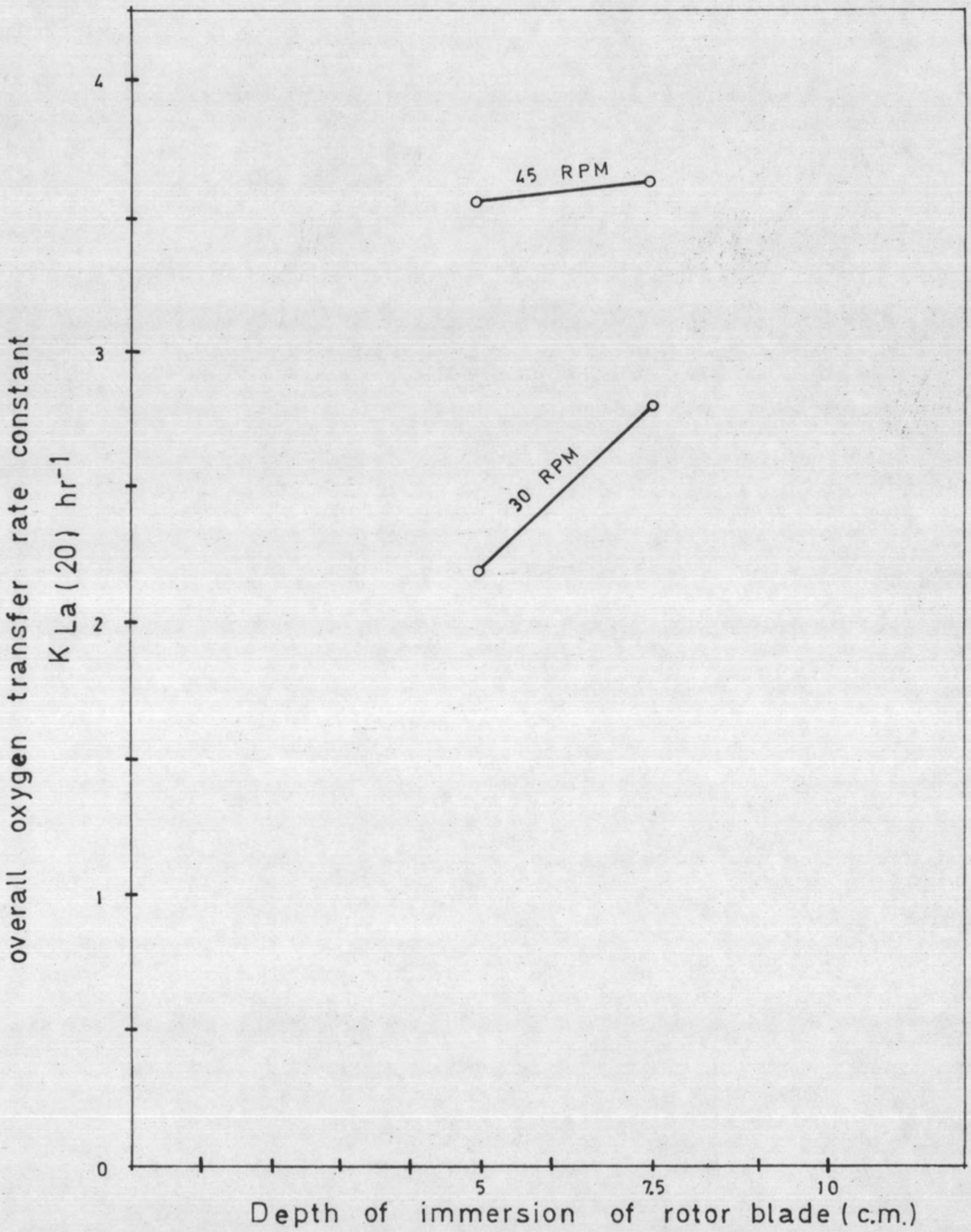

FIGURE 11 Relationship between overall oxygen transfer constant $K_{La(20)}$ and depth of immersion of rotor blade of Rectangular Rotor Nº 1 for indicated RPM

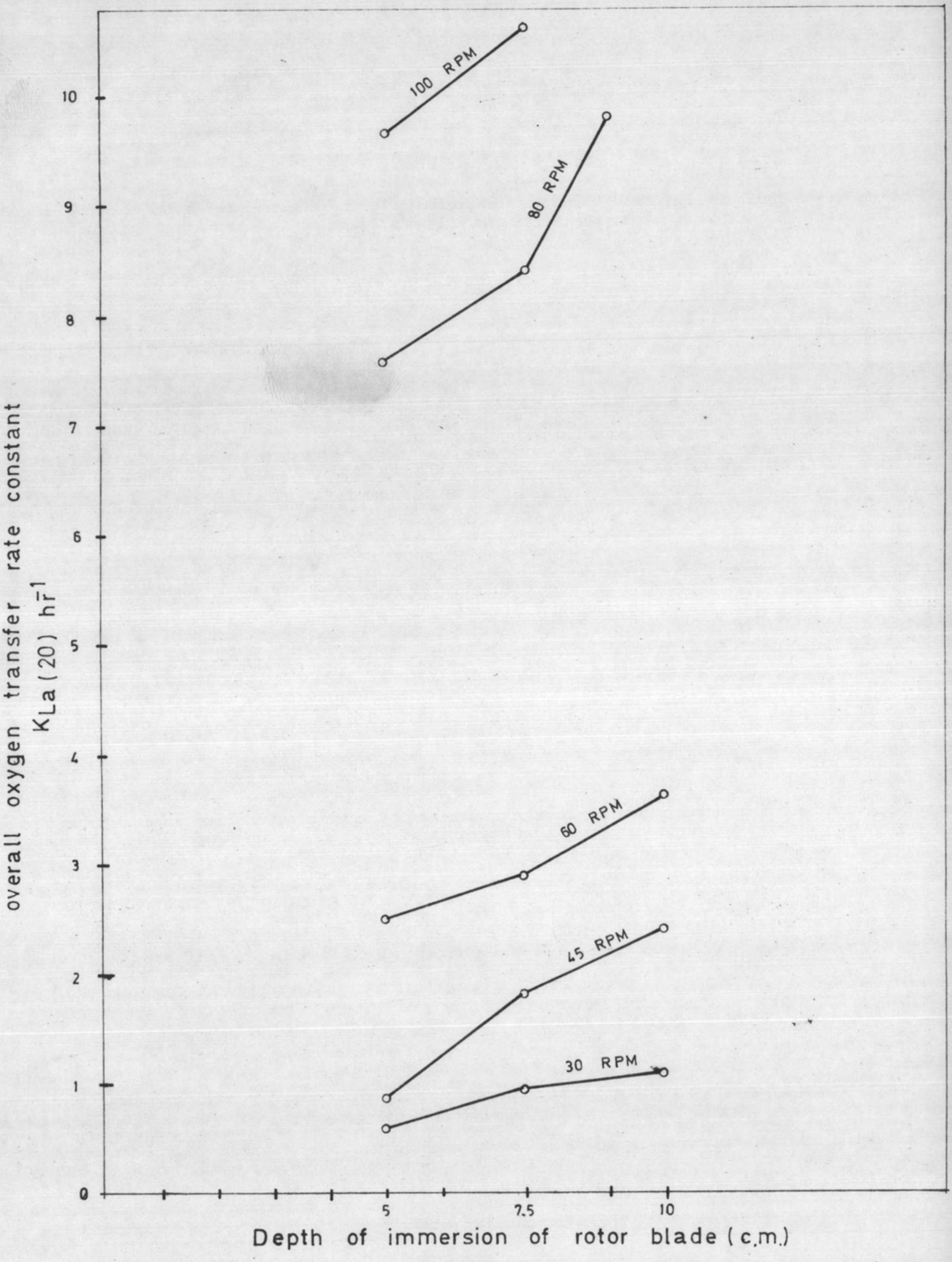

FIGURE 12 Relationship between overall oxygen fransfer constant $K_{La(20)}$ and depth of immersion of rotor blade of Rectangular Rotor № 2 for indicated RPM

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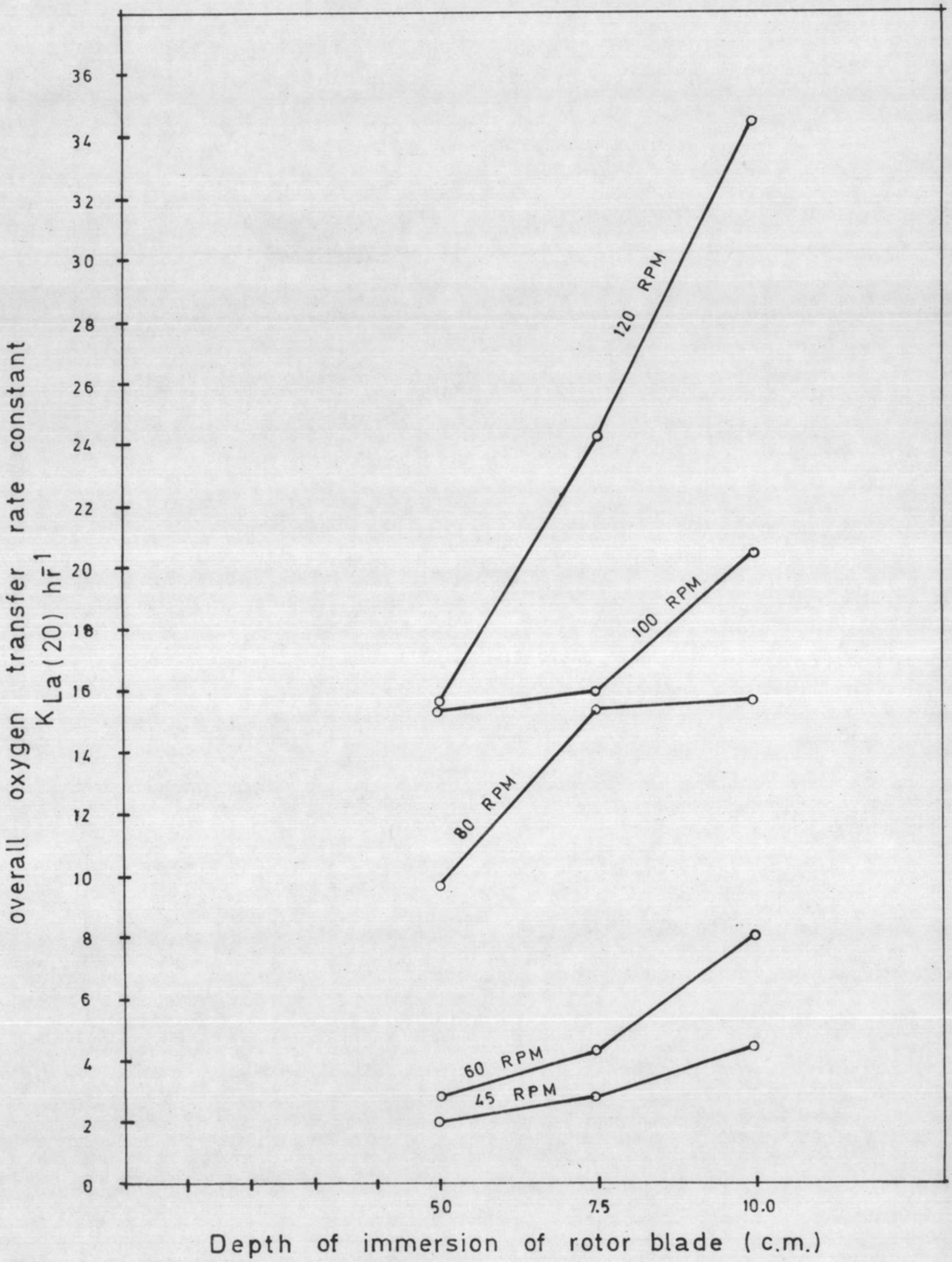

FIGURE 13 Relationship between overall oxygen transfer constant $K_{La(20)}$ and depth of immersion of rotor blade of Rectangular Rotor № 3 for

increased as depth of immersion increases for the range of blade immersion studied.

when the two effects upon the overall oxygen transfer rate constant were compared it was found that the overall oxygen transfer rate constant was more affected by speed variation than by variation in depth of immersion of rotor blades.

Jones and his co-workers (1969) found that, with a 27.5 inches in diameter Angle Iron Blade Rotor operated at 100 RPM and 6 inches immersion of rotor blade, the overall oxygen transfer rate constant for 20°C range from 14.18 to 37.85 per hour while in this experiment with Rectangular Rotor NO 3 at 120 RPM and 10 cm. immersion of rotor blade, the overall oxygen transfer rate constant for 20°C was 34.37 per hour.

Power consumption

Net power consumption was not measured for Rectangular Rotor NO 1, because only 5 sets of experiments were completed due to limitations of the available motor.

Tables 4 and 5 show the variation in net power consumption and speed of rotation for indicated depth of immersion of rotor blade of Rectangular Rotor NO 2 and Rectangular Rotor NO 3. Power consumption in aeration rotor depends on the speed and depth of immersion of rotor blade for each rotor. Increases in speed of rotation and depth of immersion of rotor blade mean an increases in net power consumption. It was found in this experiment that at 120 RPM and 10 cm. depth of immersion of rotor blade, Rectangular Rotor NO 3 gave the highest K_{La}. However this was not the condition for economic operation. The most economical operation for this study occurred for Rectangular Rotor N<u>O</u> 2 when immersion of rotor blade was 5 cm. and 80 RPM as indicated by the parameter, the overall oxygen transfer rate constant per net power consumption.

Baars and Muskat, (1959) proposed that the rate of oxygenation of the water and the amount of energy required"jointly determine the economy of the aeration system, which is an all-important item in comparing the running costs of different system".

An aeration system that gives a high overall oxygen transfer rate constant with low power consumption is desirable and is indicated by a large overall oxygen transfer rate constant per net power consumption ratio. In this study, the overall oxygen transfer rate constant per net power consumption range from 10.78 to 109.80 per kilowatt-hour for Rectangular Rotor N<u>O</u> 2 and from 14.05 to 103.36 per kilowatt-hour for Rectangular Rotor N<u>O</u> 3 and shown in Figures 14 to 17.

<u>Volume of water in the ditch</u>

The volume of water in the oxidation ditch during experiments varied from 1.55 to 1.75 cubic meter with an average depth of 40 cm. Increasing the depth by 2.5 to 5.0 cm. to obtain a blade immersion of 7.5 to 10 cm. from an initial 5 cm. immersion of rotor llade changed the volume by only 0.20 cubic meter.

Jones and his co-worker, (1969) found that the results for the angle iron cage rotor in a live stock oxidation ditch were the same when the water volume in the ditch was varied by increasing the depth of water from 11.25 to 35 inch. Since the oxygen capacity

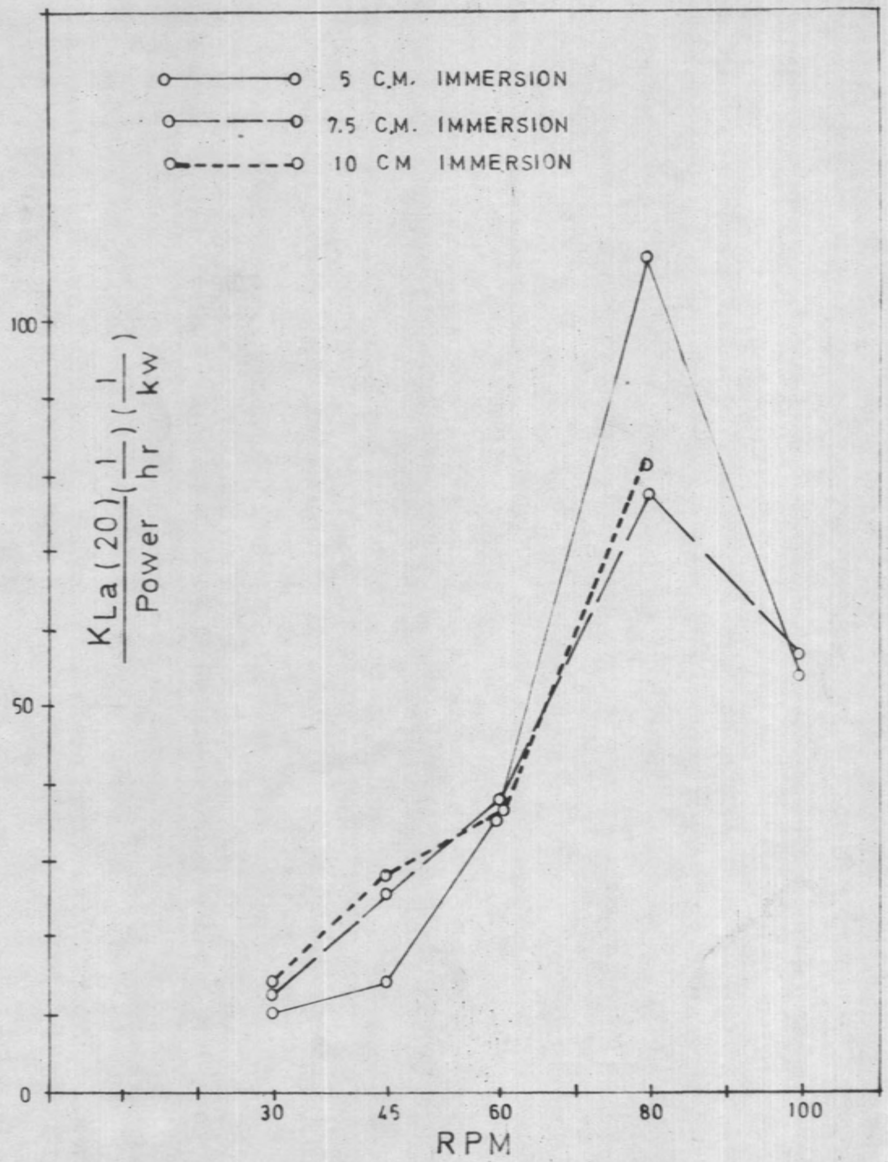

FIGURE 14 Relationship beeween $K_{La(20)}$/Power and RPM for indicated depth of immersion of rotor blade of Rectangular Rotor № 2

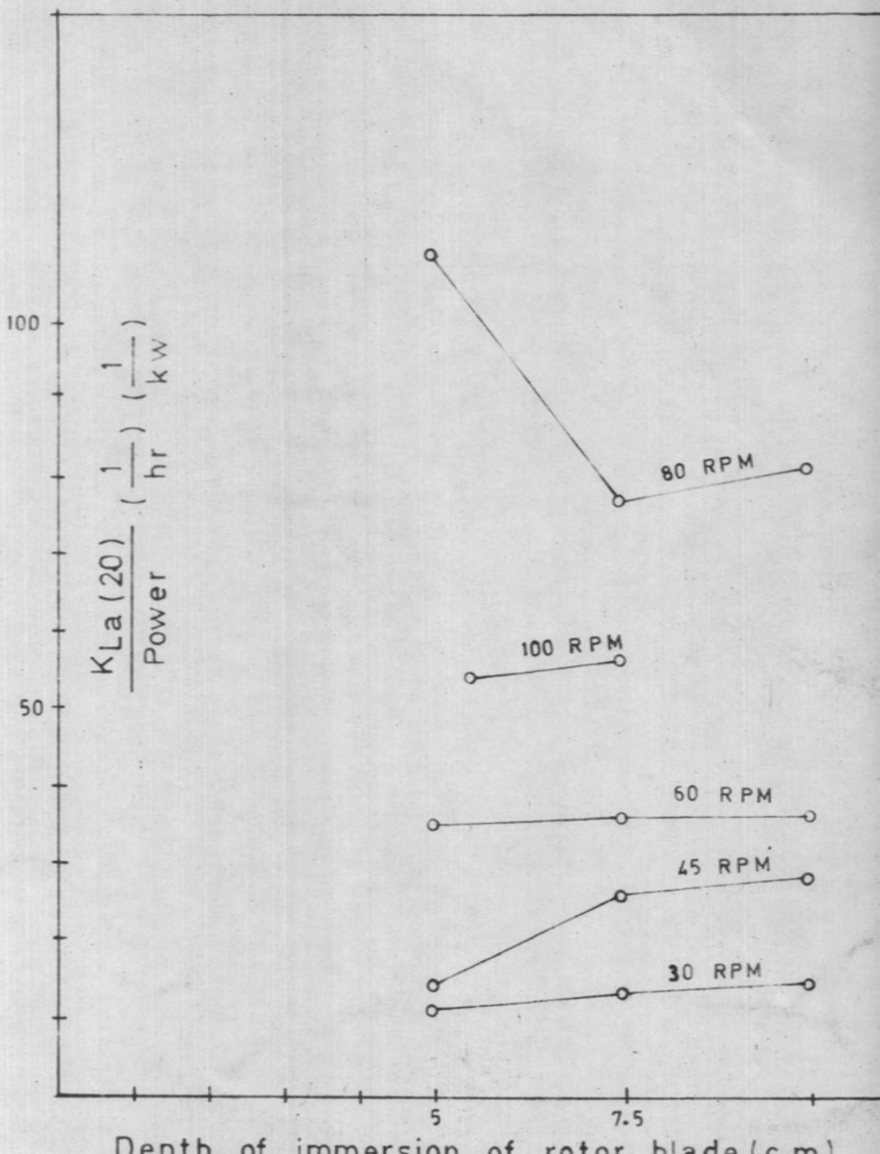

FIGURE 15 Relationship between $K_{La(20)}$/Power and depth of immersion of rotor blade for indicated RPM of Rectangular Rotor № 2

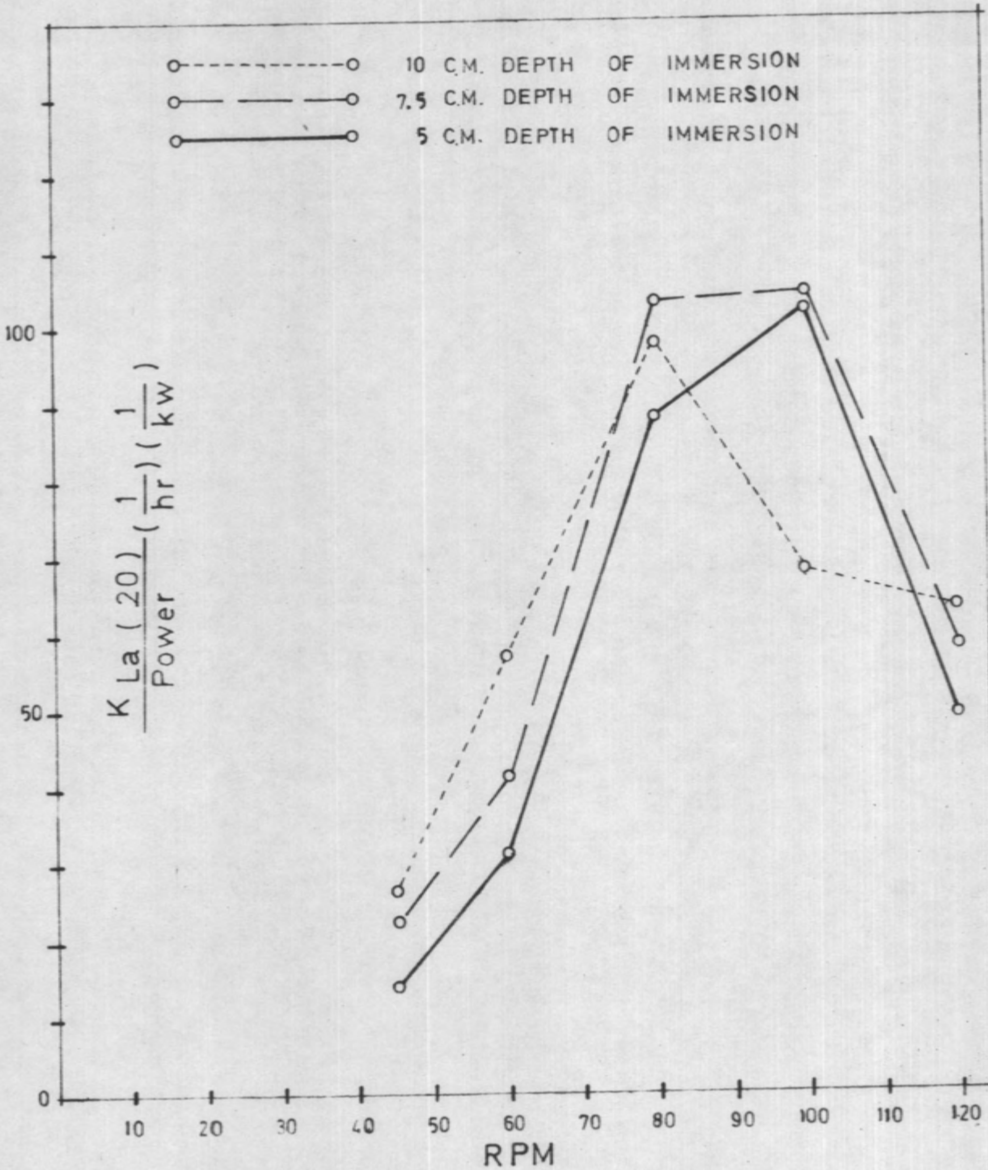

FIGURE 16 Relation-Ship between $K_{La(20)}$/Power and RPM for indicated depth of immersion of rotor blade of Rectangular Rotor № 3

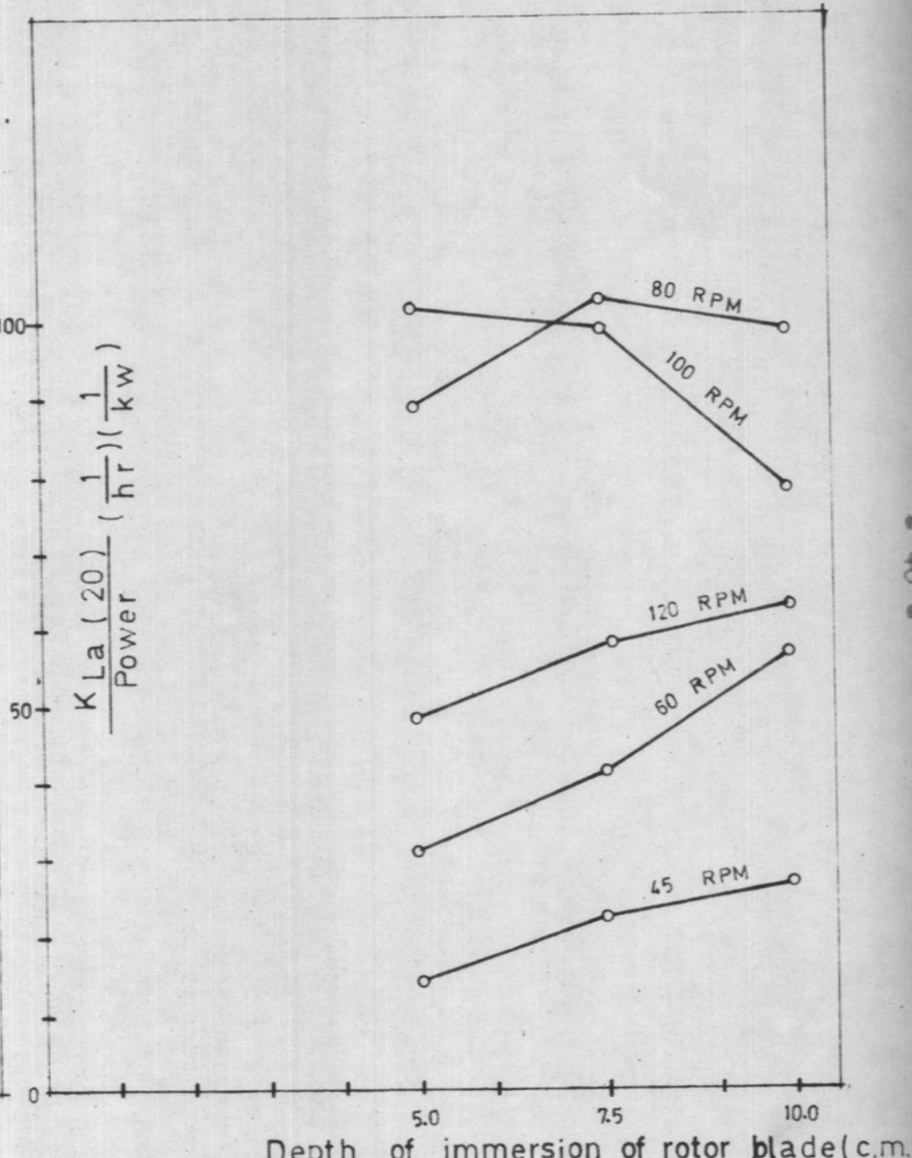

FIGURE 17 Relation-Ship between $K_{La(20)}$/Power and depth of immersion of rotor blade for indicated RPM of Rectangular Rotor № 3

per tank volume is nearly equal for all five volumes, most of the aeration process must take place in the near vicinity of the rotor blades. This also indicated there is no significant difference in oxygenation capacity between aeration process in small and large volume of water.

Temperature during the experiment

As the water temperature during the experiments varied between 21.8°C to 28.3°C, the results were first converted to the standard temperature (20°C) before comparison.

Pasveer, (1960) noted that an increase in temperature correlates not only with an increase in the coefficient of diffusion of oxygen in water but also with a decrease in deficit. From this it follows that for a given deficit the rate of aeration is higher at the higher temperature.

Parameters for rational design of rotor

No one single parameter that would characterize a rotor and aeration ditch or aeration system was found in this study. Baars and Muskat, (1959) noted some years ago in their work with bladed rotors that at low speeds the higest values of overall oxygen transfer rate constant for 20°C are obtained with the smallest interspace between set up blades. On the other hand, at higher speeds the higher values are usually obtained with the larger interspace. Rectangular Rotor NO 1 has the smallest interspace (zero interspace) and at low speeds higher overall oxygen transfer rate const for 20°C were observed than the other rotors in this study. But with higher speeds the other two rotors performed better than Rectangular Rotor N̲O̲ 1. These results agree with the observation of Baars and Muskat, (1959).