Flow Analysis of the Spin Coating Machine

*Man Yeong Ha, Dong Hoon Kang and *Bong-Kyo Jeong*

School of Mechanical Engineering, Pusan National University, Kumjung-Ku, Pusan 609-735, Korea

***Device Research Lab., LG.Philips Display Gumi 1 Plant, Gumi-city, GyungBuk 730-702, Korea**

Phone : +82-51-510-2440 , Fax : +82-51-512-9835, E-mail : myha@pusan.ac.kr

Abstract

When a braun tube becomes wider, one of the major problems to be experienced is the non-uniform coating along the four diagonal directions on its surface. This non-uniformity in the coating thickness has a deep relation with the fluid flow on the surface of a braun tube. In order to control the fluid flow properly, we install the plate to block fluid flow at the corner of a braun tube. In the present study, we investigate the effects of the geometry of plate to control the fluid flow and coating uniformity and determine the optimal shape of plate to improve the quality of coating uniformity.

1. Introduction

The demand for the bigger and wider TV is increasing rapidly. However, when a braun tube becomes larger and wider, it is very difficult to obtain the uniform coating thickness on the surface of a braun tube, which is not a big problem when the braun tube is not wide. Thus many researchers are developing the techniques to improve the coating uniformity. In the present study, we put the plate on the corner of a braun tube to block and control the fluid flow and determine the optimal shape to improve the coating uniformity on the surface of a braun tube. We carried out the experiment to measure the transmission for different plate geometries. We also carried out the numerical calculation to simulate the fluid flow in the spin coating machine. The calculated wall shear stress on the surface of a braun tube was compared with the measured transmission to obtain some correlation between them.

2. Experiment and computer simulation

We measured the transmission of coating at the corners of a braun tube in the directions of 2, 4, 8 and 10 hours, for different shapes of plate geometries as shown in Table 1. P-models in Table 1 have a rectangular shape in general, while the edge part of rectangular plate in the pg-models is cut out to prevent the staining at the corners of a braun tube. P380-40 model has the largest transmission deviation, which is defined as the difference between the maximum and minimum transmission values, whereas both p380-80 and pg350-80 model have the lowest transmission deviation. However, pg350-80 is considered as a better model because it gives no stain on the surface of a braun tube.

Table 1 Results of various cases

Model	Transmission					
	rpm	2hr	4hr	8hr	10hr	max -min
p350-60	135	57.0	52.0	58.0	49.0	9.0
p380-40	135	57.0	44.0	56.0	46.0	13.0
P380-60	135	56.1	48.0	58.0	46.0	12.0
p380-80	150	58.0	51.0	56.0	51.0	7.0
pg350-80	150	58.0	52.0	57.0	51.0	7.0
pg350-60	150	55.4	47.0	52.0	44.0	11.4

We obtained the numerical solution for the governing mass and momentum conservation equations using

the finite volume method in order to investigate the

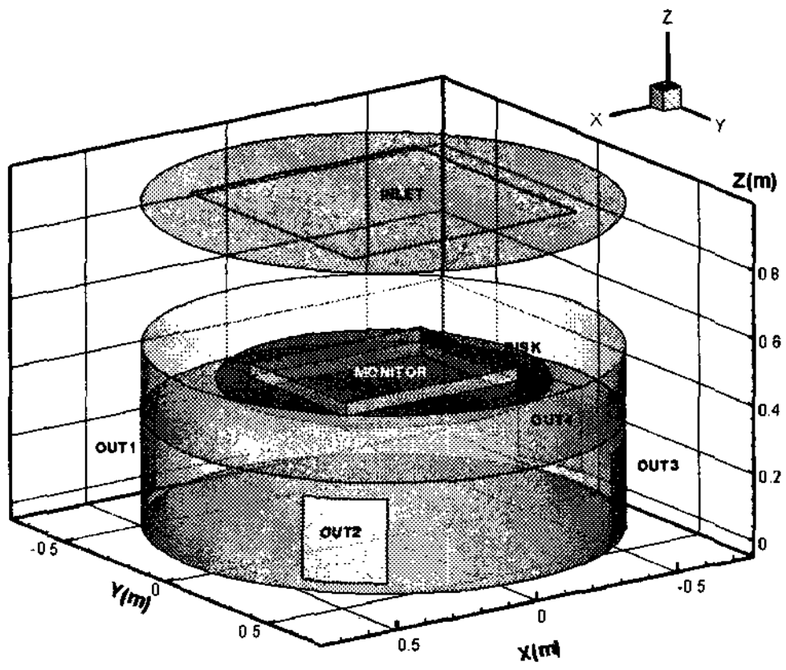


Figure 1 Simpliefied model of spin coating machine

three-dimensional fluid flow in the spin coating machine.[1-3] Figure 1 shows the simplified model of spin coating machine used in the present study. The $k-\varepsilon$ model was used to model the turbulent flow. This calculation was carried out in the rotating reference frame in order to consider of the rotation of coating machine. The number of grid used in the present calculation is about 300,000.

3. Results and discussion

3.1 Flow Field

Figure 2 shows the general fluid flow in the spin coating machine obtained from the present calculation. At the upper part of spin coating machine, the fluid flow is generally parallel in the vertical direction, impinges on the surface of a braun tube, directs radially due to the rotation of a braun tube, and finally moves to the lower part of coating machine. The large recirculating flow is formed at the lower part of coating machine, which may give a bad effect on the coating. In order to prevent the bad effect of

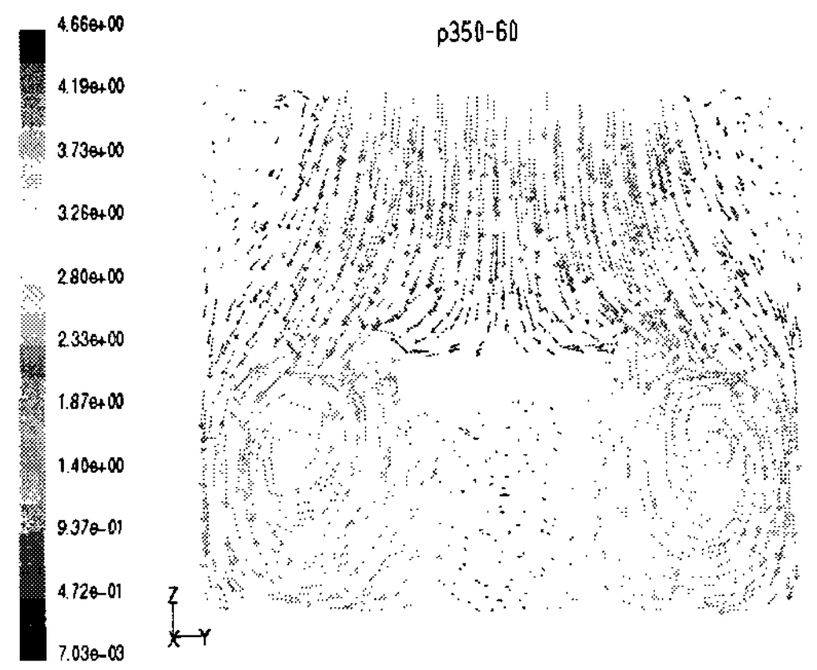


Figure 2 Fluid flow field of spin coating machine

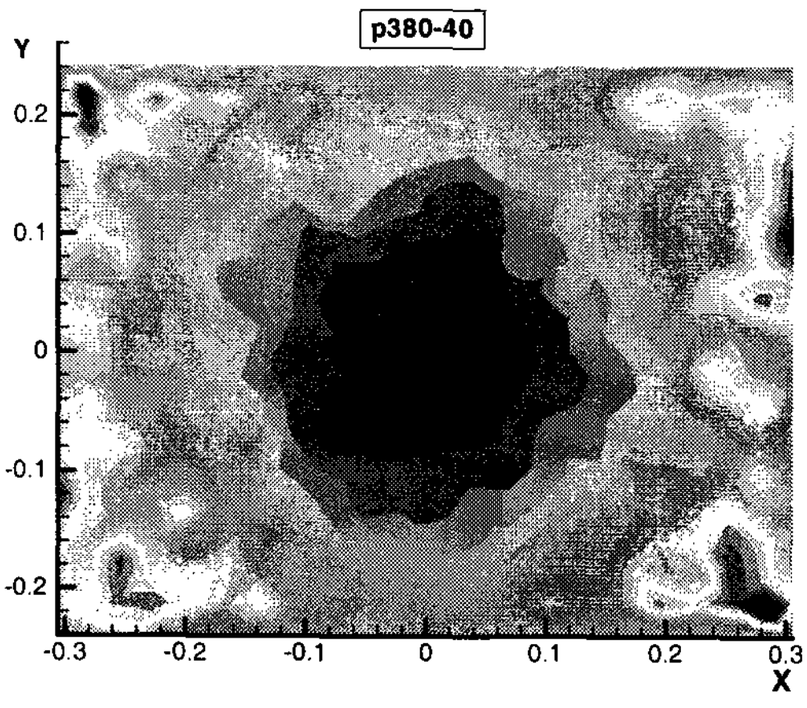
recirculating flow at the lower part of coating machine on the coating uniformity, we should install the plate on the corners of a braun tube as given in Table 1.

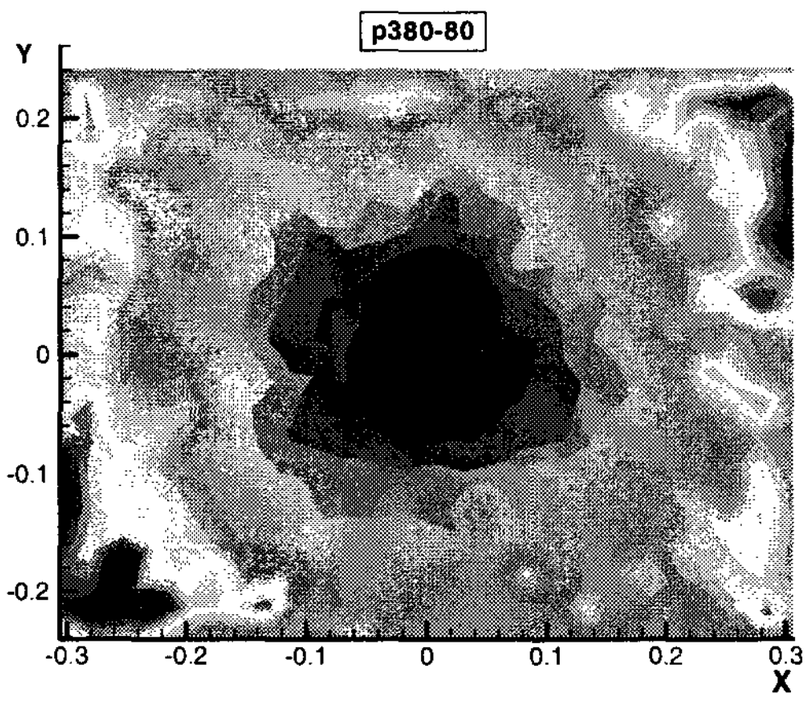
3.2 Wall Shear Stress Contour

Figure 3 shows the distribution of wall shear stress on the surface of a braun tube obtained from the present calculation. If we have large values of shear stress in the corners, we expect that it restrains the coating film from thickening in the corners, resulting in the uniform coating thickness. The p350-80 and pg350-80 models have relatively higher shear stress in corners than other models, expecting to give more uniform coating thickness. This results agrees well with the measured transmission data shown in Table 1.

3.3 Wall Shear Stress and Transmission

Figure 4 shows the comparison of calculated wall shear stress with measure transmission at different corners in the direction of 2, 4, 8 and 10 hours for





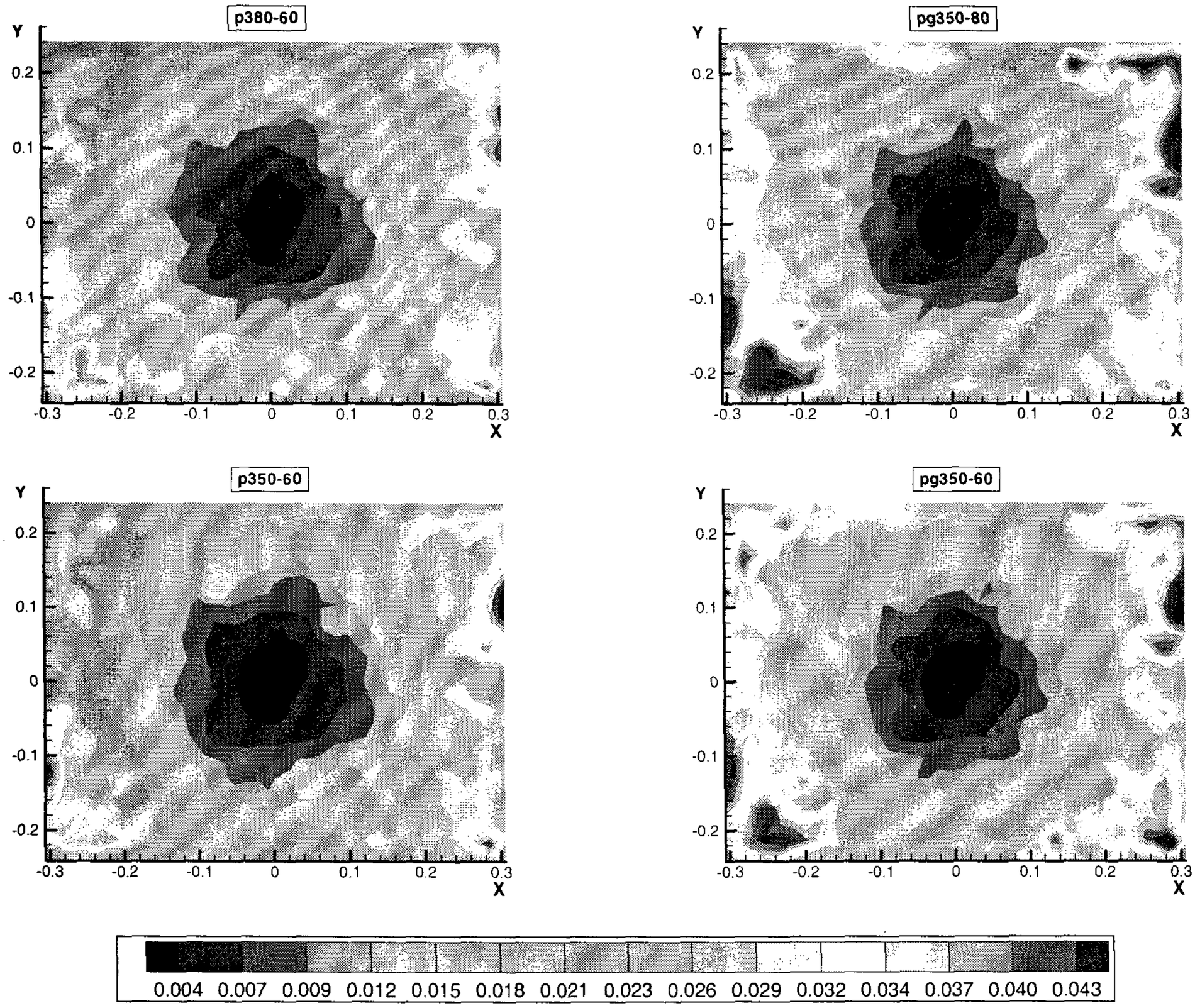
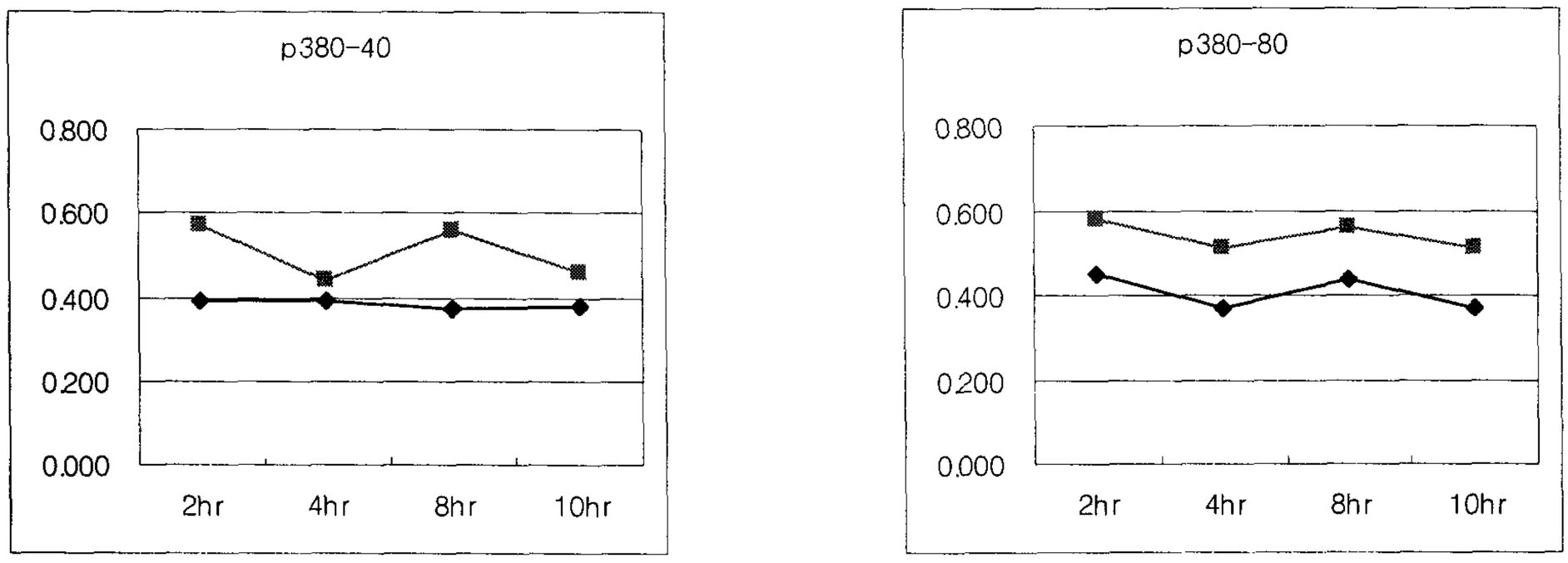
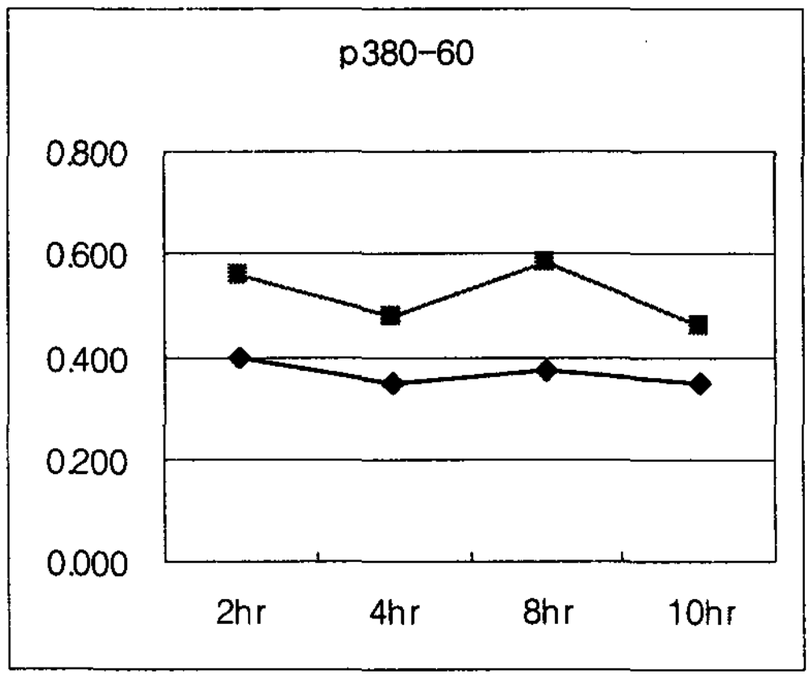
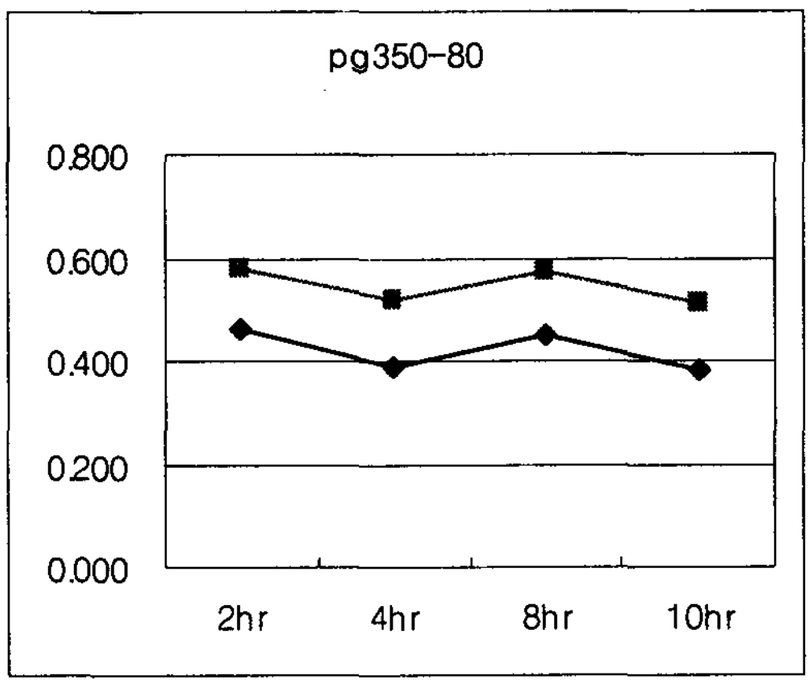
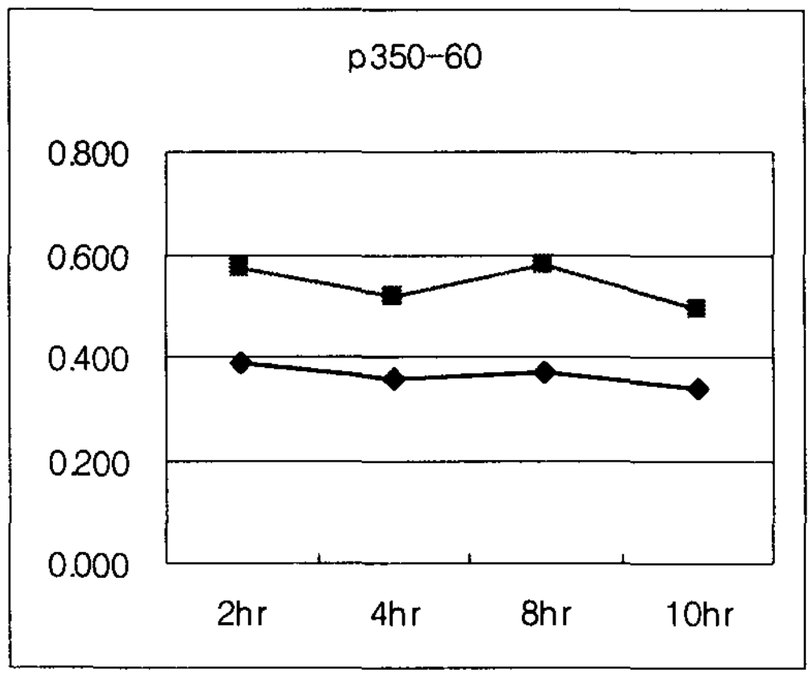


Figure 3 Wall shear stress contours on the surface of the braun tube









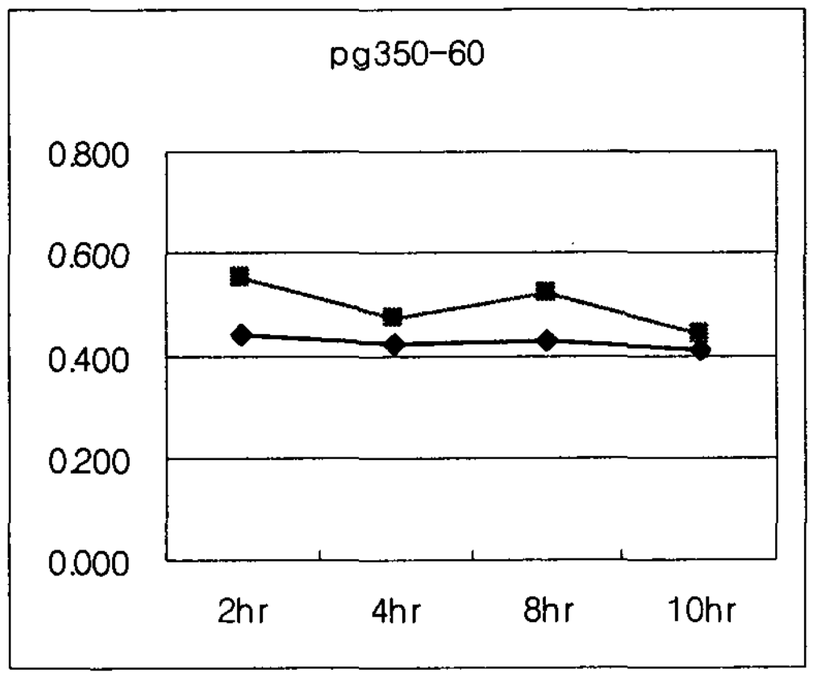


Figure 4 Comparison transmission with wall shear stress

(transmission wall shear stress)

different plate geometries. The variation of wall shear stress is generally similar to that of transmission. This result shows that transmission has a deep relation with the wall shear stress distribution. So we should design the spin coating machine to give uniform wall shear stress on the surface of a braun tube. We can also derive some correlation to relate the wall shear stress distribution and transmission and coating uniformity.

4. Conclusion

We carried out the experiment to measure the transmission of coating of a braun tube for different geometries of plate to control the fluid flow on the corners of a braun tube. We also carried out the numerical simulation to calculate the fluid flow and wall shear stress on the surface of a braun tube. Using the experimental and simulation results, we can obtain some relationship between the calculated wall shear stress and measured coating transmission. Finally we determined the optimal shape of plate to control the fluid flow.

5. Acknowledgements

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6. References

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