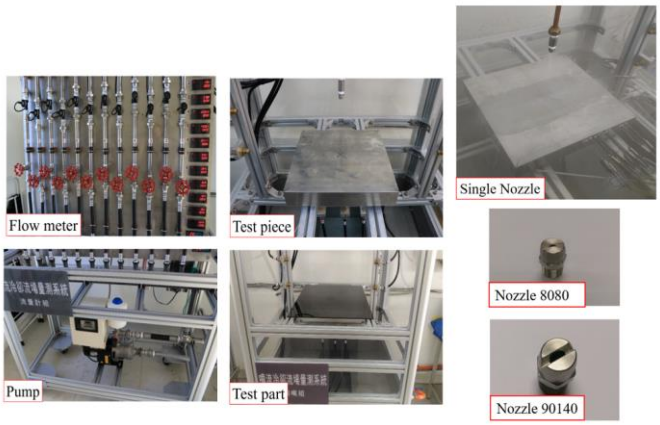

Fig. 4. Experimental apparatus

V. Results & Discussion

A. Different Type Nozzle Flow Field Observation

Fan-shaped nozzle cooling experimental flow field observations, from Fig.5 (a) and (b), see the overall impact area as the flow increases and then it becomes larger. As can be seen from the Fig.5 (c) and (d), which were taken with the camera's high-speed shutter, the shape of the atomization impact gradually increases from the centered phenomenon to the long axis as the flow increases. In the single-nozzle VVP8080 impact cooling high-speed shutter, it can be seen that as the flow rate increases from 2.5 L/min to 7.4 L/min, except that the impact shape of the atomized water gradually increases toward both sides, the water flow The impact speed can be clearly seen from the figure that the overall impact speed also increases significantly with the increase of flow rate.

Then from the point of view of spray angle, we discuss the flow field flow of two different types of nozzles VVP8080 and VVP90140 under the same flow conditions. From Figure 5(a), it can be clearly seen that the VVP8080 has a long axis length of 100 mm at the same flow rate of 2.5 L/min, and the VVP90140 has a length of 70 mm. In the clear observation of the impact area under the atomization impact, it can be seen that the long axis lengths of the atomization impacts of the two nozzles are 85 mm and 60 mm, respectively, and the distance between the fixed nozzle and the acrylic plate spacing is 200 mm. The relationship between the Pythagorean theorem and the trigonometric function can be further calculated as the spray angle angles of 46.05° and 33.40°, respectively. Therefore, the VVP8080 nozzle belongs to the long and short axis of the long flat short ellipse and the VVP90140 belongs to the same flow rate. The major axis is shorter than the minor axis.

Finally, the maximum pressure that can be driven by the pressure pump can be compared with the maximum flow that the two nozzles can impact. It can be found that the VVP8080 nozzle can reach the maximum flow rate of 7.4L/min under the pressure pump driving. From the Fig.6 (a), the long axis of the impact region of the elliptical shape was observed to increase to 260 mm and the length of the corresponding direct impact long axis was 160 mm. The spray angle calculated at this time was 77.32°. According to the relation between flow and pressure from equation (7), the maximum pressure of the pump driven by the nozzle VVP8080 is about 0.257 MPa. At the same time, the flow rate that the VVP90140 nozzle can reach is 8.4 L/min. From the Fig.6 (b), the long axis of the elliptical impact zone is increased to 240 mm and the length of the corresponding direct impact long axis is 170 mm. The angle is 80.72°. And from Equation(7) , the pressure it can reach is about 0.108 MPa, so comparing the pressures that the two can achieve under the same horsepower pump drive has more than one times of drop, mainly due to the two nozzle ports. Different friction causes the VVP90140's nozzle to have a greater pressure loss.

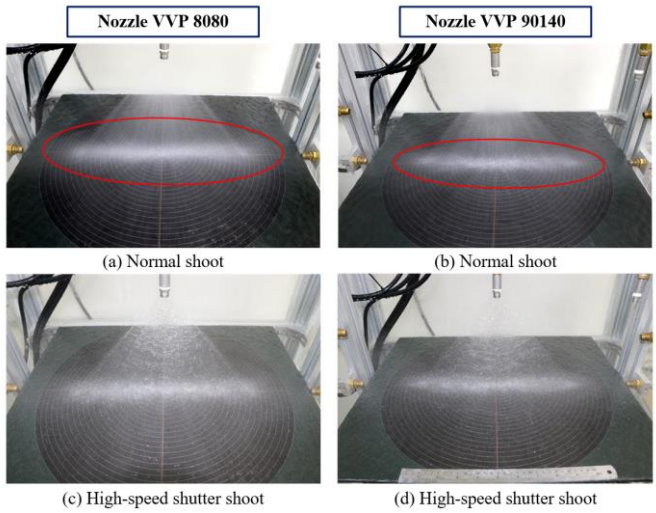

Fig. 5. Flow rate Q=2.5L/min flow field observation

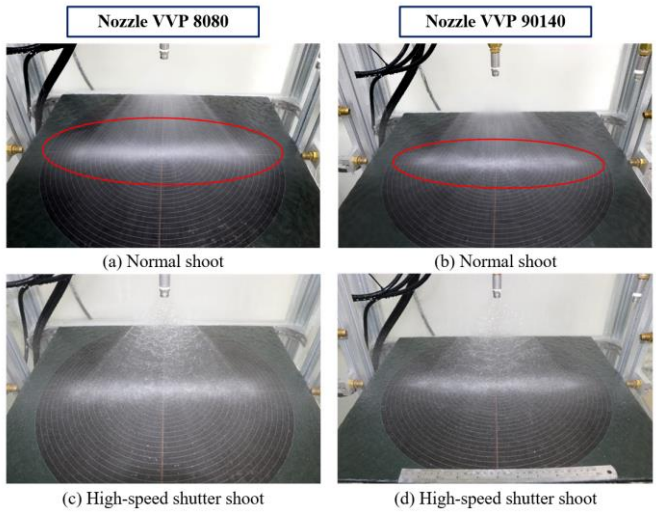

Fig. 6 Flow rate Q=7.4 & 8.5L/min flow field observation

B. Effect of Pitch of Double Nozzle

The phenomenon of interference is discussed by observing the change of the distance between the two nozzles. From Fig.7, the nozzle VVP8080 has three different flow rates: Q = 2.5 L/min, Q = 4 L/min, and At Q=5 L/min, the flow field at different nozzle spacing and the flow pattern of the interference phenomenon are observed from the Fig.7. The nozzle's spacing can be observed when the flow rate Q is 2.5 L/min. It can be clearly seen that the atomization and impact jets of the two nozzles converge at the center line, and this phenomenon still has obvious phenomena when P=150 but it reaches P=100. The