

Figure 4: Thickness swelling vs. Soaking time

Figure 4 shows the results of TS of particleboards affected by the weight fractions. The results indicated that a decrease in the weight fraction of fiber (increase in UF content) affect the thickness swelling [5]. This is because sago was less repellent to water as more resins were incorporated into the board [7]. The thickness swelling could be affected by the bonding quality between the particles and the adhesive properties [4]. An increase in adhesive creates better bonding quality as compared with small amount of UF.

The presence of sago bark in the particleboards resulted in higher water resistance. This is because the presence of

polyphenolic extractives in the barks reacted with the UF and improved the water resistance properties [8].

The high values obtained from the TS tests were due to the high percentage of highly absorbent particles in the panels. The particles were very short and constituted a high percentage of total fiber content, thus, creating a very large and highly absorbent surface area. The highly porous structure of the board allowed the water molecules to penetrate into the board and increased the water uptake, resulting in high water absorption and caused the board to swell and subsequently led to an increase in the TS [9].

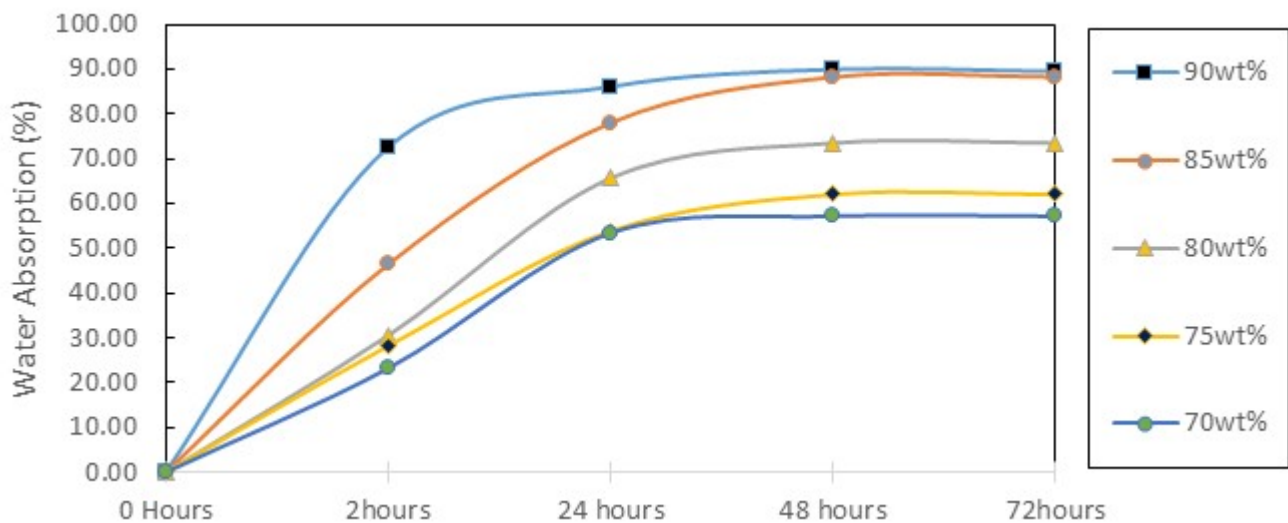


Figure 5: Water absorption vs. Soaking time

Figure 5 shows the results of water absorption (WA) of particleboards which is affected by the weight fraction. The results show that the resin content has a significant effect on the water absorption. The trend of the water uptake process was linear in the beginning, then slowed down and reached saturation after prolonged time [10]. The long term water absorption of Sago-UF particleboard maintained relatively stable dimensions after 72 hours [4]. Sago-UF particleboards with 70wt% had better qualities than the 90wt%. The addition of UF in the particleboard, caused the formation of hydrogen bonds, increased the water binding sites and reduced the particleboard's capacity of absorbing water [8]. Water absorption decreased with resin content due to the

chemical components in the resin that is capable of cross-linking with the hydroxyl group of the fibers, hence reducing the hygroscopicity of the boards. Hygroscopic expansion can be affected by various factors of the resin such as the monomer, the polymerization rates, the cross-linking and pore size of the polymer network, the bond strength, the interaction between polymer and water, the filler and the resin-filler interface [9].

Water absorption increased as the particles loading increased and this can be explained by the theory of void over volume of the board where the particles were not fully bound by the UF and hydroxyl properties by the fiber. Higher fibre loaded

samples would be expected to contain a greater diffusivity due to higher cellulose content[10].The hydrophilic character of sago particles is responsible for the water absorption in the particleboard, therefore, higher content in fiber lead to a higher amount of water absorbed. Generally, water absorption increases with immersion time until equilibrium condition is reached. When the particles content are increased in the particleboard, the number of free OH group of sago cellulose also increases. Hence, the water absorption increases[12]. Besides, sago particles consist of strong hydrophilic cellulose in an amorphous matrix of hemicelluloses and lignin; the main reason for water absorption by composite materials. This may be attributed to the fact that sago particles is extremely hydrophilic in nature due to the presence of the hydrophilic hydroxyl group of cellulose, hemicelluloses and lignin that is responsible for water absorption [13]. The 90wt% of sago particles were incomplete encapsulation of UF and probable occurrence of sago particles aggregates and lead to the high penetration ability due to the porosity.

The hydrophilic sago particles/fiber swells when the composite is exposed to moisture. As a result of fibre swelling, micro cracking of the brittle thermosetting resin occurs. The high cellulose content in sago fibre further contributes to more water penetrating into the interface, through the micro cracks induced by swelling of fibers, creating swelling stresses leading to composite failure. The water molecules actively attack the interface, resulting in deboning of fibre and matrix[10].

4. Conclusions

This study investigated the effect of weight fraction and particles size on the water absorption and thickness swelling test. 0.6mm and 2mm particle sizes were shown to have poor adhesion with the UF matrix, giving rise to water absorption and thickness swelling. The results show that the resin content has significant effects on the water adsorption and thickness swelling expansion. Water resistance can be reduced using three different methods: by adding wax (hydrophobic materials) into the adhesive during the manufacturing process, reducing the density of the particleboard to decrease the spring back effect and adding more barks to improve the water resistance. This study shows that sago particles can be utilized as a raw material in particleboard manufacturing. The findings show that the new application for sago may potentially reduce the pressure on the forest resources as well as providing additional income to the farmer in Mukah Sarawak.

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