Understanding the interaction between solutes and microgel particles is important for many potential applications of microgel particles in drug delivery, water purification and as sensors. It is known that surfactants have strong interactions with microgel particles, and thus far, many commercially available and industrially relevant surfactants have been investigated [1-5]. The theme that emerges from these investigations is that the amphiphilic character of the surfactant molecule plays a critical role in its interaction with microgel particles. The aim of this study was to investigate how the hydrocarbon chain-length of surfactant molecules influences their interaction with microgel particles. Four cationic surfactants, with different hydrocarbon chain lengths, were synthesized and their chemical structure confirmed by $^1$H NMR and mass spectroscopy. The critical micelle concentration of the surfactants was determined using a K100 Tensiometer and shown to decrease with increasing hydrocarbon chain length, as expected. A systematic investigation was conducted on the interaction between poly N-isopropylacrylamide-co-acrylic acid microgel particles and the four surfactants. The interaction was characterized by the adsorbed amount of surfactant and the effect of surfactant concentration on the particle size and electrophoretic mobility of the dispersions. The experiments were performed at pH 8 where the microgel particles were negatively charged to promote an electrostatic, in addition to the hydrophobic, interaction with the microgel particles. There is strong correlation between the hydrophobic interaction and the adsorbed amount. The adsorbed amount increases with the carbon chain length, suggesting that the hydrophobic interaction plays an important role. Release experiments were also carried out, at pH 3 where the microgel network is uncharged, to show the significance of the electrostatic interactions between the microgel particles and the surfactant molecules, and confirm the importance of the hydrophobic interaction. As expected, it is shown that the adsorbed remains high for surfactants with longer hydrocarbon chain length, while surfactant with shorter tail lengths were totally released from the microgel particles.