GLOBAL JOURNAL OF ENGINEERING RESEARCH VOL.1, NO.2, 2002: 145 - 149
COPYRIGHT(C) BACHUDO SCIENCE CO. LTD. PRINTED IN NIGERIA. ISSN 1596-292X

THE ADSORPTION OF CAUSTIZED CASSAVA STARCH FLOCCULANT GOETHITE, KAOLINITE AND QUARTZ IN RELATION TO FLOCCULATION

LINUS O. ASUQUO

(Received 24 February 2000; Revision accepted 24 May 2001).

ABSTRACT

The adsorption of caustized cassava starch on goethite, Kaolinite and quartz has been investigated using model 5500 Atomic Absorption / inductively coupled plasma spectrometer to determine the residual concentrations in the solution .The effect of such variables as pH and starch concentration on adsorption has been studied. Also the effect of reagentization time on the flocculation pH of pulp and starch concentration on the flocculation behaviour was studied. Both polymer adsorption and the flocculation of goethite, kaolinite and quartz are enhanced as the pH decreases .The amount of polymer adsorbed rises at first and then approaches a saturation value.

KeyWords: Adsorption, Flocculation, reagentization.

INTRODUCTION.

The adsorption of polymers from aqueous solution is influenced by a combination of forces. Polymer adsorption onto solid surfaces may be due to chemical short distance interaction such as covalent bonding, co-ordination bonding, and hydrogen bonding or to physical longer range forces- electrostatic bonding, dipole attraction, London – Van der Waals attraction and hydropholic association (Drzymala, 1987; Attia, 1987; and Kitchener, 1972). Hydrogen bonding is considered as the principal process for the adsorption of non –ionic polymers and hydrogen bonding together with electrostatic interactions for ionic polymers. In the case of a polymer with large number of charged units, electrostatic bonding is the predominant mechanism .The adsorption of polymers on solid surfaces by chemical forces against electrostatic repulsion can only happen when the polymer approaches the surface closely by means of other mechanisms (Stresty, 1978). This may be due either to London- Van der Waal's surface forces or to strong collisions between the polymer molecules and the solid surface (Somasundaran, 1980). Adsorption of polymers on minerals and the rate involved are dependent to a large extent on the polymer properties such as molecular weight, the nature and concentration of the functional groups and configuration. Others are the mineral properties such as surface charge and the solution properties such as ionic strength, and solvent power for the polymer (Stresy, 1978 and Somasundaran, 1980). The chief factors involved in the surface of minerals in aqueous medium are dissolution, hydration and hydrolysis of dissolved species, surface ionization and the

formation of an electrical double layer. Hydrogen bonding between non-ionic groups such as the hydroxyl groups or hydrated oxides and the-COOH groups of starches or the CONH group of polyacrylamides has been confirmed through infrared studies (Pradip , 1980) .It has been shown that adsorption of non – ionic and anionic polymers decreases as pH increases (Rubio, 1976, Van Lierde, 1974 and Michaels 1973) Flocculation is the aggregation of finely suspended solids in water by a polymeric Flocculants. In order to attain the flocculated state, the polymers dissolved in water must first

LINUS O. ASUQUO, Department of Mechanical Engineering, University of Uyo, Uyo, Nigeria

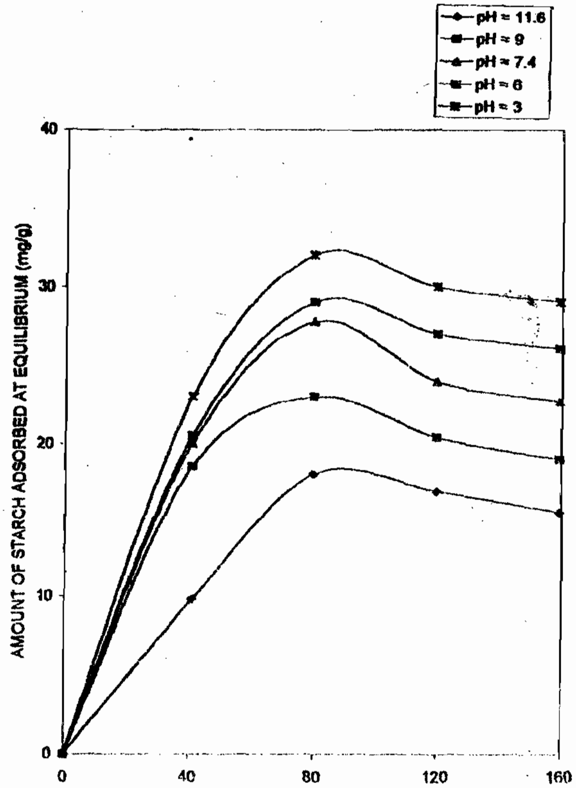

Figure 1

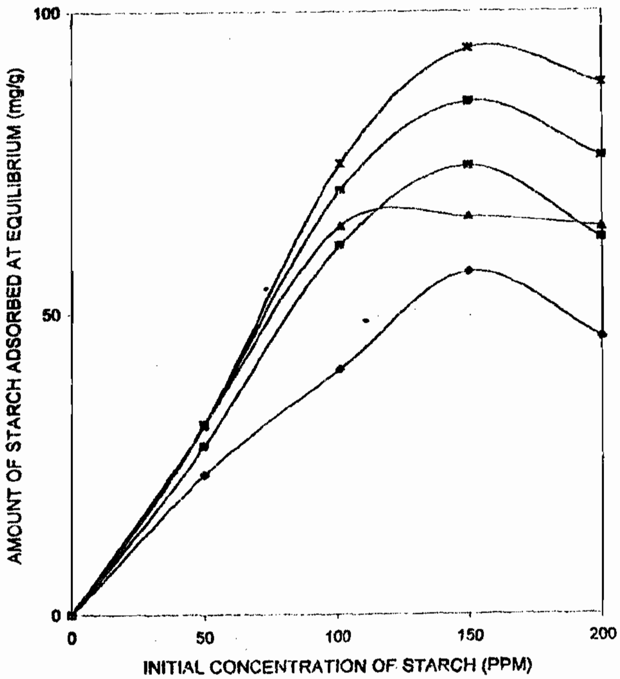

Figure 2: Equilibrium Adsorption Isotherms of Cassava Starch on kaolinite.

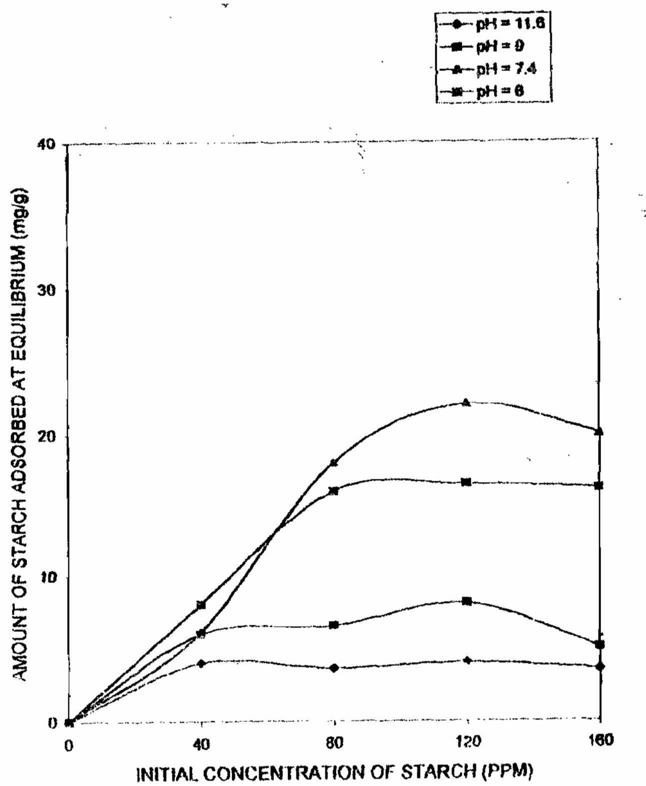

Figure 3: Equilibrium Adsorption Isotherms of Cassava Starch on quartz.

adsorb on the solids. Starches have been well known to flocculate Kalonite in preference to quartz. Generally, researchers agree that flocculantion occurs by a process of adsorption of polymers, and bridging of polymers chains between solid particles. (Nebo et al., 1996). The possibility of beneficiating iron ore following prefential flocculation of hematite from quartz using starch was first reported by Cooke et al., 1959) who demonstrated that corn starch modified to contain aminoethyl group was found to flocculate both hematite and quartz , because the presence of *aminoethyl group* causes the starch to adsorb on quartz particles as well.

EXPERIMENTAL TECHNIQUES

Materials and Preparation

The materials of pure goethite , kaolinite and quartz were supplied by the Geological Survey

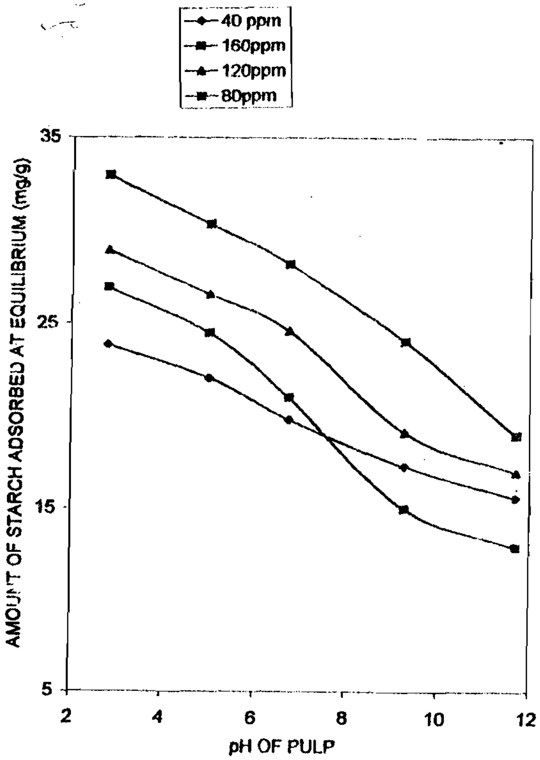

Figure 4: Effect of pH on Starch Adsorbed at Equilibrium on Geothite

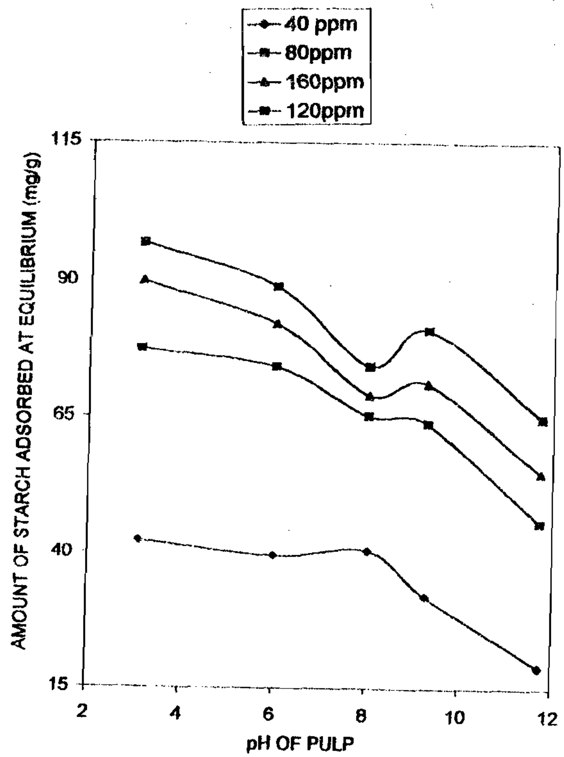

Figure 5: Effect of pH on Starch Adsorbed at Equilibrium on Geothite

Divisions , Federal Ministry of Mines and Power Enugu. The minerals were crushed , ground and wet screened (-38 µ) and then stored in a stoppered container. The reagent grade of sodium hydroxide was used in this study. The cassava starch was extracted from fresh cassava tuber. The extracted starch was net screened and dried in an oven within a temperature range of 65 -70°C to a constant weight. Dried starch was subsequently ground to powder. Starch solution was prepared by treating 4% w/v starch suspension with an equal volume of 0.5% w/c of sodium hydroxide. A series of mineral suspensions were made differently by dispersing 1kg of each in deionized water and left over-night to attain the equilibrium pH value.

Experimental Procedures

Two types of tests were carried out viz. the adsorption equilibrium and the flocculation tests. In adsorption equilibrium test, the starch solution was added to the mineral suspension, stirred mechanically for three minutes at high shear and then one minute at low shear. During the adsorption equilibrium, continuous agitation was stopped to avoid degradation of the long chain polymer. After equilibrium, sample of the supernatant liquid was taken and analyzed for residual starch. For the flocculation tests, 50g of each sample was added to de-ionized water and conditioned in the flocculation cell at 10wt per cent solids concentration for ten minutes. The desired quantity of flocculants (Cassava starch)was added and stirring was continued for one more minute after which the suspension was transferred to a 500ml measuring cylinder with cover. The suspension was allowed to settle after inverting the cylinder once. The flocs formed were allowed to settle for minutes at the end of which the supernatant suspension above a predetermined level was siphoned. This procedure was repeated with the settled flocs and finally, the flocs, and the final product (flocs) and rejects (supernatant suspension) were dried, weighed and analyzed.

RESULTS

Figs. 1, 2 and 3 show the adsorption isotherms of cassava starch on the three mineral samples at different pH values, up to a certain amount of initial starch concentration before a decrease in adsorption occurs. Figs. 4 and 5 show the effect of pH of pulp. The results of the flocculation of pure goethite, Kaolinite and quartz are shown on Figs. 6,7 and 8 respectively. Goethite shows maximum flocculation at about pH 7.5 at 50 - ppm starch concentration, under the condition of the experiments. Figure 9 shows the effect of reagenization time on the flocculation of goethite and kaolinite.

DISCUSSION

The affinity of polymer molecules for the surface depends on the nature of the polymer – water and the solid surface –water interactions. Starch

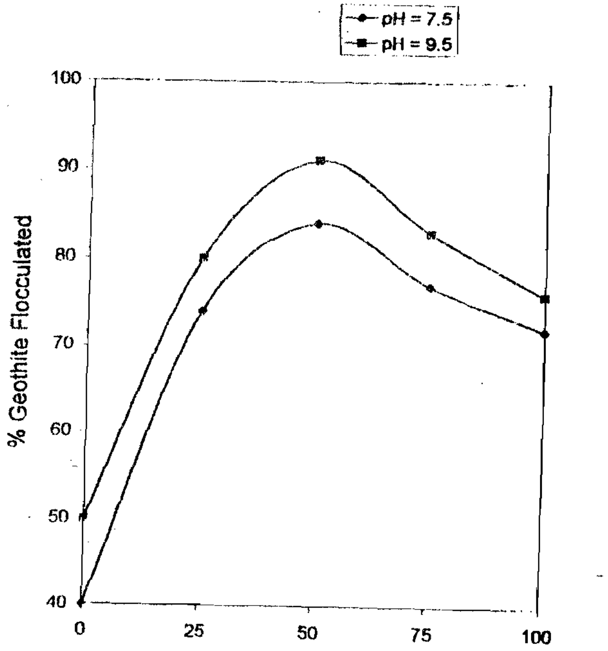

Figure 7: Effect of starch concentration and pH on the flocculation of pure Geothite

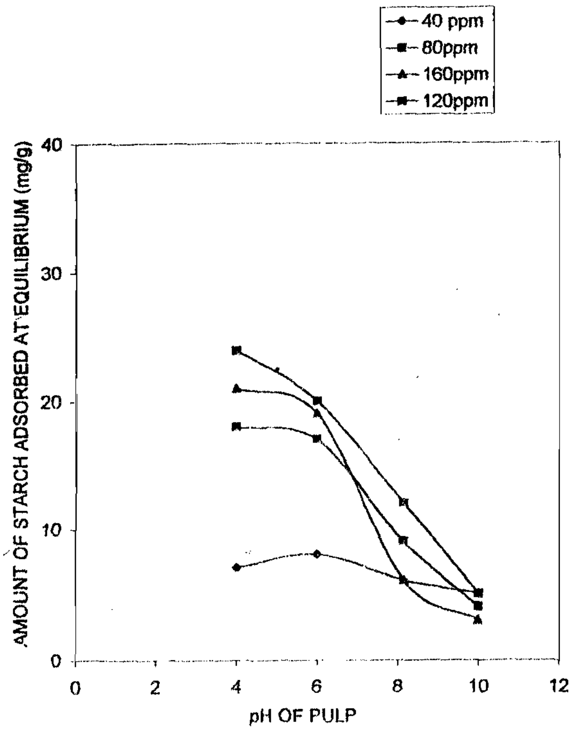

Figure 6: Effect of pH on amount of starch adsorbed at equilibrium on kaolinite

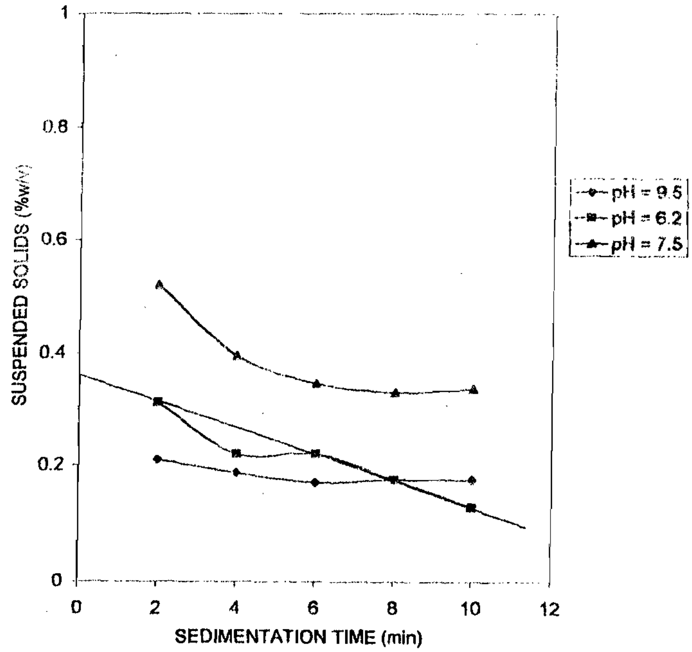

Figure 8: Flocculation of quartz with starch flocculants as a function of pH and time

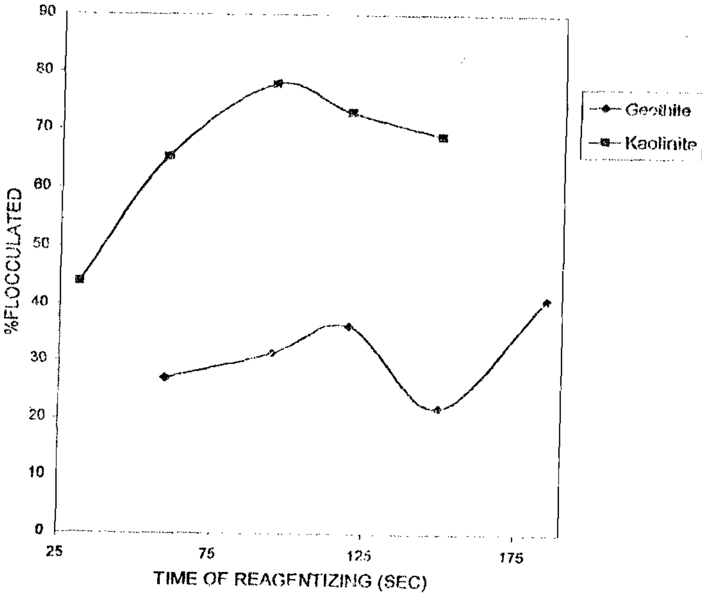

Figure 9: Effect of reagentization time on the flocculation of geothite and kaolinite

contains hydroxyl groups, which make it a nonionic compound .The hydroxyl group (-CH2OH or COH) has both hydrogen accepted properties to its oxygen atom .

Causticizing cassava starch with sodium hydroxide leads to the expansion of starch granules and the subsequent release of amylose from the confining wall of amylopectin. At this point, the polymer passes into colloidal solution, and the starch acquires some flocculation properties. Further mixing of the caustic starch solution leads to the hydrolysis of the starch to form soluble amylose and phosphoric acid thereby enhancing the flocculation properties of starch (Eligwe et. al., 1988). Inter particle bridging follows adsorption of polymers either due to adsorption of the polymer segments from different particles. Individual particles grow into flocs as a result, such flocculation can be expected to depend on both structure of adsorbed polymer species and on the availability of uncovered particle surface for bridging. Increased reagentization can result in an increase in the fraction of surface covered by polymer molecules.

SUMMARY

Adsorption isotherms of cauticized cassava starch on goethite, kaolinite and quartz were determined at various pH values. The adsorption of starch onto the minerals increases with decreasing pH but the difference in adsorption of the same polymer onto three different oxides suggests that the surface characteristics of the oxides are indeed important. Both adsorption and the flocculation of goethite, kaolinite and quartz polymer are enhanced as the pH decreases.

REFERENCES

Attia, Y.A. and Fuerstenau. 1978. Principles of Separation of Ore minerals by selective flocculation, Rec. Dev. In separation science 4: 48-56

Cooke, S.R.B. Iwasaki, I and Choi, M.S. , 1959. Effect of structure and unsaturation of collector on soap flotation of iron Ore Min. Engineering, 2:920-927.

Drzymala J. and Fuerstenau D.W., 1987. Adsorption of Polyacrylamide, partially Hydralyzed Polyacrylamide and Polyacrylic acid on Ferric oxide and silica. Biotech and separation systems 45-46.

Kitchener, J. A., 1972. Brit. Polymer journal 4: 217-221.

Nebo, C.O. Asuquo, L.O.Nworu, C.K. and Fuerstenau,M.C., 1996. A study of The Flocculation of Pure Goethite, Quartz, and Kaolinite and the selective Flocculation of Agbaja Iron - Ore Part III. Journal dispersion science and Tech. 17 (1): 13-21.

Pradip, Attia Y. A and Fuerstenau, D.W. 1980.The adsorption of Polyacrylamide Flocculants on apatites. Colloid and Polymer Science 258: 1344-1351.

Rubio J. and Kitchener J. A., 19760. The mechanism of adsorption of Polyethylene Oxide flocculant on silica journal of colloid int. Science 5, 132- 142.

Somasundaran P., 1980. Selective Flocculation of Fines, fine Particles Processing, SME- AIME (Somasundaran P. and Arbitar N.Eds) 183-196.

Stesly, G.C. Raya, A, et al., 1978. Selective Flocculation of Mineral alimes using Polymers; Recent Advances in separation science 6: 93-96