

General discussion

Prepared discussion contribution

NOTE ON THE EFFECT OF POLYACRYLAMIDES ON THE FIBRES/TiO₂-ADSORPTION EQUILIBRIUM

H. CORTE and S. JONES, Wiggins Teape Research and Development Ltd., Beaconsfield, Bucks., England

BATCHES of 100 g unbeaten, bleached softwood sulphite fibres dispersed in 20 l distilled water were prepared and mixed with increasing amounts of a commercial filler grade of titanium dioxide. The addition level ranged from 0.5 to 3.0 g TiO₂/g fibres. Each mixture was stirred slowly for 1 h with a blade stirrer (40 rpm) to prevent sedimentation. After this time the adsorption equilibrium was established. Four samples, 100 ml each, of the supernatant liquid were drawn with a plastic tube covered with a fine wire mesh at the bottom. From the TiO₂ content of the samples the amounts of TiO₂ adsorbed on the fibres were calculated. These values, expressed as g TiO₂/g fibres, were plotted against the amounts of TiO₂ still suspended in the water, expressed as g TiO₂/g water. The result is shown in Fig. 1. It is an adsorption isotherm of the Langmuir type with a 'monolayer' concentration of 2.27 g TiO₂/g fibres.

Three points on the curve are marked, corresponding to addition levels of 0.5, 2.0 and 3.0 g/g. These equilibrium mixtures were used for further experiments of the following type. 0.5 g of a laboratory-made polyacrylamide (PAA) in the form of a 1 per cent aqueous solution were added. The supernatant liquid appeared almost instantly much clearer and two samples of it were taken as soon as practicable, typically after 20–30 s. The suspension then turned 'milkier' again and further samples were taken after 90 s, 10 min, 30 min, 1 h, 3 h, etc., the last after 21–28 h. Again the adsorbed concentrations were calculated from the TiO₂ content of the samples and the results obtained with one type of PAA are shown in Fig. 2. The adsorbed concentrations calculated from the first samples taken after the addition of PAA were 0.46,

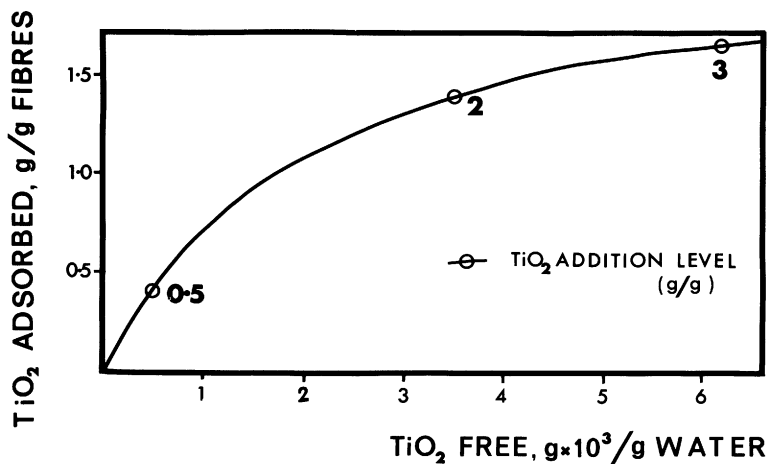
Under the chairmanship of A. A. Robertson

1.90 and 2.85 g/g for the three addition levels of 0.5, 2.0 and 3.0 g/g, respectively, but it appears that the curves start at adsorbed concentrations even closer to the addition levels. They then fall off, sharply at first and then more slowly, approaching new equilibrium levels below those obtained without PAA addition. These new values also lie on a Langmuir-type adsorption isotherm. The 'monolayer' concentration is lower than before and this might be interpreted as a reduced degree of agglomeration. The effect of adding PAA in this type of experiment is therefore that virtually all of the TiO_2 is driven on to the fibres in the first few seconds and then driven off again at a decreasing rate.

The PAA in this set of experiments had a high molecular weight and a low cationic modification. Fig. 3 shows the same results for a PAA sample with a much lower molecular weight and a high cationic modification. The overall picture is the same as before. Again, virtually all of the TiO_2 is driven on to the fibres and then driven off, much faster this time, but the final level is not as low as before. Indeed, some of the TiO_2 particles seem to reclaim their places on the fibres and the curves seem to approach the equilibrium levels without PAA addition.

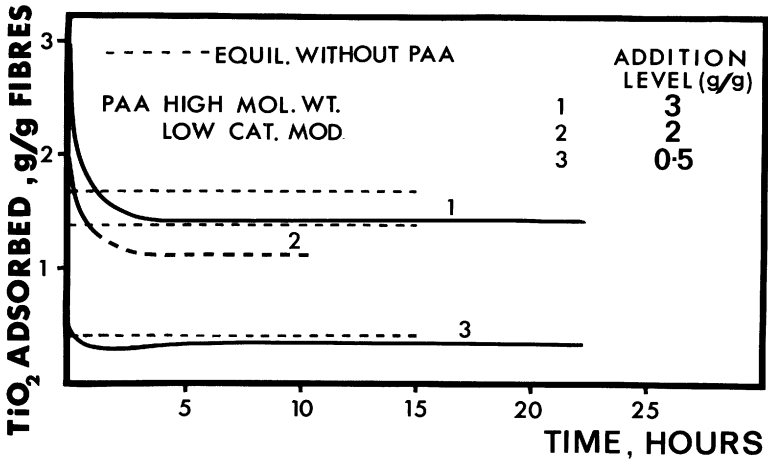
No explanation of this peculiar reaction mechanism is offered at this stage. Its exploration is the object of further experimentation.

We wish to thank Dr D. Horn and Dipl.-Ing. J. Melzer from BASF who kindly gave us the samples of polyacrylamide.



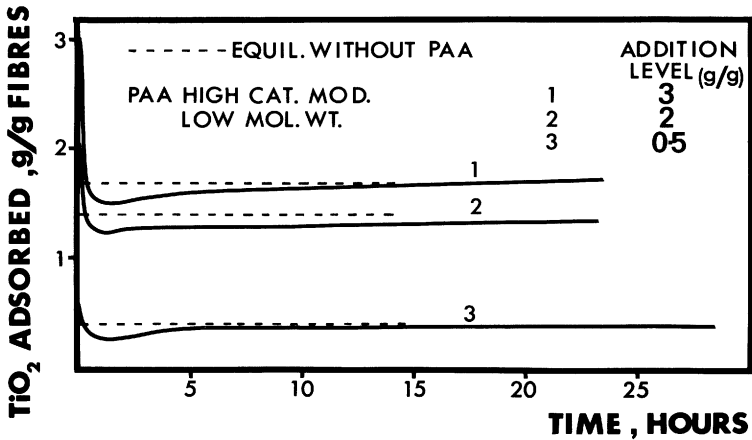
ADSORPTION OF TiO_2 ON PULP FIBRES

Fig. 1



ACTION OF PAA ON TiO₂ ADSORPTION

Fig. 2



ACTION OF PAA ON TiO₂ ADSORPTION

Fig. 3

Mr B. A. Nazir We have also been studying a very similar adsorption of TiO_2 on fibres. The difference in our system was that aluminium sulphate was used as a flocculant and the pH was varied between 3 and 10 by sulphuric acid or sodium hydroxide. An observation made is in good agreement with Dr Corte's finding.

In a system of 2 g/l pulp fibres and 0.15 g/l TiO_2 in 6.35×10^{-5} M aluminium sulphate, maximum adsorption of TiO_2 (nearly 90 per cent of the TiO_2 present in the system) was observed in the pH range of 3 to 7. This maximum adsorption remained unaltered in stirring conditions similar to the ones used by Corte. However when the pH was increased to 8 or beyond, 70 per cent of TiO_2 desorbed within 10 minutes. It suggests that the heteroflocculation of TiO_2 with fibres is easily reversed by a change in the surface characteristics of the components of the system. This should not happen if the flocculation occurs in the primary minimum. It seems therefore that either the heteroflocculation was due to a secondary minimum deeper than that predicted by the theory or that the TiO_2 particles were prevented from falling completely into the depth of the primary minimum due to the structured water at the interfaces.

Corte's results may thus be explained by considering a slower adsorption of PAA on the components of his system which will gradually alter the surface characteristics. However this might be an over-simplification considering a more likely bridging mechanism operative in his system.

Mr B. Radvan I would like to return to Dr Leask's paper with a comment and a query. The comment is about the possibility of the action of the alum being through neutralising the effect of sulphonic acid groups. There is in fact a patent on it by Durham City Council, Brit. Pat. 1 418 866, which claims just that effect when using cationic polymers and also I believe includes alum. Secondly, the 1957 symposium had a paper by Centola and Borruso which discussed the effect of cationic dyes, especially dyes which include sulphonic acid groups on the speed of beating which may be relevant. My query to Dr Leask is quite different. You used wet web stretch as a measure of effectiveness of this treatment. Would you like to comment why?

Mr R. A. Leask We did that because we had just finished a long study on runnability and we feel that wet web stretch and drainage are two very important criteria for high speed paper machine operation. This is why we are trying to get the wet web stretch up. We did indeed see an improvement in paper machine operation.