

THE EFFECT OF YELLOWING INHIBITOR TOTAL CHARGE ON THE RHEOLOGY OF PAPER COATING

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ABSTRACT:

New compounds, called inhibitors, provide anti-yellowing effect for mechanical pulps and papers, when added to the coating formulation. The rheology of coating mixtures, which contain clay, ground calcium carbonate, starch, latex, inhibitors and other minor additives, affects to a certain extent the final quality of the coated paper. The purpose of this work is to investigate the effect of the total weight charge of inhibitors, when present between coating color ingredients, on the thixotropy and visco-elasticity of the mixture and other rheological properties. We also study the degree of interaction between inhibitor and coating ingredients using Transmission Electron Microscope (TEM) and water retention measurements.

For the industrially preferred inhibitor system of low RS/UVA ratio and high total charge the coating formulation will have a significant increase in the general value of viscosity and a clear and profound shear-thinning behavior. Under the desired conditions of higher total charge the coating formulation acquires significant thixotropic behavior. A higher level of energy is required to coat such formulation. The elastic modulus increases with frequency. This rise in the elastic modulus reveals the increasing interaction between particles in the coating formulation. The total charge does not affect the resistance of a coating color to the applied stress. The coating color with low total charge has the strongest water holding capability decreasing with increasing total charge.

ZUSAMMENFASSUNG:

Kürzlich eingeführte Hemmstoffe zeichnen sich durch einen Anti-Vergilbungs-Effekt für Zellstoffe und Papiere aus, wenn sie dem Papierbeschichtungsmaterial hinzugefügt werden. Die Rheologie von Beschichtungsmischungen, die Ton, Grund-Kalzium-Karbonat, Stärke, Latex, Hemmstoffe und andere Nebenbestandteile enthalten, beeinflussen jedoch zu einem gewissen Grad die Qualität des fertigen beschichteten Papiers. Das Ziel der vorliegenden Arbeit besteht darin, den Einfluss des Hemmstoffanteils - sofern er in den Beschichtungsfarben vorhanden ist - auf die Thixotropie, die viskoelastischen und andere rheologische Eigenschaften der Mischung zu untersuchen. Wir studieren auch den Wechselwirkungsgrad zwischen Hemmstoff und Beschichtungsinhaltsstoffen durch den Einsatz eines Transmissionselektronenmikroskops (TEM) und anderer Verfahren.

Für das industriell bevorzugte Hemmstoffsystem mit niedrigem RS/UVA-Verhältnis und hoher Gesamtbeladung wird sich die Beschichtungsmasse durch einen signifikanten Anstieg der Viskosität, und ausgeprägtes scherverdünnendes Verhalten auszeichnen. Daher wird auch mehr Energie zum Herstellen dieser Substanz benötigt. Der elastische Modul steigt mit der Frequenz. Die Beschichtungsfarbe mit der niedrigsten Gesamtbeladung besitzt die stärkste Fähigkeit, Wasser zu speichern.

RÉSUMÉ:

De nouveaux composés appelés inhibiteurs apportent un effet anti jaunissant aux papiers et pâtes mécaniques, quand ils sont ajoutés à la formulation des peintures. La rhéologie des mixtures pour revêtements qui contiennent de l'argile, du carbonate de calcium primaire, de l'amidon, du latex, des inhibiteurs et d'autres additifs mineurs, affecte jusqu'à un certain point la qualité finale du papier peint. Le but de ce travail est l'investigation de l'effet du poids total de la charge en inhibiteurs, quand ils sont présents parmi les ingrédients colorant la peinture, sur la thixotropie et la viscoélasticité du mélange, de même que sur d'autres propriétés rhéologiques. Nous étudions aussi le degré d'interaction entre l'inhibiteur et les ingrédients de la peinture en utilisant la microscopie électronique en transmission (TEM) et des mesures de traitement d'eau.

Dans le cas d'un système inhibiteur possédant un bas ratio RS/UVA et une charge totale élevée, ce qui est du point de vue industriel privilégié, la formulation du revêtement présente une augmentation significative de la valeur générale de la viscosité ainsi qu'un clair et profond comportement rhéoamincissant. Avec les conditions désirées de grandes charges, la formulation acquiert un comportement thixotrope significatif. Un plus grand niveau d'énergie est requis pour appliquer de telles peintures. Le module élastique augmente avec la fréquence. Cette augmentation révèle l'augmentation de l'interaction entre les particules de la formulation du revêtement. La charge totale n'affecte pas la résistance de la peinture à l'application d'une contrainte. La peinture possédant une charge totale faible montre la plus forte rétention d'eau qui décroît avec l'accroissement en charge totale.

KEY WORDS: inhibitor, mechanical pulp, clay, rheology, microstructure

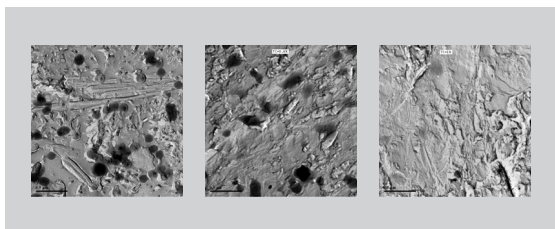
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289



color with 1%, indicating an increase in the interactions between particles. The frequency tests also reveal the coating formulations exhibit yield stresses.

Figure 9a displays the linear visco-elasticity of colors with all tested total charges at frequency 10 Hz. It is also noted that the total charge does not affect the resistance of a coating color to the applied stress. However at low frequency of 0.1 Hz (Fig. 9b) the resistance of coating colors is dependent on the amount of the total charge. The resistance of the coating colors increases with increasing the applied stress. While the linear visco-elasticity indicates that the coating color is deformed without destroying the bonds of the molecules, at low frequency, the nonlinear visco-elasticity reveals that the coating color deformation is accompanied by the destruction of bonds between particles due to the applied stress.

3.2 TEM MICROGRAPHS

Comparison of the TEM micrographs of the coating formulations containing 1, 0.6 and 0.2 % total charge are shown in Fig. 11. They indicate that the interaction between 0.2 % total charge of inhibitor and coating color is different from that for colors with 0.6 % and 1 % total charge. This is apparent from the microstructure. The micrograph (Fig. 11b, c) appears more densely packed in comparison to that for coating color with 0.2 % total charge. Coagulation occurs from the bridging between the inhibitor and coating formulation particles. According to this micrograph, it is clear that the concentration of inhibitor is predominant to the aggregation effect. Therefore, high magnification transmission electron microscopic (TEM) pictures were used as a qualitative indication of the extent of interparticle structuring and compare it to the rheological measurement.

3.3 WATER RETENTION - EFFECT OF INHIBITOR

Figure 10 shows measurements taken at various time and total charge of inhibitor. The same pressure was used for all experiments. Loss of water between application and metering will lead to a high solids level. The coating formulation including 1 % total charge has the highest water loss. This indicates that the packing of the coating color particles becomes more open at high levels of total charge addition. Because of the more

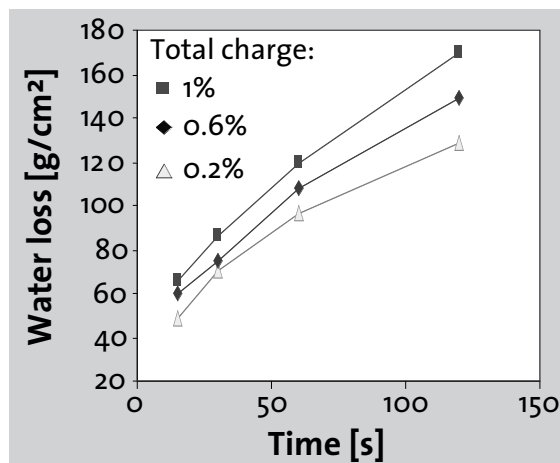


Figure 10 (right): Water loss of coating formulation with different total charge.

Figure 11 (left): Coating formulation including different total charge: a) 0.2%, b) 0.6%, c) 1%.

open structure, the water drains faster causing less water retention and increased viscosity. Addition of 0.6 % total charge of inhibitor to the coating formulation resulted in the particles becoming more densely packed than in the case of 0.2% total charge. The coating color with total charge (0.2 %) has the strongest water holding capability followed by that with 0.6 % and finally with 1 %.

4 CONCLUSIONS

We may conclude that for the industrially preferred inhibitor system of low RS/UVA ratio and high total charge, the coating formulation will have a significant increase in the general value of viscosity and a clear and profound shear-thinning behavior. We also conclude that under the desired conditions of higher total charge the coating formulation acquires significant thixotropic behavior. A higher level of energy is required to coat such formulation. The elastic modulus increases with frequency. This rise in the elastic modulus reveals the increasing interaction between particles in the coating formulation. It is also noted that the total charge does not affect the resistance of a coating color to the applied stress. The coating color with low total charge has the strongest water holding capability decreasing with increasing total charge.

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