List of Abbreviation

SDS	Sodium dodecyl sulfate
CA	Cetylalcohol
AIBN	2,2′-azobisisobutyronitrile
NaPS	Sodium persulfate
PFR	Plugflow reactors
CSTR	Continuousstirred tank reactor trains
MW	Molecular weight
MWD	Molecular weight distribution
BuA	Butyl acrylate
2-EHA	2-ethyl hexyl acrylate
HEMA	Hydroxyl ethyl methacrylate
MMA	Methyl methacrylate
EA	Ethyl acrylate
MA	Methyl acrylate
MB	4-maleimidobenzanilide
MAA	Methacrylicacid
BDA	Butanedioldiacrylate
AMA	Allylmethacrylate
EGDMA	Ethylene glycol dimethacrylate
NMA	N-methylolacrylamide
Vac	Vinyl acetate
BPO	Benzoyl peroxide
DMLL	N-lauroyl-Nα,Nα-dimethyl-lysine
LNB	N,N-dimethyl-n-laurylbetaine
NP40	Nonyl phenol ethoxylated 40 units of ethoxyation
CTAs	Chain transfer agent
EDTA	Ethylenediaminetetraacetic acid
UV	Ultra violet
TEM	Transmission Electron Microscopy
SEM	Scanning Electron Microscope
ASTM	American Standardization Testing Material
MFFT	Minimum film forming temperature
AA	Acrylic acid
RPM	Round per minute
Mn	Average molecular weight
cps	Centimeter poise
AA	Acrylic acid
PAC	Poly urethane acrylate co-polymer
AOT	Aerosol OT
SLS	Sodium Lauryl Sulphate

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Abstract

Ethyl acrylate is the backbone textile pigment printing binder due to its good adhesion, soft film formation, and good fastness properties. This study was designed to improve the physical and mechanical properties of ethyl acrylate polymer by co-polymerization with either butyl acrylate or 2-ethyl hexyl acrylate in presence of acrylic acid or methacrylic acid at different concentration ratios (ethyl acrylate/butyl acrylate or 2-ethyl hexyl acrylate) (100/0, 5, 10, 15, 20) respectively.The best textile pigment printing binder formulas wereprepared by different surfactant and initiation system.The prepared polymers were investigated by TEM, SEM as well as mechanical and physical tests. The prepared polymers used as textile pigment printing binder, and they were investigated by rubbing fastness, heat fastness and durability, the best results was achieved by 10% 2-ethyl hexyl acrylate/ethyl acrylate and 20% butyl acrylate/ethyl acrylate.

It was found that polymers prepared by free radical system had higher mechanical and physical properties than polymers prepared by redox system.

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Mostafa Mohamed Mahmoud Elsheikh

Aim of work

Ethyl acrylate emulsion polymer is widely used as a textile pigment printing binder because of its good adhesion, soft film formation and good fastness properties. This thesis aimed to study the improving of the mechanical and physical properties of ethyl acrylate polymer by co-polymerization of ethyl acrylate with either butyl acrylate or 2-ethyl hexyl acrylate, and applying each co-polymer as a textile pigment printing binder.

The emulsion co-polymers were prepared at different concentration ratios (ethyl acrylate/2-ethyl hexyl acrylate or butyl acrylate) (100/0, 5, 10, 15, and 20) respectively in the presence of (acrylic acid or methacrylic acid).

The prepared co-polymers will be characterized using (solid content, molecular weight, coagulum, viscosity, drying time, MFFT, TEM and SEM). The mechanical properties of the prepared co-polymer samples would be also examined.

The prepared co-polymers applied as binder in textile pigment printing pastes and were examined using heat and mechanical fastness testing, such as rubbing fastness, sublimation and durability.

The effect of changing surfactant (sodium lauryl sulfate) and initiator (free radical) systems were also studied on the best formulas in the presence of acrylic acid or methacrylic acid.

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Discussion

This work aimed to improve the physical and mechanical properties of ethyl acrylate polymer, which used as textile pigment printing binder by co-polymerization of ethyl acrylate with either butyl acrylate or 2-ethyl hexyl acrylate. The prepared co-polymers were applied as textile pigment printing binder.

This work was divided into five groups; each group was investigated to study the effect of changing monomers concentrations on the polymer performance.

Group (I)

Group (I) results showed that there was no significant change in solid content and coagulum of the prepared butyl acrylate/ethyl acrylate co-polymers in presence of acrylic acid in all concentrations.

It was found that the prepared co-polymers improved the mechanical and physical properties of the ethyl acrylate polymer by:

* Increasing the viscosity of the polymer.
* Increasing the drying time.
* Improving in mechanical properties such as tensile strength, elongation and young's modulus.

Furthermore group (I) results showed that the ethyl acrylate/ butyl acrylate co-polymers in presence of acrylic acid improved the mechanical and physical properties of textile pigment printing binder by:

* Minimizing stiffening in the handle of the textile.
* Increasing the viscosity of the pigment printing paste so the consumption of thickeners would be decreased.

The heat and mechanical fastness properties investigations as shown in Table (3.2) showed no significant difference between the homo ethyl acrylate polymer and the ethyl acrylate/butyl acrylate co-polymers, as well as the color yield of co-polymers are visually higher especially at 20% concentration.

So that we can conclude that the fastness properties of co-polymer are better than ethyl acrylate homo polymer.

Group (II)

It was clear that there wasn't any significant difference in solid content and coagulum of the prepared 2-ethyl hexyl acrylate/ethyl acrylate co-polymers in presence of acrylic acid; however they showed progressing in the mechanical and physical properties of the ethyl acrylate polymer by:

* Increasing the viscosity of the polymer.
* Increasing the drying time.
* Improving in mechanical properties such as tensile strength, strain.

2-ethyl hexyl acrylate/ethyl acrylate co-polymers in presence of acrylic acid improved the mechanical and physical properties of textile pigment printing binder by:

* Decreasing stiffening in the handle of the textile.
* Increasing the viscosities of the pigment printing pastes so the consumption of thickeners would be decreased.

The heat and mechanical fastness properties testing did not show any significant different between the homo ethyl acrylate polymer and the EHA/EA/AA co-polymer, in other hand visually the color yields of samples prepared by co-polymers were higher especially at 10% concentration.

So that we can conclude that the fastness properties of co-polymer is better than EA homo polymer.

Group (III)

Table (3.6) showed that there was no significant difference in solid content and coagulum of the prepared Butyl acrylate/ethyl acrylate co-polymers in presence of methacrylic acid, they also promote the mechanical and physical properties of the ethyl acrylate polymer by:

* Increasing the viscosity of the polymer.
* Increasing the drying time.
* Improving in mechanical properties such as tensile strength, elongation.

It was obvious that the butyl acrylate/ethyl acrylate co-polymers in presence of methacrylic acid improved the mechanical and physical properties of textile pigment printing binder by:

* Minimizing stiffening in the handle of the textile.
* Increasing the viscosity of the pigment printing paste so the consumption of thickeners would be decreased.

The heat and mechanical fastness properties investigations in Table (3.6) did not show any significant difference between the homo ethyl acrylate polymer and the co-polymers, visually it was observed that the color yield of group (III) co-polymers is higher than the homo polymer especially at **20% BA** concentration.

So that we can conclude that the fastness properties of co-polymers are better than ethyl acrylate homo polymer.

Group (IV)

Group (IV) showed that there was no change in solid content and coagulum of the 2-ethyl hexyl acrylate/ethyl acrylate co-polymers in presence of methacrylic acid, as well as they improved the mechanical and physical properties of the ethyl acrylate polymer by:

* Increasing the viscosity of the polymer.
* Increasing the drying time.
* Improving in mechanical properties such as tensile strength, elongation.

Table (3.8) showed that the butyl acrylate/ethyl acrylate co-polymers in presence of methacrylic acid improve the mechanical and physical properties of textile pigment printing binder by:

* Minimizing stiffening in the handle of the textile.
* Increasing the viscosity of the pigment printing paste so the consumption of thickeners would be decreased..

Table (3.8) showed that the heat and mechanical fastness tests did not show any difference between the homo ethyl acrylate polymer and the EHA/EA/AA co-polymer, in addition the color yield of EHA/EA/AA co-polymer is higher than the homo polymer especially at **10% EHA** concentration,.

So that we can conclude that the fastness properties of the co-polymers are better than EA homo polymer.

Group (V)

The best formula concentrations of the textile pigment printing binder (20% butyl acrylate/ethyl acrylate co-polymer & 10% 2-ethyl hexyl acrylate/ethyl acrylate copolymer) were studied by changing the surfactant and initiation systems using SLS/cetyl alcohol as surfactant and ammonium persulphate as free radical initiator.

(a) Characterizations of prepared polymers with changing surfactant and initiation systems

* As shown from Table (3.10), the physical properties such as viscosity& drying time of polymers prepared by free radical system are higher than the polymers prepared by redox system in presence of acrylic acid, beside both solid content and coagulum of all the prepared samples didn't show any significant difference.
* The mechanical properties of polymers prepared by free radical system are higher than the polymers prepared by redox system.
* The molecular weights of the polymers prepared by free radical system were higher than polymers prepared by redox system, as well as the polymer molecules prepared by free radical system had poly dispersibility of the molecular weight (Mn) lesser than polymer molecules prepared by redox system.
* TEM graphs of butyl acrylate/ethyl acrylate nano-particles as shown in Fig (3.1-a, b) and 2-ethyl hexyl acrylate nano-particles as shown in Fig (3.2-a, b) confirm that the average particle size of the nano-particle were 30:75 nm and 10:20 nm respectively. The dispersion of both co-polymers nano-particles were well spherical-like in shape.
* MFFT test showed that the addition of the hydrophobic monomer increase the MFFT.

(b) Characterizations of the prepared textile pigment printing binder with changing surfactant and initiation systems

* The viscosities of the textile pigment printing pastes prepared by free radical system were slightly higher than the pigment printing pastes prepared by the polymers with redox system, this means that the increasing in M.wt. of the polymer increases the viscosity of the polymer itself and so increases the viscosity of the textile pigment

printing paste.

* Neither the sublimation test nor rubbing fastness properties showed any significant difference between the textile pigment printing binders prepared by the polymers of different systems.
* There is no significant difference in the color yield even at 20% butyl acrylate/ethyl acrylate co-polymer & 10% 2-ethyl hexyl acrylate/ethyl acrylate copolymer.

Conclusion

So from the above data, it is clear that co-polymerization of ethyl acrylate with either butyl acrylate or 2-ethyl hexyl acrylate improved the physical and mechanical properties of the polymer.

In other hand when applying the co-polymer of 20% butyl acrylate/ethyl acrylate and 10% 2-ethyl hexyl acrylate/ethyl acrylate as textile pigment printing binder, They showed obvious improving in color yield, minimal stiffening in handle of the textile, heat and mechanical fastness.

INTRODUCTION