coating materials which have very good gloss, hiding, processing and colour properties.

A problem addressed at the same time by the present invention was to prepare said binder by means of a continuous preparation process. What is meant by this continuous preparation process is a process which can be carried out continuously, without interruption, consisting individually of the process steps of monomer metering, polymerization, degassing, and pelletizing.

Solution

The problems have been solved through provision of an innovative bulk polymer. This polymer is prepared by the modified use of a continuous bulk polymerization process which can be used to polymerize functional (meth)acrylates solventlessly and with high conversion. The advantage of a bulk polymerization process over suspension polymerization is the high purity of the products, which can be prepared without addition of auxiliaries such as emulsifiers, stabilizers, defoamers or other suspension auxiliaries.

In order to be able to produce a pigment preparation in accordance with the current and future requirements of the coatings industry in respect of VOC content (fraction of volatile organic constituents) using the binder of the disclosure~~invention~~, the binder must have an extremely low fraction of volatile components. This has been achieved, in accordance with the disclosure~~invention~~, by providing the binder in solvent-free and water-free form by means of a continuous bulk polymerization. By combination with a thermal after treatment, moreover, a feature of the present disclosure~~invention~~ is

also that the residual monomer content is very low and the thermal stability of the binders is improved.

It has been found, surprisingly, that the process of the disclosure~~invention~~ can also be used to prepare (meth)acrylate-based binders which contain both acid groups and hydroxyl groups. For producing such critical binders, the skilled person would prefer to use polymerization methods where these two species of monomer were either highly diluted (solution polymerization) or separated on the basis of different polarities (suspension polymerization).

Furthermore, surprisingly, compositions have been found which not only are soluble or dispersible under aqueous-alkaline conditions but are also very suitable for producing pigment preparations. In addition, coating materials comprising these pigment preparations exhibit very good gloss, hiding, processing and colour properties. Moreover, the pigment preparations can be produced and processed, using the binders of the disclosure~~invention~~, more easily than in the prior art. More particularly, this technical problem has been solved by successful provision of binders whose acid fraction is low by comparison with the prior art, without an accompanying adverse effect on the solubility or dispersibility under aqueous-alkaline conditions.

A particular feature of the present disclosure~~invention~~ is the provision of a combination of structural units which fulfils precisely these requirements on the binder. To this end, only combinations of the following structural units are suitable:

Lastly, the mixtures for polymerization include acrylic acid and/or methacrylic acid.

A further particular feature of the present disclosure~~invention~~ is the provision of the proportions between the individual structural units that are suitable for solving the technical problems. In this context it has been found, particularly surprisingly, that the polymers of the disclosure~~invention~~ can be prepared for producing pigment preparations which are soluble or dispersible under aqueous-alkaline conditions and whose acid fraction is low by comparison with the prior art.

In a first aspect, there is provided pellets for use as binder for producing pigment preparations, characterized in that the binder is soluble in aqueous-alkaline solutions, in that the binder has been prepared exclusively from the following monomers:

- 40% to 70 % by weight of one or more methacrylates characterized in that the alkyl radical is composed of 1 to 8 carbon atoms and/or styrene and/or α-methylstyrene,
- 20% to 40% by weight of one or more acrylates characterized in that the alkyl radical is composed of 1 to 8 carbon atoms,
- 1% to 15% by weight of one or more (meth)acrylates characterized in that the alkyl radical contains a hydroxyl function, and
- 1% to 17% by weight of acrylic acid and/or methacrylic acid,

and in that the binder has been prepared via a continuous bulk polymerization.

The binder of the disclosure~~invention~~ for producing pigment preparations is notable in particular for the fact that it is soluble or dispersible in aqueous-alkaline solutions and has good dispersing properties for a host of different kinds of pigments. This property is achieved more particularly by the binder being prepared exclusively from the following monomers:

- 40% to 70%, preferably 45% to 65%, by weight of one or more methacrylates which contain an alkyl radical of 1 to 8 carbon atoms, and/or styrene and/or α-methylstyrene.
  Preferably this monomer is methyl methacrylate, styrene or a mixture of methyl methacrylate and styrene.
- 20% to 40%, preferably 25% to 35%, by weight of one or more acrylates which contain an alkyl radical of 1 to 8 carbon atoms. Preferably this acrylate is ethyl acrylate.
- 1% to 15%, preferably 4% to 10%, by weight of one or more (meth)acrylates which contain a hydroxyl

- 0% to 10% by weight of one or more methacrylates which contain an alkyl radical of 1 to 8 carbon atoms. Preferably this methacrylate is methyl methacrylate.
- 20% to 40% by weight of one or more acrylates which contain an alkyl radical of 1 to 8 carbon atoms. Preferably this acrylate is ethyl acrylate.
- 40% to 60% by weight of styrene.
- 1% to 15%, preferably 4% to 10%, by weight of one or more (meth)acrylates which contain a hydroxyl function on the alkyl radical. Preferably this monomer is hydroxypropyl (meth)acrylate or hydroxyethyl (meth)acrylate.
- 1% to 17%, preferably 7% to 15%, by weight of acrylic acid and/or methacrylic acid. Preferably this monomer is acrylic acid.

Independently of the composition, the binders have a mass-average molecular weight M_w of at least 5T, preferably at least 10T and at most of 80T, preferably of 50T. The molecular weight is measured in a method based on DIN 55672-1, "Gel permeation chromatography, part 1: tetrahydrofuran (THF) as eluent" by means of gel permeation chromatography (GPC) against a PMMA standard.

In a second aspect, there is provided a process for preparing pellets as defined above, characterized in that the polymerization is carried out continuously in a kneading apparatus, in that the monomer mixture is free from solvents, and in that the polymer is pelletized directly subsequent to the polymerization.

The binders of the disclosure~~invention~~ are prepared by means of a process which is innovative for the preparation of such systems. A feature of this process is that the monomer mixtures listed are innovative in respect of a continuous bulk polymerization in a kneading device. Furthermore, the polymerization process is carried out free from solvents

and auxiliaries. In addition, the polymer is pelletized directly subsequent to the polymerization.

One advantage of bulk polymerization over suspension polymerization is the use of any desired amounts of hydrophilic comonomers such as (meth)acrylic acids, amino-functional or hydroxy-functional (meth)acrylates. The advantage over solution polymerization is the absence of or only very small fraction of volatile constituents in the polymerization procedure and in the primary product. The advantage of the process of the disclosure~~invention~~ over a bulk polymerization in batch mode is the significantly higher conversion which can be achieved, and hence the lower fraction of residual monomers in the end product. Further factors are a higher production rate and a broader possibility for variation of the operational parameters.

A particular advantage of the process of the disclosure~~invention~~ for preparing binders for coating materials or paints is the form in which the product is obtained at the end of the production operation, without further processing. Through the combination of a continuously operated kneading device for the polymerization, a degassing stage such as, for example, a flash degasser or a degassing kneading device for the removal of volatile constituents and for the thermal aftertreatment of the polymer, and a pelletizer, products are obtained which firstly are free from solvents and secondly are composed exclusively of constituents which originate from the employed monomers, chain-transfer reagents and initiators and which have an adjustable pellet size.

The binder prepared in accordance with the disclosure~~invention~~ further comprises no coarse constituents, i.e. particles

aliphatic chlorine compounds; enol ethers or dimeric α-methylstyrene.
If branched polymers are to be prepared, the monomer phase may also contain up to about one per cent by weight of polyfunctional monomers, examples being ethylene glycol di(meth)acrylate, butane diol di(meth)acrylate or divinylbenzene.

In a third aspect, there is provided the use of pellets prepared as defined above, characterized in that a pigment preparation is produced by extrusion from the pellets, pigments and optional additives.

In a fourth aspect, there is provided the use of the solution or dispersion as defined above as an aqueous coating material.

The bulk polymer of the disclosure~~invention~~, preferably in the form of pellets, is compounded preferably with pigments, and optionally further additives, to give a pigment preparation. Compounding is preferably accomplished by means of extrusion. The product produced accordingly is in the form of pellets which comprise a high fraction of pigments and which can be incorporated into a coating composition with binders and further coating constituents. For this purpose, the pellets, together with these other constituents, are dissolved in an alkaline-aqueous medium. This solution can be used as an aqueous coating material. The pellets may contain between 20% and 80% by weight of pigments. These pigments, without imposing any restriction, may be, for example, carbon black, organic pigments or mineral pigments.

Although these pigment preparations have been developed primarily for use in aqueous coating formulations, the pellets can also be used in solvent-based coating systems, high-solids systems or 100% systems.

The field of application for the coating formulations prepared in this way is broad. They are preferably used in coatings on surfaces, for example, of metal, plastic, ceramic or wood. Examples are, in particular, the use of

the pigment preparations in architectural paints, marine paints or container paints, and more particularly in automotive finishes.

The examples given below are given for better illustration of the present disclosure~~invention~~, but have no capacity to confine the disclosure~~invention~~ to the features disclosed therein.

Examples

Particle sizes

The particle sizes and the particle-size distributions, reported below in the form of the d_{50} value, were determined using a Coulter LS 13 320 in accordance with ISO 13320-1 in a measurement range between 0.04 µm and 2000 µm. The average particle size d_{50} identifies the median of the particle diameter, based on the particle volume; in other words, 50% of the total particle volume is smaller, and 50% larger, than the average particle size. Particle sizes larger than 2000 µm were determined additionally using a Camsizer from Retsch Technology in accordance with ISO/FDISm13322-2.2:2006(E).

Measurement of glass transition temperatures

The glass transition temperatures T_g are measured by means of dynamic scanning calorimetry (DSC) in accordance with ISO 11357-2.

Measurement of dissolution times