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[54] **POLYACRYLAMIDE CONTAINING OPHTHALMIC SOLUTIONS**

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[56] **References Cited**

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[57] **ABSTRACT**

An ophthalmic solution is provided for treatment of "dry eye," providing lubricating and cushioning effects for traumatized eyes, including trauma caused by the wearing of hard of gel-type contact lenses, and as a carrier for ophthalmic medicaments. The solution is an aqueous solution of polyacrylamide optionally and preferably including polyethylene glycol, and other optional ingredients.

18 Claims, No Drawings

POLYACRYLAMIDE CONTAINING OPHTHALMIC SOLUTIONS

The present invention relates to a multi-functional ophthalmic solution designed for and adapted to general use in the eyes of humans and domestic animals. The present invention further relates to the provision of a synthetic mucous layer which serves as a wetting agent in the eye, i.e. an artificial tear material useful for the treatment of both "dry eye" or as a cleaning, lubricating and cushioning agent for the eye after an injury or therapeutic surgery. The invention also relates to the utilization of the ophthalmic solution as a carrier for ophthalmic medicaments. Still further, the invention relates to an ophthalmic solution useful as a cleaning, lubricating and cushioning agent for both hard and gel-type contact lenses. The invention also relates to the attainment of all the foregoing functions without optical interference and with a solution which may be readily buffered to any convenient pH. The invention further relates to an ophthalmic solution having bactericidal activity.

Heretofore, ophthalmic solutions have generally conformed to the general specifications required for all such intended utilizations in the treatment of the eye. Such solutions have generally been isotonic, buffered to the required pH, sterile and have contained additives for improved viscosity and longer retention in the eye. However, with many of such solutions, the problems of dosage, irritation to the eye, stability and occular response persist.

Many attempts have been made to resolve these problems by modifying existing formulas, using different forms of eye-treating substances, or using bases immiscible with aqueous solutions. Such attempts have added little to the performance qualities of the products.

It is accordingly an object of the present invention to provide a multipurpose opthalmic solution, suitable for general utilization in the eye of both humans and domestic animals.

A further object of the present invention is the provision of such solutions which can be readily modified for particular purposes and utilizations, including the introduction into the eye and the retention therein, of opthalmic medicaments, the provision of a wetting agent which serves as an artificial tear for the treatment of "dry eye," or a cushioning or lubricating agent for an injured or surgically treated eye, as a cleaning, lubricating and cushioning agent for utilization in conjunction with both hard and gel-type contact lenses and the like.

These and still other objects, as will become apparent from the following disclosure, are attained by the composition of the present invention which, in its broadest terms, comprises a polyacrylamide polymer having a molecular weight of from about 75,000 to about 10,000,000, water, and optionally, a polyalkylene glycol, preferably polyethylene glycol or polypropylene glycol, and having a molecular weight of about from 400 to 6,000.

Polyacrylamide are known to exhibit excellent lubricating characteristics in aqueous solution and are freely soluble in water without degradation. Wide ranges of molecular weights are available. In the present invention, these can be from 75,000 up to several million, e.g. 10,000,000 or even greater. The medium molecular weight materials are preferred in the present invention and a range of 250,000 to 6,000,000 has been found particularly useful. Most preferred is a polyacrylamide having a molecular weight of about 5,000,000. Such resins have extraordinary thickening action in water, even in the presence of salts. The thickening power increases sharply with both concentration and molecular weight. Thus, to attain the desired viscosity, substantially less polyacrylamide polymer is required for a relatively higher weight that would be the case when a lower molecular weight polymer is utilized. In addition, the higher molecular weights result in a higher strength lubricating film in solutions due to orientation of polymer will vary in the present invention with the molecular weight to provide a viscosity of from 0 to about 30,000 cps at 20°C. as measured by Brookfield Viscosimeter, where viscosities of from 0 to about 200 cps are measured using the ultra-low viscosity adapter rotated at a speed of 0.6 rpm, and viscosities greater than about 200 cps are measured with a number 6 spindle rotated at 10 rpm. Such viscosities will ordinarily be obtained when the concentration is within the range of about 0.05 to 20.0 weight percent, often preferably about 0.1 to 5.0 weight percent, depending upon the molecular weight of the polymer employed. With lower viscosities (whether due to lower molecular weight polymers or lower concentration, or both) inferior lubrication results. Higher viscosities result in difficult handling properties and characteristics, including insufficient flowability for fully effective utilization in the eye.

As used in the present disclosure, the term polyacrylamide is used to refer to homopolymers obtained by the addition polymerization of acrylamide, and is limited to such materials having a molecular weight of at least about 25,000, preferably at least about 100,000, ranging up to as much as 10,000,000 or more. The polymers of interest are generally linear, N-unsubstituted materials, and are per se well known to those of ordinary skill in the art, and are widely available commercially. Such polymers are formed by numerous addition polymerization techniques, usually by those involving the employment of free radical catalyst systems.

The polymers are water soluble, meaning that the polyacrylamides form true solutions in pure water, free of gel particles, and are infinitely dilutable with water.

Aqueous solutions of the polyacrylamide resins have a low level of oral toxicity and an extreme level of compatability in contact with the skin or in the eye. They are also characterized by a high level of pituitousness and an extraordinarily high degree of pseudo-plasticity. The solutions are highly stable through a wide range of temperatures and can tolerate extremely wide variations in pH.

Because of the strong hydrogen bonding affinity of the amide group in the polyacrylamide chain, the resin solutions will form association complexes with a wide variety of materials. Such association complexes per se often exhibit properties markedly different from either component alone, but it has been found that the resin will give up associated materials when introduced into the eye. The dissociation in vivo may result from a salting out effect produced by the materials with which the solutions are contacted, e.g., various salts occuring in tears and the like.

Because of the high levels of pseudo-plasticity and pituitousness of polyacrylamide aqueous solutions, it is highly desirable to include in the solution a material which will render a plasticizing effect. In addition, it is also desirable to include a humectant which will en-

hance fluid retention over the course of long term usage in the eye. These functions are provided by the inclusions in the solution of a polyalkylene glycol. The preferred polyalkylene glycol is polyethylene glycol, such as the Carbowaxes, as supplied by Carbide and Carbon Chemicals Company. Such materials have molecular weights ranging from about 400 up to as much as about 6000. Particularly preferred in the compositions of the preferred invention is polyethylene glycol having molecular weight of about 400, although this preference is primarily because of the ready availability and convenience of processing of the particular material. Polyglycols containing other alkylene groups can be utilized, such as polypropylene glycol and the like, but such materials are often not as readily available, and for this reason alone are not particularly preferred in the present invention. The polyalkylene glycol can be present in amounts ranging up to 5000, preferably 500 to 5000, weight percent based on the weight of the polyacrylamide polymer. Less than about 100% by weight can occasionally result in insufficient water retention and plasticizing effect, with concomittent drying of the eye and irritation of occular tissue, while amounts greater than about 5,000 weight percent can exhibit a "salting out" effect, with the formation of waxy solid globules or particles which be irritating to occular tissue.

The basic opthalmic solution of the present invention, i.e., the aqueous solution of polyacrylamide and polyalkylene glycol, is useful per se in a number of contexts. Primary among these is the provision of a synthetic mucous layer, which serves to clean and lubricate the eye, serving as a wetting agent and artificial tear for the treatment of "dry eye" or to provide a cushioning effects attained when the solution of the present invention is used in conjunction with contact lenses, of both the hard resin and gel-type contact lenses, and accordingly, the use of the solution will be discussed with particular reference thereto.

The advent of the gel contact lens has generated entirely new requirements for contact lens treating solutions and entirely new problems in hygenic handling and care for the lenses. In contrast to the more common hard type lens, usually made of polymethylmethacrylate, the gel lens will absorb relatively large proportions of water to form a soft, pliable material which has a tendency to fray. The gel is a three-dimensional lattice formed by the polymerization of glycol esters and diesters of acrylic acids. The glycol moieties of the molecules imparts a strong hydrophilic character to the lattice, with the consequent ability to absorb rather large amounts of water. by utilizing the unique properties of these lenses, new therapeutic options are presented for the treatment of occular debilities. Since the lens per se represents only the environment of use of the composition, a more complete discussion of its physical parameters need not be repeated here. A discussion of the gel contact lens, including both the preparation and use thereof occurs in Augenoptika, Heft 6, 1965, pages 5 and 6, Vienna, Austria, which reports a paper delivered by Maximillian Dreyfus at the 15th WVA annual meeting.

One characteristic peculiar to the gel lens is the requirement that treating solutions contain no component that can become entrained in the lattice of the gel, since such materials tend to accumulate and become irritating to the occular tissue. The lens does, however, require a cleaning and lubricating solution to cushion the occular tissue from direct contact with the lens. The requirement for a cleaning action is shared by the gel-type lens with hard lenses and with synthetic tears and other such opthalmic solutions. The exposure of the eye to various atmospheric pollutants, such as smoke, dust, pollen, noxious and irritating gases and the like can create severe discomfort and irritation, particularly in situations where the pollutants collect in the natural or artificial tear film to persist for substantial periods of time to exert their initiating effects. In addition to avoidance of materials which can accumulate in the gel, the materials must be compatible with the gel and with occular tissue and not interfere with the physio-chemical balance of the precorneal films. The attainment of these objectives is illustrated by the following example:

EXAMPLE I

A polyacrylamide polymer having a molecular weight of about 250,000 (American Cyanamid Company Cyanamer **P26**) and polyethylene glycol having a molecular weight of about 4,000 (Carbowax 4000) are dissolved in distilled water in the following proportions:

Polyethylene glycol	Polyacrylamide	Distilled water	Sodium chloride
9.00 gms	0.30 gms	300.00 ml	2.55 gms.

The solution is utilized to clean and hydrate gel-type contact lenses by immersing each lens in sufficient of the solution to completely cover the lens. Full hydration is effected in about 60 minutes. At the end of the immersion, the lens is lightly rubbed between the fingers and rinsed with water. Each lens is examined and was found to be fully hydrated and optically clear. The lenses are then implaced in human eyes in conventional fashion and are left in place for periods of 12 to 17 hours without noticeable irritation. In dry environments or drafts, some subjects flush the lenses while in place with small increments of the solution (which is found to effectively clean and rehydrate the lenses), whereby the tolerance period of the subject is enhanced and any drying problem alleviated.

By comparison, conventional lens wetting solutions of types commercially available are found to provide inferior cleaning and the ingredients occlude in the lens and cause irritation of the occular tissues.

In addition to the foregoing tests, both the solution of the present invention and the commercially available lens solution of U.S. Pat. No. 3,171,752 were tested for retention in the eye in the following fashion:

A minor amount of fluorescein dye was incorporated into each solution. One solution was placed in one eye, the other solution in the other eye, of a number of rabbits. Examination of the eyes using an ultra-violet light source gave a quantitative base measure of the amount of solution present. Periodic repetitions of the examination revealed that this solution was gradually lost in either case, but that the commercial solution was retained much less effectively. The eyes treated with the solution of this example retained at one and one-half hours the same amount of solution as did the eyes treated with the commercial solution at twenty-five minutes. Details of the fluorophotometric determination can be found in Waltman et al. Investigative Ophthalmology, Vol. 9, No. 4, pp. 247–249, April, 1970.

In no case, including both the utilization of the gel-type contact lens in the human eye or the solution alone in the eyes of test rabbits, was any evidence of irritation of the eye found to result from the solution of the present example.

In addition to the per se usefulness of the ophthalmic solution of the present invention as illustrated in the foregoing Example I, the ophthalmic solution of the present invention finds an additional area of broad utility as a carrier for ophthalmic treating materials such as medicaments (particularly those requiring an acid pH). The high effectiveness of the ophthalmic solution of the present invention is believed due to the strong ionic bonding affinity of the amide group of the chain. When combined with the ophthalmic solution of the present invention, ophthalmic medicaments are found to exhibit a much greater retention on orbital tissue and results in a longer duration of medicament activity. In addition, the degree of retention attained permits the use of smaller amounts of the eye treating substances than has been found heretofore possible while maintaining the necessary levels of effectiveness. Examples of medicaments with which the carrier can be used are:

Pilocarpine, HCl
Hydrocortisone USP (alcohol)
Hydrocortisone Acetate
Prednisolene Acetate and other cortisones
Neomycin Sulfate
Bacitracin
Penicillin
Sulfamerazine
Sodium sulfacetamide
Sulfadiazine
Sulfasoxozone and other sulfa derivatives
Scopolamine hydrobromide
Epinephrine bitrartrate
Phenylephrine HCl or other derivatives
Prostigmin bromide
Pilocarpine (any of the salts)
Idoxuridine
Antipyrine
Naphthazoline HCl
Antazoline phosphate

The foregoing list is intended to merely exemplary. As the list illustrates, the opthalmic solution of the present invention can be utilized as a carrier for substances such as antibiotics, mydriates, miotics, antihistamines, and the like. The amount of eye treating substances used with the composition of the present invention depends upon the nature of this substance or substances employed and the response of the individual receiving treatment. Typically, up to 500% or even more, based on the weight of the polyacrylamide, of the eye treatment medicament can be used.

When the eye treating substance or substances are those requiring an acid pH, one or more acids can be present in amounts sufficient to maintain the solutions at a pH of less than 7 and as low as about 3. An example of an acid which can be used with eye treating substances such as medicaments requiring an acid pH is boric acid. However, many eye treating substances must be maintained in a basic or neutral medium. In these instances, one or more pH buffers such as sodium borate is added to maintain a solution of a neutral or slightly basic pH. Typically, the buffering substances present in an amount sufficient to maintain the pH at the desired level are from between about 7.4 and about 8.2, and preferably at about 7.6. Other buffering compositions can be used as well, including a combination of phosphates such as, for example, monosodium phosphates and disodium phosphate to provide both acid and base control. Other photphates, acetates and carbonates can be substituted for the phosphates mentioned above — provided they are compatible with the eye. Specifically, the amount of buffering additions can range from about 0 to 4%, preferably about 0.2% for the dibasic component, and from about 0 to about 0.5% for the mono-basic component, wherein the percentages are by weight based upon the total weight of the overall composition, with the ratio of components balanced to provide proper pH for the overall composition.

The utilization of the opthalmic solution of the present invention as the carrier for the opthalmic medicaments is illustrated by the following example:

EXAMPLE II

The following composition is illustrative of the utilization of the composition of the present invention as a carrier for medicaments: a polyacrylamide polymer having a molecular weight of about 5—6,000,000 (American Cyanimid Company Cyanamer cyanamer P250), and a polyethylene glycol having a molecular weight of about 4,000 (Carbowax 4000) are dissolved in distilled water in the following proportions:

Polyethylene glycol	9.00 gm
Polyacrylamide	0.30 gms
Distilled water	300.00 ml

To the base solution, there are then added 6.00 gm of pilocarpine HCl and 3.00 gm of boric acid. Both the salt and the acid dissolve readily in this solution.

The foregoing formulation is utilized in the treatment of glaucoma patients who had previously required four standard pilocarpine treatments per day. It is found that three treatments with the formulation of the present invention provides the same therapeutic effects as the four standard treatments. Studies on normal eye of both animals and humans, after the fashion indicated in Example I, showed no adverse effects after prolonged application periods, and a much longer period of retention in the eye for each application.

Whatever the contemplated utilization of the opthalmic solution of the present invention, it can be desirable to include in the solution one or more of a variety of secondary additives as hereinafter described in fuller detail. For example:

Highly compatible cellulose derivatives of a variety soluble in water, such as for example, methyl cellulose, hydroxyethyl cellulose, hydroxypropyl cellulose, carboxylmethyl cellulose, hydroxypropyl methyl cellulose and the like, can be included in the solution to act as a mechanical buffer or as a viscosity control agent. These can also be used to maintain the viscosity of the overall composition within the desired range as hereinbefore described. Specifically, the cellulose derivatives when employed employed should be present in an amount sufficient to maintain viscosity of the overall composition at the desired level.

The composition of the invention can also contain one or more eye compatible biocides, such as thimerosal (sodium ethylmercurithiosalicylate), and the di-, tri-, or tetrasodium ethylenediamine tetraacetates. The percentages of such biocides can vary over a broad range, but typically do not exceed about 1% by weight

of the overall composition.

In addition, the composition of the present invention can also contain one or more eye compatible non-ionic surfactants in amounts varying over a wide range (but typically in amounts up to about 0.5% by weight) in order to provide product stability. An example of the surfactants which can be utilized are Tergitol 1559 (Carbide and Carbon Chemicals Co.) Pluronic F68 (Wyandotte Chemical Corp., Michigan Alkali Division); Tweens of H.L.B. value of 11 or higher (Atlas Powder Company).

Still another subsidiary component which can be added to the opthalmic solutions of the present invention includes polyvinyl pyrrolidone (such as Plasdone C, supplied by Entira Chemicals, division of GAF Corp.) which performs a number of desirable functions. Polyvinyl pyrrolidone (PVP) acts as a detoxicant, binding anti-toxins present in eye fluids and rendering them harmless. PVP also acts to protect the solution by preventing its breakdown because of particle agglomeration and acts as a demulcent lubricant by a combination of adhesive and lubricating properties which aid in the spreading of the viscous solution. The PVP also operates to prevent blepharospasm (involuntary eyelid contraction), but has little effect on an overall composition viscosity. PVP is desirably present in an amount of from 0.5 to 10.0 weight percent based on the overall solution.

The foregoing illustrations of secondary additives for the ophthalmic solution of the present invention are intended to be merely exemplary of the more common of the additives to ophthalmic solutions well known to those of ordinary skill in the art. It should accordingly be understood that such additives are not required for effective operation of the ophthalmic solution of the present invention, nor is it intended by the enumeration of certain additives to exclude others.

While the ophthalmic solution of the present invention is readily formed by simply combining the ingredients, the polyacrylamide material can occasionally present difficulties in readily dissolving due to the formation of lumps. such difficulties can be avoided by the utilization of the following technique:

an increment of distilled water sufficient to dissolve the constituents of the composition is placed in a stainless steel container and heater to about 50°C. If a surfactant is included in a composition, it is dissolved first in distilled water by agitation, e.g. with a dispersing mixer which has a variable speed control set at low speed.

Any medicament (such as pilocarpine HCl, pH buffers) and the polyalkyline glycol (such as Carbowax 4000) and other additives (such as biocides and the like) are then dissolved with medium speed agitation in the water/surfactant mixture, following which the polyvinyl pyrrolidone is added with high-speed mixing and agitation. If a cellulosic derivative mechanical buffer is utilized, it is sifted slowly into the vortex created by the agitator at high speed. When the cellulosic substance is completely dispersed, the polyacrylamide is sifted slowly into the vortex at high agitation, until the resin appears to be climbing up to agitator shaft, at which time the speed is reduced to 100 to 200 rpms. Agitation is then continued until the resin is completely dissolved in the solution, typically from 2 to 6 hours. Additional distilled water is then added to bring the solution up to volume. When some components are temperature sensitive, the product may be sterilized after packaging by means of ethylene oxide gas sterilization. Containers for the solution are placed in racks in a gas autoclave, which draws a vacuum of about 24 ml of mercury, after which all air is replaced with an ethylene oxide-freon mixture (12–88%) at 12 psi for 12 hours and at relative humidity of 45 to 50%. It is also possible to sterilize in an autoclave if the conditions are controlled to minimize thermal damage to any sensitive ingredients.

EXAMPLE III

As an illustration of the composition of the present invention containing the aforementioned secondary additives, the following composition was prepared on a relatively large scale:

bacteriocide (Thimerosal, 10%)	240 cc
disodium phosphate	1200 gms
polyethylene glycol (MW. 4,000)	6000 gms
polyvinyl pyrrolidone	3000 gms
disodium ethylenediamine-tetracetate	600 gms
non-ionic surfactant	132 gms
hydroxy ethyl cellulose (MW 52,000)	3000 gms
polyacrylamide (Cyanamer P250)	3000 gms
distilled water	150 gallons

The solution formed from the foregoing components was clear and free of polymer globules and was found to have a pH of about 7.3 and a viscosity of about 150 cps.

The solution was utilized as a wetting, cleaning and cushioning medium by a number of patients using hard-type, polymethyl methacrylate contact lenses. With patients who had previously worn the lenses, greater comfort and tolerance were reported, even by those who had previously experienced difficulty with the lenses. Most patients reported that they were able to wear their lenses for greater periods of time than had previously been possible, regardless of the type of wetting solution they had used before. With patients who had not previously worn contact lenses, the solution of the present invention dramatically reduced the problems of lens delivery and greatly accelerated the adaptation of the patients to the use of the lenses. In all the trials, no adverse side effects or irritation was noted either subjectively or by clinical examination.

It has been noted that in the utilization of the opthalmic solution of the present invention with contact lenses, certain ranges of viscosity provide better results than others. For example, with hard-type lenses, the best results are attained at a viscosity of about 30 to 200 cps and that range is accordingly preferred for such usage. The most preferred viscosity for the use with hard-type lenses is about 150 cps. With the gel-type lens, the most effective (and hence the preferred) viscosities lie in the range of about 0 to 30 cps, with values of about 10 being most preferred. No variation of effectiveness with viscosity has been noted when the solution is used as a carrier for medicaments or as a synthetic tear or the like.

It should be noted that a viscosity of zero as measured is a result of the limitations of the available techniques and apparatus and does not represent such an anomaly as it might superficially appear. It should be further noted that all designations of viscosity appearing herein represent the values as obtained with the Brookfield Viscosimeter where all values below 100 are obtained with the ultra-low viscosity adapter rotated at 0.6 rpm and all values above 200 are obtained with a number 6 spindle at 10 rpm. For values ranging

from about 175 to 250 cps, results obtained by the two differing adaptations are generally comparable in the case of the present solutions.

A further example of the effectiveness of the composition of the present invention occurs primarily in the area of ophthamologic diagnosis, where it is conventional to apply fluorescein or a comparable material, dissolved in a carrier, to the eye. After allowing the dye to penetrate the tissues of the eye, an examination is conducted by visual inspection with the aid of an ultraviolet light source, which causes the dye to fluoresce. It has been found that when the opthalmic solution of the present invention is utilized as the carrier, the dye is absorbed in substantially greater proportions and at a much faster rate than has been possible with the compositions of the prior art. Accordingly, solutions, of fluorescent dyes in the opthalmic solution of the present invention are of great aid in the examination of the eye.

While certain specific considerations have been disclosed and discussed herein, such have been offered solely to exemplify the present invention and should in no way be constructed as limiting. The proper scope and nature of the invention is set forth in the following claims.

What is claimed is:

1. An ophthalmic solution comprising an aqueous solution of a water soluble polyacrylamide polymer, having a molecular weight of at least about 75,000, in an amount of from about 0.05 to 20 weight percent sufficient to provide a viscosity of from about 0 to 30,000 cps and from about 100 to about 5000 weight percent, based on the polyacrylamide polymer, of a polyalkylene glycol selected from the class consisting of polyethylene glycol and polypropylene glycol having a molecular weight of from about 400 to 6000.

2. The composition of claim **1** wherein said polyacrylamide polymer has a molecular weight of about 200,000 to 10,000,000.

3. The composition of claim **1** wherein said polyacrylamide polymer has a molecular weight of about 5 to 6,000,000.

4. The composition of claim **1** wherein said polyalkylene glycol is polyethylene glycol.

5. The composition of claim **4** wherein said polyethylene glycol has a molecular weight of about 4,000.

6. The composition of claim **1** wherein said aqueous solution further comprises, a material selected from the group of (1) eye compatible acids in an amount to maintain the pH of the solution at from about 3 to about 7, and (2) eye compatible pH buffers in an amount sufficient to maintain the pH of the solution at from 7.4 to about 8.2.

7. The composition of claim **6** wherein said acid is boric acid.

8. The composition of claim **6** wherein said buffer is a combination of mono-sodium and di-sodium phosphates.

9. The composition of claim **1** wherein said aqueous solution further comprises a mechanical buffer selected from the group consisting of methyl cellulose, hydroxyethyl cellulose, hydroxypropyl cellulose, carboxymethyl cellulose, hydroxypropyl methyl cellulose and mixtures thereof.

10. The composition of claim **1** wherein said aqueous solution further comprises up to about 0.5 percent by weight of an eye compatible non-ionic surfactant.

11. The composition of claim **1** wherein said aqueous solution further comprises up to about 5 percent by weight polyvinyl pyrrolidone.

12. An ophthalmic solution comprising an aqueous solution of a polyacrylamide, having a molecular weight of at least about 100,000 in an amount of from about 0.05 to 20 weight percent sufficient to provide a viscosity of from about 0 to 30,000 cps. and a material selected from the group of (1) eye compatible acids in an amount to maintain the pH of the solution at from about 3 to about 7, and (2) eye compatible pH buffers in an amount sufficient to maintain the pH of the solution at from about 7.4 to about 8.2.

13. The composition of claim **12** wherein said material is boric acid.

14. The composition of claim **12** wherein said buffer is a combination of monosodium and disodium phosphates.

15. The composition of claim **12** wherein said aqueous solution further includes a mechanical buffer selected from the group consisting of methyl cellulose, hydroxyethyl cellulose, hydroxypropyl cellulose, carboxymethyl cellulose, hydroxypropyl methyl cellulose, and mixtures thereof.

16. The composition of claim **12** wherein said aqueous solution further includes up to about 0.5% by weight of an eye compatible non-ionic surfactant.

17. The composition of claim **12** wherein said aqueous solution further includes up to about 5% by weight polyvinyl pyrrolidone.

18. A method of treating the human or animal eye to provide a synthetic mucous membrane layer to serve as a wetting, cleaning, lubricating and cushioning agent, which comprises adding thereto an effective amount of an ophthalmic solution comprising an aqueous solution of a polyacrylamide polymer, having a molecular weight of at least about 100,000, in an amount from about 0.05 to 20 weight percent sufficient to provide a viscosity of from about 0 to 30,000 cps.

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