A dosage form is disclosed comprising an injection-molded housing member free of organic solvents.
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INJECTION-MOLDED DOSAGE FORM

FIELD OF THE INVENTION

This invention pertains to dosage forms provided by injection-molded principles. More specifically the invention relates to injection-molded membranes manufactured into advanced dosage forms expressed as osmotic dosage forms especially for peroral administration of a therapeutic agent. The invention concerns also compositions comprising at least one polymer used for injection-molding an article of manufacture.

BACKGROUND OF THE INVENTION

Unique dosage forms, manufactured as osmotic delivery systems entered the fields of medicine and pharmacy with the invention of osmotic delivery systems by inventors Theeuwes and Higuchi as disclosed in U.S. Pat. Nos. 3,845,770 and in 3,916,899. The osmotic systems disclosed in these patents comprise a semipermeable membrane that surrounds a compartment containing a therapeutic agent. The membrane is permeable to the passage of an external fluid, and it is substantially impermeable to the passage of drug. There is at least one exit through the membrane for delivering the therapeutic agent from the osmotic dosage form.

A pioneering advancement in osmotic delivery systems in the dispensing arts was presented in U.S. Pat. No. 4,327,725 by patentees Cortese and Theeuwes. This invention provides an osmotic delivery system for delivering a therapeutic agent that, because of its solubility in aqueous and biological fluids is difficult to deliver in meaningful amounts at a controlled rate over time. The osmotic delivery system of this patent comprises a semipermeable wall that surrounds a compartment containing a therapeutic agent that is insoluble to very soluble in aqueous and biological
fluids, and an expandable hydrogel. In operation, the hydrogel expands in the presence of an external fluid that is imbibed into the delivery system and pushes the therapeutic agent from the delivery system, through an exit passageway.

A further contribution to the delivery arts in an inventive delivery system disclosed in U.S. Pat. No. 5,023,088 by patentees Wong, Theeuwes, Eckenhoff, Larsen, and Huynh. In this patent, the patentee disclosed a delivery system that comprises a semipermeable housing member with a compartment that contains a plurality of movable therapeutic units. The patentees disclosed further a driving member for displacing the therapeutic units through an opened orifice formed in the housing members, when the delivery system is in operation in an environment of use.

It will be appreciated by those skilled in the dispensing art, that the above disclosed dosage forms have a positive inventive value and they represent a practical and useful advancement in the dispensing art. Also, while the above described dosage forms possess ideal kinetics useful for delivering numerous and different drugs and at a controlled and continuous rate to many environments of use, there is an instance where the manufacturer of these dosage forms can be improved to lead to more desirable results. For example, the dosage forms of the prior art are manufactured by a process of membrane coating wherein an organic solvent such as acetone or methylene chloride is used to coat the membrane onto the dosage form. While these solvents form excellent membranes, there are serious shortcomings associated with their use. That is, these organic solvents are expensive, they are explosive, traces can be possibly toxic, and during processing solvent fumes can escape and cause environmental concern. The conditions needed for optimizing production to produce a thin or a thick membrane often become impractical in mass production as variability between membrane weight and thickness uniformity can lead to
differences in release profiles of the dosage form. Further, the optimization of coating conditions are very costly of each successive layer scale and production of a thick membrane often becomes impractical in mass production due to extremely long coating time. In addition, some special shapes of membrane could not be fabricated by coating process because of its complex in geometry.

It will be appreciated by those skilled in the dispensing art, that if a dosage form can be provided that exhibits a high level of reliable dispensing activity and is manufactured by a process that overcomes the shortcomings and disadvantages associated with the prior art, such a dosage form and its accompanying manufacturing process would have a positive value and also represent an advancement in the dispensing art. It will be immediately appreciated also by those skilled in the dispensing art that is a dosage form designed as an osmotic essentially free from organic solvents, such a dosage form would find a practical application in the fields of pharmacy and medicine. Likewise, it will be appreciated by those skilled in the art that if a novel composition is provided for injection-molding that lessens the problems known heretobefore, such a composition would represent a positive advancement in the art.

OBJECTS OF THE INVENTION

Accordingly, in view of the above presentation, it is an immediate object of this invention to provide a dosage form designed as an osmotic system that can be manufactured by standard manufacturing techniques that overcome the shortcomings and disadvantages known to the prior art.

Another object of the invention is to provide a dosage form designed and manufactured essentially-free of organic solvents.
Another object of the invention is to provide an injection-molding process for manufacturing membranes for dosage forms that can be used in mass commercial production.

Another object of the invention is to provide membranes made by an injection-molding procedures wherein the membrane possess permeability to water, is substantially impermeable to a therapeutic agent, and possess mechanical properties useful for manufacturing an osmotic dosage form.

Another object of the invention is to provide a composition useful for injection-molding items of medicine and health.

Another object of the invention is to provide a composition with thermoplastic properties.

Another object of the invention is to provide a composition comprising at least one polymer, which composition is capable of being injection-molded into any desired shape preferably as a housing member for a dosage form.

Another object of the invention is to provide a composition comprising two or more polymers useful for thermoplastic-molding thereof.

Other objects, features, aspects, and advantages of this invention will be more apparent to those versed in the dispensing art from the following detailed specification taken in conjunction with the accompanying claims.

DETAILED DESCRIPTION OF THE INVENTION

According to the mode and the manner of this invention, novel compositions are provided for injection-molding into membranes, that are shaped into dosage forms. The compositions comprise a thermoplastic
polymer, or the compositions comprise a mixture of thermoplastic polymers and optional injection-molding ingredients. The thermoplastic polymer that can be used for the present purpose comprise polymers that have a low softening point, for example, below 200°C, preferably within the range of 40°C to 180°C. The polymers, are preferably synthetic resins, for example, linear polycondensation resins, condensation polymerized resins, addition polymerized resins, such as polyamides, resins obtained from diepoxides and primary alkanolamines, resins of glycerine and phthalic anhydrides, polymethane, polyvinyl resins, polymer resins with end-positions free or esterified carboxyl or carboxamide groups, for example with acrylic acid, acrylic amide, or acrylic acid esters, polycaprolactone, and its copolymers with dilactide, diglycolide, valerolactone and decalactone, a resin composition comprising polycaprolactone and polyalkylene oxide, and a resin composition comprising polycaprolactone, a polyalkylene oxide such as polyethylene oxide, poly(cellulose) such as poly(hydroxypropylmethylcellulose), poly(hydroxyethylmethylcellulose), poly(hydroxyethylcellulose), and poly(hydroxypropylcellulose). The membrane forming composition can comprises optional membrane-forming ingredients such as polyethylene glycol, talc, polyvinylalcohol, lactose, or polyvinyl pyrrolidone. The compositions for forming an injection-molding polymer composition can comprise 100% thermoplastic polymer. The composition in another embodiment comprises 10% to 99% of a thermoplastic polymer and 1% to 70% of a different polymer with the total equal to 100%. The invention provides also a thermoplastic polymer composition comprising 1% to 98% of a first thermoplastic polymer, 1% to 90% of a different, second polymer and 1% to 90% of a different, third polymer with all polymers equal to 100%. Representation composition comprises 20% to 90% of thermoplastic polycaprolactone and 10% to 80% of poly(alkylene oxide); a composition comprising 20% to 90% polycaprolactone and 10% to 60% of poly(ethylene oxide) with the ingredients equal to 100%; a composition comprising 10% to 97% polycaprolactone, 10% to 97% poly(alkylene oxide), and 1% to 97% of
poly(ethylene glycol) with all ingredients equal to 100%; a composition comprising 20% to 90% polycaprolactone and 10% to 80% of poly(hydroxypropylcellulose) with all ingredients equal to 100%; and a composition comprising 1% to 90% polycaprolactone, 1% to 90%

poly(ethylene oxide), 1% to 90% poly(hydroxypropylcellulose) and 1% to 90% poly(ethylene glycol) with all ingredients equal to 100%. The percent, %, expressed is weight percent, wt %.

In another embodiment of the invention, a composition for injection-molding to provide a membrane is prepared by blending a composition comprising a polycaprolactone 63 wt %, polyethylene oxide 27 wt %, and polyethylene glycol 10 wt % in a conventional mixing machine, such as a Moriyama® Mixer at 65°C to 95°C, with the ingredients added to the mixer in the following addition sequence, polycaprolactone, polyethylene oxide and polyethylene glycol. All the ingredients were mixed for 135 minutes at a rotor speed of 10 to 20 rpm. Next, the blend is fed to a Baker Perkins Kneader® extruder at a 80°C to 90°C, at a pump speed of 10 rpm and a screw speed of 22 rpm, and then cooled to 10°C to 12°C to reach a uniform temperature. Then, the cooled extruded composition is fed to an Albe Pelletizer, converted into pellets at 25°C and a length of 5 mm. The pellets next are fed into an injection-molding machine, an Arburg Allrounder® at 200°F to 350°F (93°C to 177°C), heated to a molten polymeric composition, and the liquid polymer composition forced into a mold cavity at high pressure and speed until the molded is filled and the composition comprising the polymers are solidified into a preselected shape. The parameters for the injection-molding consists of a band temperature through zone 1 to zone 5 of the barrel of 195°F (91°C) to 375°F (191°C), an injection-molding pressure of 1818 bar, a speed of 55 cm³/s, and a mold temperature of 75°C.
The phrase therapeutic agent and drug are used interchangeably herein, and they refer to an agent, drug compound, composition of matter or mixture thereof which provides a therapeutic, often beneficial, effect. This includes pesticides, herbicides, germicides, biocides, algicides, rodenticides, fungicides, insecticides, antioxidants, plant growth promoters, plant growth inhibitors, preservatives, antipreservatives, disinfectants, sterilization agents, catalysts, chemical reactants, fermentation agents, foods, food supplements, nutrients, cosmetics, drugs, vitamins, sex sterilants, fertility inhibitors, fertility promoters, microorganism attenuators and other agents that benefit the environment of use. As used herein, the terms further include any physiologically or pharmacologically active substance that produces a localized or systemic effect or effects in animals, including warm blooded mammals, humans and primates; avians; domestic household or farm animals such as cats, dogs, sheep, goats, cattle, horses and pigs; laboratory animals such as mice, rats and guinea pigs; fish; reptiles, zoo and wild animals; and the like. The active drug that can be delivered includes inorganic and organic compounds, including, without limitation, drugs which act on the peripheral nerves, adrenergic receptors, cholinergic receptors, the skeletal muscles, the cardiovascular system, smooth muscles, the blood circulatory system, synoptic sites, neuroeffector junctional sites, endocrine and hormone systems, the immunological system, the reproductive system, the skeletal system, autcoid systems, the alimentary and excretory systems, the histamine system, and the central nervous system. Suitable agents may be selected from, for example, proteins, enzymes, hormones, polynucleotides, nucleoproteins, polysaccharides, glycoproteins, M. lipoproteins, polypeptides, steroids, hypnotics and sedatives, psychic energizers, tranquilizers, anticonvulsants, muscle relaxants, antiparkinson agents, analgesics, anti-inflammatory, local anesthetics, muscle contractants, antimicrobials, antimalarials, hormonal agents including contraceptives, sympathomimetics, polypeptides and proteins capable of eliciting physiological effects, diuretics, lipid regulating agents, antiandrogenic agents, antiparasitics, neoplastics,
antineoplastic, hypoglycemics, nutritional agents and supplements, growth
supplements, fats, ophthalmics, antietenteritis agents, electrolytes and
diagnostic agents.

Examples of beneficial agents which this invention can be utilized with
are prochlorperazine edisylate, ferrous sulfate, aminocaproic acid,
mecaxylamine hydrochloride, procainamide hydrochloride, amphetamine
sulfate, methamphetamine hydrochloride, benzphetamine hydrochloride,
isoproterenol sulfate, phenmetrazine sulfate, isoproterenol sulfate,
phenmetrazine hydrochloride, bethanechol chloride, methacholine chloride,
pilocarpine hydrochloride, atropine sulfate, scopalamine bromide,
isopropamide iodide, tridihexethyl chloride, phenformin hydrochloride,
methylphenidate hydrochloride, theophylline cholinate, cephalexin
hydrochloride, diphenidol, meclizine hydrochloride, prochlorperazine maleate,
phenoxybenzamine, thiethylperazine maleate, anisindone, diphenadione,
erthrityl tetrani-trate, digoxin, isofluorophate, acetazolamide, methazolamide,
bendroflumethiazide, chlorpropamide, to-lazamide, chloramadinone acetate,
phenaglycodol, allopurinol, aluminum aspirin, methotrexate, acetyl
sulfoxazole, erythromycin, hydrocortisone, hydrocorticosterone acetate,
cortisone acetate, dexamethasone and its derivatives such as
betamethasone, triamcinolone, methyltestosterone, 17-β-estradiol, ethinyl
estradiol, ethinyl estradiol 3-methyl ether, pednisolone, 17-β-
hydroxyprogesterone acetate, 19-norprogestosterone, norgestrel, norethindrone,
norethisterone, norethiederon, progesterone, norgestrene, norethisterone,
norethynodrel, aspirin, indomethacin, naproxen, fenoprofen, sulindac,
indoprofen, nitroglycerin, isosorbide dinitrate, propranolol, timolol, atenolol,
alpenolol, cimetidine, clonidine, imipramine, levodopa, chlorpromazine,
methyldopa, dihydroxyphenylalanine, theophylline, calcium gluconate,
ketoprofen, ibuprofen, cephalexin, erythromycin, haloperidol, zomepirac,
ferrous lactate, vincamine, diazepam, phenoxybenzamine, diliazem,
milrinone, cipropril, mandol, quabenz, hydrochlorothiazide, ranitidine,
flurbiprofen, fenbufen, fluprofen, tolmetin, aiclofenac, mefenamic, flufenamic, difuninal, nimodipine, nitrrendipine, nisoldipine, nicardipine, felodipine, lidoflazine, tiapamil, gallopamil, amlodipine, mioflazine, lisinopril, enalapril, captopril, ramipril, endlapriet, famotidine, nizatidine, sucralfate, etindine, tetratolol, minoxidil, chlordiazepoxide, diazepam, amitriptylin, and imipramine.

Further examples are proteins and proteins which include, but are not limited to, insulin, colchicine, glucagon, thyroid stimulating hormone, parathyroid and pituitary hormones, calcitonin, renin, pro lactin, corticotrophin, thyrotropic hormone, follicle stimulating hormone, chorionic gonadotropin, porcine somatropin, oxytocin, vasopressin, prolactin, somatostatin, lypressin, pancreozymin, lut einizing hormone, LHRH, interferons, interleukins, growth hormones such as human growth hormone, bovine growth hormone and porcine growth hormone, fertility inhibitors such as the prostaglandins, fertility promoters, growth factors, and human pancreas hormone releasing factor.

It is to be understood that more than one therapeutic agent can be incorporated into the dosage form of this invention, and the use of the expressions therapeutic agent or drug in no way excludes the use of two or more such therapeutic agents or drugs. The therapeutic agent can be in a wide variety of chemical and physical forms, such as uncharged molecules, components of molecular complexes, nonirritating pharmaceutically acceptable salts, therapeutic derivatives of the therapeutic agent such as ethers, esters, amides, etc, therapeutic derivatives of the therapeutic agent that are easily hydrolyzed by the body pH, and enzymes, are included in this invention. The amount of therapeutic agent in the dosage form is an amount necessary to produce the desired therapeutic response. In practice, this will vary widely depending upon the particular therapeutic agent, the site of delivery, the severity of the medical condition, and the desired therapeutic effect. Thus, often it is not practical to define a particular therapeutic range for a therapeutically effective dose of the therapeutic active agent incorporated into the dosage form, however, the dosage form generally will
contain 10 ng to 2.5 g of the therapeutic agent. The therapeutically active
drugs are disclosed in Pharmaco-therapy, Vol. 8, pp 147-157 (1988); Drugs,
Vol. 30, pp 333-354, (1985); Remington's Pharmacological Basis of
Million Company, London.

The term osmagent as used herein also includes osmotically effective
solute, osmotically effective compound and osmotic agent. The osmotically
effective compounds that can be used for the purpose of this invention
include inorganic and organic compounds that exhibit an osmotic pressure
gradient across a semipermeable membrane against an external fluid.
Osmotically effective compounds useful for the present purpose include
magnesium sulfate, magnesium chloride, sodium chloride, lithium chloride,
potassium sulfate, sodium carbonate, sodium sulfate, lithium sulfate,
potassium chloride, sodium sulfate, calcium bicarbonate, calcium sulfate,
potassium acid phosphate, calcium lactate, mannitol, urea, inositol,
magnesium succinate, tartaric acid, carbohydrates, raffinose, sucrose,
glucose, lactose monohydrate, and mixtures thereof. The osmotically
effective solute can be in any physical form such as particle, crystal, pellet,
tablet, strip, ground, pulverize, film, or granules. The osmotically effective
solute and procedures for measuring osmotic pressures are dissolved in
U.S. Pat. No. 5,232,705.

The push composition, contains an expandable means also known as
osmopolymer, hydrogel, and expandable member in the dosage form for the
purpose of this invention comprise a push composition that interacts with
water, or aqueous biological fluids and swell or expand to an equilibrium
state. The osmopolymers exhibit the ability to swell in water and retain a
significant portion of the imbibed water within the polymer structure. The
osmopolymers swell or expand to a very high degree, usually exhibiting a 2 to
50 fold volume increase. The osmopolymers can be noncrosslinked or
crosslinked. The swellable, hydrophilic polymers are, in one presently preferred embodiments, lightly crosslinked, such as cross-links being formed by covalent or ionic bonds. The osmopolymers can be of plant, animal or synthetic origin. Hydrophilic polymers suitable for the present purpose include poly(hydroxyalkylmethacrylate) having a molecular weight of from 30,000 to 5,000,000; poly(vinylpyrrolidone) having molecular weight of from 10,000 to 360,000; anionic and cationic hydrogels; polyelectrolyte complexes, poly(vinyl alcohol) having a low acetate residual, crosslinked with formaldehyde, or glutaraldehyde and having a degree of polymerization from 200 to 30,000; a mixture of methyl cellulose, crosslinked agar and carboxymethyl cellulose, a water insoluble, water swellable copolymer produced by forming a dispersion of finely divided copolymer of maleic anhydride with styrene, ethylene, propylene, butylene or isobutylene crosslinked with from 0.0001 to about 0.5 moles of polyunsaturated cross-linking agent per mole of maleic anhydride in the copolymer; water swellable polymers of N-vinyl lactams, and the like.

Other osmopolymers include polymers that form hydrogels such as Carbopol® acidic carboxy polymers generally having a molecular weight of 450,000 to 4,000,000; the sodium salt of Carbopol® acidic carboxy polymers and other metal salts; Cyanamer® polyacrylamides; crosslinked water swellable indene maleic anhydride polymers; Goodrite® polyacrylic acid having, but not limited to, a molecular weight of 80,000 to 200,000, and the sodium and other metal salts; Polyox® polyethylene oxide polymers having a molecular weight of 100,000 to 7,800,000; starch graft copolymers; Aqua-Keeps® acrylate polymers; diester crosslinked polyglucan, and the like. Representative polymers that form hydrogels are known to the prior art in U.S. Pat. No. 3,865,108 issued to Hartop; U.S. Pat. No. 4,207,893 issued to Michaels, and in Handbook of Common Polymers, by Scott and Roff, published by the Chemical Rubber, CRC Press, Cleveland, OH.
Other osmoplymers that can be present in the first layer include agarose, algines, amylopectin, arabinoglactan, carrageen, eucheuma, fucoidan, furcellaran, gelatin, guar gum, gum agar, gum arabic, gum ghatti, gum karaya, gum tragacanth, hypnea, laminarin, locust bean gum, pectin, polyvinyl alcohol, polyvinyl pyrrolidone, propylene glycol aginates, N-vinyl lactam polysaccharides, xanthan gum, and the like. The osmopolymer are known in Controlled Release System. Fabrication Technology, Vol. II, pg 46 (1988), published by CRC Press, Inc.

The composition comprising a therapeutic agent for use in the invention are made by standard manufacturing techniques. For example, in one manufacture a therapeutic agent is mixed with composition forming ingredients and then pressed into a solid shape corresponding to the internal dimensions of the space inside the dosage form. In another embodiment the therapeutic agent and other composition forming ingredients and mixed into a solid, or into a semisolid, by conventional methods such as ballmilling, calendering, stirring, or rollmilling and then pressed into a preselected layer forming shape. A push expansion composition comprising an osmopolymer are prepared in a similar manner, and pressed into a shape corresponding to the internal composition of the dosage form. Procedures for preparing a therapeutic agent composition, and an osmopolymer composition are disclosed in U.S. Pat. No. 5,024,843.

The following examples are illustrative of the present invention, and they should not be considered as limiting the scope of the invention in any way as these examples and other equivalents thereof will become apparent to those versed in the art in light of the present disclosure and the accompanying claims.
A dosage form comprising an injection-molded membrane consisting of the polycaprolactone, polyethylene oxide and polyethylene glycol composition that surrounds an internal space with an opened mouth and a dosed bottom is charged at its bottom with a push composition and then with a drug composition at the opened mouth. The push composition comprises 58.75 wt % sodium carboxymethylcellulose, 30.00 wt % sodium chloride, 5.00 wt % hydroxypropylmethylcellulose, 5.00 wt % hydroxypropylcellulose, 1.00 wt % red ferric oxide, and 0.25 wt % magnesium stearate. The drug composition comprises 66.70 wt % gemfibrozil, 14.30 wt % acid-di-sol, a sodium croscarmellos, 9.50 wt % polyethylene oxide of 200,000 molecular weight, 5.00 et % Myrij 52-S surfactant, also known as poly(ethylene glycolate 40) stearate, 3.00 wt % hydroxypropylmethylcellulose of 9,200 molecular weight, 1.00 wt % cab-O-sil, a colloidal silicon dioxide, and 0.50 wt % magnesium stearate. The opened mouth of the dosage form is crimped to 15 mil (0.381) mm orifice to provide an osmotic dosage form. A prior art dosage form made by solvent technique is disclosed in U.S. Pat. No. 4,327,725 issued to Cortese and Theeuwes and assigned to the ALZA Corporation.

Another dosage form provided by the invention comprises a housing consisting of a first membrane section and a second membrane section. The first section and the second section are designed to close in telescopic arrangement with each other. The membrane forming the first section is injected-molded from a polycaprolactone hydroxypropylcellulose composition and the second section comprise polycaprolactone, polyethylene oxide, and polyethylene glycol at various ratios. The first section comprises a therapeutic composition for administering to an animal or to a human. The second section is a means for closing the first section as a cap during storage. The second section is a means for opening the dosage form, when the dosage form is in operation in a fluid environment of use for dispensing a therapeutic composition from the first section to the environment. The second section comprises an osmotic layer comprising 58.75 wt % sodium
carboxymethylcellulose, 30.00 wt % sodium chloride, 5.00 wt %
hydroxypropylmethylcellulose of 9,200 molecular weight, 5.00 wt %
hydroxypropylcellulose, 1.00 wt % red ferric oxide, and 0.25 wt % magnesium
stearate. The osmotic layer is positioned against the bottom of the second
section. Next, a barrier layer comprising 95.00 wt % stearic acid and 5.00 wt
% hydroxypropylmethylcellulose of 9,200 molecular weight is positioned on
the section in bilayer arrangement with the osmotic layer. The dosage form is
assembled by the smaller opened end fitted inside the layer open end and
compressed together until the first section and the second section fit together
tightly. A dosage forms made by solvent techniques is disclosed in U.S. Pat.
No. 5,312,388 issued to Wong, Theeuwes, and Larsen and assigned to the
ALZA Corporation. Conventional injection-molding machines as disclosed in
Encyclopedia of Polymer Science and Engineering, Vol. 8, Injection-Molding,
pp 102 to 138, 1987 can be used for the purpose of this invention.

A dosage form is manufactured for containing a liquid formulation by
injection-molding a housing member for containing the liquid formulation.
The housing member comprises a semipermeable membrane that surrounds
and internal compartment. The housing has a wide opened mouth and a
closed bottom. The injection-molded membrane comprises a
polycaprolactone and a cellulose derivative blend or polycaprolactone,
polyethylene oxide polyethylene glycol to provide a semipermeable
membrane. The cellulose derivative is selected from the group consisting of
a cellulose ether, cellulose ester, hydroxyalkylcellulose and
hydroxypropylalkylcellulose. The dosage form is manufactured by first
placing in the bottom of the housing an expandable-push pressed layer
comprising 79.00 wt % Keltoine HV, sodium alginate, 15.00 wt % calcium
sulfate, 5.00 wt % poly(vinylpyrrolidone), 0.50 wt % ferric oxide, and 0.50 wt
% magnesium stearate; next a barrier layer for preventing a liquid formulation
from mixing with the expandable-push layer in inserted into the opened
housing member in contacting bilayer arrangement. The barrier
layer comprises 95.00 wt % stearic acid and 5.00 wt %
hydroxypropylmethylcellulose. Next, membrane surrounding the opened
mouth is crimped against air pressure leaving an orifice of 30 mil. A liquid
formulation then is injected into the crimped housing member through the
orifice. The liquid formulation comprises 41.75 wt % cremophor, a polyoxyl
40 hydrogenated castor oil, 35.05 wt % corn oil, 21.97 wt % propylene glycol,
1.10 wt % tocopherol, and 0.14 wt % blue dye.

Accompanying Figures 1 and 2, demonstrate the unexpected
properties provided by the invention. In Figure 1, the permeability of a
membrane comprising 63 wt % polycaprolactone, 27 wt % polyethylene oxide
of 5,000,000 molecular weight and 10 wt % polyethylene glycol 3350 is
expressed as volume against time. The water permeation through the
membrane was measured with a saturated salt solution having an osmotic
pressure, Π for a membrane of 20 mils thick (0.5/mm), at a temperature of
37°C, and a permeability area of 0.64 cm². The permeability equation used is
as follows: K(cm² mil/hr atm) = (dV/dt•)/A•Π wherein dV/dt=slope of the plot,
equals the thickness of membrane, A equals permeation area, and Π equals
the osmotic pressure of the salt solution. Accompanying Figure 2 illustrates
the permeability through membranes prepared by various techniques. In the
drawing Figure 2, the clear triangle illustrates the aqueous permeability
through a cellulose acetate membrane comprising an acetyl content of 39.8%
at changing percents of polyethylene glycol flux enhancer in coated
membranes; the clear circles depict the aqueous flux through a membrane
comprising polycaprolactone and polyethylene oxide of 5,000,000 molecular
weight at a ration of 70/30 with additional amounts of polyethylene glycol
3350; and the black circles denote the effect of varying concentration of flux
enhancer on the water permeability through a polycaprolactone-
hydroxypropylcellulose calendered membranes.
Inasmuch as the foregoing specification comprises preferred embodiments of the invention, it is understood that variations and modification may be made herein, in accordance with the inventive principles disclosed, without departing from the scope of the invention.
We claim:

1. A dosage form for delivering a therapeutic agent to an environment of use, the dosage form comprising:

   (a) an internal compartment;

   (b) a therapeutic composition comprising a therapeutic agent in the compartment;

   (c) an expandable composition comprising means for expanding for pushing the therapeutic composition from the dosage form in the compartment;

   (d) exit means in the dosage form that connects the therapeutic composition with the environment of use, wherein the dosage form is characterized by:

   (e) an injection-molded membrane comprising a softening point below 200°C, permeable to the passage of fluid that surrounds and defines the internal compartment.

2. The dosage form for delivering the therapeutic agent according to claim 1, wherein the injection-molded membrane is free of solvents.

3. The dosage form for delivering the therapeutic agent according to claim 1, wherein the injection-molded membrane has a softening point of 40°C to 180°C.

4. A dosage form for delivering a therapeutic agent to an environment of use, the dosage form comprising:

   (a) an internal compartment;

   (b) a therapeutic composition comprising a therapeutic agent in the compartment;
(c) an expandable composition comprising means for expanding for pushing the therapeutic composition from the dosage form in the compartment;

(d) exit means in the dosage form that connects the therapeutic composition with the environment of use, and wherein the dosage form is characterized by:

(e) an injection-molded membrane comprising a polycaprolactone, which injection-molded membrane is permeable to the passage of fluid and surrounds and forms the internal compartment.

5. The dosage form for delivering the therapeutic agent according to claim 4, wherein the injection-molded membrane comprises a polycaprolactone copolymer with a member selected from the group consisting of dilactide, diglycolide, valerolactone and decalactone.

6. The dosage form for delivering the therapeutic agent according to claim 4, wherein the injection-molded membrane comprises a polycaprolactone and a polyalkylene oxide.

7. The dosage form for delivering the therapeutic agent according to claim 4, wherein the injection-molded membrane comprises polycaprolactone, polyalkylene oxide and hydroxypropylcellulose.

8. The dosage form for delivering the therapeutic agent according to claim 4, wherein the injection-molded membrane comprises a polycaprolactone and polyethylene glycol.

9. A dosage form for delivering a therapeutic agent to an environment of use, wherein the dosage form comprises:

(a) a first section;
(b) a second section;
(c) an internal lumen formed by the first section and the second section engaged in closed arrangement;

(d) a therapeutic composition in the first section;

(e) an osmotic composition in the second section as means for opening the dosage form in an environment of use; and wherein the dosage form is characterized by:

(f) an injection-molded membrane forming the first section and the second section, the injection-molded membrane comprising a softening temperature of 40°C to 180°C and is permeable to the passage of fluid in the environment of use.

10. A dosage form for delivering a therapeutic agent to an environment of use, wherein the dosage form comprises:

(a) a first section;

(b) a second section;

(c) an internal lumen formed by the first section and the second section engaged in closed arrangement;

(d) a therapeutic composition in the first section;

(e) an osmotic composition in the second section as means for opening the first section and the second section when the dosage form is in the environment of use; and wherein the dosage form is characterized by:

(f) an injection-molded membrane forming the first section and the second section, the injection-molded membrane comprising a polycaprolactone that is permeable to the passage of fluid.

11. The dosage form for delivering the therapeutic agent according to claim 10, wherein the injection-molded membrane comprises a polycaprolactone copolymer selected from the group consisting polycaprolactone dilactide copolymer, polycaprolactone diglycolide, polycaprolactone valerolactone, and polycaprolactone decalactone.
12. A dosage form for delivering a therapeutic agent to an environment of use, wherein the dosage form comprises:
   (a) a first section;
   (b) a second section;
   (c) an internal lumen formed by the first section and the second section engaged in closed arrangement;
   (d) a therapeutic composition in the first section;
   (e) an osmotic composition in the second section as means for opening the first section and the second section when the dosage form is in the environment of use; and wherein the dosage form is characterized by:
   (f) an injection-molded membrane forming the first section and the second section, the injection-molded membrane comprising a polycaprolactone and a polyalkylene oxide.

13. A dosage form for delivering a therapeutic agent to an environment of use, wherein the dosage form comprises:
   (a) a first section;
   (b) a second section;
   (c) an internal lumen formed by the first section and the second section engaged in closed arrangement;
   (d) a therapeutic composition in the first section;
   (e) an osmotic composition in the second section as means for opening the first section and the second section when the dosage form is in the environment of use; and wherein the dosage form is characterized by:
   (f) an injection-molded membrane forming the first section and the second section, the injection-molded membrane comprising a polycaprolactone, polyalkylene and hydroxypropylcellulose.

14. A dosage form for delivering a therapeutic agent to an environment of use, wherein the dosage form comprises:
   (a) a first section;
(b) a second section;
(c) an internal lumen formed by the first section and the second section;
(d) a therapeutic composition in the first section;
(e) a composition comprising an osmopolymer in the second as means for opening the first section and the second section when the dosage form is in the environment of use; and wherein the dosage form is characterized by:
(f) an injection-molded membrane forming the first section and the second section that comprises a polycaprolactone and a polyalkylene glycol.

15. A dosage form for delivering a therapeutic liquid formulation to an environment of use, wherein the dosage form comprises:

(a) an internal compartment;
(b) an exit in the dosage form that connects the internal compartment with the environment of use;
(c) a push composition comprising means for expanding and pushing a therapeutic liquid formulation form the dosage form, said push composition in the internal compartment distant from the exit; and wherein the dosage form is characterized by:
(d) a therapeutic liquid formulation in the internal compartment and adjacent to the exit; and,
(e) an injection-molded membrane comprising a softening temperature of 40°C to 180°C that surrounds and forms the internal compartment, the injection-molded membrane permeable to the passage of fluid in the environment of use.

16. A dosage form for delivering a therapeutic liquid formulation to an environment of use, wherein the dosage form comprises:

(a) an internal compartment;
(b) an exit in the dosage form that connects the internal compartment with the environment of use;
(c) a push composition comprising means for expanding and pushing a therapeutic liquid formulation form the dosage form, said push composition in the internal compartment distant from the exit; and wherein the dosage form is characterized by:
(d) an injection-molded membrane comprising a softening temperature of 40°C to 180°C that surrounds and forms the internal compartment, the injection-molded membrane permeable to the passage of fluid in the environment of use, and,
(e) a therapeutic liquid formulation in the internal compartment and positioned near the exit.

17. A composition comprising 20% to 90% polycaprolactone and 10% to 80% of poly(alkylene oxide) with the composition equal 100%.

18. A composition comprising 10% to 97% polycaprolactone, 10% to 97% poly(alkylene oxide) and 1% to 97% of poly(ethylene glycol) with the composition equal to 100%.

19. A composition comprising 1% to 90% polycaprolactone, 1% to 90% poly(alkylene oxide) 1% to 90% poly(hydroxypropylcellulose) and 1% to 90% poly(ethylene glycol) which composition is used for injection-molding a membrane.

20. A composition comprising 20% to 90% polycaprolactone and 10% to 80% poly(hydroxypropylcellulose), which composition is useful for injection-molding a membrane and equals 100 wt %.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61K9/00

According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>8 August 1989</td>
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Further documents are listed in the continuation of box C.

| Patent family members are listed in annex. |

Date of the actual completion of the international search: 22 March 1996

Date of mailing of the international search report: 04.04.96

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