II. REVIEW OF LITERATURE

The literature survey revealed various studies of osmotic tablets.

1. Kh. Hussan Reza et al,(2011)\textsuperscript{17} Prepared the monolithic osmotic tablet system, composed of a monolithic tablet coated with cellulose acetate (CA) and membrane drilled with two orifices on both side surfaces. The influences of tablet formulation variables including amount of polymer Explotab (Expt), amount of sodium chloride (NaCl), has been investigated.

2. Sameer Sheaikh et al(2010)\textsuperscript{18} Designed osmotically driven oral drug delivery system containing aceclofenac as an active ingredient which is most beneficial for patients with long term treatment of NSAID(e.g. Arthritis).

3. D Gondaliya et al., (2003)\textsuperscript{19} Prepared a controlled porosity osmotic pump, in the form of a bilayered tablet containing a drug compartment (pull compartment) and an osmogen layer (push compartment), for the delayed release of diltiazem HCL.

4. CVS Subrahmanyam et al (2009)\textsuperscript{20} Had determined solubility parameter of celecoxib by current methods.

5. Longxiao Liu et al.,(2006)\textsuperscript{21} Prepared monolithic osmotic pump tablet by coating the indented core tablet compressed by the punch with a needle. Atenolol was used as the model drug, sodium chloride as osmotic agent and polyethylene oxide as suspending agent. Ethyl cellulose was employed as semipermeable membrane containing polyethylene glycol 400 as plasticizer for controlling membrane permeability.

6. Verma R., et al.,(2004)\textsuperscript{22} Study the effect of different formulation variables, namely, level of solubility modifier in the core, membrane weight gain, and level of pore former in the membrane. In these drug release was found to be affected
by the level of solubility modifier in the core formulation. Glipizide release was inversely proportional to the membrane weight but directly related to the initial level of pore former (PVP) in the membrane.


8. Vooturi, R., et al,(2011)\textsuperscript{24} Developed Elementary osmotic pump (EOP) for controlled release of phenylpropanolamine hydrochloride (PPA). System based on osmotic technology using an osmogen, sodium chloride. The formulations comprise of a core tablet coated with a semi permeable coating polymer and cellulose acetate. The coated tablets were drilled with microneedle and evaluated for physicochemical characteristics and in vitro release studies. The optimized formulation was evaluated for in vivo performance by pharmacokinetic and pharmacodynamic studies.


10. M. N. Freitas et al (2007)\textsuperscript{26} Developed Osmotically controlled and oral drug delivery systems which utilize osmotic pressure for controlled delivery of active agent(s). Drug delivery from these systems, to a large extent, is independent of the physiological factors of the gastrointestinal tract and these systems can be utilized for systemic as well as targeted delivery of drugs. They apply the thermal methods and IR spectroscopy to study compatibility between atenolol and several excipients usually found in the osmotic systems formulations (Polyethylene oxide, $MW$ 3350, 100000, 200000 and 5000000; HPMC K4000, magnesium stearate and cellulose acetate.
11. Sapna N.et al,(2003)\textsuperscript{27} Developed a controlled release system for a period of 12 hr using pseudoephedrine as a model drug. The controlled porosity of the membrane is accomplished by the use of different channeling agents in the coating, Sodium bicarbonate was used as the osmogent. The effect of different ratios of drug:osmogent on the in-vitro release were studied. Cellulose acetate (CA) was used as the semipermeable membrane. Different channeling agents tried were diethylphthalate (DEP), dibutylphthalate (DBP), dibutylsebacate (DBS) and polyethylene glycol 400 (PEG 400). The effect of polymer loading on in-vitro drug release were studied.

12. Longxiao Liu et al,(2008)\textsuperscript{28} Developed a method for the preparation of monolithic osmotic pump tablet by modulating atenolol solubility with acid. Tartaric acid were used as solubility promoter, sodium chloride as osmotic agent and polyvinyl pyrrolidone as retardant agent. Ethyl cellulose were employed as semipermeable membrane containing polyethylene glycol 400 as plasticizer.

13. En-Xian Lu(2003)\textsuperscript{29} Formulate monolithic osmotic tablet system (MOTS) with two orifices in both side surfaces. Water-insoluble naproxen were selected as the model drug. Gum arabic was used as an osmotic, suspending and expanding agent, and cellulose acetate (CA) was used as semipermeable membrane. Polyethylene glycol 400 (PEG-400) was employed as plasticizer for controlling membrane porosity. The influences of gum arabic, PEG-400, membrane thickness and orifice size on the naproxen-release profiles were investigated.

14. Nurten Ozdemir et al.,(1997)\textsuperscript{30} In this study, the effect of the delivery orifices and the concentration of osmotic agents on the rate of release of the active material was investigated. For this purpose, ibuprofen tablets were prepared and sodium chloride and polyethylene glycol 6000 were used as osmotic agents. The tablets were coated with a mixture of cellulose acetate and polyethylene glycol 400 by the use of a modified fluidized bed apparatus. Delivery orifices on the coated tablets are produced using a microdrill.


17. I. Krogel et al. (1999)33 developed and evaluated floating and pulsatile drug delivery system based on the reservoir system consisting of a drug containing effervescent core and a polymeric coating.

18. P.Rama Rao et al., (1996)34 Prepared and evaluated plasticizer free films of cellulose acetate (CA) alone and in combination with different concentration of polyvinyl pyrroldione (PVP) for transdermal use.

19. K.P.R. Chowdhary et al., (1990)35 prepared sustained-release tablets with three theophylline compounds of increasing solubility: Theophylline, dyphylline and proxyphylline, using cellulose acetate as a the matrix polymer.

20. T. Guyonnet et al., (1990)36 prepared sustained release tablet with three theophylline compounds of increasing solubility: theophylline, dyphylline and proxyphylline, using cellulose acetate as the matrix polymer.

21. D. Gondaliya et al., (2003)37 prepared a controlled porosity osmotic pump, in the form of a bilayered tablet containing a drug compartment( pull compartment) and an osmogen layer (push compartment), for the delayed release of diltiazem HCL.

22. N.Ozdemir et al., (2000)38 Studied the effects of surface active agens in different types and concentrations added into the coating solution, on release of model hydrophilic compound.
23. M.A. Khan et al., (2000)\textsuperscript{39} evaluated the main effects of the formulation of the formulation variables on the release of captopril from osmotically-controlled drug delivery system coated with a custom-made cellulose acetate pseudolatex.

24. S. Jonnalagadda et l., (2000)\textsuperscript{40} designed and characterized a zero order bioresorbable reservoir delivery system (BRDS) for a different osmotically controlled delivery of model drug including macromolecule.

25. B. Bittner et al., (2000)\textsuperscript{41} Investigated the selected cosolvents for compatibility with the interior of ALZET osmotic pumps.


27. Eastman Chemical Company.,(1997)\textsuperscript{43} Technical Literature: cellulose esters for pharmaceutical drug delivery.


36. Okimoto K. et al (2004) Investigated the general application of a controlled-porosity osmotic pump tablet (OPT) utilizing (SBE) 7m-cyclodextrin as both a solubilizer and an osmotic agent for drugs with varying physical properties. OPTs utilizing (SBE) 7m-cyclodextrin were prepared for five poorly soluble and two highly water-soluble drugs.


38. Garg S. et al (2004) extended release formulation of glipizide based on osmotic technology was developed and evaluated. The effect of different formulation variables, namely, level of solubility modifier in the core, membrane weight gain, and level of pore former in the membrane, were studied. Drug release was found to be affected by the level of solubility modifier in the core formulation. Glipizide release was inversely proportional to the membrane weight but directly related to the initial level of pore former (PVP) in the membrane.

39. Bindschaedler  C. et al (1986) The use of aqueous colloidal dispersions of cellulose acetate instead of organic solutions is proposed as an alternative way to obtain osmotic tablets. At the same plasticizer level, the semipermeable membranes produced from lattices were more permeable to water and swell to a greater extent than those prepared from organic solutions.
40. Garg S. et al (2003) Developed extended release formulations of isosorbide mononitrate (IMN), based on osmotic technology, and were developed. Target release profile was selected and different variables were optimized to achieve the same. Formulation variables like type of polymer (PVP, PEG-4000 and HPMC) and level of pore former (0–55%, w/w of polymer), percent weight gain were found to affect the drug release from the developed formulations. Drug release was inversely proportional to the membrane weight but directly related to the initial level of pore former in the membrane.

41. Vyas S. et al (2003) Evaluate Effect of hydrophilic polymers on the release of diltiazem hydrochloride from elementary osmotic pumps. Diltiazem hydrochloride (DLTZ) is a freely water-soluble drug, because of its higher aqueous solubility, the suitability of the drug with elementary osmotic pumps is restricted. Plain DLTZ elementary osmotic pump had shown higher release rate. Drug entrapment in polymer matrix or addition of release retardant materials (various polymers) can reduce the release rate of drug. In present study, effect of appropriate hydrophilic polymers (HP) on the release pattern was investigated. Ingredients of the system were optimized for parameters like drug:polymer ratio and amount of osmagent, for the desired release pattern.

42. Kanagale P. et al (2007) Design a porous osmotic pump–based drug delivery system for controlled release of oxybutynin. The porous osmotic pump contains pore-forming water-soluble additives in the coating membrane, which after coming in contact with water, dissolve, resulting in an in situ formation of a microporous structure. The dosage regimen of oxybutynin is one 5-mg tablet 2 to 3 times a day. The plasma half-life ranges from ~2 to 3 hours. Hence, oxybutynin was chosen as a model drug with an aim to develop a controlled release system for a period of 24 hours.


45. Liu L. et al (2008) studied method for the preparation of monolithic osmotic pump tablet was obtained by modulating atenolol solubility with acid. Tartaric acid was used as solubility promoter, sodium chloride as osmotic agent and polyvinyl pyrrolidone as retardant agent. Ethyl cellulose was employed as semipermeable membrane containing polyethylene glycol 400 as plasticizer. The formulation of atenolol monolithic osmotic pump tablet was optimized by orthogonal design and evaluated by similarity factor (f2). The optimal monolithic osmotic pump tablet was found to be able to deliver atenolol at the rate of approximate zero-order up to 24 h, independent of release media and agitation rate. The approach of solubility-modulated by acid-alkali reaction might be used for the preparation of osmotic pump tablet of other poorly water-soluble drugs with alkaline or acid groups.

46. Stella J. et al., (1998) Developed controlled porosity osmotic pump system for poorly water soluble drugs has been developed using sulfobutyl ether-β-cyclodextrin sodium salt, (SBE)-β-CD, which can act as both a solubilizing and an osmotic agent. The release of testosterone, a poorly water soluble drug (0.039 mg/ml at 37\(^{\circ}\)C), was evaluated using a new model device.

47. Bindschaller c. et al,(1986) developed osmotically developed controlled drug delivery system produced from organic solution and aqueous dispersion of cellulose acetate, the release rate of the model drug potassium chloride from coated tablets produced from aqueous dispersions was higher and the time delay before constant release was shorter.

48. Bhanushali R. et al,(2009) developed oral monolithic osmotically controlled delivery system for nifedipine using asymmetric membrane technology, Asymmetric membrane is formed by dry process with phase inversion technology using cellulose acetate as the coating material. Higher water influx of this
membrane aids in delivery of nifedipine, which is highly water insoluble with low osmotic pressure.

49. Appel l. et al.(1992)\textsuperscript{64} developed modified microporous cellulose acetate latex coating for osmotic pumps, a cellulose acetate latex was modified for use of microporous coating for osmotic devices, potassium chloride core tablets were coated with cellulose acetate latex formulation containg a plasticizer(triacetin) and pore forming agent (urea).

50. Sutton S. et al,(1990)\textsuperscript{65} evaluated performance of diltiazem tablet and multiparticulate osmotic formulation in dog, the in vivo performance of two extended release osmotic formulation of diltiazem were evaluated in beagle dog. Both extended release formulation had similar bioavailablities as the diltizem solution.

51. P. Kanagale et al,(2007)\textsuperscript{66} developed formulation and optimization of porous osmotic pump based controlled release system of oxybutynin, The porous osmotic pump contains pore-forming water-soluble additives in the coating membrane, which after coming in contact with water, dissolve, resulting in an in situ formation of a microporous structure.

52. Encarnacion M., et al,(1994)\textsuperscript{67} studied salivary nystatin concentration after administration of an osmotic controlled release tablet and pastille. Mucosal oral therapeutic system (MOTS) is a controlled-release osmotic system for oral cavity therapy. MOTS(nystatin) is designed to deliver approximately 200,000 units of nystatin over several hours. A crossover study was conducted in five healthy volunteers to evaluate the amount of nystatin released (based on residual drug content) when the system is held in the mouth for 30 min, 1 h, and 2 h, and to compare these concentrations with those achieved with a Mycostatin(nystatin) pastille.
53. Okimoto K. et al, (1999) developed osmotic pump tablet for chlorpromazine using (SBE)βm β-CD. Chlorpromazine free base (CLP) was chosen as a model drug for this study. The release of CLP from osmotic pump tablet was studied in-vitro. In-vivo absorption of CLP from the osmotic pump tablet was evaluated in male beagle dogs.

54. Philip A. et al,(2006) studied osmotic flow through asymmetric membrane for controlled delivery of drugs with varying solubility. A non disintegrating, controlled release, asymmetric membrane capsular system of flurbiprofen was developed and evaluated for controlled release of the drug to overcome some of its side effects. Asymmetric membrane capsules were prepared using fabricated glass mold pins by phase inversion process. The effect of different formulation variables was studied based on 23 factorial design; namely, level of osmogen, membrane thickness, and level of pore former.

55. Stella J., et al,(1998) studied Release of testosterone from an osmotic pump tablet utilizing (SBE)βm -β-cyclodextrin as both a solubilizing and an osmotic pump agent. The release of testosterone, a poorly water soluble drug (0.039 mg/ml at 37°C), was evaluated using a new model device. The effect of (SBE)βm -β -CD as the solubilizing and osmotic pump agent was compared with hydroxypropyl-β-cyclodextrin (HP- β -CD)7m, neutral cyclodextrin, and a sugar mixture (osmotic agent only). Testosterone release from the device was significantly faster with (SBE)βm -β -CD than with HP- β -CD or the sugar mixture. The solubility of testosterone in the device increased to 76.7 7m mg/ml through complexation with (SBE)βm –β -CD in the imibed water.

56. Waterman K., et al,(2009) developed extrudable core system, tablet has been developed which osmotically delivers high doses of low solubility active pharmaceutical ingredients (API's). The tablet has a single core formed in a modified oval shape with a semi-permeable coating. The core contains hydroxyethylcellulose, which serves to entrain the API particles as they are extruded out a hole in the coating at one end of the tablet, and a sugar, which provides the osmotic driving force for water imbibing.
57. Mehramizi A., et al (2007)\(^7\) prepared the elementary osmotic pumps with lovastatin β-cyclodextrin complex with cellulose acetate and polyethylene glycol as plasticizer. The effect of the β-cyclodextrin molar ratio on enhancement of lovastatin dissolution rate and the influences of various parameters on drug release profiles were investigated. The results confirmed that dissolution rate of lovastatin β-cyclodextrin complex were greatly enhanced and this system has suitable solubility behavior in elementary osmotic pumps tablet formulations.\(^6\)

58. Hui L. et al, (2007)\(^7\) prepared A microbially triggered colon-targeted osmotic pump (MTCT-OP) of budesonide. The scanning electron microscopy (SEM) study and the calculation of membrane permeability were applied to elucidate the mechanism of MTCT-OP. The effects of different formulation variables, including the level of pH-regulating excipient(citric acid) and the amount of chitosan in the core, the weight gain of semi permeable membrane and enteric-coating membrane, and the level of pore former (chitosan) in the semi permeable membrane, have been studied. These results showed that MTCT-OP based on osmotic technology and microbially triggered mechanism had a high potential for colon-specific drug delivery.

59. Yueqi B. et al (2007)\(^7\), developed controlled porosity of osmotic pump system with biphasic release of theophylline. The developed system was composed of a tablet-in-tablet (TNT) core and a controlled porosity coating membrane. Micro-environmental osmotic pressure decreased and micro-environmental pH increased continuously during the whole dissolution process, theophylline release was dominated by the successive dissolution of sodium chloride and sodium phosphate.

60. Shokri J., et al,(2008)\(^7\) formulated a swellable elementary osmotic pump tablet for efficient delivery of poorly water-soluble/practically insoluble drugs. Tablets were prepared by compressing the mixture of micronized drug and excipients into convex tablets. The results showed that the swellable elementary osmotic pump can be a very effective device for the delivery of poorly water-soluble drug with zero order patterns.
61. Zenter GM. And Thombre AG. et al(1985,89)\textsuperscript{76,77} investigated the zero order release of water soluble, osmotically active agents from tablets coated with controlled porosity walls. The walls were sponge-like in appearance and substantially permeable to both water and dissolved solutes. The rate of release was a function of the wall thickness, level of bleachable additives incorporated, and permeability of the polymer component of the walls, the total solubility of the core tablet, the drug load, and the osmotic pressure difference across the wall. Release was insensitive to the pH and degree of agitation in the receptor media. Release was primarily due to an osmotic pumping mechanism with diffusion playing a minor role.

62. Vyas S. et al.(1985)\textsuperscript{78} developed an elementary osmotic pump of Ciprofloxacin hydrochloride. The in vitro release was carried out in a simulated gastric fluid for first 2 hours and simulated intestinal fluid for other 6 hours.

63. Okimoto K. et al.(1999)\textsuperscript{79} developed a controlled porosity osmotic pump of testosterone by using β-cyclodextrine as both solubilizing and osmotic pumping agent. The coating membrane was composed of 59.3% cellulose acetate, 29.6% sorbitol and 11.1% of PEG-400. The final concentration of 3.34% (w/w) in dichloromethane- methanol- water (3/2/0.2, w/ w/ w).

64. Longxiao L. et al.,(2007)\textsuperscript{80} prepared an osmotic pump system for prazosin hydrochloride by coating the core tablet. The osmotic pump system was obtained by coating the indented core tablet compressed by the punch with a needle. The influences of the indentation size of the core tablet, environmental media, and agitation rate on drug release profile were investigated. The optimal osmotic pump tablet was found to deliver prazosin hydrochloride at an approximately constant rate up to 24 hours, and independent on both release media and agitation rate. Indentation size of core tablet hardly affected drug release in the range of 0.8 0-1. 15mm.

65. Mishra B. etal (2006)\textsuperscript{81} Formulated and evaluated oral osmotic pumps of pentazocine HCl that are expected to deliver the drug as solution for prolonged period of time with reduced frequency of drug administration and reduced side effects. Push-Pull osmotic pumps of pentazocine HCl were prepared using different formulation variables like diameter of pores, presence of surfactant in
formulation core, addition of osmopolymer pectin and presence/absence of water-soluble polymer (carboxymethylcellulose sodium). Fabricated osmotic pumps were evaluated for weight variation, coating thickness, pore diameter, drug content and in vitro release studies. Release rates were found to be independent of size of pores, agitation intensity, and pH of the release medium. The presence of surfactant, water-soluble polymer and osmopolymer (pectin) affected the drug release significantly. Almost all the osmotic pumps gave controlled and prolonged drug release profiles beyond 2 h of lag phase.

66. Pana et al.(2004)\(^2\) prepared a controlled release effervescent osmotic pump tablet (EOPT) of Traditional Chinese Medicine Compound Recipe (TCMCR), named Fuzilizhong, was successfully prepared with sodium chloride, sodium hydrogen carbonate and hydroxypropyl methylcellulose (HPMC) as osmotic agents. Since the osmotic pressure in EOPT with sodium chloride and sodium hydrogen carbonate increased greatly, which was induced mostly by gas carbon dioxide generating from the reaction of sodium hydrogen carbonate and the acidic drugs in TCMCR after the fluid being imbibed into the compartment through the semipermeable membrane and the in vitro accumulative dissolution percent from prescription 3 was up to 96.6% at 14 hour.

67. Ouyang et al.(2005)\(^3\) prepared a simple elementary osmotic pump (EOP) system that could deliver metforminhydrochloride(MT) and glipizide(GZ) simultaneously for extended periods of time was developed in order to reduce the problems associated with multidrug therapy of type-2 non-insulin-dependent diabetes mellitus. Good sustained effect in comparison with the conventional product. The prototype design of the system could be applied to other combinations of drugs used for cardiovascular diseases, diabetes, etc.

68. Zhihong Zhang et al.(2009)\(^4\) Designed and Evaluated a Novel Floating Osmotic Pump System of Dipyridamol. matrix tablets were prepared for compares. The effects of pH, temperature and hydrodynamic conditions on drug release and the floating behavior of floating osmotic pump system (FOP) was investigated. In vivo valuation was performed by a three-crossover study in six Beagle dogs relative to the conventional tablet. Cumulative percent input in vivo was compared with that of in vitro release.
69. Mitrevej et al. (2003)85 developed Salbutamol elementary osmotic pump (EOP) tablets and fundamental variables affecting their release characteristics were evaluated. The effects of film thickness and compression force on drug release from the tablets containing fixed amount of sodium chloride used as osmogent were evaluated. The core tablets were directly compressed at four compression forces and coated with 3% wt/vol cellulose acetate in acetone to levels of 2%, 3%, and 4% wt/wt. Coated tablets were drilled with CO₂ laser beam to form drug delivery orifice of approximately 400 microm in diameter. The drug release was found to follow zero order fashion.

70. Razaghi et al. (2002)86 developed a Osmotically rupturable systems and the release of cyclobenzaprine hydrochloride (model drug) from the systems was investigated. Systems were designed using mannitol (osmotic agent) and increasing amounts of polyethylene oxide (PEO, a water-swellable polymer) surrounded by a semipermeable membrane. When placed in an aqueous environment, osmotic water imbibition into the systems distended and swelled the systems until the membrane ruptured and released the active compound to the outside environment. Tablets with increasing amount of PEO exhibited longer rupture times.

71. Gan Y. et al. (2003)87 developed poorly soluble glipizide was selected as the model drug to prepare osmotic pump tablets (OPT) with proper accessorrial material after it was made an inclusion complex by kneading method in order to increase solubility. Polyethylene glycol 4000 (PEG4000) and cellulose acetate (CA) were selected as the coating materials, and acetone–water (95:5) co-solvent was employed as the coating medium. The effects of the osmotic promoting agent, diameter of the drug-releasing orifice, coating composition, and coat weight on the drug release profile were investigated. The drug release profile of the optimal formulation was compared with a commercialized push–pull osmotic tablet. The results indicated that glipizide–cyclohextrin inclusion complex OPT had excellent zero-order release characteristics in vitro.

72. Rao B. et al., (2009)88 Developed swellable controlled porosity osmotic pump tablet of theophylline and studied the formulation and process variables responsible for drug release by applying statistical optimization technique. Drug
release from the osmotic drug delivery system was studied using USP Type I paddle type apparatus. The membrane morphology of the delivery system was determined by scanning electron microscopy (SEM). Optimization results indicated that the release rate of theophylline from the swellable controlled porosity osmotic pump tablet is directly proportional to the levels of osmotic agent, solubilizing agent and pore former in the tablet core and the membrane, respectively. SEM showed the formation of pores in the membrane through which drug release occurred. The best formulation showed 98.2 % drug release and complied with USP requirements.

73. Vamshi K., et al. (2010) Developed Elementary Osmotic Pump (EOP) tablets of metformin Hcl. Linear and reproducible release similar to that of Fortamet® ER 1000 mg tablets was achieved for optimized formulation (f2 >50) independent of hydrodynamic conditions. The effect of different formulation variables, namely, ratio of drug to osmogent, membrane weight gain, and level of pore former on the in vitro release was studied. The drug release by Metformin HCl ER tablets by osmotic technology is around 85% in 20 hrs. The optimized formulations were subjected to stability studies as per International Conference on Harmonisation (ICH) guidelines and formulations were stable after a 3 month study.

74. Patel H. et al, (2010) prepared and evaluated an osmotically controlled mucoadhesive cup-core (OCMC) containing aceclofenac. A special technique was used while preparing an OCMC. Stability of OCMC was determined in natural human saliva, and it was found that both pH and device are stable in human saliva. OCMC was evaluated by weight uniformity, thickness, hardness, friability, swelling, mucoadhesive strength and in vitro drug release. Swelling index was higher with formulations containing hydroxypropyl methylcellulose (HPMC) K4M alone, and it decreases with its decreasing concentration in the OCMC. The in vitro drug release studies showed a release with the composition of formulation up to 12 h. The mechanism of drug release was found to be zero order kinetics with diffusion controlled drug release. It has shown significant anti-inflammatory activity (P<0.001) and no hypersensitive reaction. It can be concluded that by changing the content of OCMC system, a desire effect is generated and it overcomes the drawback associated with the conventional buccal adhesive tablet.
75. Khan Z. et al (2011)\textsuperscript{91} investigated the feasibility of the design of a novel floating elementary osmotic pump tablet (FEOPT) to prolong the gastric residence of a highly water-soluble drug. Diethylcarbamazine citrate (DEC) was chosen as a model drug. The FEOPT consisted of an osmotic core (DEC, mannitol, and hydrophilic polymers) coated with a semipermeable layer (cellulose acetate) and a gas-generating gelling layer (sodium bicarbonate, hydrophilic polymers) followed by a polymeric film (Eudragit RL 30D). The integrity of the orifice and polymeric film layer was confirmed from scanning electron microscopy image. All the developed FEOPT showed floating lag time of less than 8 min and floating duration of 24 h. The formulations were found to be stable up to 3 months of stability testing at 40°C/75% relative humidity.

76. Muthhar R. et al, (2011)\textsuperscript{92} design and evaluate a new Elementary Osmotic Pump (EOP) for efficient delivery of Poorly Water-Soluble Drugs (PWSDs). Drug release from the new system called Expandable EOP (EEOP), is through a porous semipermeable membrane in the form of a suspension ready for dissolution and absorption. EEOP tablets were prepared by compressing the mixture of drug and excipient in to convex tablets. PWS antidyslipidemic drug Nicotinic acid (NA) is used as model drug. Guar gum (GG) is used as an osmotic, suspending and expanding agent and cellulose acetate as Semipermeable Membrane (SPM) containing Polyethylene glycol (PEG) as plasticizer. The effect on the in vitro dissolution profile of NA was examined using varying GG percentage content in the formulations. The influences of GG, PEG and SPM thickness on the NA release profiles of optimal tablet were the focus of study.

77. Srinivas I. et al (2012)\textsuperscript{93} prepared elementary osmotic pump-based drug delivery systems of Glibenclamide. The elementary osmotic pump (EOP) consists of an osmotic core with the drug surrounded by a semipermeable membrane drilled with a delivery orifice through which drug releases where as in controlled porosity osmotic pump drug release is accomplished by the use of pore forming agents in the coating. It was found that drug release rate increased with the amount of osmotic agent due to the increased water uptake, and hence increased driving
force for drug release. Sodium chloride containing formulations showed highest drug release compared to mannitol due to high osmotic pressure. The release profile of formulation was fitted to different kinetic models and it was found to follow zero order kinetics. The optimized formulation was characterized by differential scanning calorimetry (DSC) and scanning electron microscopy (SEM).

78. Sheaikh S. et al (2013)\textsuperscript{94} designed osmotically driven oral drug delivery system containing Pantoprazole as an active ingredient that inhibits gastric acid secretion by inhibiting H\textsuperscript{+}-K\textsuperscript{+} ATPase (proton-pump) activity. In most of the conventional dosage form Pantoprazole is degraded due to gastric acid therefore it is available in the enteric coated form. The core tablet containing drug is prepared and coated with cellulose acetate polymer.

79. Parekh D., et al, (2013)\textsuperscript{95} formulated solid dosage form system (tablets) for Trimetazidine dihydrochloride (TDH) using the principles of osmosis which will bring down its dosing frequency to once a day and at the same time produce a zero-order release system. Optimization study of HPMC K4M, Carbopol 71G, Osmogen (Mannitol and sodium chloride) and coating composition was done by varying the proportion of each in various formulations (MT1 to MT20) and analysing the release profile kinetics. Comparison of the release profiles of each formulations was made with the theoretically calculated target release profile using the f\textsubscript{1} (Difference Factor) and f\textsubscript{2} (Similarity factor). Formulation MT20 was selected as the final optimized formulation for monolayer osmotic drug delivery system. It showed an almost perfect zero order release ($r_2 = 0.995$) and almost 100% release after 24 hours.

80. Johri U., et al, (2012)\textsuperscript{96} developed Elementary Osmotic Pump (EOP) Tablets for controlled zero order delivery of Sodium Fluoride (NaF) as an inorganic therapeutic agent. The EOP tablets coated with cellulose Acetate (CA) semi-permeable membrane has exhibited zero-order release of NaF. The Osmotic pump tablets coated with microporous membrane delivered the NaF with first order release rate. The NaF EOP tablet with NaCL in core composition has showed more sustained release of NaF than EOP tablets without NaCL. The significantly
more sustained delivery of NaF from EOP tablet may be attributed to the common ion effect produced because of Na+ common ion in both NaF and NaCl. Hence common ion effect can be utilized in EOP tablets to have more sustained delivery of inorganic therapeutic agent and to achieve its targeted delivery rate by using optimized quantity of common ion salt.