List of Tables

Table 1: Major constituents of typical domestic wastewater (page no. 6)

Table 2: Possible levels of pathogens in wastewater (page no. 8)

Table 3: Government regulations and PCB standards for discharge of sewage (page no. 19)

Table 4: Evaluation of raw sewage for various physico-chemical parameters for 10 successive days (page no. 418)

Table 5: Colony forming units produced by individual microorganisms on nutrient agar medium after adaptation to sterilized sewage (page no. 419)

Table 6: Effect of *Bacillus megatherium* and *Nitrosomonas sps.*, as inoculum @ 1% in the domestic sewage treatment (page no. 420)
Table 7: *Nitrobacter* sps., and *Pseudomonas denitrificans* effect as 1% inoculum in domestic sewage treatment (page no. 421)

Table 8: 1% inoculum of *Chromatium* sps., and *Bacillus mucilaginosus* effect in the treatment of domestic sewage (page no. 422)

Table 9: *Lactobacillus acidophilus* and *Bacillus licheniformis* effect in the treatment of domestic sewage (page no. 423)

Table 10: Effect of *Rhodobacter terrae* and *Thiobacillus ferrooxidans* in domestic sewage treatment (page no. 424)

Table 11: % of consortium effect in domestic sewage treatment (page no. 425)

Table 12: Effect of 0.2 % and 0.3 % consortium in domestic sewage treatment (page no. 426)
Table 13: Effect of 0.4 % and 0.5% consortium in domestic sewage treatment (page no. 427)

Table 14: 4 hours and 8 hours HRT effect in domestic sewage treatment with 0.2% consortium (page no. 428)

Table 15: 12 hours and 16 hours HRT effect in domestic sewage treatment with 0.2% consortium (page no. 429)

Table 16: Effect of 20 hours and 24 hours HRT with 0.2% consortium in domestic sewage treatment (page no. 430)

Table 17: Effect of stones as biofilter material in 10% and 20% volumes along with 0.2% consortium and 12 hours HRT in domestic sewage treatment (page no. 431)

Table 18: 30% volume and 40 % volume of stones as biofilter material effect along with 0.2%
consortium and 12 hours HRT effect in domestic sewage treatment (page no. 432)

Table 19: Effect of 8 hours HRT, 9 HRT with 10% volume of granite stones and 0.2% consortium in domestic sewage treatment (page no. 433)

Table 20: 10 hours HRT and 11 hours HRT effect with 10% volume of granite stones and 0.2% consortium in domestic sewage treatment (page no. 434)

Table 21: 12 hours HRT effect with 10% volume of granite stones and 0.2% consortium in domestic sewage treatment (page no. 435)

Table 22: Time period of 10 days and 20 days effect in domestic sewage treatment along with 10% volume of granite stones, 0.2% consortium and 12 hours HRT (page no. 436)
Table 23: Effect of 30 days time period and 40 days time period in domestic sewage treatment along with 10% volume of granite stones, 0.2% consortium and 12 hours HRT (page no. 437)

Table 24: 50 days time period and 60 days time period effect in domestic sewage treatment along with 10% volume of granite stones, 0.2% consortium and 12 hours HRT (page no. 438)

Table 25: Effect of clay balls as biofilter material in 10% and 20% volumes along with 0.2% consortium and 12 hours HRT in domestic sewage treatment (page no. 439)

Table 26: 30% volume and 40% volume of clay balls effect as biofilter material along with 0.2% consortium and 12 hours HRT for domestic sewage treatment (page no. 440)
Table 27: 8 hours HRT and 9 hours HRT effect in domestic sewage treatment in the presence of 30% volume of clay balls and 0.2% consortium (page no. 441)

Table 28: 10 hours HRT and 11 hours HRT effect in domestic sewage treatment along with 30% volume of clay balls and 0.2% consortium (page no. 442)

Table 29: 12 hours HRT effect in presence of 30% volume of clay balls and 0.2% consortium for domestic sewage treatment (page no. 443)

Table 30: Time period of 10 days and 20 days effect in domestic sewage treatment along with 30% volume of clay balls, 0.2% consortium and 10 hours HRT (page no. 444)

Table 31: 30 days and 40 days time period effect along with 30% volume of clay balls, 0.2%
consortium and 10 hours HRT for domestic sewage treatment (page no. 445)

Table 32: 50 days and 60 days time period effect along with 30% volume of clay balls, 0.2% consortium and 10 hours HRT for domestic sewage treatment (page no. 446)

Table 33: 10% and 20% volume of sintered glass cylinders effect as biofilter material in the presence of 0.2% consortium and 12 hours HRT for domestic sewage treatment (page no. 447)

Table 34: 30% and 40% volume of sintered glass cylinders as biofilter material effect along with 0.2% consortium and 12 hours HRT for domestic sewage treatment (page no. 448)

Table 35: 8 hours and 9 hours HRT effect along with 30% volume of sintered glass cylinders and
0.2% consortium for domestic sewage treatment (page no. 449)

Table 36: 10 hours and 11 hours HRT effect in presence of 30% volume of sintered glass cylinders and 0.2% consortium for domestic sewage treatment (page no. 450)

Table 37: 12 hours HRT, 30% volume of sintered glass cylinders and 0.2% consortium effect in domestic sewage treatment (page no. 451)

Table 38: 10 days and 20 days time period effect along with 30% volume of sintered glass cylinders, 0.2% consortium and 10 hours HRT for domestic sewage treatment (page no. 452)

Table 39: 30 days and 40 days time period effect along with 30% volume of sintered glass cylinders, 0.2% consortium and 10 hours HRT for domestic sewage treatment (page no. 453)
Table 40: 50 days and 60 days time period effect along with 30% volume of sintered glass cylinders, 0.2% consortium and 10 hours HRT for domestic sewage treatment (page no. 454)

Table 41: 10% and 20% volume of corn cobs effect as biofilter material along with 0.2% consortium and 12 hours HRT for domestic sewage treatment (page no. 455)

Table 42: Effect of 10% and 20% volume of hollow cylindrical corn cobs as biofilter material in the presence of 0.2% consortium and 12 hours HRT for domestic sewage treatment (page no. 456)

Table 43: Effect of 30% and 40% volume of hollow cylindrical corn cobs as biofilter material in the presence of 0.2% consortium and 12 hours HRT for domestic sewage treatment (page no. 457)
Table 44: 8 hours and 9 hours HRT effect along with 20% volume of hollow cylindrical corncobs and 0.2% consortium for domestic sewage treatment (page no. 458)

Table 45: 10 hours and 11 hours HRT effect along with 20% volume of hollow cylindrical corncobs and 0.2% consortium for domestic sewage treatment (page no. 459)

Table 46: 12 hours HRT effect in domestic sewage treatment along with 20% volume of hollow cylindrical corncobs and 0.2% consortium (page no. 460)

Table 47: 10 days and 20 days time period in domestic sewage treatment along with 20% volume of hollow cylindrical corncobs, 0.2% consortium and 9 hours HRT (page no. 461)

Table 48: 30 days and 40 days time period in domestic sewage treatment along with 20% volume of
hollow cylindrical corncobs, 0.2% consortium and 9 hours HRT (page no. 462)

Table 49: 50 days and 60 days time period effect in domestic sewage treatment along with 20% volume of hollow cylindrical corncobs, 0.2% consortium and 9 hours HRT (page no. 463)

Table 50: 10% volume and 20% volume of wood chips effect in domestic sewage treatment in presence of 0.2% consortium and 12 hours HRT (page no. 464)

Table 51: 30% volume and 40% volume of wood chips effect in domestic sewage treatment in presence of 0.2% consortium and 12 hours HRT (page no. 465)

Table 52: 8 hours and 9 hours HRT effect in presence of 30% volume of wood chips and 0.2% consortium for domestic sewage treatment (page no. 466)
Table 53: 10 hours and 11 hours HRT effect in presence of 30% volume of wood chips and 0.2% consortium for domestic sewage treatment (page no. 467)

Table 54: 12 hours HRT effect in presence of 30% volume of wood chips and 0.2% consortium for domestic sewage treatment (page no. 468)

Table 55: 10 days and 20 days time period effect in presence of 30% volume of wood chips, 0.2% consortium and 10 hours HRT for domestic sewage treatment (page no. 469)

Table 56: 30 days and 40 days time period effect in presence of 30% volume of wood chips, 0.2% consortium and 10 hours HRT for domestic sewage treatment (page no. 470)

Table 57: 50 days and 60 days time period effect in presence of 30% volume of wood chips, 0.2%
consortium and 10 hours HRT for domestic sewage treatment (page no. 471)

Table 58: 10% volume and 20% volume of nylon threads effect in domestic sewage treatment with 0.2% consortium and 12 hours HRT (page no. 472)

Table 59: 30% volume and 40% volume of nylon threads effect in domestic sewage treatment with 0.2% consortium and 12 hours HRT (page no. 473)

Table 60: 8 hours and 9 hours HRT effect along with 30% volume of nylon threads and 0.2% consortium for domestic sewage treatment (page no. 474)

Table 61: 10 hours and 11 hours HRT effect along with 30% volume of nylon threads and 0.2% consortium for domestic sewage treatment (page no. 475)
Table 62: 12 hours HRT effect along with 30% volume of nylon threads and 0.2% consortium for domestic sewage treatment (page no. 476)

Table 63: 10 days and 20 days time period effect in domestic sewage treatment along with 30% volume of nylon threads, 0.2% consortium and 9 hours HRT (page no. 477)

Table 64: 30 days and 40 days time period effect in domestic sewage treatment along with 30% volume of nylon threads, 0.2% consortium and 9 hours HRT (page no. 478)

Table 65: 50 days and 60 days time period effect in domestic sewage treatment along with 30% volume of nylon threads, 0.2% consortium and 9 hours HRT (page no. 479)
Table 66: 10% volume and 20% volume of plastic balls effect in presence of 0.2% consortium and 12 hours HRT for domestic sewage treatment (page no. 480)

Table 67: 30% volume and 40% volume of plastic balls effect in presence of 0.2% consortium and 12 hours HRT for domestic sewage treatment (page no. 481)

Table 68: 8 hours and 9 hours HRT effect along with 10% volume of plastic balls and 0.2% consortium for domestic sewage treatment (page no. 482)

Table 69: 10 hours and 11 hours HRT effect along with 10% volume of plastic balls and 0.2% consortium for domestic sewage treatment (page no. 483)
Table 70: 12 hours HRT effect along with 10% volume of plastic balls and 0.2% consortium for domestic sewage treatment (page no. 484)

Table 71: 10 days and 20 days time period effect in domestic sewage treatment along with 10% volume of plastic balls, 0.2% consortium and 12 hours HRT (page no. 485)

Table 72: 30 days and 40 days time period effect in domestic sewage treatment along with 10% volume of plastic balls, 0.2% consortium and 12 hours HRT (page no. 486)

Table 73: 50 days and 60 days time period effect in domestic sewage treatment along with 10% volume of plastic balls, 0.2% consortium and 12 hours HRT (page no. 487)

Table 74: Effect of granite stones as biofilter material with 10% volume, 0.2% consortium and 12
hours HRT for 60 days time period for domestic sewage treatment (page no. 488)

Table 75: Effect of clay balls as biofilter material in domestic sewage treatment with 30% volume, 0.2% consortium and 10 hours HRT for 30 days time period (page no. 489)

Table 76: Effect of sintered glass cylinders as biofilter material with 30% volume, 0.2% consortium and 10 hours HRT for 30 days time period for domestic sewage treatment (page no. 490)

Table 77: Effect of corn cobs as biofilter material in domestic sewage treatment with 20% volume, 0.2% consortium and 9 hours HRT for 40 days time period (page no. 491)

Table 78: Effect of wood chips as biofilter material with 30% volume, 0.2% consortium and 10 hours
HRT for 50 days time period for domestic sewage treatment (page no. 492)

Table 79: Effect of nylon threads as biofilter material in domestic sewage treatment in presence of 30% volume, 0.2% consortium and 9 hours HRT for 60 days time period (page no. 493)

Table 80: Effect of plastic balls as biofilter material with 10% volume, 0.2% consortium and 12 hours HRT for 60 days time period for domestic sewage treatment (page no. 494)

Table 81: Effect of various filter media on food to microorganism (F/M) ratio during the treatment of domestic sewage (page no. 495)

Table 82: Rf values of proteins extracted from molecular marker, biofilm, consortium, raw sewage and treated sewage in SDS PAGE (page no. 496)

Table 83: Molecular Weight values of samples (page no. 497)
List of Images and Figures

Image 1: Sample collection at sewage treatment plant, vijayawada (page no. 498)

Image 2: Surface area calculation of corn cob (page no. 499-502)

Image 3: Unprocessed natural biofilter material – granite stones (page no. 503)

Image 4: Processed natural biofilter material – clay balls (page no. 504)

Image 5: Natural processed biofilter material – sintered glass cylinders (page no. 505)

Image 6: Biogenic biofilter material – corn cobs (page no. 506)

Image 7: Biofiltration system setup using corn cobs as biofilter material (page no. 506)

Image 8: Biogenic biofilter material – woodchips (page no. 507)

Image 9: Synthetic biofilter material – nylon threads (page no. 508)

Image 10: Synthetic biofilter material – plastic balls (page no. 509)
Fig.1: Concentration effect of microbial consortium on pollutant removal efficiency (page no. 510)

Fig.2: Hydraulic retention time (HRT) effect on pollutant removal efficiency (page no. 511)

Fig.3: Volume % effect on removal efficiency of pollutants in presence of granite stones as biofilter material, 0.2% inoculum and 12 hours HRT (page no. 512)

Fig.4: HRT effect on removal efficiency of pollutants in presence of 10% volume of granite stones as biofilter material, 0.2% inoculum (page no. 513)

Fig.5: Time period effect on removal efficiency of pollutants in presence of 10% volume of granite stones as biofilter material, 0.2% inoculum & 12 hours HRT (page no. 514)

Fig.6: Effect of % of volume on removal efficiency of pollutants in presence of clay balls as biofilter material, 0.2% inoculum & 12 hours HRT (page no. 515)

Fig.7: HRT effect on removal efficiency of pollutants in presence of 30% volume of clay balls as biofilter material & 0.2% inoculum (page no. 516)
Fig. 8: Time period effect on removal efficiency of pollutants in presence of 30% volume of clay balls as biofilter material & 0.2% inoculum and 10 hours HRT (page no. 517)

Fig. 9: Effect of % of volume on removal efficiency of pollutants in presence of sintered glass cylinders as biofilter material & 0.2% inoculum and 12 hours HRT (page no. 518)

Fig. 10: HRT effect on removal efficiency of pollutants in presence of 30% volume of sintered glass cylinders as biofilter material & 0.2% inoculum (page no. 519)

Fig. 11: Time period effect on removal efficiency of pollutants in presence of 30% volume of sintered glass cylinders as biofilter material, 0.2% inoculum & 10 hours HRT (page no. 520)

Fig. 12: Effect of % of volume on removal efficiency of pollutants in presence of corn cobs as biofilter material, 0.2% inoculum & 12 hours HRT (page no. 521)

Fig. 13: HRT effect on removal efficiency of pollutants in presence of 20% volume of corn cobs as biofilter material & 0.2% inoculum (page no. 522)
Fig.14: Time period effect on removal efficiency of pollutants in presence of 20% volume of corn cobs as biofilter material, 0.2% inoculum & 9 hours HRT (page no. 523)

Fig.15: Effect of % of volume on removal efficiency of pollutants in presence of wood chips as biofilter material, 0.2% inoculum & 12 hours HRT (page no. 524)

Fig.16: HRT effect on removal efficiency of pollutants in presence of 30% volume of wood chips as biofilter material & 0.2% inoculum (page no. 525)

Fig.17: Time period effect on removal efficiency of pollutants in presence of 30% volume of wood chips as biofilter material, 0.2% inoculum & 10 hours HRT (page no. 526)

Fig.18: Effect of % of volume on removal efficiency of pollutants in presence of nylon threads as biofilter material, 0.2% inoculum & 12 hours HRT (page no. 527)

Fig.19: HRT effect on removal efficiency of pollutants in presence of 30% volume of nylon threads as biofilter material & 0.2% inoculum (page no. 528)
Fig.20: Time period effect on removal efficiency of pollutants in presence of 30% volume of nylon threads as biofilter material, 0.2% inoculum & 9 hours HRT (page no. 529)

Fig.21: Effect of % of volume on removal efficiency of pollutants in presence of plastic balls as biofilter material, 0.2% inoculum & 12 hours HRT (page no. 530)

Fig.22: HRT effect on removal efficiency of pollutants in presence of 10% volume of plastic balls as biofilter material & 0.2% inoculum (page no. 531)

Fig.23: Time period effect on removal efficiency of pollutants in presence of 10% volume of plastic balls as biofilter material, 0.2% inoculum & 12 hours HRT (page no. 532)

Fig.24: Variations in pH in the presences of various filter media during the sewage treatment process (page no. 533)

Fig.25: Electric conductivity variations with various filter media during the sewage treatment process (page no. 534)

Fig. 26: Effect of various filter media on removal efficiency of total suspended solids (page no. 535)
Fig. 27: Filter media effect on removal efficiency of volatile suspended solids (page no. 536)

Fig. 28: Removal efficiency of chlorides in presence of various filter media (page no. 537)

Fig. 29: Hardness removal efficiency with various filter media (page no. 538)

Fig. 30: Alkalinity removal efficiency in presence of various filter media (page no. 539)

Fig. 31: Chemical oxygen demand elimination efficiency of various filter media (page no. 540)

Fig. 32: Effect of various filter media on removal efficiency of biochemical oxygen demand (page no. 541)

Fig. 33: Total nitrogen removal efficiency of various filter media (page no. 542)

Fig. 34: Ammonical nitrogen removal by various filter media (page no. 543)

Fig. 35: Nitrite nitrogen removal by various filter media (page no. 544)

Fig. 36: Nitrate nitrogen removal by various filter media (page no. 545)
Fig. 37: Kjeldhal nitrogen removal by various filter media (page no. 546)

Fig. 38: Effect of various filter media on removal efficiency of phosphorus (page no. 547)

Fig. 39: Oil & grease removal efficiency of various filter media (page no. 548)

Fig. 40: Hydrogen sulphide removal efficiency of various filter media (page no. 549)

Fig. 41: Sludge volume index removal efficiency of various filter media (page no. 550)

Fig. 42: Effect of volume of biofilter materials on removal efficiency of biochemical oxygen demand (page no. 551)

Fig. 43: Hydraulic retention time effect in presence of biofilter materials on removal efficiency of biochemical oxygen demand (page no. 552)

Fig. 44: Time period effect on removal efficiency of biochemical oxygen demand along with various biofilter materials (page no. 553)

Fig. 45: Effect of various filter media on food to microbe ratio (page no. 554)
Fig. 46: Surface of corn cob showing bacterial species at 1000 X (page no. 555)

Fig. 47: Bacterial species at 8000 X on the surface of corn cob (page no. 556)

Fig. 48: Various species of bacteria on the surface of corn cob at 10000 X (page no. 557)

Fig. 49: Bacterial species on the surface of nylon thread at 3000 X (page no. 558)

Fig. 50: Surface of nylon thread showing bacterial species at 6000 X (page no. 559)

Fig. 51: Bacterial species on the surface of nylon thread at 10000 X (page no. 560)

Fig. 52: Biofilm on corn cobs (page no. 561)

Fig. 53: Biofilm formation on nylon threads (page no. 562)

Fig. 54: Matrix of corn cob (page no. 563)

Fig. 55: Surface of Nylon threads (page no. 564)

Fig. 56: SDS-PAGE of proteins from biofilm, consortium, raw sewage and treated sewage (page no. 565)
Fig. 57: Rf values of proteins extracted from molecular marker, biofilm, consortium, raw sewage and treated sewage in SDS PAGE (page no. 566)

Fig. 58: Mass spectrum of protein sample from raw sewage in positive mode (page no. 567)

Fig. 59: Mass spectrum of protein sample from raw sewage in negative mode (page no. 568)

Fig. 60: Treated sewage sample mass spectrum in positive mode (page no. 569)

Fig. 61: Treated sewage sample mass spectrum in negative mode (page no. 570)

Fig. 62: Mass spectrum of protein sample from consortium in positive mode (page no. 571)

Fig. 63: Mass spectrum of protein sample from consortium in negative mode (page no. 572)

Fig. 64: Mass spectrum of protein sample from biofilm in positive mode (page no. 573)

Fig. 65: Mass spectrum of protein sample from biofilm in negative mode (page no. 574)