MSc Theses Abstract

Master of Science in

Sustainable Water Sanitation Health and Development

Published by

Center for Applied Research and Development (CARD)
2013

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Published by
Center for Applied Research and Development (CARD)
Ananda Niketan, Institute of Engineering, Pulchowk Campus,
Tribhuvan University, Nepal
G.P.O. Box: 1915
Phone: 977-1-5521310

Design
Aadhaar Group Pvt. Ltd., Kupondole, Nepal
E-mail: info@aadhaargroup.com.np

Print

Padma Press, Kirtipur, Kathmandu, Nepal

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Graduation Year 2010

Thesis Title: **COMPARISON OF PREFERENTIAL FLOW OF SOLUTE IN POROUS MEDIA WITH DARCY'S FLOW**

Submitted by: **Indra Narayan Shrestha**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

Vertical flow of solute in porous media (preferential flow) is studied and compared with Darcy's flow. The methodology used for the study is experimental. The laboratory model used is similar to Darcy apparatus with slight modification. The study has compare measured time of first reach of solute with computed time based on Darcy's average velocity.

The laboratory model consists of 150 mm diameter HDPE pipe of 750 mm height filled with uniform sand. Nine sets of experiment is conducted with 3 types of sand (D_{10}= 0.6 mm and C_u 1.42, D i o = 0.11mm and C_u 1.55, D_{10} = 0.3 mm and C_u 1.4) and 3 types of brine concentration (5 %, 10 %, 20 % by wt. brine solution). Brine solution is found to be 1.13 to 1.84 times faster than average velocity of flow as a result of preferential flow.

Graduation Year 2011

Thesis Title: **WASTE WATER FERMENTATION USING YEAST**

Submitted by: **Nitish Maharjan**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

Water pollution occurs mainly due to dumping of liquid wastes into the water bodies which aggravates drinking water problem. The polluted water is harmful to human and aquatic lives and needs treatment to make it suitable for drinking and other purposes. The aim of this research is to utilize yeast which is readily available in the market to biodegrade the wastewater. Yeast is cheaply available in the market and widely used for the alcohol production. The fermentation of organic matters by Yeast to produce alcohol is the subject of investigation of this research. The results showed the successful fermentation of wastewater by Yeast. The process can be utilized in wastewater treatment for biodegradation of organic matters which will help to reduce water pollution problems of water bodies.

The parameters tested during the study are BOD, Nitrogen (NH_3-N), Phosphorous, Potassium and pH.

The results showed that, the lesser the amount of Yeast added, better the BOD removed. Yeast cells itself contribute to the BOD of the system, thus the use of large amount of Yeast looks impractical and uneconomical. The study showed that Yeast dose in the range of 0.5 to 1 gram for 11 liters of wastewater was suitable for BOD removal.

Yeast was found ineffective in the removal of NH3-N and Potassium from wastewater. Yeast was observed effective in removal of Phosphorous. As Yeast dose increased, the amount of Phosphorous removal increased.

Thesis Title: **FILTER MEDIA LENGTH IN HORIZONTAL ROUGHING FILTER FOR TURBIDITY REMOVAL**

Submitted by: **Krishna Ram Yendyo**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

Horizontal Roughing Filter (HRF) is becoming vital pre treatment unit used before slow sand filter especially in Rural Water Supply Schemes. It is a composite unit which can lower the turbidity level of raw water to less than 50 NTU making acceptable to slow sand filter.

This study determines filter length of locally available three different filter media and generates new media by combining different length of those filter media on the basis of average turbidity removed. The study was conducted at laboratory scale model consisting of 60cm x 30cm x 40cm inlet and outlet chambers connected by 12.88m long 160mm diameter HDPE pipe with sample ports at the interval of 1.00m approximately.

The raw water from the deep tube well was mixed with local pottery clay to prepare the influent water with turbidity in the range of 219 to 264 NTU. In the first phase of the study the influent water was fed to the HRF packed with media 1 having

effective size (dio) of 12.2mm and uniformity coefficient (Cu) of 1.14 and the turbidity at the various ports along the filter length were measured. Similar studies were carried out with media 2 having effective size (dio) of 4.90mm and uniformity coefficient (Cu) of 1.60 and media 3 having effective size (dio) of 1.40mm and uniformity coefficient (Cu) of 1.50 separately. The study showed that the effluent turbidity reduced to less than 50 NTU in all three media within 100 hours of filter run time. The filter media length required to reduce the effluent turbidity to 50 NTU is found to be 8.00m, 5.26m and 2.50m for media 1, media 2 and media 3 respectively. The turbidity removed is dependent on filter length, effective size and influent turbidity.

Based on the turbidity profile of each individual media, the length of media 1, media 2 and media 3 to generate mix media is determined as 2.11m, 1.94m and 1.94m respectively with total combined length of 5.99m. The study carried out in the mix media during second phase of study showed the removal of influent turbidity of 254 NTU to effluent turbidity of 18 NTU with turbidity removal efficiency of 92.11%. The overall turbidity removal efficiency and effluent turbidity in the mix media are stand to be closer to the predicted turbidity removal efficiency and effluent turbidity used on the turbidity profiles of the individual media.

Thesis Title: **APPLICATION OF THE HUMAN URINE IN CABBAGE CULTIVATION**

Submitted by: **Bikash Adhikari**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

The study was field oriented and the area chosen for field experimentation was located in the premises of M.Sc. hostel of I.O.E, Pulchowk Engineering Campus, Krishnagali Lalitpur. The main objective of the study is to determine the appropriate urine dilution level in cabbage cultivation. The study was conducted with 8 treatments with 10 numbers of cabbages in each treatment in the area of (1*2.5) m in each treatment with uniform interplant distance of 50 cm. Treatment plots were made of 3 types: common farmer practice, where no urine and chemical fertilizer was applied, treatment plots with different human urine water dilution such as 1:0, 1:2, 1:4, 1:6, 1:8, 1:10 and chemical fertilizer applied plot. Urine water dilution level (UW) of 1:0, 1:2, 1:4, 1:6, 1:8 and 1:10 was made in different five buckets. Undiluted urine was kept in the separate bucket. Urine was applied 10 cm far from the plant's main stem. Half liter urine was applied three times a week for 10 weeks and then twice a week for next 3 weeks.

The plant height and leaf area was measured at least once a week to study the development pattern. The highest height and leaf area was seen in UW dilution level of 1:8 i.e 45.6 cm and 705 cm^2 respectively. Plot 6, treated with the urine dilution of 1:10 had first started the formation of cabbage head in week 6. The heaviest fresh weight of cabbage was obtained 3.8 kg in UW 1:8, 3.2 kg in chemical fertilizer, 2.4 kg in conc. Urine and 1.8 kg in control. The shortest root was seen in UW 1:8 i.e 26 cm and the longest root was seen in the control i.e 28.3 cm. Mass balance calculation for NPK was also carried out to find the loss as a leachate or gain either from environmental fixation or uptake from deep soil. From the cost benefit analysis the net benefit obtained from UW 1:8 over chemical fertilizer was Rs. 301.66 and net benefit over common farmer practice was Rs. 401.66. This calculation is done taking 10 cabbages from each treatment plots. So the most recommendable human urine water dilution ratio from this study is 1:8.

Thesis Title: **OPTIMIZATION OF WATER DISTRIBUTION NETWORK USING IMPROVED GENETIC ALGORITHM**

Submitted by: **Rajesh Maharjan**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

An improved genetic algorithm (GA) formulation for pipe network optimization is studied which relates genetic algorithm to the well known problem of least-cost design of water distribution network.

Water distribution network is used to convey the water from the service reservoir to the consumers through a network of pipes. In conventional method, pipe distribution network is designed by an iterative procedure where diameter of the pipes is assumed and simulation is carried out to determine the velocity in the pipes and pressure at the various locations. The process is repeated until all the hydraulic constraints of pressure and velocity are maintained. The minimization of the pipe network cost is generally overlooked.

The study deals with the development of the software model to design water distribution network which optimize the cost

meeting the all hydraulic constrains. Genetic Algorithm (GA) has been used for the development of the model. The computer software program named GAPipe has been written in C-Sharp (C#) computer language. The developed model was tested on a hypothetical network created by Alperovits and Shamir (1977). The model tested showed the usefulness of the GAPipe for the optimal design of water distribution network meeting all the hydraulic constraints.

The optimum population is found to be between 40 to 100 depending on the size of the pipe network and commercially available pipe size. Elitism rate, which is the measure of the fittest individual in a population, should be between 10 to 30 percent. Mutation rate of around 1 to 10 percent should be selected depending again on the size of the network and optimum population size. Multipoint crossover with high rate of 90 to 95 percent is found to produce better solution. The pressure penalty parameters are found to be much important than velocity parameters. The findings indicated that the proposed method is superior to enumeration techniques with respect to solution speed and cost. The developed model has been evaluated on Shamir and Hanoi Networks which shows that it can obtain near optimal cost.

Thesis Title: **SELF ADAPTIVE PENALTY FOR GENETIC OPTIMIZATION OF WATER DISTRIBUTION NETWORK**

Submitted by: **Narayan Nyaupane**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

Optimal design and rehabilitation of a water distribution network is a constrained nonlinear optimization problem. A penalty function is often employed to transform a constrained optimization problem into a non-constrained optimization problem in the framework of genetic algorithm search. A penalty factor is often used for defining the penalty function and calculating penalty cost for the solutions with constraint violations. Effective penalty factors vary from one optimization model to another. In this study, a self-adaptive penalty approach is introduced to simultaneously optimize both the penalty factor and the design of the water distribution network. A computer program named, WinGAPipe has been developed for this purpose. It relieves modellers from tuning the penalty factor/cost and facilitating practical optimization modelling for water distribution network design.

WinGAPipe computer model involves the application of an evolutionary optimization technique, differential evolution, linked to the hydraulic simulation solver, EPANET, for optimal design of water distribution networks. A model has been formulated with the objective of minimizing cost and is applied to two benchmark water distribution network optimization problems—Hanoi and Triple Hanoi water distribution networks. The study yielded promising results as compared with earlier studies in the literature and encouraged to reformulate the model for a new objective of maximizing network resilience. The results of the analysis demonstrate that WinGAPipe can be considered as a potential alternative tool for economical and reliable water distribution network planning and management. The Application of WinGAPipe to optimize a real water distribution network of small town water supply system named, Karahiya Makrahar Water Supply System showed its usefulness to achieve the optimal design of the water distribution network with self adaptive penalty for genetic algorithm process.

Thesis Title: **QUANTIFICATION OF VEHICULAR EMISSIONS CONTRIBUTED BY TRAFFIC CONGESTION IN URBAN AREA OF KATHMANDU**

Submitted by: **Kuber Nepali**

Supervisor: **Dr. Padma Bahadur Shahi, Mr. Ram Kumar Shrestha**

ABSTRACT

This study tries to find the contribution of Congestion in the urban area of Kathmandu in the Green House Gas emission by transport sector as the same is taken as major sector to contribute in degrading air quality of Kathmandu. Key pollutants arising from congestion has been estimated.

The study estimates that the emission of TSP, CO, C02, HC, NOx, SOx and Pb was estimated to be 535.88, 17797.34,148865.59, 10134.74, 1822.92 , 191.41 and 0.16kg per day respectively due to congestion in Kathmandu. The share of C02, CO, HC and NOx emission by congestion only in total emission by transport sector was 10 %, 20%, 29 % and 36% respectively. The study concludes that share is significant.

Under the existing traffic management system, road facility and vehicle numbers the average speed in the selected routes considered to be subjected to congestion were in between 5 to. 10 km/hr. With calculated average speed of 7.9 km/hr for all routes the percentage reduction of 72 %, 83%and 84 % for CO can be achieved by attaining speed to design speed i.e. 40 km per hour for Heavy Duty Gasoline Vehicles, Heavy Duty Diesel and Passenger cars respectively. Similarly, the reduction of HC could be could be 68%, 62% and 46 % respectively. But for NOx, Diesel vehicles only have reduction possibility of 45 % at speed of 40 km per hour.

Thesis Title: **ANAEROBIC DIGESTION OF WASTE ATER USING PLASTIC MATERIALS AS HABITAT**

Submitted by: **Purna Chandra Dhakal**

Supervisor: **Mr. Iswar Man Amatya**

ABSTRACT

Research focuses on the feasibility study of the treatment of domestic wastewater UAF reactor. Study was carried out in real field condition in ambient temperature without external source of heat. One settler tank, one reserve tank, one constant head tank and two anaerobic filter tanks each having capacity of 200 ltrs tank with the diameter of 50 cm and height of 90 cm. Each tank was interconnected by 25 mm diameter PPR pipe. Both the anaerobic filters was packed in between the perforated slabs with the pieces of plastic bottles as a filter media. All reactors were made airtight. Biomass used in this research was the fresh cow dung. Study was conducted on different conditions of HLR, HRT, temperature and pH. Anaerobic process required eight week long maturation period to reach on steady state condition. The parameters tested during the study are COD, BOD, Nitrogen (NH_3N), Phosphorous, Potassium, VSS, Temperature and pH. Treatment process was m0re efficient for high strength wastewater.

The result showed that UAF was more efficient in removal of BOD and marginally efficient in removal of COD and less effective in the removal of Potassium. Performance of UAF on COD removal was 77.94 %, 79.4 %, and 82.3 % in 2.0, 1.5 and 0.75 m^3/m^2-d HLR respectively It was found that with the decrease in HLR and HRT, the percentage removal of COD, BOD, Nitrogen (NH_3- N), Phosphorous, Potassium was increased. The maximum percentage removal was achieved as 85.66 % of BOD5 and minimum was 73.21 % of Potassium removal in 2.0 m^3/m^2-d HLR. The effect of temperature and pH in anaerobic process was significant. An increase in temperature and pH resulted the increase in the performance of UAF. Both the reactors ie AF_1 & AF_2 seems effective for removing COD than other parameters.

Thesis Title: **OPTIMIZATION OF COLLECTION AND TRANSPORTATION COSTS IN INTEGRATED SOLID WASTE MANAGEMENT**

Submitted by: **Kanchha Kaji Silwal**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

The study is conceived considering at the rising concerns of solid waste management in Kathmandu Valley. Municipal solid waste (MSW) management has been one of the significant issues faced by municipalities giving rise to health and environmental problems. This research has attempted to study MSW management of solid waste in Kathmandu Metropolitan City, Lalitpur Sub-Metropolitan City and Kirtipur Municipality with analysis of the collection and transportation costs as well as variable costs associated with transfer station, waste processing and sanitary landfill.

The mathematical linear programming model is developed to integrate different options and facilities available in MSW management in KV as a tool for solid waste planner in decision making concerning the collection and transportation management in municipalities. The model has been formulated as mixed

integer linear programming problem. The application of model confirmed its validity and robustness for transportation cost optimization of Kathmandu and Lalitpur municipalities in integrated solid waste management (ISWM) system. The model allows planning the number of transfer stations (TS), waste processing facilities (WPF) and sanitary landfills (SLF), and determines the quantities and type of waste that has to be sent to waste management centre (WMC) and landfills. It is also possible to determine the number and the type of trucks.

In model there is one linear objective function and linear constraints that cover waste flows among the sources, WMC and landfills, capacity, site selection and facility availability. The objective function in model describes total operation and maintenance costs as well as collection and transportation costs. The benefits from compost and recycling are also incorporated in the objective function. TORA software is used in this study for processing and solving. The result indicates that in Integrated Solid Waste Management, management of waste is beneficial. The methodology offered in this study provides a basis for investigations in ISWM and the optimization model can be formulated for assessing the resources allocation and management. The application of model in ISWM system of Kathmandu Valley showed it as important tool for planners in

MSW management in an urban environment. The models may as well be adapted for use in other areas of application like industrial warehouse location and product distributions of industry agents.

Thesis Title: **EFFECT OF GLUCOSE ON BIODEGRADATION OF FOOD WASTE COMPOSTING**

Submitted by: **Sweachha Shrestha**

Supervisor: **Mr. Ram Kumar Sharma**

ABSTRACT

Composting is one of the easiest ways of handling the organic waste. This study was an experimental study carried out in the researcher's resident in Bakhundol, Lalitpur. The objective of the study was to determine the best concentration of the glucose for the growth of microbial population. The study was carried out with the construction of $_s$ five compost bin made of wire mesh and wooden frame each of size 3'x3'x3'.The vegetable waste comprising of the cabbage and cauliflower leaves were collected from the Kalimati vegetable market. These wastes were shredded into small pieces and added to the bin until it were completely full. Once the compost bin were completely filled with the waste the top layer were covered with a bunch of straw. A total of 50 ml glucose of various concentrations i.e. *5%,* 10%, 25% and 50% wt were applied to- the respective compost bin in intervals. Along the process various physiochemical analysis were done to determine the effect of glucose on the compost. The test showed that among various concentration of the glucose 10% wt applied

compost samples showed the microbial load to the highest number. The microbial growth increased by 200 times after application of a single dose of the glucose. Also the application of glucose enhanced the composting process with the formation of the final compost within 68 day of composting. The compost obtained from the application of 10% wt glucose seem to have all the required properties of the mature compost that too in a short period of composting. Thus the most recommended concentration of glucose is the 10% wt glucose.

Thesis Title: **BIOGAS GENERATION FROM THE ORGANIC KITCHEN WASTE**

Submitted by: **Arjun Kumar Bam**

Supervisor: **Mr. Iswar Man Amatya**

ABSTRACT

This thesis work tends to the biogas production as alternative fuel by using the biodegradable wastes as feeding materials along with being a solution for sustainable management of wastes at household level as well as institutional level. It also attempts to determine energy content in the biogas. The research study was conducted on bioreactor biogas plant of 1.81m^3 biodigester and 0.397 m^3 slurry chamber. The methane content was determined by using biogas analyzer Gas Board-3200P. The result analysis showed that amount of biogas production increased gradually along with increasing amount of feeding materials and digestion period. Average maximum of 192.2 litre gas production was recorded per day i.e. 49.24 minutes/day burning period. The maximum digester and ambient temperature found to be 30.8 C and 30 °C respectively. However, pH value found to be great variation. The average pH value for slurry chamber has been found to be 6.88 which lie within the favourable value for biogas production. Initially the percentage of CH4 was slowly raised but $C0_2$ gradually decreased along with the digestion period.

Methane content in the biogas has been found as 57.26% maximum, 53.19% average and 44.78% as minimum value during the test. The energy content in biogas has been found as methane content of 5.693 kWhth/m^3 maximum, 5.288 kWhth/m^3 average and 4.452 kWhth/m^3 as minimum value. Although the fertilizer values in terms of nitrogen, phosphorus and potassium were increased gradually but was found below 1 percent i.e. 0.58%, 0.38% in the case of Nitrogen and Phosphorus respectively, while the Potassium was found 1.02%. The volatile solid in slurry found to be 41.2% and 39.5% at time of 6 and 12 days respectively. The C/N ratio of feeding material has been found to be 21.47 which lie in satisfactory region for biogas production but after 6 days it found to be 70. The financial analysis of the biogas plant showed the effective return of investment or simple payback period of 4.51, 4.62 and 5.71 years in kerosene, firewood and LPG substitutions respectively. Similarly total cost saving in a year due to installation of biogas in kerosene, LPG gas and firewood has been found to be NRs.5553.17, NRs.4372.99 and NRs.5416.04 respectively. The multiple criteria decision making tool showed that kerosene can be best substituted model among the three above mentioned options.

Thesis Title: **MODELING OF SOLID WASTE GENERATION IN BHAKTAPUR MUNICIPALITY**

Submitted by: **Bibas Gurgai**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

This thesis was carried out in- Bhaktapur Municipality ward no 2 and 4. Information regarding socio-economic characteristics (age, household size, education, monthly income) was obtained through questionnaires and amount of waste generated was weighed. Simple and Multiple regression analysis were done to find out the main determinants of waste generation. The results in the form of regression models showed that household size, occupation (agriculture or others) and to some extent income were the main factors that affect waste generation in the study area. In contrast, age of house head and education had no significant effect. Also information sought regarding willingness to pay showed that age group and occupation had no direct effect. But income had a significant relation to pay for better solid waste management systems. Thus it is shown here that, affecting factors vary with regions and even personal attitudes. It is important to analyze as much as factors, so that waste generation and its consequent problems can be well managed.

Thesis Title: **NUTRIENT REMOVAL IN DAIRY WASTE WATER BY EICHHORNIA CRASSIPES**

Submitted by: **Deepa Baniya**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

In this study, the potential of an aquatic macrophyte water hyacinth to treat anaerobically digested dairy wastewater was evaluated in first set with undiluted, 1:1, 1:2 and 1:4 dilutions and second set with 2:1 and 1.5:1 dilutions using batch culture method for 20 days. The percentage biomass of water hyacinth was found to be increased in all dilutions except in undiluted dairy wastewater in which the plant growth was completely inhibited owing to the high concentrations of toxic chemicals. The percentage increase in biomass was found to be the highest in 1:4 dilution because the COD level favoured the growth of water hyacinth the most in this dilution with respect to other dilutions. The trend of pH increased from slightly acidic pH 6.0 to 9.5 in all dilutions.

In nutrient removal, water hyacinth showed the best performance in 1:4 dilution followed by 1:2, 1:1, 1.5:1 and 2:1 dilutions. In

1:4 dilutions, COD, BOD, potassium, phosphorus and nitrogen were reduced by 70.88%, 78.71%, 65.21%, 62.44% and 64.42%, respectively within 20- day interval. Similarly, EC was found to be reduced **by** 84.46% in 1:4 dilution followed by 59.60 % in 1:2 dilution, 43.37% in 1:1 dilution, 47.77% in 1.5:1 dilution, 55.11% in 2:1 dilution and 6.45% in undiluted dairy waste water.

Thesis Title: **DISSOLVED IRON OXIDATION IN INCLINED AERATOR**

Submitted by: **Bibhusa Mishra**

Supervisor: **Mr. Iswar Man Amatya**

ABSTRACT

Aeration is simple water treatment unit for removal of dissolved iron from groundwater. High concentration of iron content in ground water source is one of the main undesirable water qualities in Kathmandu valley. Therefore, an attempt was made to reduce higher dissolved iron concentration only by aeration followed by sedimentation using corrugated sheet. A small scale gravity inclined aerator was built which aerates water by natural gravity flow down an inclined, transversely corrugated surface. A study was carried out for angle of inclination 5 to 50 with an interval of 5 and 60° also, at different flow rates of 0.06, 0.08 and 0.1 lps respectively with reference to dissolved iron, contact time and dissolved oxygen.

The study with inclined aerator revealed that the maximum dissolved iron oxidation rate was3.31ppm (34.66%) for discharge 0.061ps. Similarly the minimum oxidation rate was noted 0.29 ppm (3.04%) for discharge 0.1 lps. For angle 50° and 60° dissolved iron oxidation was3.00ppm (31.31%),

2.48ppm(25.79%), 2.19ppm(22.84%) and 2.54 (26.52%) 2.07ppm (21.53%) 1.87ppm(19.55%) respectively for discharge0.06,0.08 and 0.1 lps.

The dissolved oxygen was also observed 6 mg/I for 45 at lower discharge of 0.06 lps whereas the effectiveness declines to 1.94 mg/1 for 5° at discharge 0.1 lps. The dissolved oxygen rate decreases above angle 45°.

The results showed that the dissolved iron oxidation rate was highest at the lower discharge of 0.06 lps for angle 45°. That means with increase in angle of inclination oxidation rate also increases whereas oxidation rate increases with decrease in discharge. The increment of angle beyond 45 results significant decrease of dissolved oxidation rate as compared to 45°.

But, the effluent iron concentrations were found more than the WHO guideline and Nepal drinking water standard of 0.3ppm. Hence, further additional oxidation process has to be adopted to attain WHO guideline value.

There was slight increment in dissolved iron oxidation till 30°, from 30° to 45° abruptly increment in oxidation rate was observed and above 45° oxidation rate decreases. Thus the result showed that the effective angle lies between 30° to 45°.

Graduation Year 2012

Thesis Title: **GROUND WATER QUALITY MAPPING OF KATHMANDU VALLEY**

Submitted by: **Dinesh Bista**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

As a result of the increased population and industrial activities water demand is increasing rapidly in Kathmandu Valley, Nepal. Groundwater is being extracted haphazardly which has led to depletion in groundwater levels, and well yields. In addition to the quantity, the quality of the valley's groundwater is also degraded by different forms of pollution. Therefore, the study has attempted to present the overview of groundwater quality of the valley.

Groundwater samples were collected from existing wells during pre-monsoon and monsoon seasons in 2011/12. The collected samples were analyzed for physicochemical properties, and water quality mapping was done using GIS software. The quality of groundwater is varied spatially. In course of spatial variation, relatively higher concentrations of arsenic, ammonia and electrical conductivity are observed in central groundwater

district. The seasonal variation of water quality parameters was not found significant. Groundwater quality is relatively good in northern part of the valley. The use of raw groundwater is not safe for drinking require water treatment particularly for iron removal, ammonia removal prior to its use in central part of the valley. Based on the analysis of the study, groundwater quality mapping of Kathmandu Valley has been prepared for arsenic, turbidity, color, pH, electrical conductive, total alkalinity, total hardness, calcium hardness, magnesium hardness, calcium, magnesium, total iron, chloride and total ammonia.

Thesis Title: **FILTRATION THROUGH PERFORATED PIPES WRAPPED WITH NYLON NET**

Submitted by: **Prem Kumar Shrestha**

Supervisor: **Mr. Iswar Man Amatya**

ABSTRACT

A perforated pipe wrapped with nylon net is a single unit which can remove turbidity only. A detail study of lab scale model nylon net filter consisting collection chamber with dimension 60cm x 60cm x 60cm with three 60cm long outlet pipe having external diameter 45mm wrought iron pipe (Internal diameter 44mm) installed at cross section of chamber. This study determines turbidity profile of three different filtrations rate 15, 20, and 25m/hr for three different 100, 200 and 300 numbers of net winding in case of synthesis and natural water respectively.

The research was carried out by operating the filter in higher filtration 15m/hr rate to bring the effluent turbidity within the acceptable level (5-10 NTU) by changing net winding having pressure flow in pipe. Similar study was carried out for next two filtration rates 20m/hr and 25m/hr to find the average turbidity removal profile. The same process was repeated for the study of natural water of Pulchowk Campus.

The optimum number of net windings 420, 430 and 780 with filter run time of 100 hours reduces average influent turbidity of 210 NTU to 10 NTU by Nylon Net Filter for flow rates 15. 20 and 25m/hr respectively in synthesis water. The number winding for flow rates 15 and 20m/hr were nearly same but for flow rate 25m/hr deviates more. So, there is no significant implication of increasing filtration rate more than 20m/hr. The overall efficiencies of synthetic water were 95.24%, 79.68%, and 63.49% for flow rate 15m/hr. 20m/hr and 25m/hr respectively.

Similarly, the optimum number of net windings is 435, 520 and 600 with filter run time of 48 hours reduces average influent turbidity of 55 NTU to 10 NTU by nylon net filter for flow rates 15, 20 and 25m/hr respectively in natural water. Similarly, for natural water overall efficiencies were 81.81%, 75%, and 61.81% for flow rate 15m/hr, 20m/hr and 25m/hr respectively.

Thesis Title: **CHLORINE DECAY MODEL FOR DHANKUTA MUNICIPALITY WATER DISTRIBUTION SYSTEM**

Submitted by: **Rajesh Shilpakar**

Supervisor: **Prof. Dr. Bhagwan Ratna Kansakar**

ABSTRACT

Dhankuta municipality water supply system of Salleri consists of Tin dovane, Ghatte khola I and Devi khola as the sources with capacity 5 lps, 31ps and 2 lps respectively, transmission main, treatment plant, reservoir and distribution system. The main components of the I treatment plants are plain sedimentation tank, roughing filter, slow sand filtration and disinfection unit. The water quality parameters of the water supply systems were analyzed which shows faecal coliform of 20 CFU/100ml at Ghatte khola source, 10 CFU/100ml at reservoir and 1 CFU/l00ml at the distribution system. All other water quality parameters were within the Nepal Drinking Water Quality Standard, 2005.

In this study chlorine decay model based on EPANET has been developed for the water distribution system of Dhankuta municipality of Salleri, ward no. 6 and calibrated with the observed field data. Two hundred fifty two numbers of free

residual chlorine values at the main of distribution line has been measured. The correlation between the observed mean and the computed mean from the model for free residual chlorine was found to be 0.902. The correlation coefficient of 0.902 shows that there is strong positive association between the observed and computed values indicating the usefulness of the developed model for the determination of the free residual chlorine in the water distribution system of Dhankuta municipality.

Thesis Title: **SOLAR DISINFECTION SYSTEM USING PARABOLIC THROUGH REFLECTOR**

Submitted by: **Sujata Joshi**

Supervisor: **Mr. Iswar Man Amatya, Mr. Ram Kunar Sharma**

ABSTRACT

Solar disinfection system is a very simple method. Solar disinfection system using parabolic trough reflector combines the germicidal effects of increased temperature and UV radiation. The combination of water disinfection by solar radiation and thermal water treatment by solar energy achieve best results.

The research was done in two modes of experiments, one SODIS using parabolic trough reflector and the other plain SODIS. The average solar radiation and average UVA radiation during the research were 412.84 W/m^2 and 26.00 W/m^2 respectively. The average UVA radiation required for total inactivation of faecal coliform in SODIS using reflector and without reflector were 98.52 Wh/m^2 and 131.90 Wh/m^2 respectively.

The faecal coliform removal efficiency in two different modes of experiment SODIS using reflector and without using reflector attained 100% and 99.75% efficiencies respectively. The

exposure time required for total inactivation of faecal coliform in the SODIS using reflector was 2 hours and without using reflector was 4 hours. Modifying the SODIS disinfection process using reflector reduced the exposure time to half.

The maximum mean water temperature reached in SODIS using reflector and without using reflector were 53 °C and 35°C. As the water temperature in SODIS using reflector reached above 50 °C, a synergetic effect of UV radiation and increased temperature occurred. The maximum water temperature gained during the research using reflector was 66°C and without using reflector was 42°C.

The faecal coliform die-off equations with combine effect of UVA, temperature and time was derived using reflector and without using reflector were Faecal coliform die-off= 439.195-15.684*UVA + 12.727*temperature + 435.067* time and Faecal coliform die- off^ -862.030-26.776*UVA + 82.217* temperature + 563.620* time respectively.

The test result shows solar disinfection system using parabolic trough reflector as a effective disinfection method.

Thesis Title: **NUTRIENT REMOVAL IN HORIZONTAL FLOW BED CONSTRUCTED WETLAND**

Submitted by: **Sushil Kumar Shrestha**

Supervisor: **Mr. Iswar Man Amatya**

ABSTRACT

In the developing countries, direct discharge of domestic wastewater in river is . creating many problems in river ecosystem which directly affects the urban environment. Thus to overcome those problems, there is a need of an efficient, cost effective, and environment friendly wastewater treatment system. Constructed wetland is one of the options for such treatment system.

Constructed wetland is efficient in removing nutrients such as nitrogen, phosphorous, potassium, and COD from the wastewater. This study is done in the constructed wetland situated in the compound of IOE Pulchowk where the domestic wastewater from the periphery area and the grey water of canteen block comes as an influent of CW.

For the study discharge in the wetland is maintained constant at different three flow rates 8 m^3/d, 11 m^3/d, and 15 m^3/d .The

temperature of the wastewater is ranges from 20 °C- 28 °C within the study period (autumn season).Among three flow rates, flow rate at 8 m^3/d is most efficient in the nutrients removal than other two flow rate. At 8 m^3/d flow rate, the equation of NH/-N removal = 0.6053 * Length - 0.9284. Similarly, the equation of Phosphorous removal = 0.3147 * Length - 0.8909; the equation of Potassium removal = 0.1176* length - 0.4569, and the removal equation of the COD removal = 8.7124 * Length - 4.7511.

Thus the study shows that the nutrients removal by the constructed wetland is better in the flow rate of 8 m^3/d than 11 m^3/d and 15 m^3/d. From the influent of wastewater NH/-N removal from wastewater is 22.31 mg/1 (51.22%), Phosphorous removal is 10.97 mg/I (63.81%), Potassium removal is 4.49 mg/l(16.75), and COD removal is 320 mg/1 (88.89%).

Thesis Title: **HORIZONTAL SAFE SANITATION DISTANCE IN DIFFERENT SAND MEDIA**

Submitted by: **Top Bahadur Khatri Chhetri**

Supervisor: **Mr. Iswar Man Amatya**

ABSTRACT

Microbiological contamination is the major public health threat, especially in poor communities of developing countries. The most serious water-borne diseases (such as dysentery and cholera) are caused by the ingestion of faeces, both human and animal.

On-site sanitation systems are a significant source of ground water contamination leading to waterborne disease outbreaks and other adverse health effects. The bacteria, protozoa, and viruses found in sanitary wastewater can cause numerous diseases, including gastrointestinal illness, cholera and typhoid. So, most jurisdictions have adopted minimum horizontal setback distances from septic systems and the water well. Septic systems should be located a safe distance from drinking water sources to avoid potential contamination. This research had been conducted to find safe horizontal distance between onsite sanitation practice and water collection point in three different sand media.

In this research, three different sand media has been taken for the determination of horizontal setback distance. The research was done by maintaining low flow rate and minimum hydraulic gradient with small water head. This study mainly effective for plain area where there is minimum ground slope. The E-coli transport from source as onsite sanitation practice to the groundwater may be affected by so many factors such as rainfall, soil type, temperature etc. Here the study was mainly focused on determination of horizontal safe distance for sandy soil.

For this, three different sand media coarse, medium and fine sand have been compacted separately in 35m long low density polyethylene pipe and effluent from the septic tank had been applied through it. The flow rate of the effluent for each test had been maintained such that the effective water head at the feeding bucket is always constant at 19cm. To maintain this water head, the flow rate obtained on these media was 702, 491 and 364 litres/day for coarse, medium and fine sand respectively. By considering these flow rates and minimum slope of the ground with lin 100, it has been found that the horizontal safe sanitation distance to meet National drinking water quality standard of Nepal is about 30m, 21.25m and 15.25m horizontal distance for coarse, medium and fine sand respectively with temperature range of 15 to 25 °C.

Graduation Year 2013

Thesis Title: **TURBIDITY REMOVAL EFFICIENCY IN HORIZONTAL AND UP FLOW ROUGHING FILTERS**

Submitted by: **Laxmi Pant**

Supervisor: **Prof. Dr. Bhagwan Ranta Kansakar**

ABSTRACT

Roughing Filters (RF) play an important role in rural water supply schemes as pre treatment unit before slow sand filter to reduced the turbidity level of raw water up to 20 NTU, which is required for better performance of slow sand filter. This study determines the turbidity removal efficiency of Horizontal Roughing Filter (HRF) and Up Flow Roughing Filter (URF) at three different flow rates (0.5m/h, 0.75m/h and 1.0 m/h).

The study was conducted at laboratory scale models. URF was 1.7m long 200mm diameter HDPE pipe with one sample port at 50cm above from the under drainage system and outlet 1.0 m above the under drainage. HRF consisted 1.4 m long filter box of rectangular in shape having 18 cm width 45 cm height, made from steel plates and angles. Sample port was at 50 cm away from inlet chamber. Two different sizes of filter media were used for this study. Size of filter media 1 was 8mm diameter in

average and (U_c) was 1.58. Size of media 2 was 4.5mm diameter in average and (U_c) was 1.25. Total depth of filter media was 1 meter consisting 50 cm of each type.

The sludge of sedimentation tank was mixed with tap water to prepare the influent turbidity of die range of 50 to 200 NTU. Initially both filters were operated at flow rate 0.5m/h having influent turbidity range 50 to 200 NTU. Turbidity at the sample port and outlet of both roughing filters were measured after interval of 1 hour until effluent turbidity reduces less than 20 NTU. Same process was repeated for other two flow rates.

The study showed that the effluent turbidity reduced to less than 20 NTU in all three flow rates within 134 hours of filter run time for both filters. The turbidity removal depends on filter length or depth, flow rates and influent turbidity. This study shows that highest influent turbidity reduction of 200NTU to less than 20 NTU in HRF and URF was found 96.25% and 93% at flow rate 0.75m/h. highest turbidity reduction in HRF and URF was found 96.75% and 95% after 134 hours of filter run time. Natural water turbidity reduction is more in URF than HRF. Filter length less than 0.5 meter sufficient for influent turbidity up to 50 NTU. Influent turbidity more than 150 NTU required more than 0.5 meter long filter to reduces effluent turbidity in Horizontal and Up flow roughing filters.

Thesis Title: **OPTIMIZATION OF MUNICIPAL SOLID WASTE COLLECTION ROUTES USING GENETIC ALGORITHM**

Submitted by: **Namita Shrestha**

Supervisor: **Associate Prof. Iswar Man Amatya**

ABSTRACT

A well designed urban solid waste collection system has less impact on labor, operation cost transportation cost, public health and the environment Proper vehicle routing is one of the main components of solid waste management in the cities where the collection takes maximum cost. The collection route for the solid waste vehicle is fixed manually which cannot be assured to be an efficient and optimum path. In this study genetic algorithm based methodology is introduced for designing a municipal solid waste collection system.

The basic idea of the study is to collect all the generated solid waste of any given area by using computer software with the objective of minimizing the collection cost- Firstly the collection points of the given area are identified and then the vehicle routing is done by developing program software named GARoute written in C plus plus (C++). The route network data like travel time, node numbers, labor cost, fuel cost, waste generation at nodes are input by the user. Then an advanced

intelligent technique based on genetic algorithm (GA) performs the robust search which gives an optimum path for the collection of loop network. The path is chosen in such a way that all nodes are visited only once and repetition of path does not take place.

The developed model was tested for solid waste collection of Madhyapur Thimi Municipality (MTM). The total cost of vehicle operation in MTM by using GARoute was found to be Rs 1099.4/day. For the cost comparison of GARoute, nearest neighbor algorithm was also used. From the nearest neighbor algorithm the cost for MTM was found to be Rsl 120.2/day. Critical Path Method (CPM) analysis of MTM network was also done to test the accuracy of GARoute. The results of the analysis demonstrated that the software can be considered as a potential alternative tool for economical and reliable solid waste collection vehicle routing. The study also shows that using GA techniques for finding the optimized route for the solid waste collection vehicle can yield near optimal cost and contribute in saving waste-management cost.

Thesis Title: **GUI ALGORITHM FOR WATER TREATMENT PLANT DESIGN**

Submitted by: **Bikash Wagle**

Supervisor: **Prof. Dr. Bhagwan Ranta Kansakar**

ABSTRACT

This report presents a design method for water treatment plant based on Graphical User Interface (GUI) which is very much easy to adopt in designing the water treatment plant. The designing the different component of treatment plant by manual calculation method is tedious and time consuming and the use of advance software is very expensive. Computer software program in Visual C-Sharp (C#) environment has been developed for the design of water treatment plant. The program is user friendly with focus on visual aid.

The study focused on GUI based application development on windows environment for water treatment plant design. The program has been developed to design various water treatment components such as screen, aerator, sedimentation tank, and filtration tank. The calculation in this software application is based on the design criteria provided which can be modified by the user as required. It is user friendly and the data generated can be saved in Microsoft word format. The program also produce simple sketch of the treatment plant units which helps to know

the typical layout of the unit. The design of the inter link pipelines between different units of treatment plant, considering major as well as minor losses in pipeline has also been incorporated in the program.

The program developed was tested with hypothetical data to design a water treatment plant consisting of screen, aeration, sedimentation tank and filtration unit. The ability to design various components of water treatment plants along with the design of the interconnecting pipes with hydraulic profile of the water treatment plant shows its usefulness in the design of the water treatment plant. The developed software can be a useful tool in the planning and designing of different components of water treatment plant and a treatment plant as a whole.

User's manual of the program showing the various steps required to run the program has also been prepared.

Thesis Title: **COMPOSTING KITCHEN FOOD WASTE WITH GRASS CLIPPINGS**

Submitted by: **Gehendra Maharjan**

Supervisor: **Prof. Dr. Bhagwan Ranta Kansakar**

ABSTRACT

Composting is one of the easiest ways of handling the organic waste. This study is a research work carried out in the researcher's residence Chapagaun, Lalitpur. The objective of the study was to determine the best quality of compost from various mixtures of kitchen food waste and grass clippings. The experiment began with the purchase of fifteen compost bins, each with 100 liter capacity. The kitchen food waste comprised mostly of cooked rice, cauliflower, cabbage leaves, potato peelings and banana peelings, rotten fruits etc. collected from households of Chapagaun and Satdobato. Both kitchen food waste and grass clippings were segregated and shredded into small pieces and added to the bins until they were completely full. The fifteen bins were divided into five groups, each group consisted three bins with the same ratios of kitchen food waste to grass clippings. The ratios chosen were: 2:1, 1:0, 1:1, 1:2 and 1:3. The ratios were based on the weight of the wastes. Once the compost bins were completely filled with the above mentioned ratios of waste, the bins were closed with its cover. Various physiochemical analyses were performed every week during the

process to determine the best ratio. From the tests, the compost from ratio 1:2 i.e. one part kitchen food waste and two part grass clipping had an average value of 15600 ppm nitrogen, 7500 ppm phosphorus, 19000 ppm potassium, 65% moisture, 30.44% Organic matter, 7.5 pH and a carbon to nitrogen ratio of 19 and got matured in an average of 72 days which is the best among the other ratios. Thus, to manage waste, 1:2 i.e. one part of kitchen food waste and two parts of grass clippings is recommended as the best ratio for making compost using bins.

Thesis Title: **USE OF NUTRIENT ON ALGAE GROWTH TO PRODUCE BIODIESEL**

Submitted by: **Januka Thapa**

Supervisor: **Associate Prof. Iswar Man Amatya**

ABSTRACT

Algae biodiesel is now widely accepted as a future source of biodiesel worldwide. There are more than hundred thousand algae species identified all around the world and more than three thousand species were taken at lab for detail research. This study was done in three phase, in first phases, culture collection from various ponds, rivers, stream was done and the collected culture was identified in the lab by microscope. There were 60 samples collection. Out of 60 samples 10 algae species were identified with majority of Oedogonium. Spyarogyara, H.reticulatum, H.africanum, Ulva laecuta, Cladaphora, Pediastrum simplex, Oscilatoria, Stigicolonium, Cyanobacteria is the identified algae in this study. Out of 10 identified algae, Oedogonium was choose for the detail analysis because of its higher availability, growth rate, high oil content, suitability of temperature and higher resistivity of changing environment. This study was conducted in natural condition. The temperature found in this study in the range from 18.67°C to 23.3°C. The highest temperature was shown in 23.3°C in fourteenth and nineteenth days .The lowest temperature was shown in the 18.67°C in second days. Equal and

known mass of algae was kept initially in all experiments. The maximum concentration of *Oedogonium* was found after twenty one days in experiment C (0.30ml agroliv/L of water) and its value is 15.25 g/L. Dissolved Oxygen (DO) maintained within the study period was approximate 5 to 8 mg/L.

Nitrate removal efficiency of algae found from 55 ppm to 12 ppm in experiment C (0.30ml agroliv/L of water). Similarly, phosphorous removal efficiency of algae found from 84 ppm to 28 ppm in experiment C (0.30ml agroliv/L of water). Maximum oil yield capacity of *Oedogonium* was found on 3.30 ml per 10 gram dry weight from experiment D (0.45ml agroliv/L of water). The minimum oil yield capacity of *Oedogonium* was found 2.33 ml per 10 gram dry weight from experiment E (0.60ml agroliv/L of water). Highest biodiesel production found 2.45ml/10 gram dry algae from experiment C (0.30ml agroliv/L of water) and lowest biodiesel production found 2.10ml/10 gram dry algae from experiment E(0.60ml agroliv/L of water). Maximum fatty acid and glycerol production found 0.46 gram/10 gram dry algae from experiment D (0.45ml agroliv /L of water) and minimum 0.42gram/10 gram dry algae found from experiment A (0ml agroliv/L of water).

Thesis Title: **ASSESSMENT OF THE EFFECTIVENESS OF HUMAN URINE DISPOSAL THROUGH CAULIFLOWER CULTIVATION**

Submitted by: **Laxmi Saiju**

Supervisor: **Associate Prof. Er. Shiv Shanker Karki**

ABSTRACT

A field experiment was earned out at Gundu VDC, Bhaktapur, Nepal on farmer's field during December, 2012 to April, 2013 to find the effectiveness of human urine as a potential supplement to nitrogenous fertilizers in improving yield and quality of cauliflower. The experiment was laid out in a randomized plot design with different plots; common farmer's practice; Treatment plots (urine: water ratio of 1:0, 1:3, 1:5, 1:7, 1:10 and 1:12); chemical fertilizer with 7 plants in each row. Each plot was prepared with 60cm width and at 55cm depth from the top; a white plastic was laid in base and side also. The plantation was done keeping 55cm spacing between the plants. Half liter urine was applied three times a week for 12 weeks and then twice a week for next 5 weeks with the selected dilution ratio. The plant height and leaf area was measured at a frequency of once a week to study the development pattern of plants. The highest height of 55.4cm jB was found in the chemical used plant followed by in urine water (UW) dilution ratio of ^B 1:7 and largest leaf area

(750 cm2) was observed in plot with UW dilution ratio of 1:7. The highest fresh weight (1.9 kg) of cauliflower was obtained in UW 1:7, and 1.0 kg in control plot. From the cost benefit analysis the net return obtained from UW 1:7 is found to be NRs. 441.25 which is 1.93 times more than that from chemical fertilizer used production and 3 times more than that from control plot. From this study the most recommendable human urine water dilution ratio for cauliflower cultivation is found to be 1:7.

Thesis Title: **IRON ADSORPTION KINETICS IN KAOLIN FOR GROUND WATER**

Submitted by: **Opendra Hamal**

Supervisor: **Prof. Dr. Bhagwan Ranta Kansakar**

ABSTRACT

The study is conceived considering at the rising concerns of iron content in water. Iron content in water creates great problems especially in water from ground source. Although there are many methods related to removing iron. Amongst them adsorption is one of them. Kaolin is used as adsorbent in this research.

Kaolin is type of china clay which is easily available in market. Kaolin is first dissolved in small amount of water. Then added to the water to be treated making the concentration of water to 0.3 gm/1 to **0.7** gm/L lime period of adsorption is measured.

The adsorptive kinetics increases gradually up to 25 ppm of iron concentration and then started to decrease slowly as concentration of iron further increases. The maximum adsorptive Kinetics (0.794) is in 25 ppm iron concentration and minimum adsorptive Kinetics (0.726) is in 5 ppm iron concentration and adsorptive kinetics in 40 ppm is found to be 0.786.

Kaolin first adsorbs iron from water and settles down. The contact time and concentration of Kaolin is found to be 15.88 hours in 0.5 mg/1 of Kaolin respectively. In this study

Freundlich's isotherm was found best fit to describe the total iron adsorption on kaolin.

As Kaolin is easily available in market, this method of adsorption of iron can be used in small scale of water treatment.