

PAPER • OPEN ACCESS

Biochemical Treatment of Municipal Sewage in Northeast China in Winter


To cite this article: Jianhui Song *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **237** 022048

View the [article online](#) for updates and enhancements.

You may also like

- [Seasonal tropospheric cooling in Northeast China associated with cropland expansion](#)
Yaqian He, Eungul Lee and Justin S Mankin
- [Rice production and climate change in Northeast China: evidence of adaptation through land use shifts](#)
Yanan Hu, Lingling Fan, Zhenhuan Liu et al.
- [Effects of climate and soil properties on regional differences in nitrogen use efficiency and reactive nitrogen losses in rice](#)
Siyuan Cai, Xu Zhao and Xiaoyuan Yan





The
Electrochemical
Society

Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

Biochemical Treatment of Municipal Sewage in Northeast China in Winter

Song Jianhui¹, Cui Shuang^{1*}, Han Qing², Li Ping¹, Zhang Qikai¹, Li Mingrui¹ and Jiang Changjia¹

¹College of Chemistry, Chemical Engineering and Environmental Engineering, Liaoning Shihua University, Fushun, Liaoning, 113000, China

²School of Materials & Metallurgy, Northeastern University, Shenyang, Liaoning, 110819, China

* Cui Shuang's e-mail: ccshuang@163.com

Abstract. In view of the colder winter conditions in the north of China, and taking into account the high removal rate and low operating cost of biological wastewater treatment methods, which is the leading treatment process for organic wastewater. This paper selects the biological treatment technology to treat the urban sewage in Northeast China in winter. Temperature is one of the most important factors that affect microbial activity, therefore, in the application of wastewater biochemical treatment, the effect of sewage treatment is greatly affected by temperature. In order to solve the problem of low temperature, cold-resistant bacteria should be used to treat low-temperature domestic sewage. The result of this operation is that in the low temperature (10°C) sewage, the removal efficiency of COD with chilling resistant bacteria can reach more than 40%, and the adaptability to temperature change is also strong. Cold-tolerant microbial Complex flora has a good COD treatment ability under low temperature conditions, and has a good application prospect in low temperature domestic sewage biological treatment, the treatment of domestic sewage in Northeast China in winter can be carried out by the above methods.

1. Introduction

Over the years, the state has been aware of the seriousness of urban water pollution, so the central and local governments take the treatment of urban water pollution as an important part of their daily work, and are speeding up the construction of urban sewage treatment projects. However, it is very difficult to treat urban sewage in cold areas in winter. It is of great significance to solve the problem of sewage treatment in cold areas and improve the efficiency of urban sewage treatment in winter. This can more effectively control water pollution, improve people's living standards, and promote the further development of productivity. With the increase of human activities, environmental resources are constantly changing, and the problem of environmental pollution is becoming more and more serious. The shortage of water resources and the pollution of water resources are the most serious crises the development of human beings faced with, which hinder the economic development of human beings and has affected the human survival environment. China is a country with scarce water resources, and its per capita freshwater resource is much lower than that of the rest of the world. Therefore, it is necessary to control water pollution and improve the status quo of water scarcity.



2. Analysis of characteristics and treatment methods of municipal domestic sewage in Northeast urban area

2.1. Characteristics of domestic sewage

Because the latitude is high and the winter temperature is low in Northeast China, the influence of temperature should be taken into account in the treatment of domestic sewage. In the urban domestic water use, most of the water is discharged as sewage after only one use, and no recycling is carried out[1]. The turbidity and COD content of the domestic sewage discharged were high, which indicated that the suspended matter and organic matter were the most, COD removal should be the main treatment for sewage treatment [2].

2.2. Biochemical treatment of Urban domestic sewage in Northeast China in Winter

In view of the low economic level in Northeast China, biological methods are chosen to treat domestic sewage. The most important factor in biological treatment of municipal sewage is microorganism, and temperature is one of the important factors affecting microbial activity[3]. As one of the biological wastewater treatment technologies, activated sludge treatment technology has been more mature and widely used[4]. It includes traditional activated sludge process, oxidation ditch process, SBR (batch activated sludge process), AB process, biological aerated filter and so on[5]. Activated sludge process is used in nearly 80% of wastewater treatment plants, these technological processes are close to those of some developed countries[6]. In this paper, biological aerated filter is listed to reflect the advantages of biochemical treatment of domestic sewage in northeast cities and towns. In the activated sludge process, biological aerated filter, or "BAF" process for short, it is a new biological technology which has been developed by drawing full reference from the design ideas of wastewater contact oxidation process and feed water fast filter process, it brings together biological oxidation, biological flocculation and filtration functions, the biofilm attached to the filter media was used for mechanical interception and bioflocculation before degradation, and the pollutants were decomposed and removed[7]. The advantages of BAF filter are: stable operation, good water purification effect, the aggregate biological concentration of BAF filter is high, it has a high biochemical reaction rate, and the effluent quality is better than that of the conventional wastewater treatment process; the construction of the whole process technology occupies a small amount of land, and can carry 5~10 times the BOD volume load of the conventional activated sludge process, without the need for the second treatment; biological aerated filter can also enhance the utilization rate of oxygen and save air volume and electricity consumption; operation safety, no serious adverse effects on the surrounding environment, the released air no odour, aeration tank released odour will be well controlled, will not pollute the surrounding environment[8].

3. Study on the Application of biochemical treatment in the treatment of Urban domestic sewage in Northeast China in Winter

3.1. Biochemical treatment problems caused by low temperature

In the process of biological treatment of urban sewage in northeast China in winter, due to the decrease of temperature, the treatment effect becomes worse, and the effluent quality is often not up to standard[9-10]. In order to solve this problem, it is often used in engineering to reduce sludge load, increase sludge reflux, prolong sewage residence time, and build the structure indoors to take heat preservation to reach the pretreatment standard[11]. However, in the actual operation process, the above measures not only increase the project investment and operation cost, but also the treatment effect is difficult to ensure, and sludge bulking often occurs[12]. At low temperatures, especially when the temperature drops to the minimum growth temperature of the microorganism, the metabolic activity of the bacteria will be reduced to a minimum, even in a dormant state, but the bacteria are not dead, when the temperature increased, the bacteria could still recover their activity. At moderate temperature, it is generally 20~25°C, the maximum number of microbial active population was

5.7~6.5 times higher than that of low temperature(6~9°C) [13-14]. And the composition of the microbial population will be reduced accordingly(at room temperature, sludge is usually composed of 8~9 dominant bacteria, at 5~10°C, only 5 species were dominant) [15].

3.2. *Solutions to the problems in the treatment of low temperature Biochemistry*

In order to make the sewage meet the national discharge standard at low temperature, measures such as heat preservation are usually taken, but this will undoubtedly increase the cost of capital construction and operation. Some scholars have studied the dominant strains of low temperature resistance that can be used in low temperature sewage treatment, screening low temperature microorganisms with high degradation efficiency under low temperature conditions and applying them to wastewater treatment systems, it is one of the effective methods to treat low temperature sewage and reduce processing costs[16-17]. This kind of low temperature microorganism can be divided into psychrophiles and psychrotrophs. According to research, psychrophiles are microbes that can only live at low temperatures and have a maximum growth temperature of no more than 20°C, their optimum growth temperature is no more than 15°C, and they can also grow and reproduce below 0°C. The psychrophiles can only grow in a narrower temperature range, while the psychrotrophs can grow in a wider temperature range. The psychrophiles are sensitive to temperature and die after being heated for a short time. Currently discovered psychophilic microbes include true bacteria, cyanobacteria, yeasts, fungi and algae. One of the main factors of microorganism growth at low temperature is whether the cells have the ability to transport foreign nutrients into the cells near 0°C. The highest growth temperature of psychrotrophs can exceed 20°C, and it can also grow in the environment of 0~5°C, the general growth temperature range is 0~35°C, because of its special physiological characteristics and low temperature catalytic activity, it has a broad application prospect in the field of biotechnology[18-19]. Current studies show that psychrotrophs have good characteristics and application value in low-temperature domestic sewage treatment[20-21]. The COD removal rate of a low temperature strain was over 90% at 5°C[22]. Wu et al. used psychrotrophs and yeast to treat simulated sewage at low temperature (8°C), the removal rate of COD can reach 66.6% and 72.2%[23]. The method is to select three chilling resistant bacteria with high COD degradation efficiency from the municipal sewage plant and form a complex bacteria group to treat the low temperature domestic sewage. The result of this operation is that in the wastewater at low temperature (10°C, the three strains of cold-tolerant bacteria have higher COD removal function, the degradation efficiency can reach more than 40%, and the adaptability to temperature change is also strong. The combined microflora can improve the ability of biological treatment, and the removal efficiency of COD is 10%~20% higher than that of single bacteria[24]. Therefore, the complex dominant microflora with low temperature tolerance has better COD treatment ability under low temperature conditions, it has a good application prospect in biological treatment of low-temperature domestic sewage, the treatment of domestic sewage in Northeast China in winter can be carried out by the above methods.

4. **Conclusion and Prospect**

As for the problem of urban sewage treatment in winter in Northeast China, the low temperature will greatly affect the physiological activities of microbes. To solve the problem of sewage treatment in cold regions in Northeast China, it is more effective to control water pollution by improving the efficiency of urban sewage treatment in winter. Biological treatment is the most commonly used method in wastewater treatment. In view of the cold winter situation in Northeast China, it is necessary to consider the complex dominant microflora with low temperature tolerance. Because it has better COD treatment ability under low temperature conditions and has a better application prospect in low temperature domestic sewage biological treatment, the treatment of domestic sewage in Northeast China in winter can be carried out by the above methods. The temperature adaptation range of psychrotrophs is 0~30°C, therefore, in low temperature environment, the psychrotrophs play a very important role in the degradation of domestic sewage[19]. The composition of domestic sewage is

quite complex. The use of multi-species synergistic action can help to improve the ability of biological treatment, and has a higher development potential. The complex strains interact with each other, but the treatment efficiency is not the simple addition of the single strain ability. The mixing ratio has a certain effect on the degradation efficiency of the complex flora, which needs to be further studied.

Acknowledgements

This work was financially supported by National Natural Science Foundation of China (41773093, 31470552); Liaoning Science and Non-profit Foundation (2015003017) .

References

- [1] Ge, L., Ge, D.B. (2010) Investigation on the quantity of municipal domestic sewage and analysis of its quality. *Environ. Sci. Manage.*, 35(2): 16-17.
- [2] Mao, S.F., Gao, X.H., Zhang, Y. (2014) Characteristics and treatment techniques of Rural sewage in the Cold region of Northeast China. *Mod. Agric. Sci. Technol.*, 23: 236-237.
- [3] Qian, C., Ren, L.B. (2008) Study on the influence of Winter low temperature on the Operation efficiency of sewage treatment Plant in Cold region. *Environ. Sci. Manage.*, 33 (5): 84-86.
- [4] Wei, H.T., Liu, X.J., Li, T. (2005) Summary on treatment of domestic sewage by activated sludge process. *Hebei Electric. Power Technol.*, 24 (4): 36-38.
- [5] Wei, W.Q., Li, L.B., Wisaam, S., Al-Rekab. (2009) Study on treatment of domestic sewage by SBR and CW process at low temperature. *Environ. Technol.*, 32(12D): 295-298.
- [6] Dai, X.M., Wang, X., Ma, Y.X. (2004) Development and evolution of activated sludge process. *J. Hebei Inst. Agric. Eng.*, 22(2): 25-27.
- [7] Zhu, X.F., Wu, Z.C., Wang, Z.W. (2011) Relationship between sludge Properties and membrane fouling in supermarket Wastewater treatment by membrane Bioreactor. *J. Environ. Eng.*, 5(1): 60-64.
- [8] Chen, J.B., Zhang, F. (2010) Application of Biotechnology in Municipal sewage treatment . *Fujian Forum (Soc. Sci. Educ. Ed.)*, 4: 65-66.
- [9] Zhou, X.F., Ren, N.Q. (2001) An example of biological treatment of methanol containing wastewater . *Water for China.*, 17(6): 50-52.
- [10] Du, Y.W., Hao, Y.P. (2008) Process and strengthening measures of municipal sewage treatment in cold region. *Low Temp. Build. Technol.*, 3: 133-134.
- [11] Yao, W. (2015) Simulation Test and Regulation of low temperature Operation in Municipal sewage treatment Plant. *Changchun: Changchun Inst. Eng.*, 2-5.
- [12] Cui, H.S., Bai, X.H., Li, G. (2001) Sludge bulking and its control methods in municipal wastewater treatment plants in cold regions. *J. Harbin Const.Univ.*, 34(2): 79-82
- [13] Yin, J., Wang, X.F., Wang, J.H. (2007) The influence of low temperature on the biological treatment process of sewage and its improvement measures. *J. Jilin Inst. Agric. Eng.*, (24)2: 29-33.
- [14] Yuan, M. (2016) Application of low temperature sewage treatment Technology in Northern Railway Station. *Low Temp. Build. Technol.*, 5: 42-43.
- [15] Meng, X.Z., Jiang, A.X., Zhao, R.Y. (2000) Study on the treatment of biological wastewater in cold region with cold tolerant bacteria. *J. Harbin Const.Univ.*, 33(6): 68-73.
- [16] Ren, N.Q., Zhou, D.S., Ma, F. (2002) Microbiology of water pollution control. Harbin: Harbin Univ. Technol. Press., 7-29.
- [17] Zhang, M., Li, Z.B. (2003) Screening and degradation of Nonionic surfactant-psychrophilic bacteria. *Nat.*, 25(4): 228-232.
- [18] Zhang, Y.X., Zhao, W. C., Yu, Y. (2008) Cold adaptation Mechanism of low temperature microorganisms and its Application. *J. Ecol.*, 28(8): 3 921-3 926.

- [19] Liu, J., Zhang, S., Yang, N. (2010) Isolation, identification and biological characteristics of the Arctic marine mud flora. *Biotechnol. Bull.*, 1: 136-141.
- [20] Gratia, E. (2009) Selection of a cold-adapted bacterium for bioremediation of wastewater at low temperature. *Extremophiles.*, 13(5): 763-768.
- [21] Zhang, L., Jiang, W. (2007) Studies on the characteristics and efficacy of immobilized compound cold-tolerant bacteria. *J. Harbin Com.Univ.*, 23(1): 62-66.
- [22] Xu, Q., Zhu, G.B. (2010) Isolation, Identification and degradation characteristics of a High efficiency Cold tolerant strain. *J. Environ. Eng.*, 4(2): 277-382.
- [23] Wu, D., Sun, W., Zhang, L. (2006) Preliminary report on simulated experiment of two strains of low temperature resistant microorganisms for sewage treatment. *J. Microbiol.*, 26(3): 65-66.
- [24] Gu, M.Y., Wang, Y.P., Xie, Y.Q. (2011) Study on biological treatment of low temperature domestic sewage. *Xinjiang Agric. Sci.*, 48(5): 948-953.