1 TASK 3.1: TREATMENT TECHNOLOGY DETAILS

1.1 FOCUS REPORT TASK DESCRIPTION

- Submit treatment technology specifications (e.g., optimal performance range of the technology) and an assessment of the efficacy of the proposed treatment technology for use at the NPNS facility, to the satisfaction of NSE. For example, peak effluent temperature is proposed to be above the generally accepted range of temperatures to achieve optimal biological treatment.
- Explain how the proposed higher than optimal treatment temperature would affect the treatment performance.

1.2 TECHNOLOGY SPECIFICATIONS

1.2.1 Primary Treatment

The operation of the primary clarifier is discussed in Section 2.4. This section will review the clarifier sizing for primary treatment at NPNS. Untreated effluent will be pumped underground and enter a 56 m diameter concrete circular clarifier with a 5.5 meter side water depth. The average flowrate through the unit from the KSH design specification is 65,000 m^3/day. This translates into a settling time of about 5.7 hours or an overflow rate of 26.4 $m^3/d/m^2$ based on the Veolia specifications. The design flowrate through the unit from the KSH design specification is 85,000 m^3/day. This translates into a settling time of about 4.3 hours or an overflow rate of 34.6 $m^3/d/m^2$, which, based on typical design practices, is conservative even at peak flow rates (see Table 1-1 below).

Table 1-1: Standard Design Values for Primary Clarifiers.[1]

Process	Overflow Rate ($m^3/m^2/d$)		Detention Time(hours)		Weir Loading ($m^3/d/m$)	
	Average	Peak	Average	Peak	Average	Peak
Primary Treatment followed by Secondary Treatment	30 – 50	80 – 120	2.5	1.5	125	500
Primary Treatment with Waste Activated Sludge Return	24 – 32	48 – 70	2.5	1.5	125	500
Northern Pulp New ETF	26.4	34.5	5.7	4.3	369	483

1.2.2 Secondary Clarifiers

The operation of the secondary clarifiers are discussed in Section 2.4. This section will review the clarifier sizing for the two secondary clarifiers at NPNS. Treated effluent leaving the AS stage will be pumped underground and the flow split evenly between two 56 m diameter concrete circular clarifier with a 6.2 meter liquid side water depth, which allows for longer sludge storage and minimizes the risks of odour generation from sludge septicity issues in a standard storage tank.

The average flowrate through each unit from the KSH design specification is 32,500 m^3/day. This translates into a settling time of about 11.3 hours or an overflow rate of 13.2 $m^3/d/m^2$ based on the Veolia specifications. The design flowrate through each unit from the KSH design specification is 42,500 m^3/day. This translates into a settling time of about 8.6 hours, or an overflow rate of 17.3 $m^3/d/m^2$, and a solids loading rates of 5.8 $kg/m^2/h$, which, based on typical design practices, is conservative even at peak flow rates (see Table 1-2, below). Solids removal efficiency at the secondary clarifiers is expected to be around 99%.

[1] Metcalf & Eddy, Wastewater Engineering, 4th Edition, McGraw-Hill, 2003

Table 1-2: Standard Design Values for Secondary Clarifiers[2]

Activated Sludge Process	Overflow Rate ($m^3/m^2/d$)		Solids Loading ($kg/m^2/h$)		Depth (m)
	Average	Peak	Average	Peak	
Air Activated Sludge	16 – 28	40 – 64	4 – 6	8	3.5 - 6
Oxygen Activated Sludge	16 – 28	40 – 64	5 – 7	9	3.5 - 6
Extended Aeration	8 – 16	24 – 32	1 – 5	7	3.5 - 6
Northern Pulp New ETF	13.2	17.3	4.4	5.8	6.2

1.3 DISCUSSION OF TREATMENT TEMPERATURE

1.3.1 Bacteria Temperature Ranges

Bacteria fall into one of four temperature classifications or ranges as follows:

1. Psychrophilic:
   - Psychrophiles are extremophilic microorganisms that are capable of growth and reproduction in low temperatures, ranging from −20 °C to +10 °C. They are found in places that are permanently cold, such as the polar regions and the deep sea, and are organisms that prefer extreme environments.
2. Mesophilic:
   - A mesophile is a microorganism that grows best in moderate temperature, neither too hot nor too cold, typically between 20 and 45 °C. The term is mainly applied to microorganisms that live in soil, water and decaying organic materials.
3. Thermophilic:
   - A thermophile is a type of extremophilic microorganism that thrives at relatively high temperatures, between 41 and 122 °C; and

[2] Metcalf & Eddy, Wastewater Engineering, 4th Edition, McGraw-Hill, 2003

4. Hyperthermophilic:
   - A Hyperthermophile is a microorganism that thrives in extremely hot environments—from 60 °C upwards. An optimal temperature for the existence of hyperthermophiles is above 80 °C.

Figure 1-1 and Table 1-3, below, provide details as to the temperature ranges where they are normally found. Current literature shows that, while there seems to be both agreement and disagreement regarding these four classifications, what is agreed upon is that microorganisms in aerobic biological wastewater treatment systems fall into the mesophilic temperature range.

Figure 1-1 – Temperature Range for Effluent Treatment Bacteria[3]

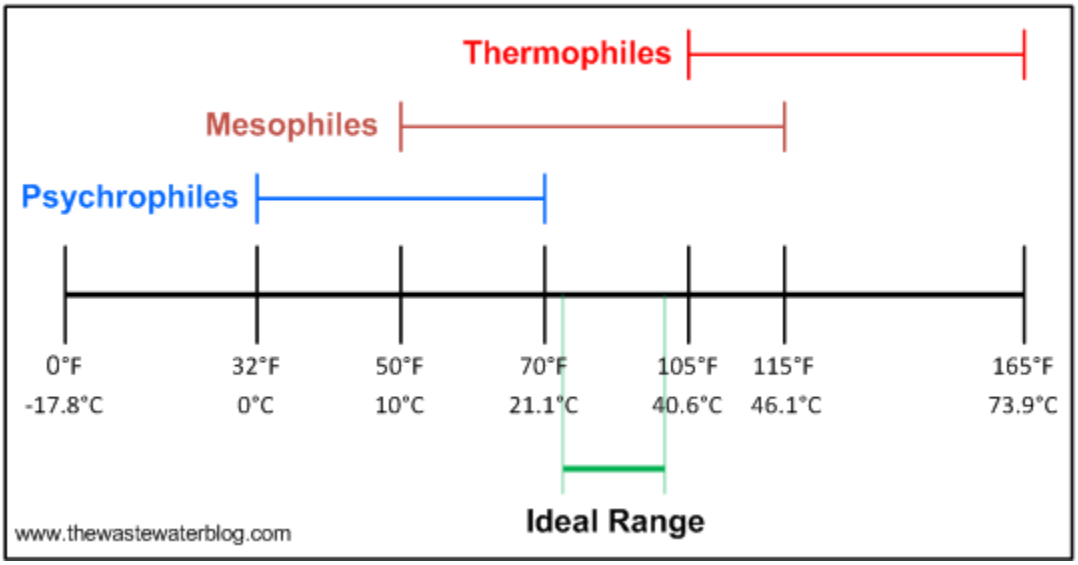


Table 1-3 – Temperature Classification of Biological Processes[4]

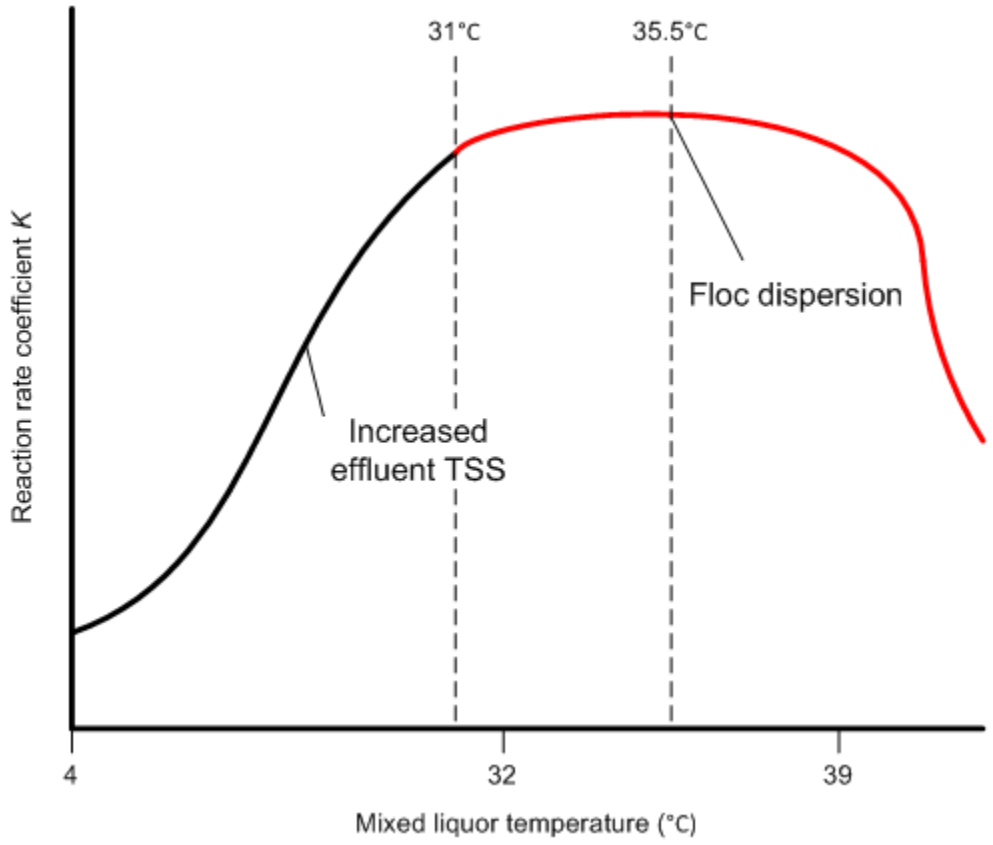
Type	Temperature Range (°C)	Optimum Temperature Range (°C)
Psychrophilic	10 to 30	12 to 18
Mesophilic	20 to 50	25 to 40
Thermophilic	35 to 75	55 to 65

[3] www.theastewaterblog.com
[4] Metcalf & Eddy, Wastewater Engineering, 4th Edition, McGraw-Hill, 2003

1.3.2 Diversity of Bacterial Populations with Temperature Variation

A biological reactor does not contain a single, identical, bacterial population. There are numerous groups of microorganisms with dominance among any group constantly shifting in response, or adaptation, to the constantly changing composition and quality of the effluent. As the temperature changes in the effluent, one group of microorganisms will slow down, even die off, and another group will gain influence and become dominant. Variations in temperature affect all biological processes. In the mesophilic range, the rate of the biological reaction will increase with temperature to a maximum value around 35.5 °C for most aerobic effluent systems. Temperatures above 39°C will result in a decreased oxidation rate for mesophilic organisms as can be seen in Figure 1-2. Below.

Figure 1-2 - Effect of Temperature on Biological Oxidation Rate Constant K[5]



[5] Harold B. Gotaas, *Sewage Works Journal* Vol. 20, No. 3 (May, 1948), pp. 441-477

With increasing effluent temperature, bacterial activity increases. The maximum acceptable operating temperature for typical activated sludge systems is limited to about 39°C, which corresponds to the maximum temperature for the growth of mesophilic organisms. Even short-term temperature variations above this must be avoided since thermal inactivation of mesophilic bacteria occurs quickly. Increasing effluent temperature and increased bacterial activity are critical factors that affect secondary solids settleability. Operators have the ability to control MLVSS, mixed liquor suspended solids, at lower concentrations when temperatures are high to slow down the bacterial activity.

1.3.3 ETF Design Temperatures

The KSH design specifications indicate a design temperature range after cooling from 28-37°C. Temperature will be controlled by varying raw water flow to the cooling towers to achieve the desired operating temperature setpoint, most likely set at or near 35 °C in the summer and likely slightly less in the winter.

A review of other Paper Excellence mills confirms the operating ranges for the biological treatment stage chosen, both by KSH and Veolia, for this project are appropriate. Howe Sound Pulp and Paper operates the ETF at a maximum of 37.0-38.5 °C and the Port Alberni mill operates at a maximum of 37 – 38 °C in summer. Activated sludge treatment facilities operate well in these ranges.

35 °C and 37 °C were carried through to the RWS as maximum summer effluent temperatures at the outfall. It is important to note that the temperature at the outfall will be different than the operating temperature of the system in the winter time at NPNS. Heat loss calculations were performed, indicating that the temperature at the diffuser outfall could be 2-10 °C less than the high summer ETF operating temperature, both due to system temperature fluctuations and heat lost to the atmosphere. A minimum effluent temperature of 25 °C was carried through for the RWS winter case.

1.4 WORKS CITED

- Metcalf & Eddy, Wastewater Engineering, 4th Edition, McGraw-Hill, 2003;
- www.theastewaterblog.com;
- Harold B. Gotaas, *Sewage Works Journal* Vol. 20, No. 3 (May, 1948), pp. 441-477.

1.5 SIGNATURES

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