Effect of Sole Nitrogen Sources and Temperature on Activated Sludge

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Introduction

- Objectives
- Literature Review
- Modified Arrhenius Equation
- Methodology
- Results and Discussion
- Summary and Conclusions

Objectives

- Evaluate the effects of temperature on biokinetic coefficients used to design aerobic biological systems treating wastewaters with different nitrogen sources.
- Examine the impact of temperature on substrate removal, sludge production, and oxygen requirements.

Literature Review

- Novak (1974) recommended that both k and K_s be corrected for temperature variations in aerobic treatment systems
- Characklis and Gujer (1979) stated that biomass yield is constant over a wide range of temperature.
- Characklis and Gujer (1979) indicated that maximum growth rate ($:_{max}$), k, K_s, and k_d were temperature dependent.

Literature Review

- Knowles et al. (1965) indicated that both k and K_s for *Nitrosomonas* and *Nitrobacter* increased as temperature increased.
- Benefield et al. (1975) found that k_d varied between 15 and 25 ° C and suggested a θ ranging between 1.02 and 1.06 for correcting k_d.
- Benefield and Randall (1980) presented data showing yield (Y) to be independent of temperature in the range of 15 to 25 ° C.

Arrhenius Equation

$$K_{(T°C)} = K_{(20°C)}(\theta)^{(T°C - 20°C)}$$

$$K = Kinetic\ rate\ coefficient$$

Materials and Methods

- Literature Search for Biokinetic Coefficients
- Example Problem to illustrate the effects of temperature on substrate removal, biosolids production, and oxygen requirements

Temperature Corrections

- Microbial yields for heterotrophs and autotrophs were not corrected for temperature changes.
- A theta value (θ) of 1.04 was used to correct the k_d value for heterotrophs and autotrophs.
- A theta value (θ) of 1.08 was used to correct the k value for heterotrophs and autotrophs.

Temperature Corrections

- The heterotrohpic K_s value was not corrected for temperature.
- The autotrophic K_s value was corrected for temperature variations with a theta value (θ) value of 1.14 .

Biokinetic Coefficients with Ammonia as Nitrogen Source

Temperature	5° C		10° C	
Coefficient	Heterotrophs	Autotrophs	Heterotrophs	Autotrophs
Y (mg/mg) K (days-1) K_s (mg/L) K_d (days-1)	0.4 1.89 120 0.039	0.2 0.63 0.28 0.028	0.4 2.78 120 0.047	0.2 0.93 0.54 0.034
Temperature	20° C		30° C	
Coefficient	Heterotrophs	Autotrophs	Heterotrophs	Autotrophs
Y (mg/mg) K (days-1) K_s (mg/L) K_d (days-1)	0.4 6 120 0.07	0.2 2 2 0.05	0.4 12.95 120 0.104	0.2 4.32 7.41 0.074

Biokinetic Coefficients with Nitrate as Nitrogen Source

Temperature	5° C	10° C	20° C	30° C
Coefficient	Heterotrophs	Heterotrophs	Heterotrophs	Heterotrophs
Y (mg/mg)	0.27	0.27	0.27	0.27
K (days-1)	1.89	2.78	6	12.95
K_s (mg/L)	120	120	120	120
K_d (days-1)	0.028	0.034	0.05	0.074

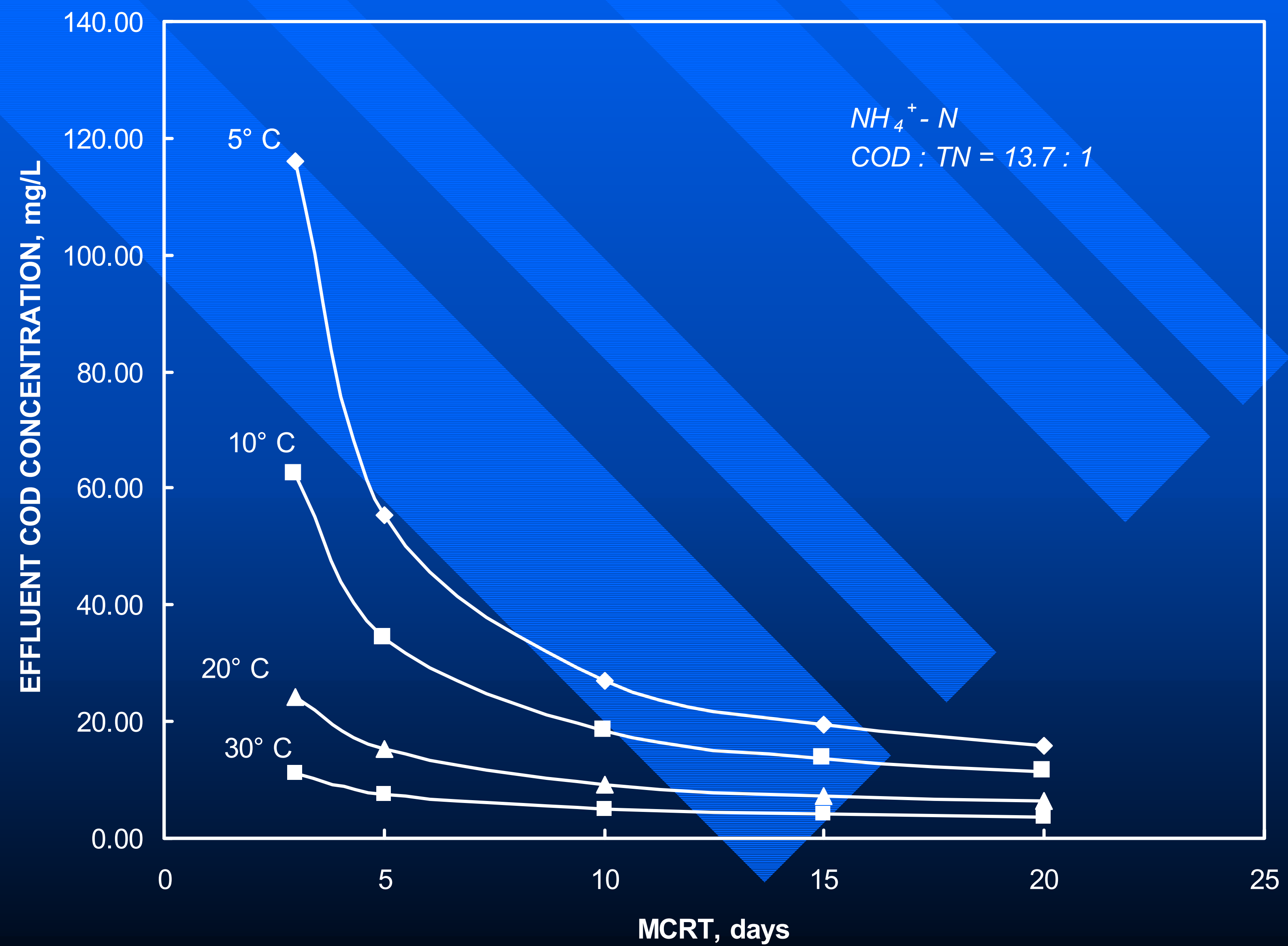
Example Problem

- Completely-mixed activated sludge process
- COD : N Ratio = 13.7 : 1
- Initial Operating Temperature = 20 ° C
- Influent Flowrate = 37, 850 m^3/day (10 mgd)
- Hydraulic Detention Time = 0.25 days
- Temperatures varied at 5, 10, 20, and 30 ° C

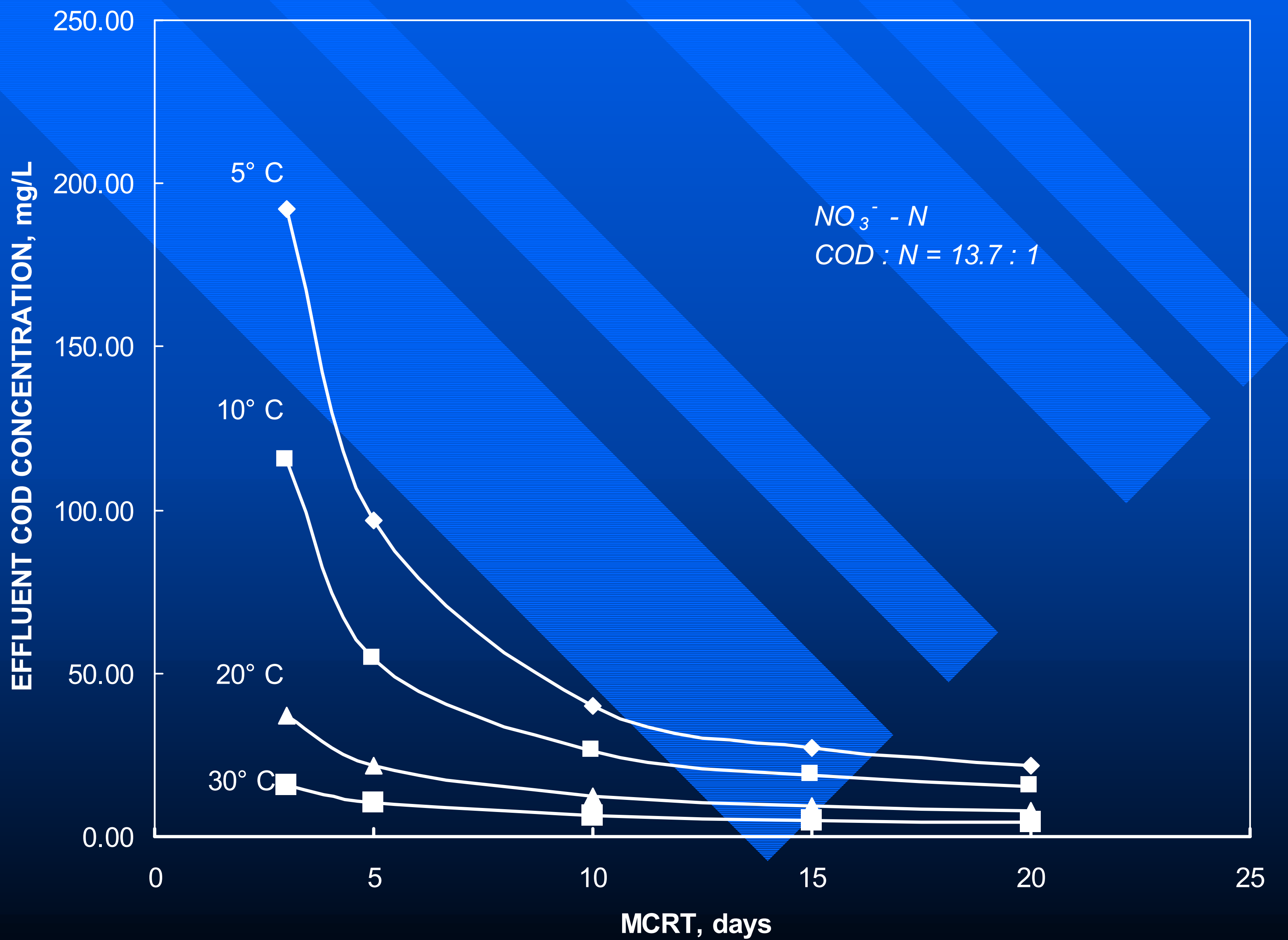
Results and Discussion

- Effluent COD Concentration
- Biosolids Production
- Oxygen Requirements

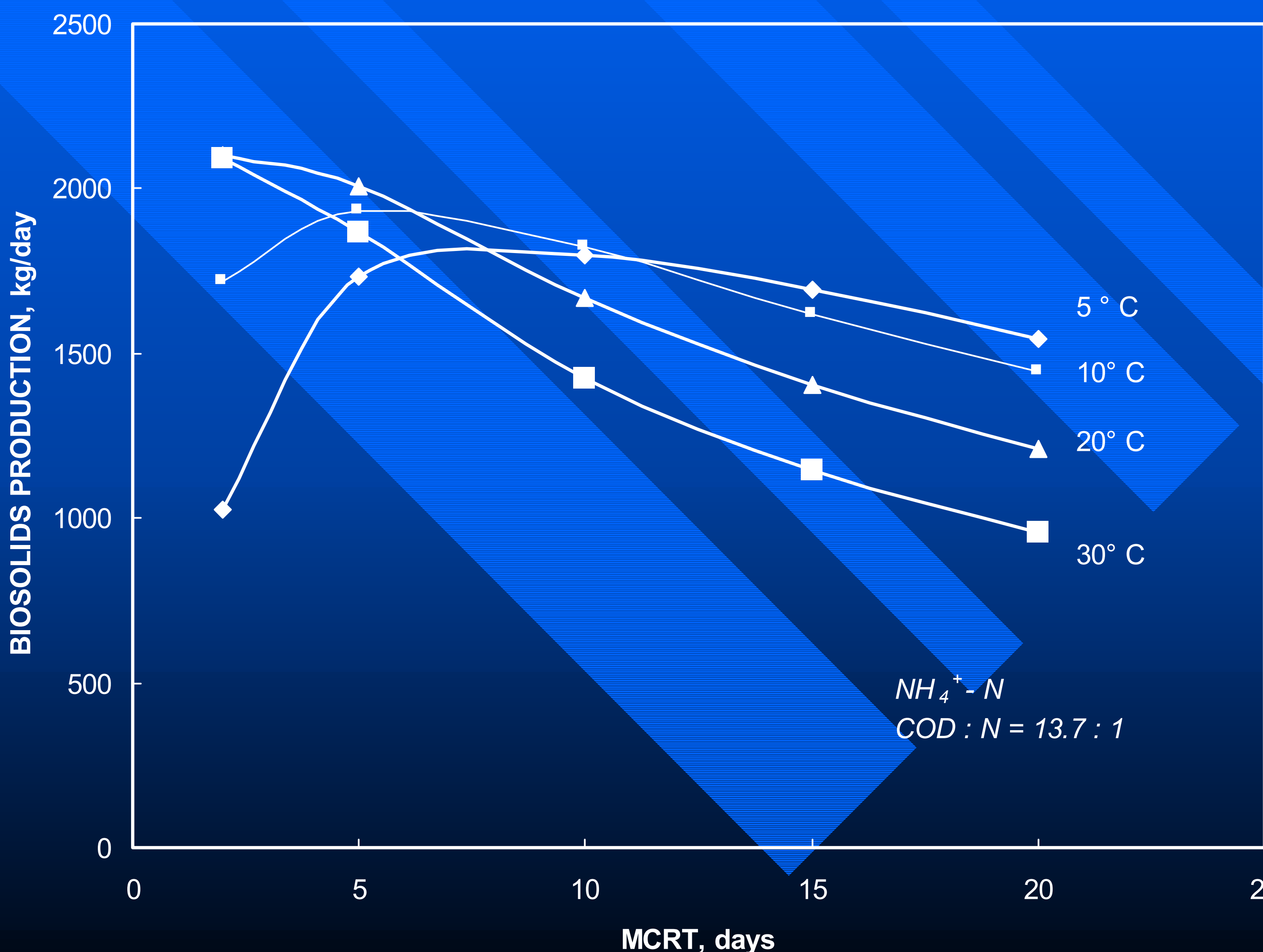
Effluent COD vs MCRT with Ammonia as Nitrogen Source



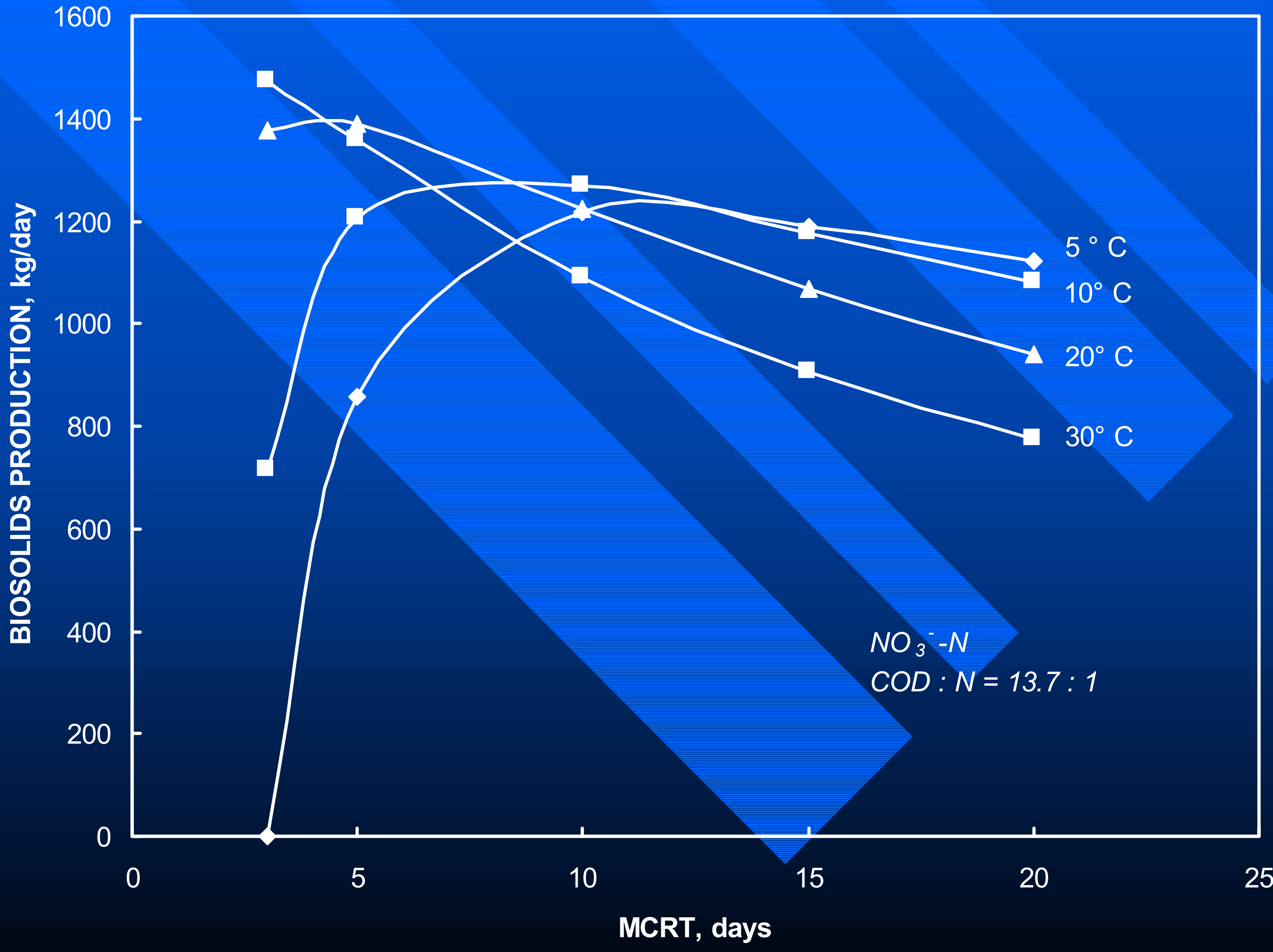
Effluent COD vs MCRT with Nitrate as Nitrogen Source



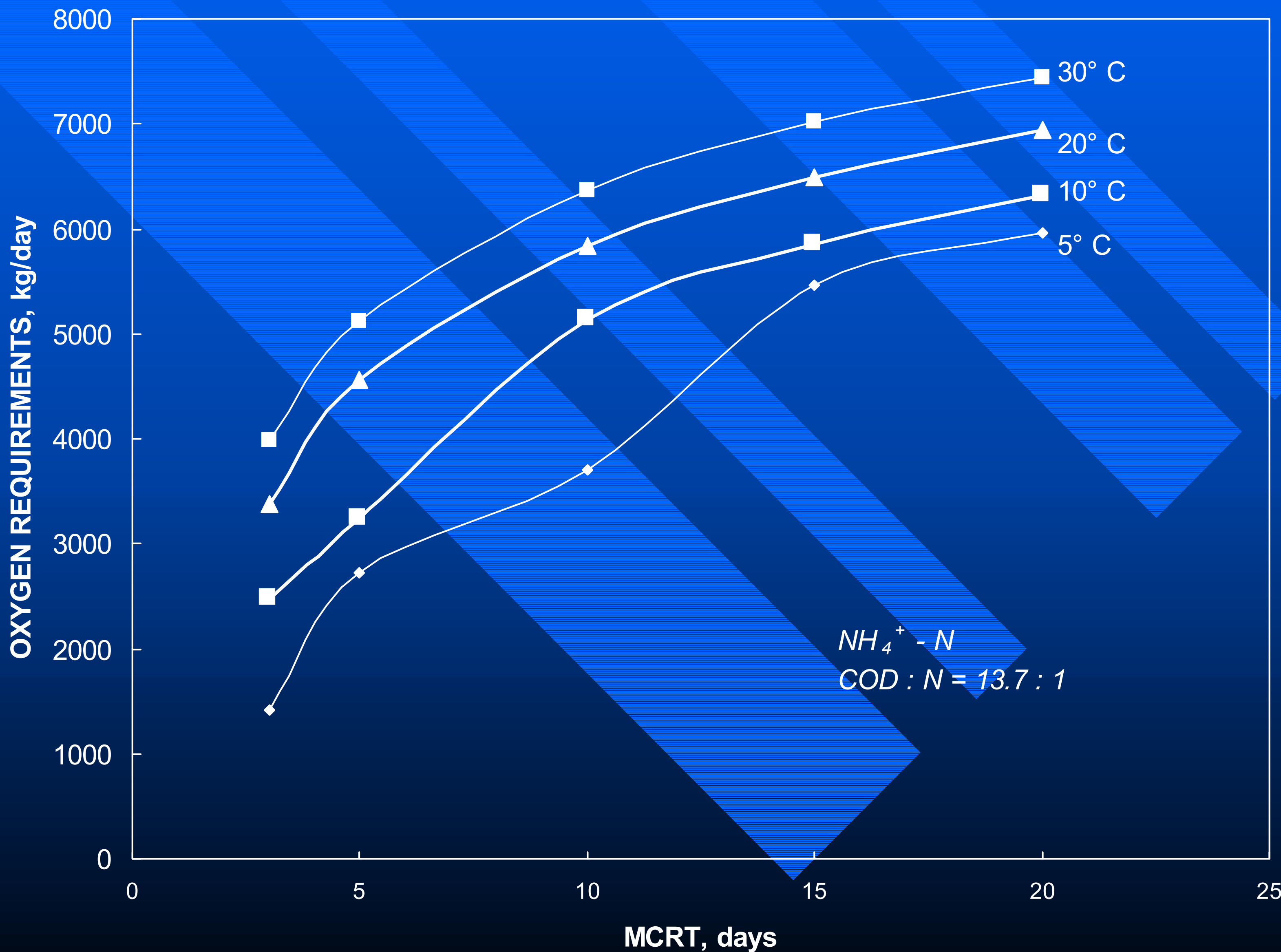
Biosolids Production vs MCRT with NH_3 as Nitrogen Source



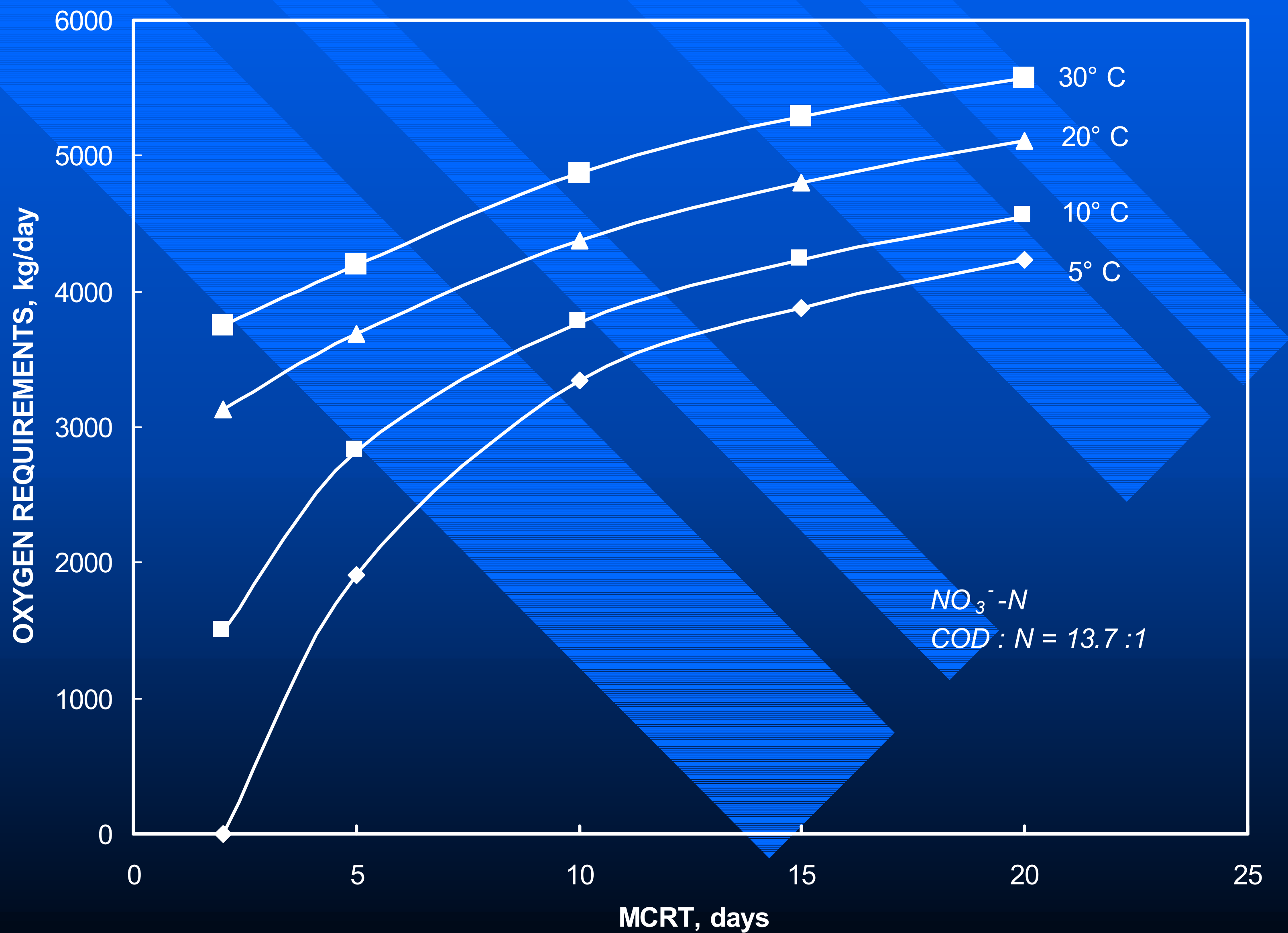
Biosolids Production vs MCRT with Nitrate as Nitrogen Source



Oxygen Required vs MCRT with NH_3 as Nitrogen Source



Oxygen Required vs MCRT with Nitrate as Nitrogen Source



Conclusions

- Lower effluent soluble CODs can be achieved as wastewater temperature increases and MCRT increases.
- At similar MCRTs, the effluent COD concentration will be lower when ammonia rather than nitrate serves as the nitrogen source.

•Conclusions Continued

- At similar MCRTs, less waste biosolids are produced as the wastewater temperature increases.

- At similar MCRTs, biosolids production is significantly larger when ammonia rather than nitrate serves as the nitrogen source.

•Conclusions Continued

- Oxygen requirements are significantly higher when ammonia rather than nitrate serves as the nitrogen source since nitrification will occur.