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(54) Titre : SYSTEME DE REFROIDISSEMENT POUR ORDINATEUR
(54) Title: COMPUTER COOLING SYSTEM

Computer Cooling System

A computer cooling system may include a control center component or module with a cooling functionality, referred to sometimes herein as Predictive Cooling™, that effectively allows computers to anticipate heat production from the CPU and adjust cooling power accordingly to provide a new level of cooling stability. In one embodiment, a Control Center module may include a USB connected control board that allows full software interaction to dynamically control the cooling power and fan speeds of nearly any chilling solution depending on the preferences of the end user.

One of several liquid cooling systems that this cooling functionality technology may work with is the liquid cooling systems and, for example, the Boreas 12-TEC (Thermoelectric Cooler) chiller. While other cooling alternatives are restricted to a single processor, the *Boreas* all-in-one solution applies MTEC technology to chill the CPU, GPU, and chipsets allowing for unprecedented levels of overclocking performance.

Some other items of interest may be *RAM Fan* and *PCI Cooling Booster* which provide direct air flow to cool RAM, Video Cards and other heat sensitive components on the motherboard like chipsets and voltage regulators.

Proprietary P.I.D. (Proportional, Integral and Derivative) Algorithm

$$\Delta C_{pwr}(t) = K_p (e(t) + K_i \int_0^t e(\tau)d\tau + K_d \, de/dt)$$

e(t) is the error, or difference between the target temperature and the current coolant temperature at time t

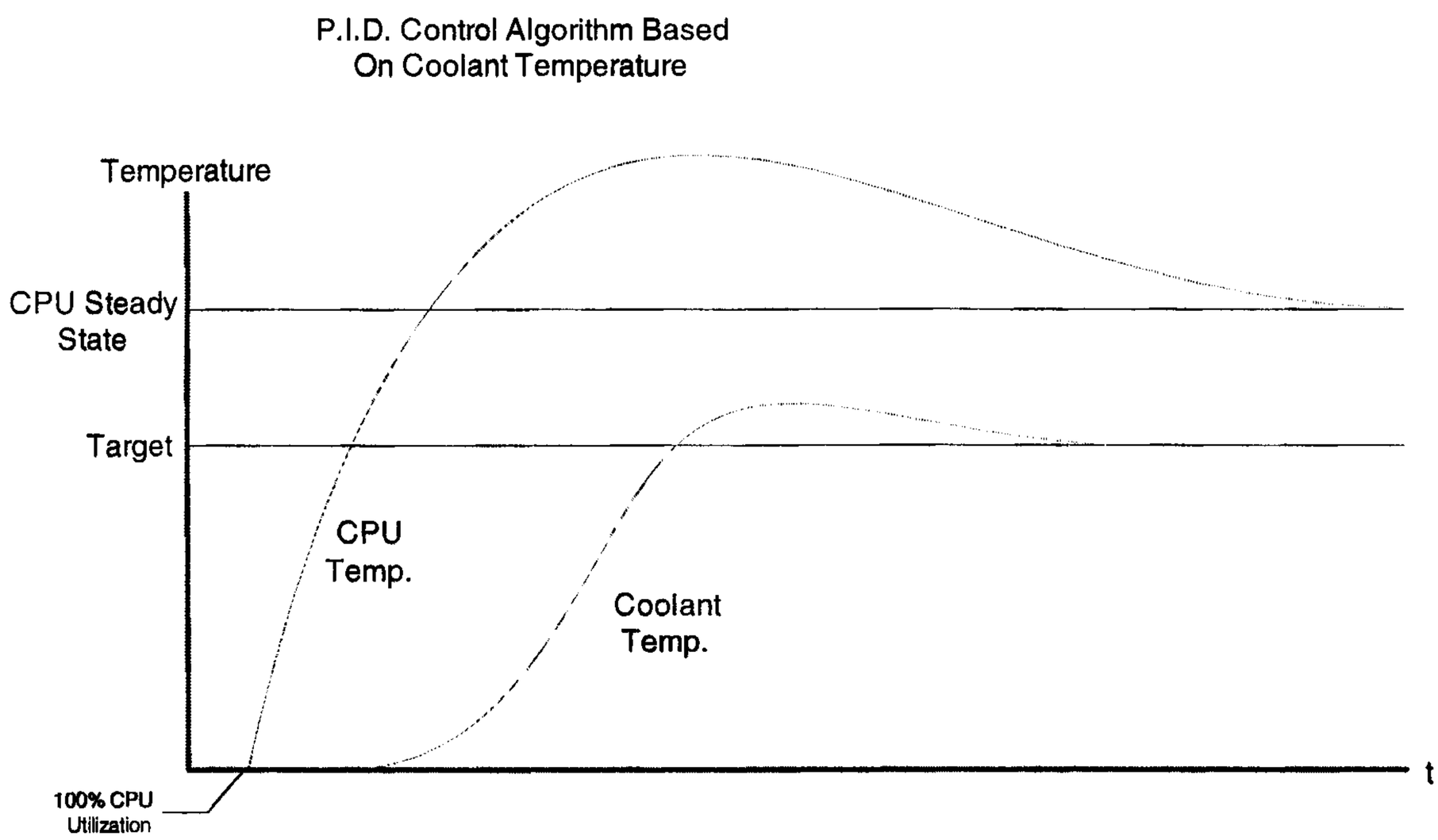
K_p, K_i and K_d are constants tuned to a known chiller technology.

$\int_0^t e(\tau)d\tau$ – average error over a set time period

K_d de/dt – change over time of the errors

Benefit: Proprietary, tuned P.I.D. algorithm offers accurate, non-oscillating temperature control.

Con: Decreased response time due to equation based on coolant temperature.



Predictive Cooling™ - P.I.D. + CPU Utilization

A second term is added to the above PID equation to account for CPU utilization.

$$\Delta Cpwr(t) = K_p\left(e(t) + K_i \int_0^t e(\tau)d\tau + K_d\, de/dt \right) + U_p\left(u(t) + U_i \int_0^t u(\tau)d\tau + U_d\, du/dt \right)$$

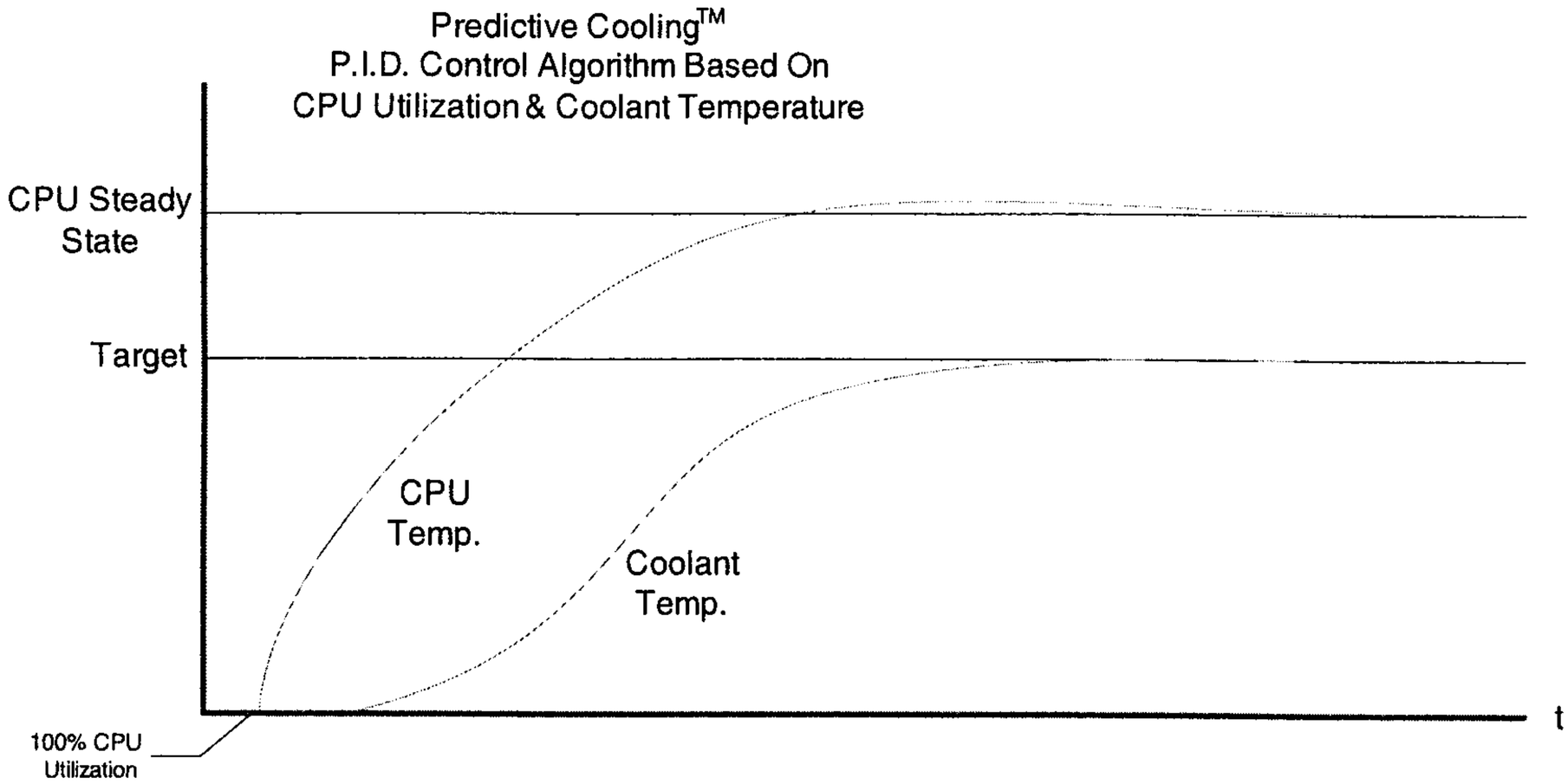
u(t) is the error, or difference between the nominal cpu utilization and the average cpu utilization at time t

U_p, U_i and U_d are constants tuned to a known chiller technology

$\int_0^t u(\tau)d\tau$ – average cpu utilization over a set time period

$K_d\, du/dt$ – change over time of the cpu utilization

Benefits: Will anticipate and react to cpu temperature changes based on the cpu utilization. Lower CPU temperatures and lower cooling power will be required as a result.



Predictive Cooling™ + P.I.D. is Power Efficient.
Power is saved when CPU Temperature does
not overshoot steady state .