Analysis of Mean Maximal Power with a modified Critical Power model allowing for a variable Effective Anaerobic Work Capacity

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Background

The Standard CP - Model (Monod-Sherrer 1965)

\[ P(t) = CP + \frac{W'}{t} \]

The model is valid for a small synergetic muscle group (peripheral fatigue), and for times to exhaustion higher than 5 minutes

The Critical Power CP is the threshold between exhaustible and non-exhaustible power

\[ W' \] is total energy reserve in excess of CP

The modified CP - Model

\[ P(t) = \left\{ \begin{array}{ll}
\frac{MAP + \frac{W'}{t} \left( 1 - e^{-\frac{t}{T_{SCP}}} \right)}{1 - \left( \frac{t}{T_{SCP}} \right)^2} U(t) & t < T_{SCP} \\
U(t) & t \geq T_{SCP}
\end{array} \right. U\left( t - tsbw \right) \]

\[ p_{max} = MAP + \frac{W'}{\tau} \]

\[ W'_{eff}(t) = (P(t) - CP)t \]

Meaning of the Parameters

- MAP = Maximal Aerobic Power
- \( W'_s \) = Maximal Anaerobic Capacity in excess of MAP
- \( p_{max} \) = Maximal power at short time, sprinting power
- \( \tau \) = Time constant of Anaerobic Capacity
- CP = Critical Power
- \( W' \) = Maximal Work in excess of CP
- \( W'_{eff} \) = Variable work capacity available in excess of CP
- \( tsbw \) = Switching time between Short Anaerobic and Long Quasi-Aerobic efforts.

- Short Anaerobic: Sprinting, 4K TT etc...
- Long Quasi-Aerobic: TT, GT Mountain stages...

SCP = Super Critical Power (M. Puchowicz)

\[ T_{SCP} = \text{Duration corresponding to SCP} \]

\[ W'_{eff} \] for \( T_{SCP} < t < \infty \)

or \( CP < P < SCP \)

Conclusions

- Hyperbolic CP analysis is replaced by a modified CP model.
- Hyperbolic CP analysis is valid only for sustainable times \( T > T_{SCP} \)
- The full Performance Curve shows 2 Regions of Interest ROI
- The short ROI describes sprinting, break-aways and 4K TT
- The long ROI describes TT’s and climbing stages
- \( W'_{eff} \) is fully available for intensities \( P < SCP \)
- \( W'_{eff} \) is lowered for \( P > SCP \)

Further research and questions

- Are MAP, CP and SCP possible markers for training zones?
- What is the physiological meaning of MAP, CP and SCP?
- Which quantity \( W' \) or \( W'_{eff} \) is to be called Anaerobic Capacity?