



EIFER

EUROPÄISCHES INSTITUT FÜR ENERGIEFORSCHUNG
INSTITUT EUROPEEN DE RECHERCHE SUR L'ENERGIE
EUROPEAN INSTITUTE FOR ENERGY RESEARCH

Aerodynamik

Leistung & Leistungsregelung

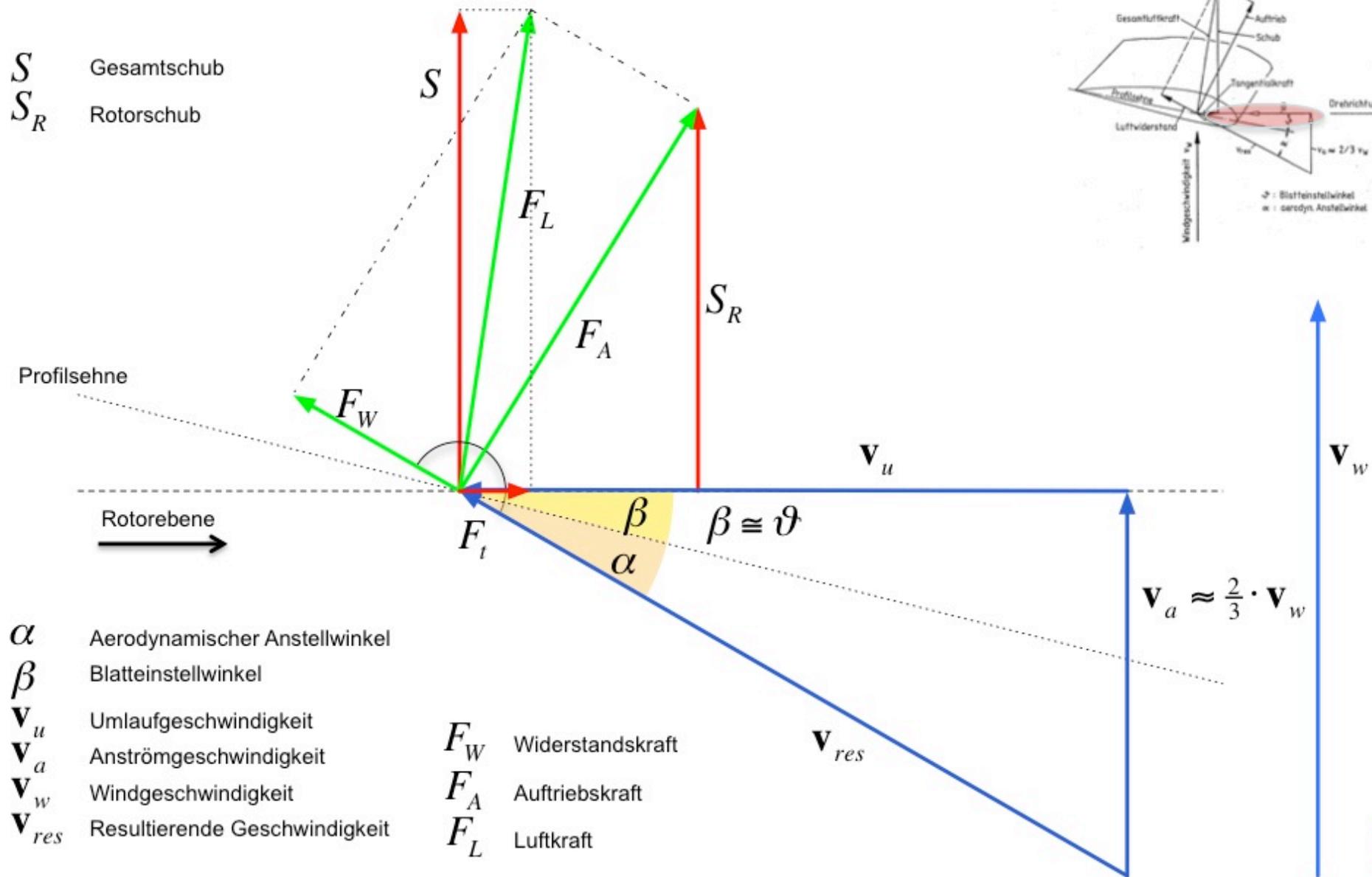
KIT





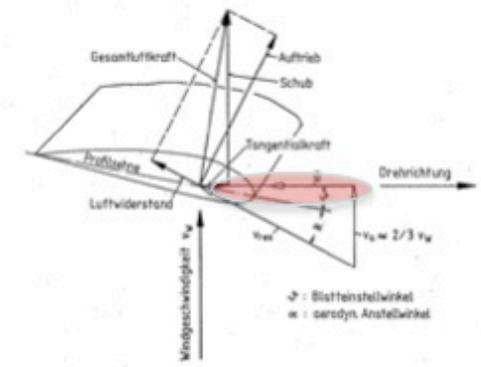
Winddreiecke - Krätedreiecke

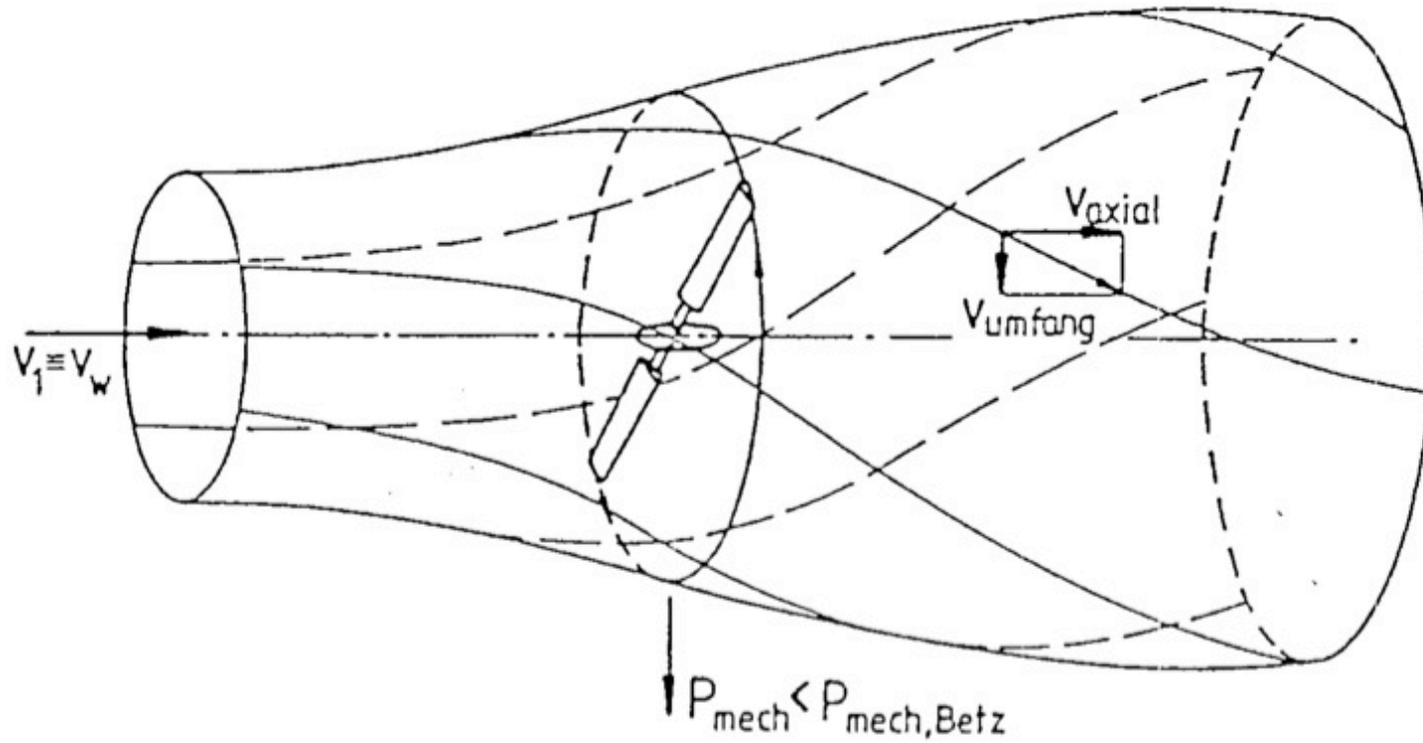
S Gesamtschub
 S_R Rotorschub

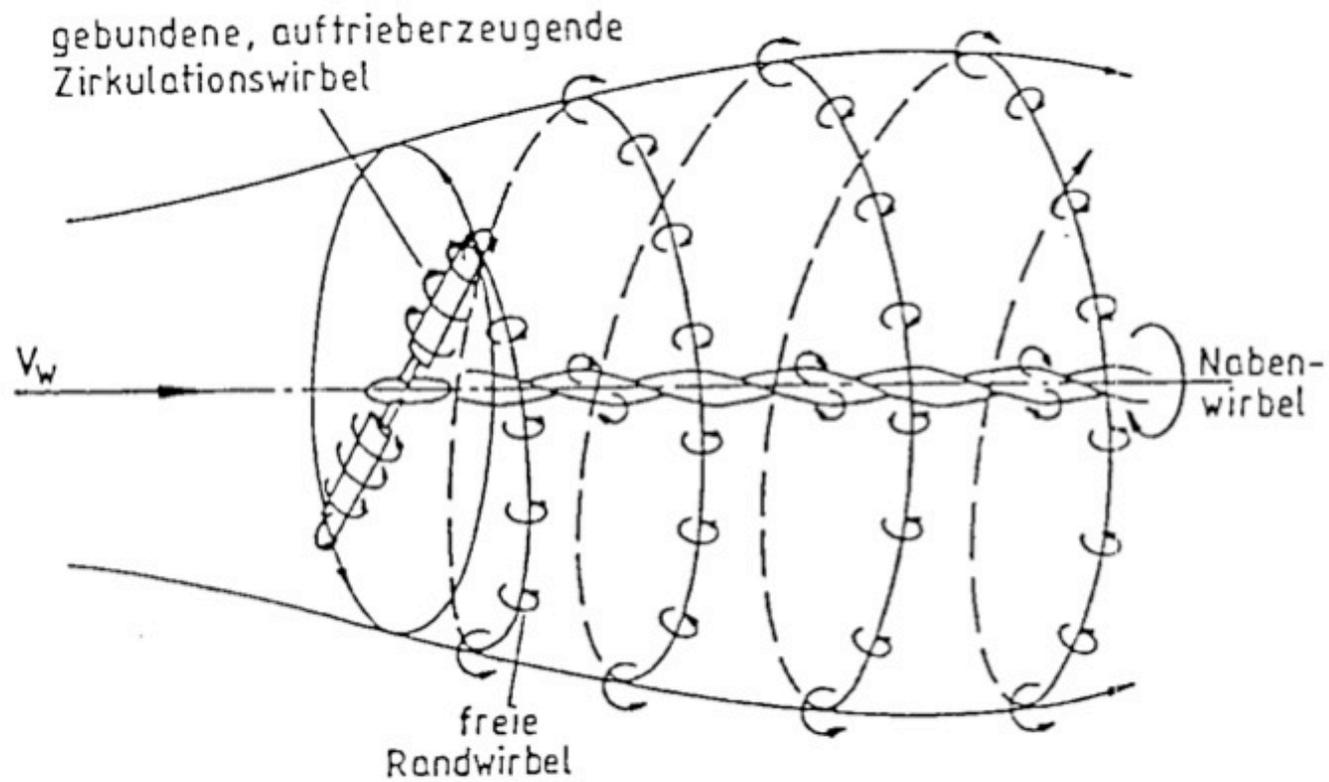


α Aerodynamischer Anstellwinkel
 β Blatteinstellwinkel
 v_u Umlaufgeschwindigkeit
 v_a Anströmgeschwindigkeit
 v_w Windgeschwindigkeit
 v_{res} Resultierende Geschwindigkeit

F_W Widerstandskraft
 F_A Auftriebskraft
 F_L Luftkraft

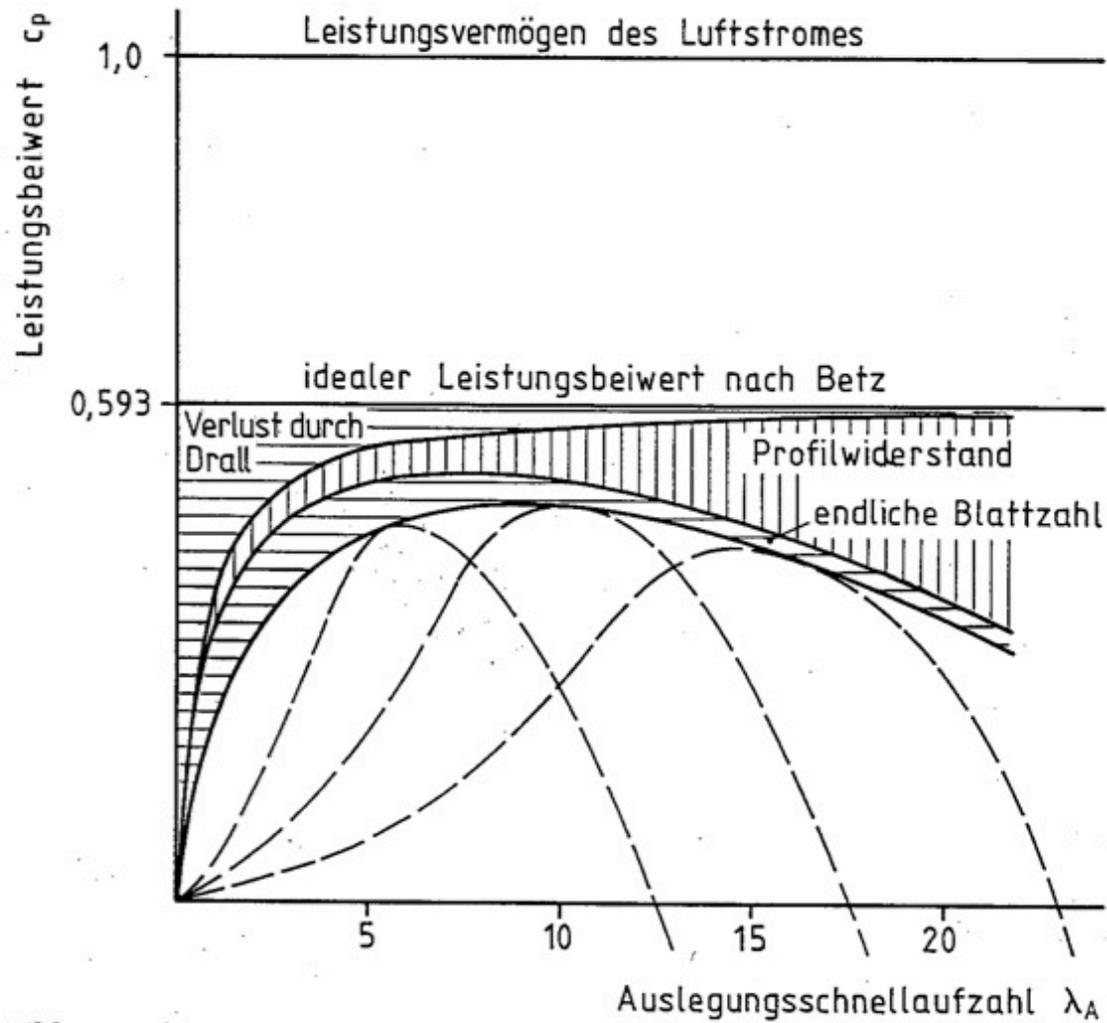


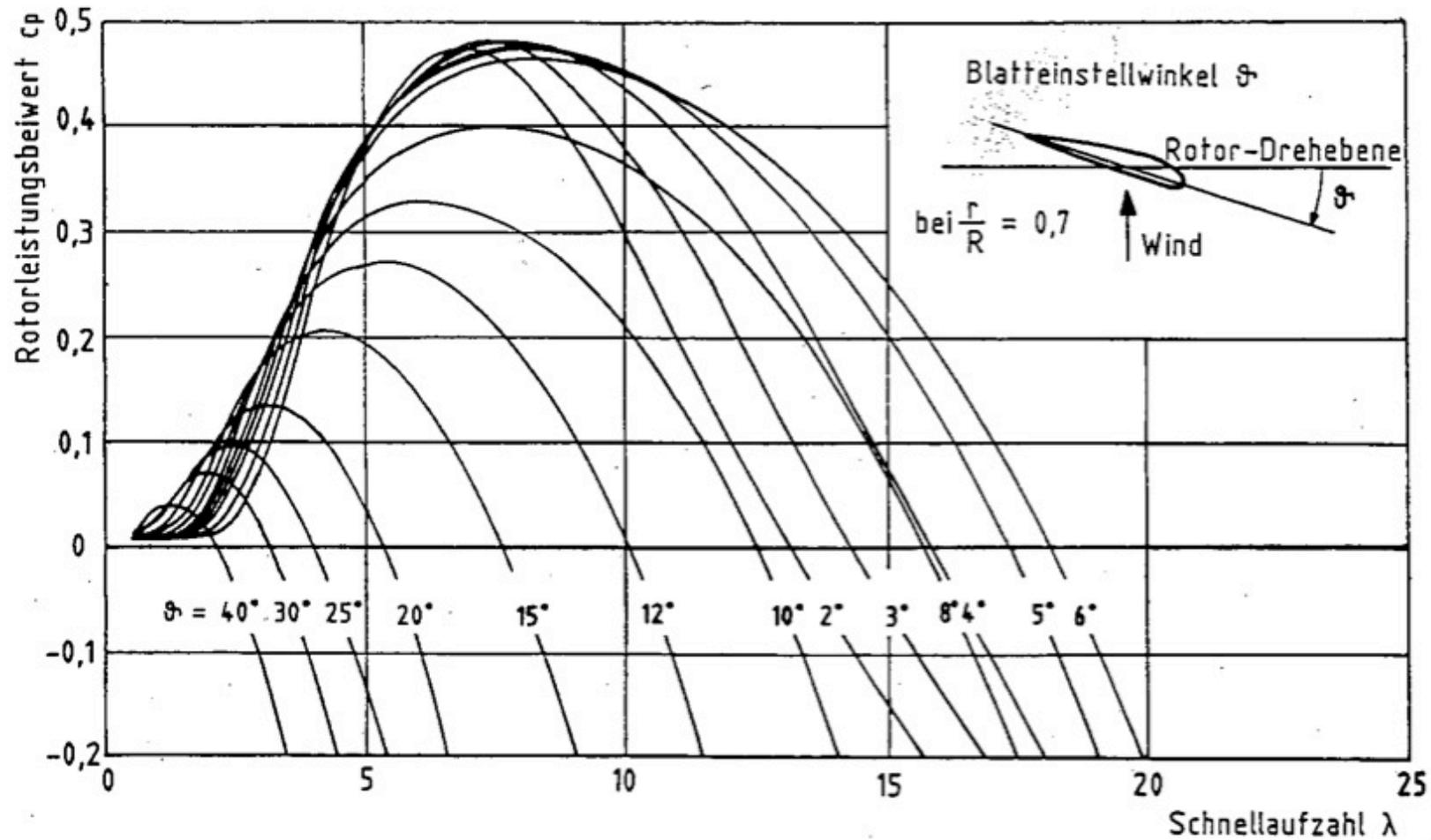






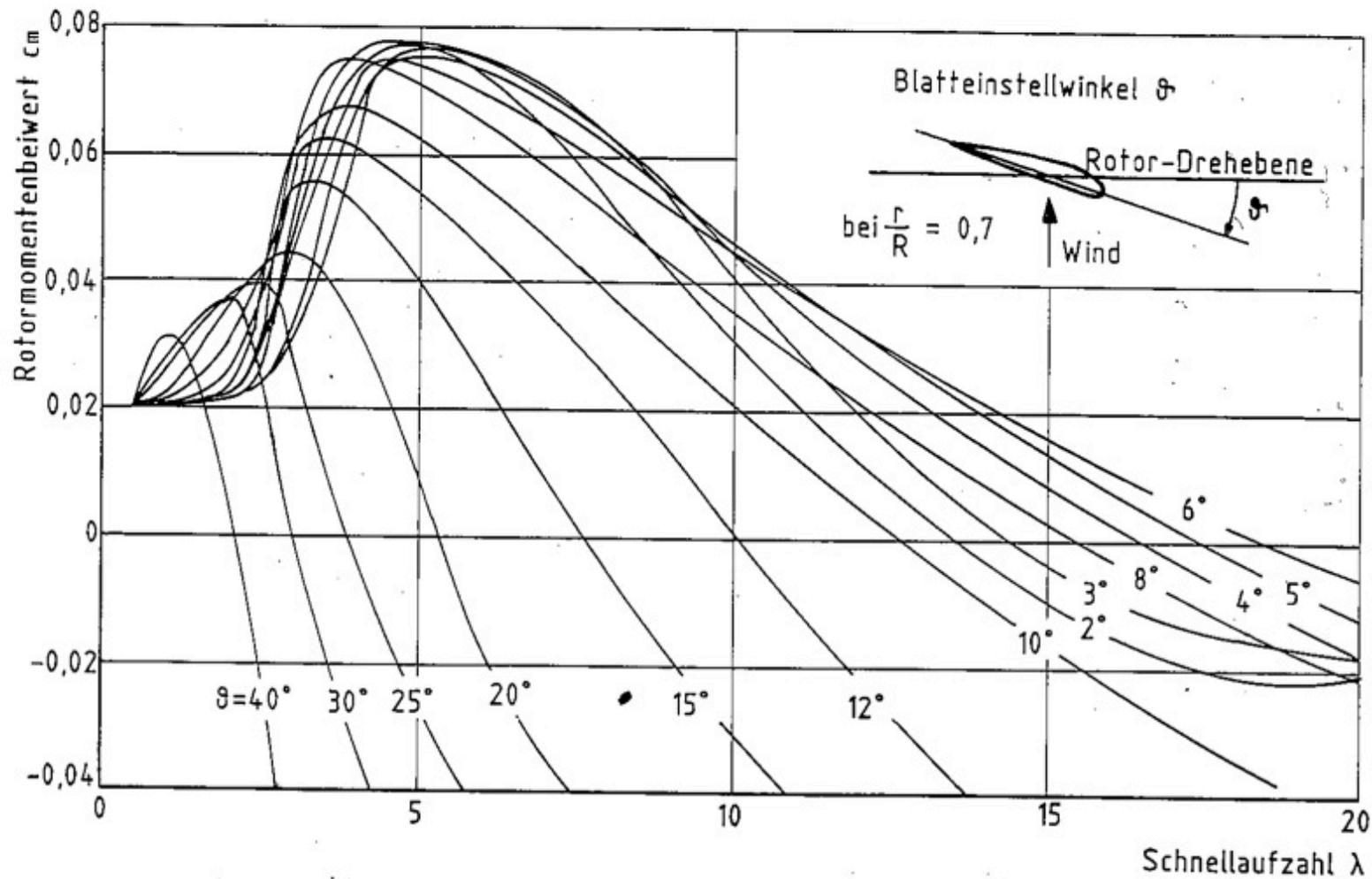
Leistungsverluste





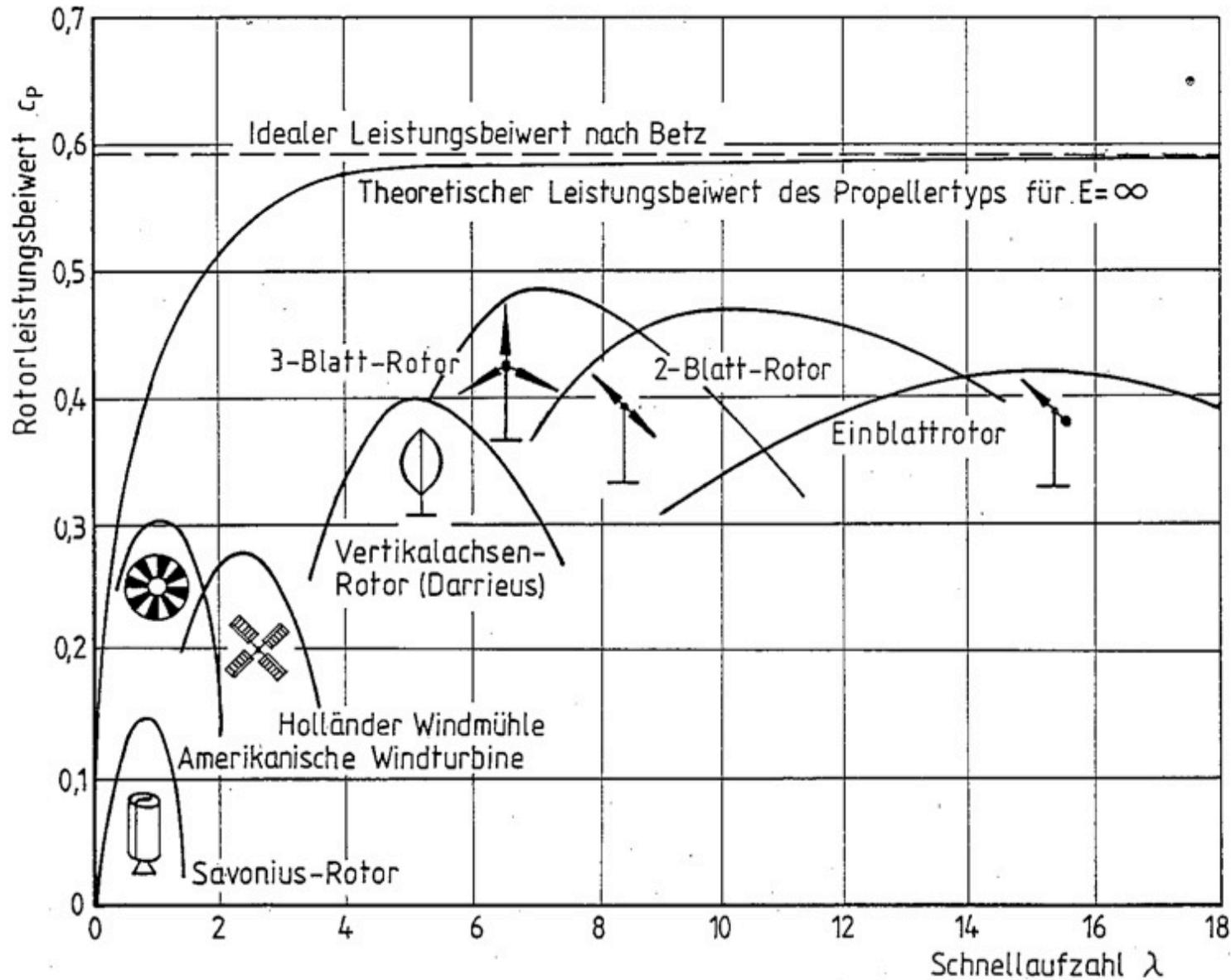


Kennlinienfeld - Momentenbeiwert



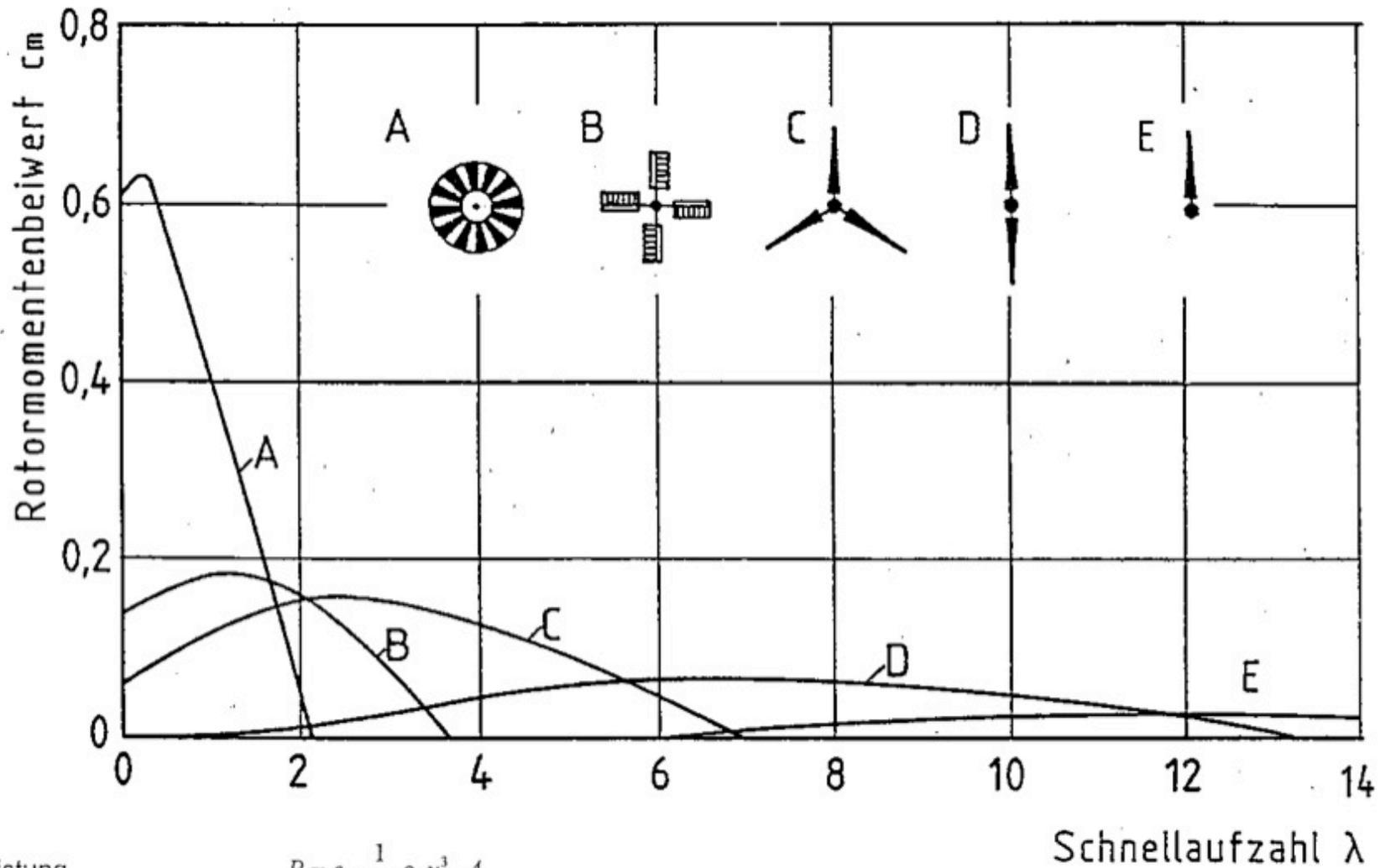


Leistungskennlinien typischer WKA





Momentenfeld typischer WKA



Leistung

$$P = c_P \cdot \frac{1}{2} \cdot \rho \cdot v^3 \cdot A$$

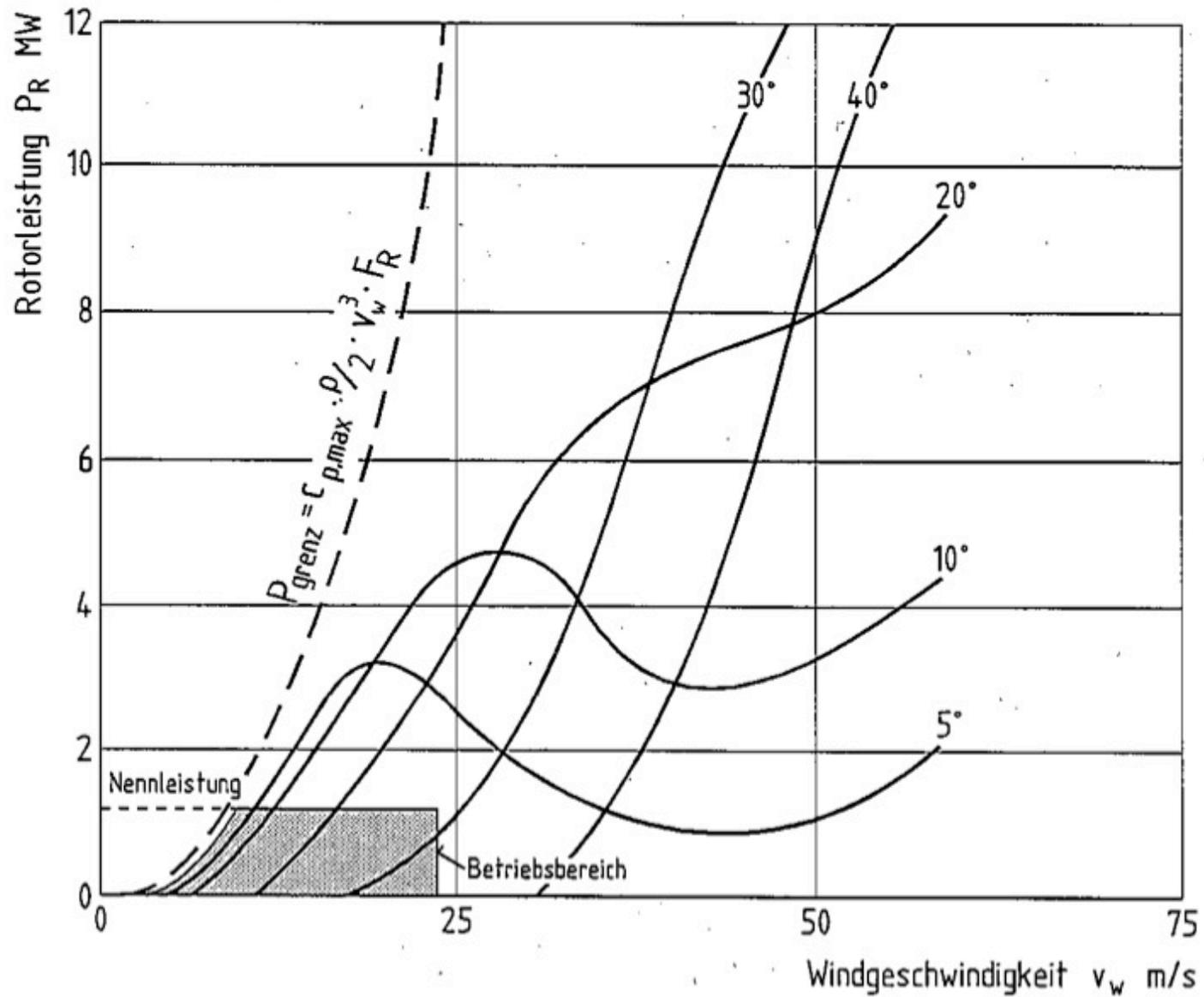
Drehmoment

$$M = c_M \cdot \frac{1}{2} \cdot \rho \cdot v^2 \cdot A \cdot R$$

$$c_P = \lambda \cdot c_M$$



Rotorleistungskennlinien



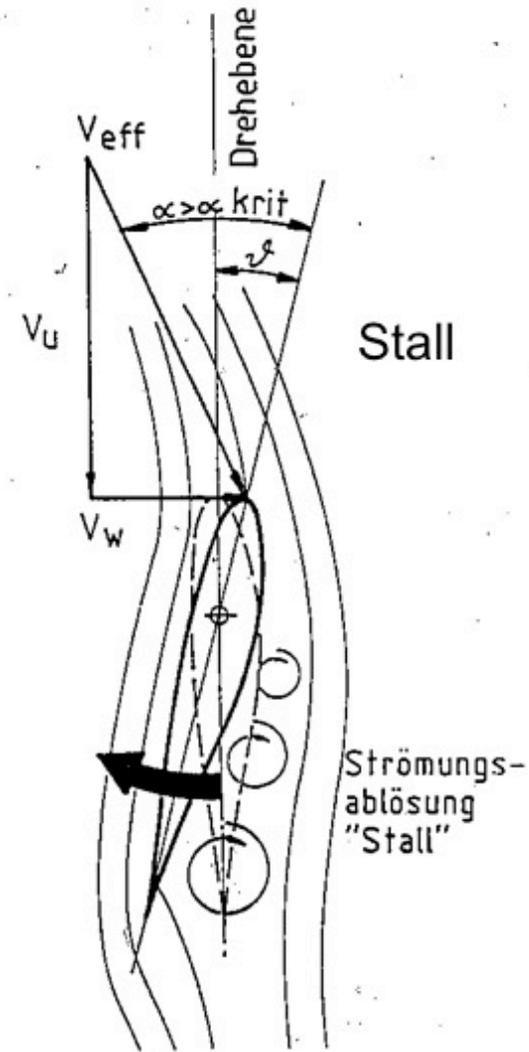
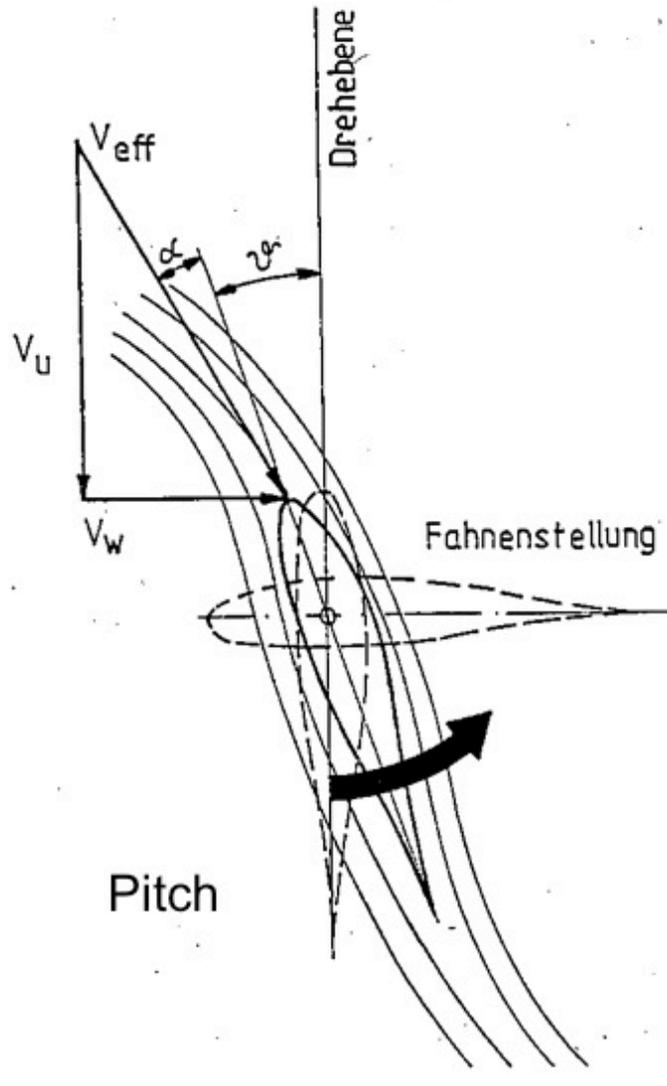
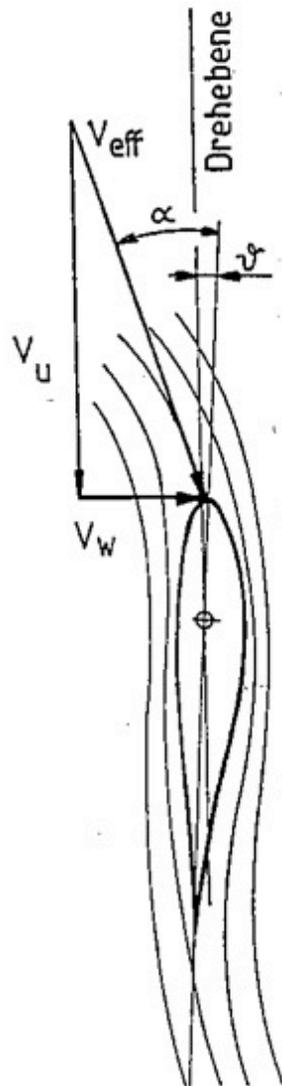


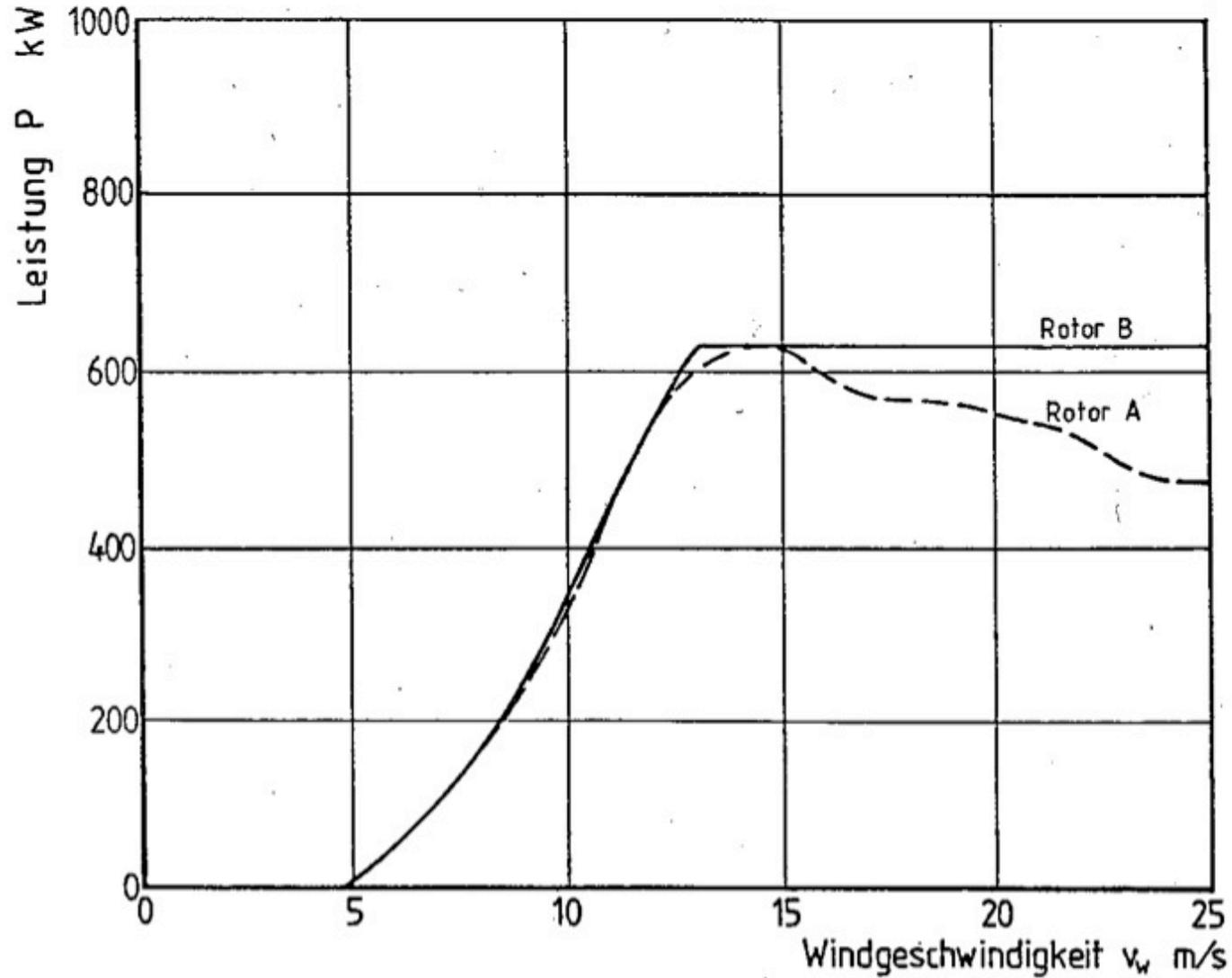
- Pitch (aktiv)
 - Aktive Reduzierung von α
- Stall (aktiv)
 - Aktive Vergrößerung von α bis Strömungsabriss durch α (kritisch)
- Stall (passiv)
 - Strömungsabriss durch α (kritisch)
- Aus dem Wind drehen
 - Schräganströmung

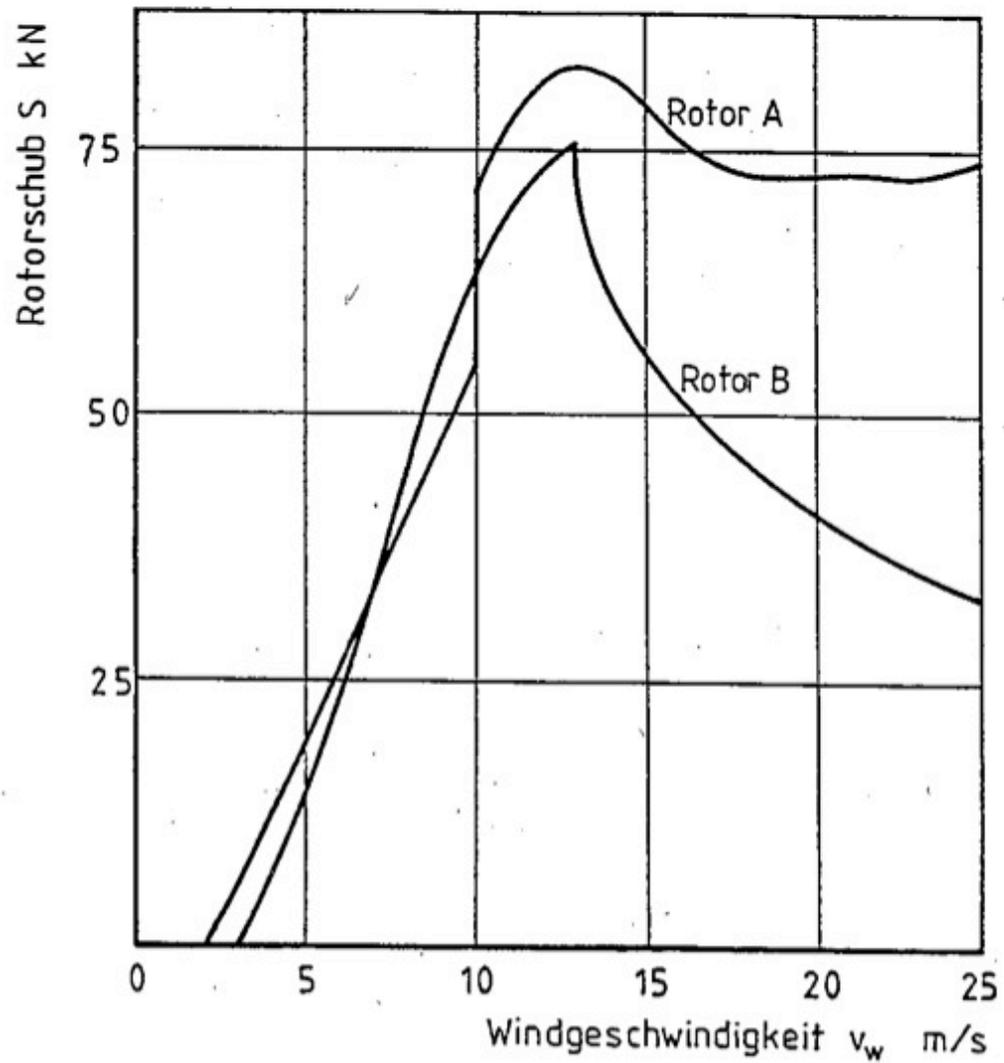


Leistungsregelung

Pitch – Stall aktiv





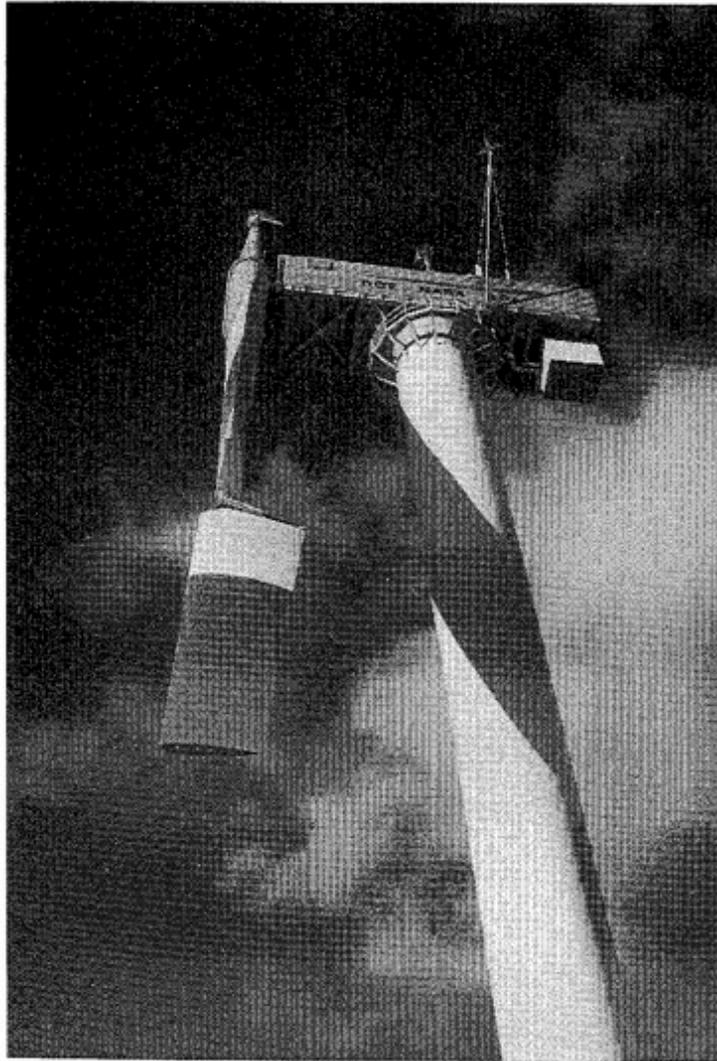


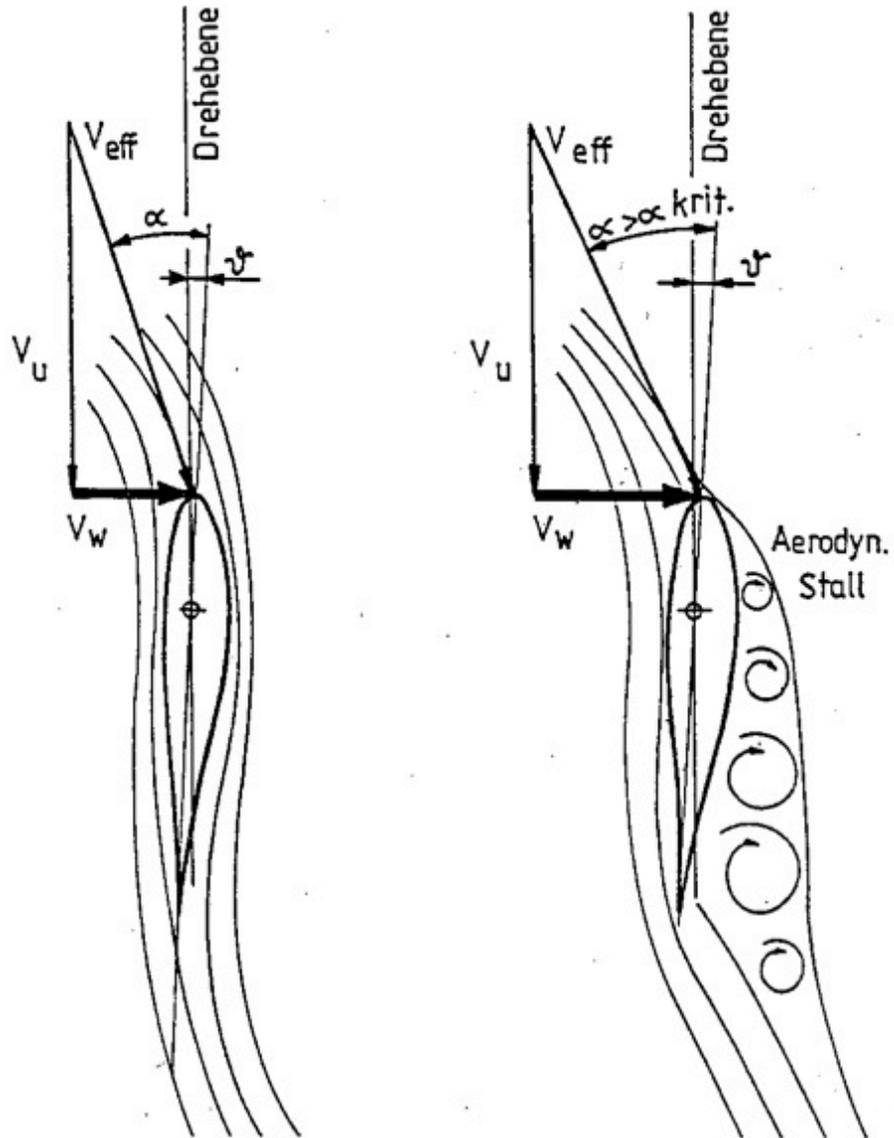


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Leistungsregelung

Teilblattverstellung

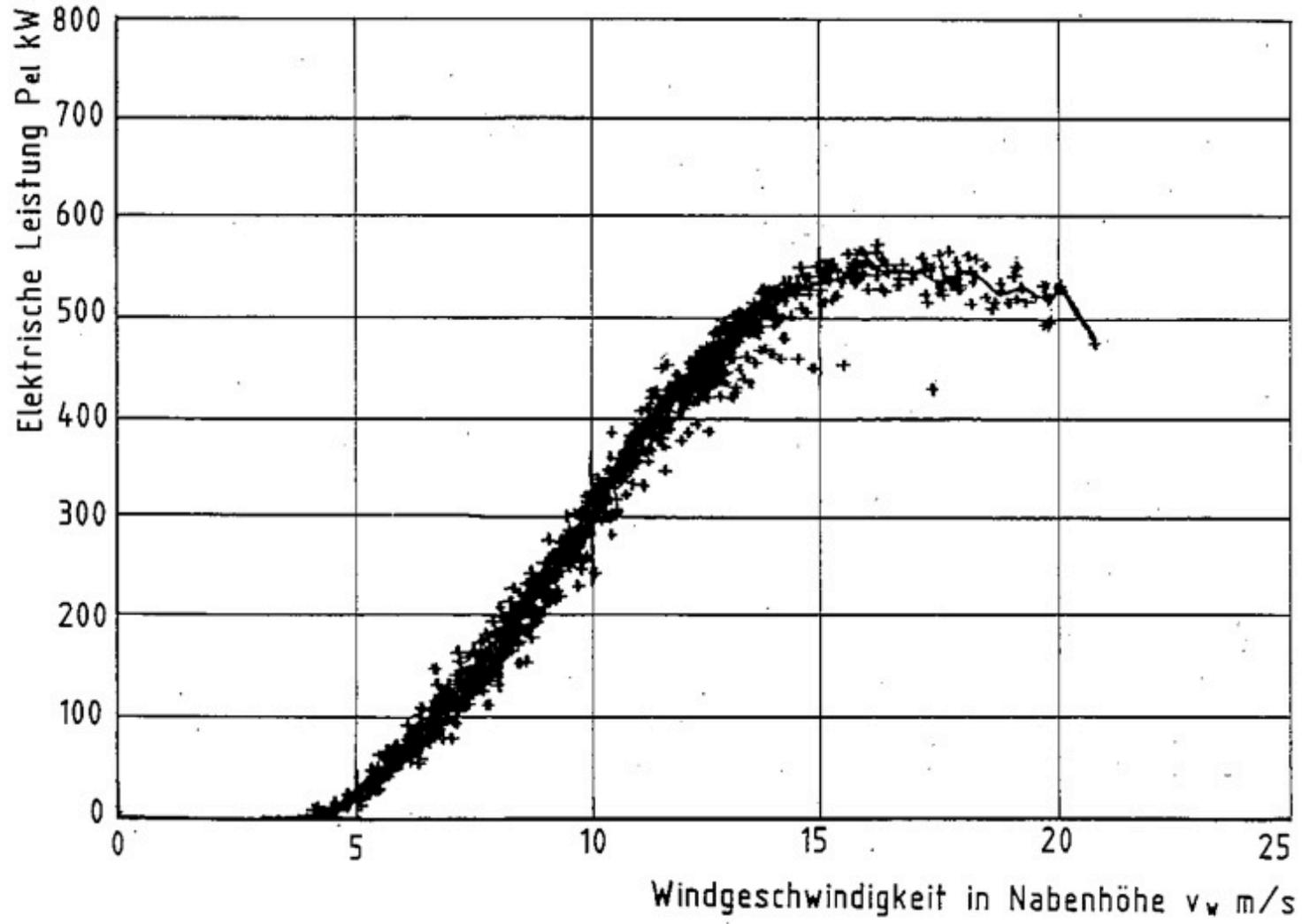






Leistungskennlinie

Stall - passiv

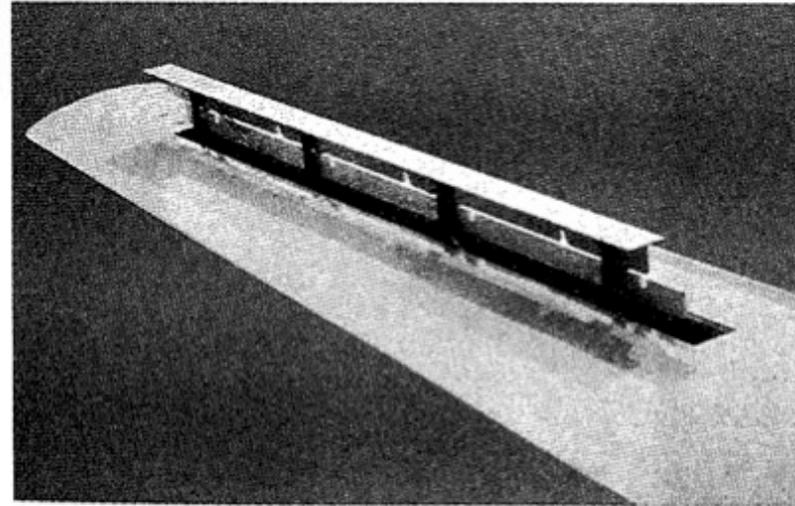
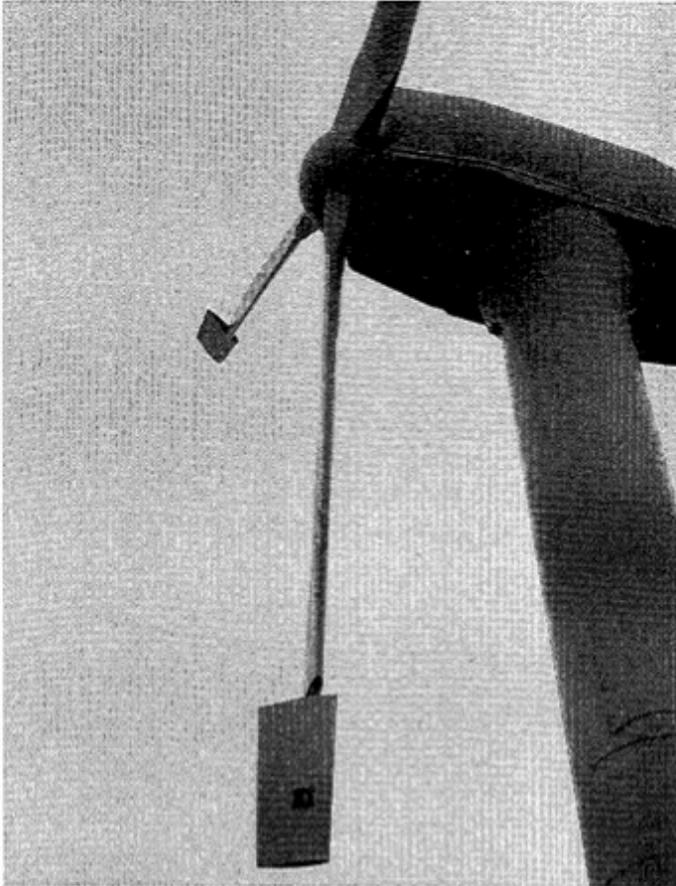


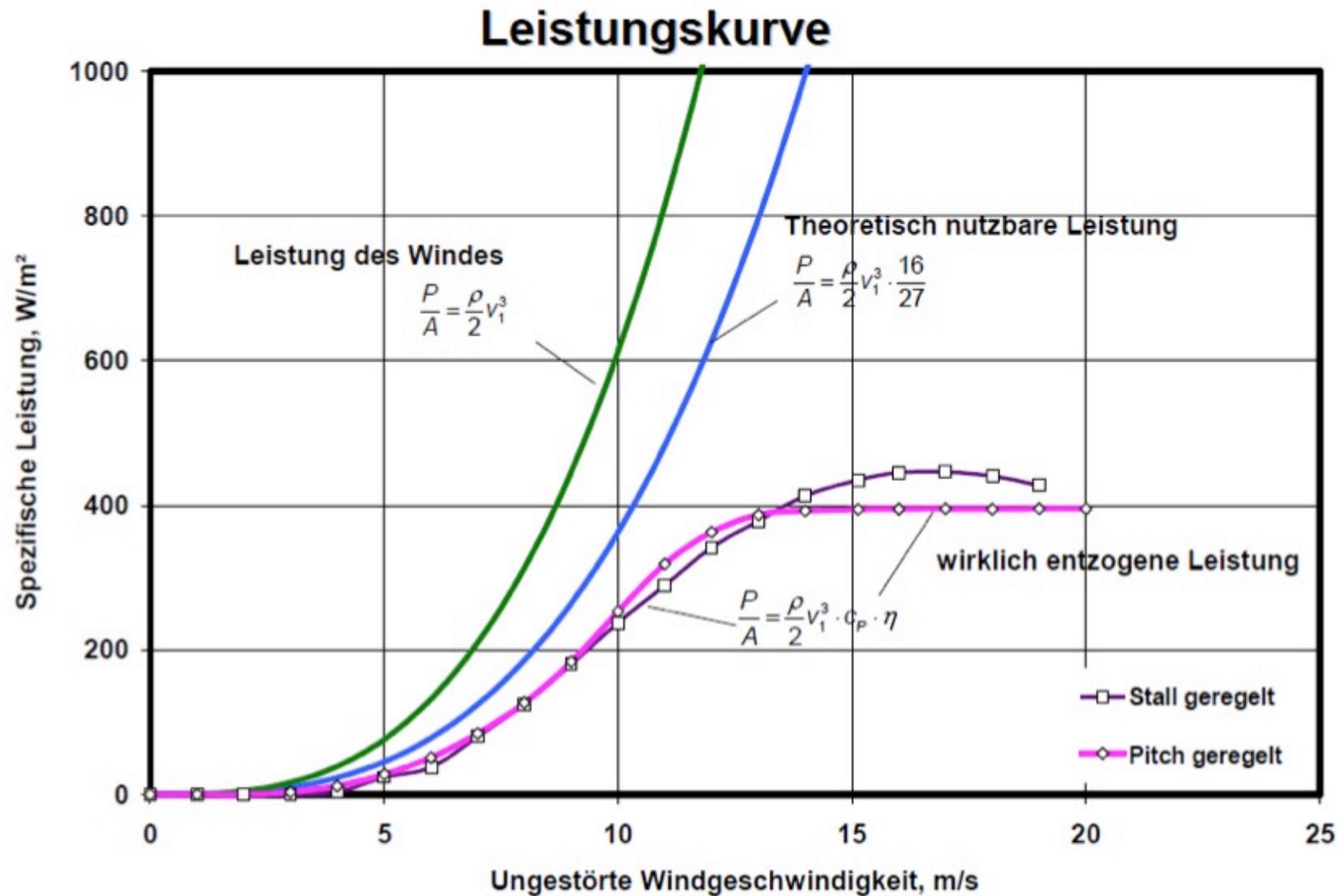


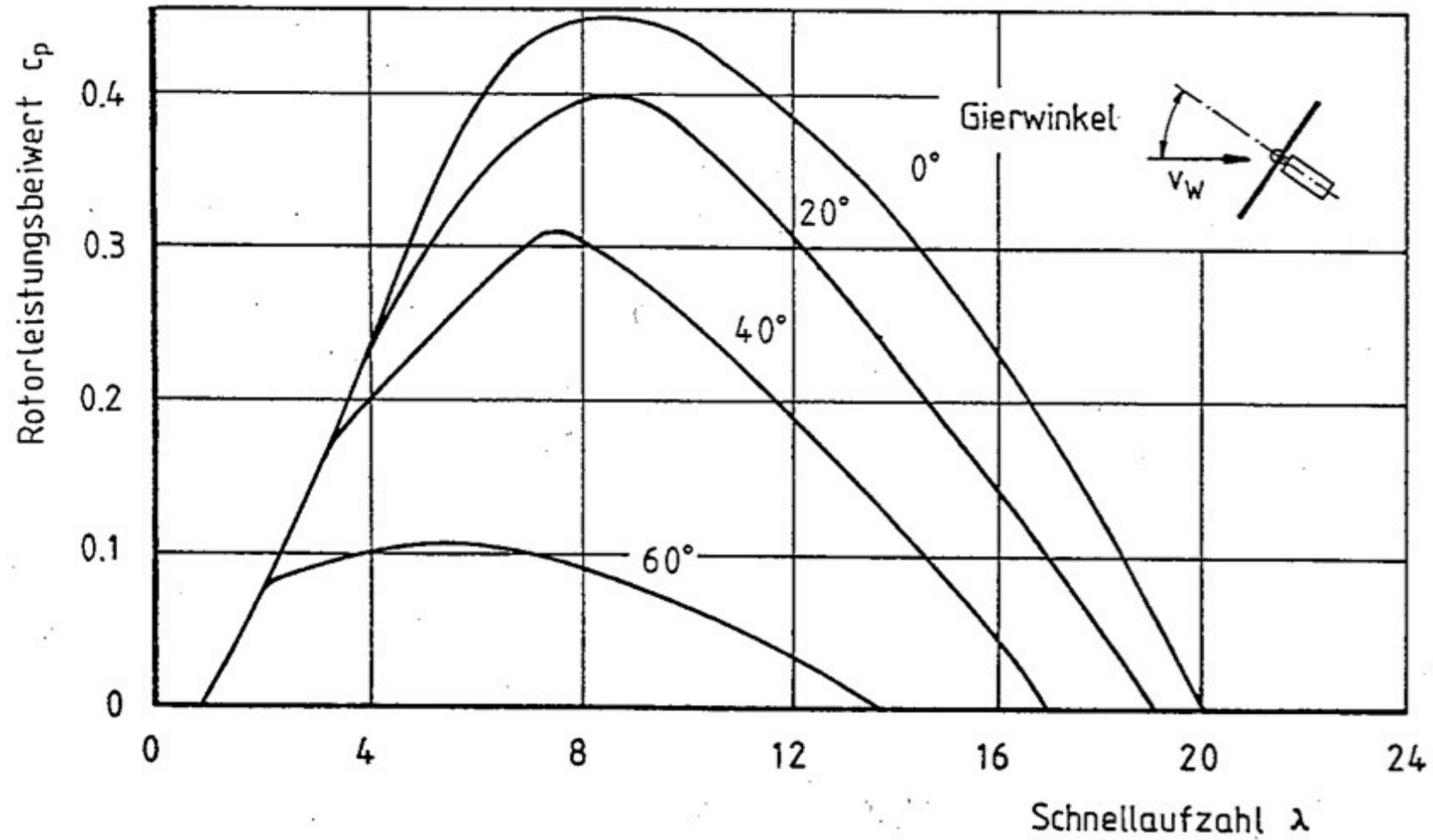
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Leistungsregelung

Stall – passiv





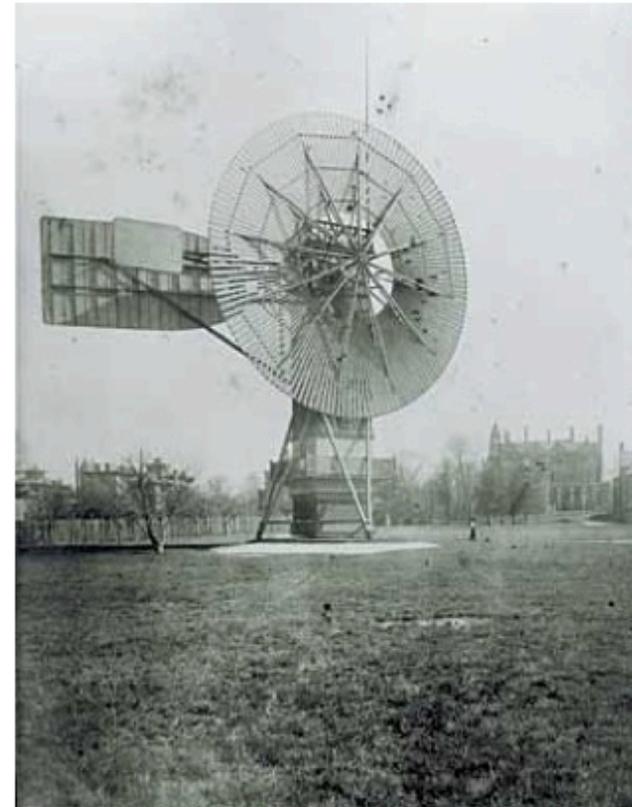




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Leistungsregelung

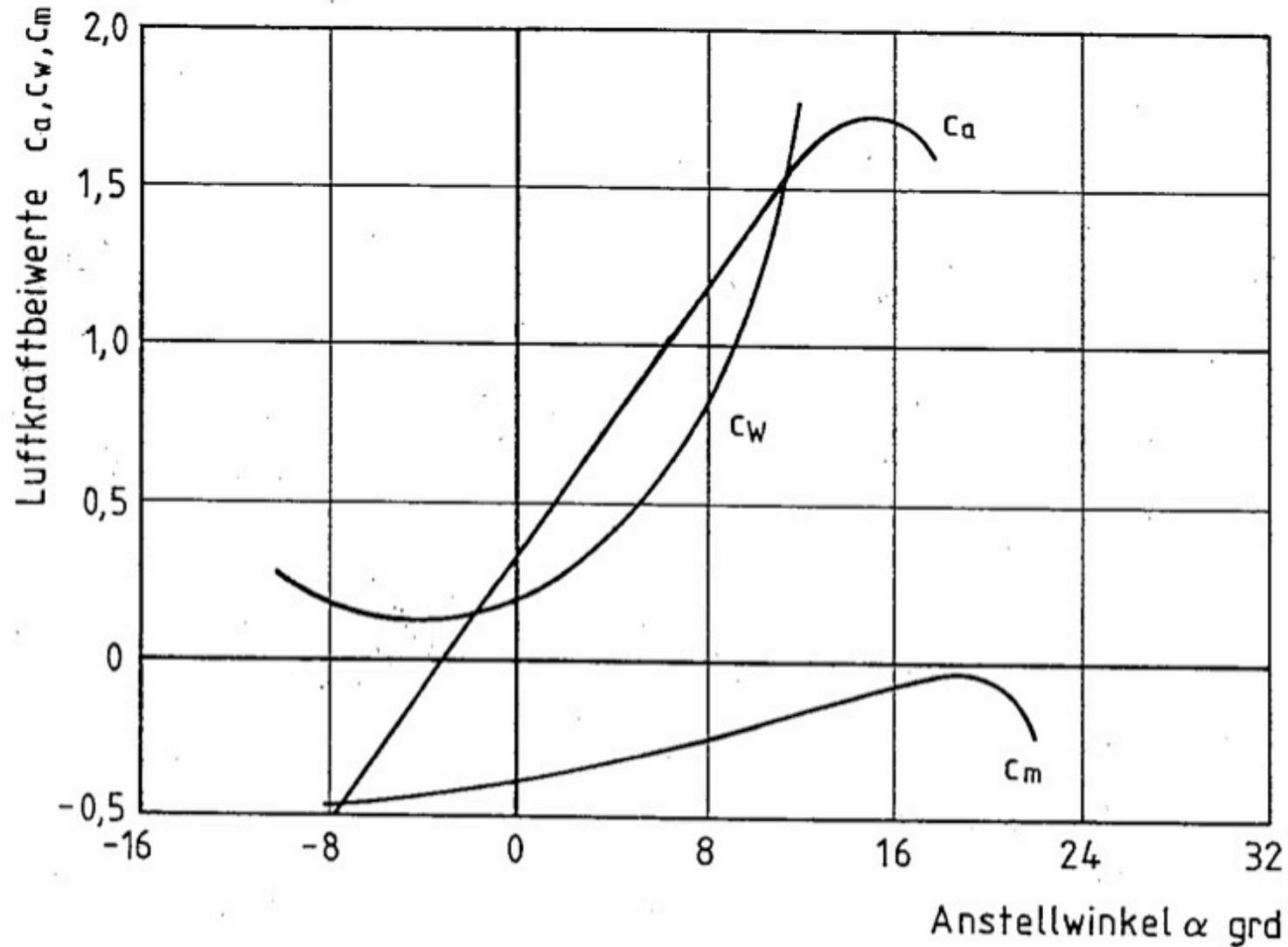
Aus dem Wind drehen - Beispiel

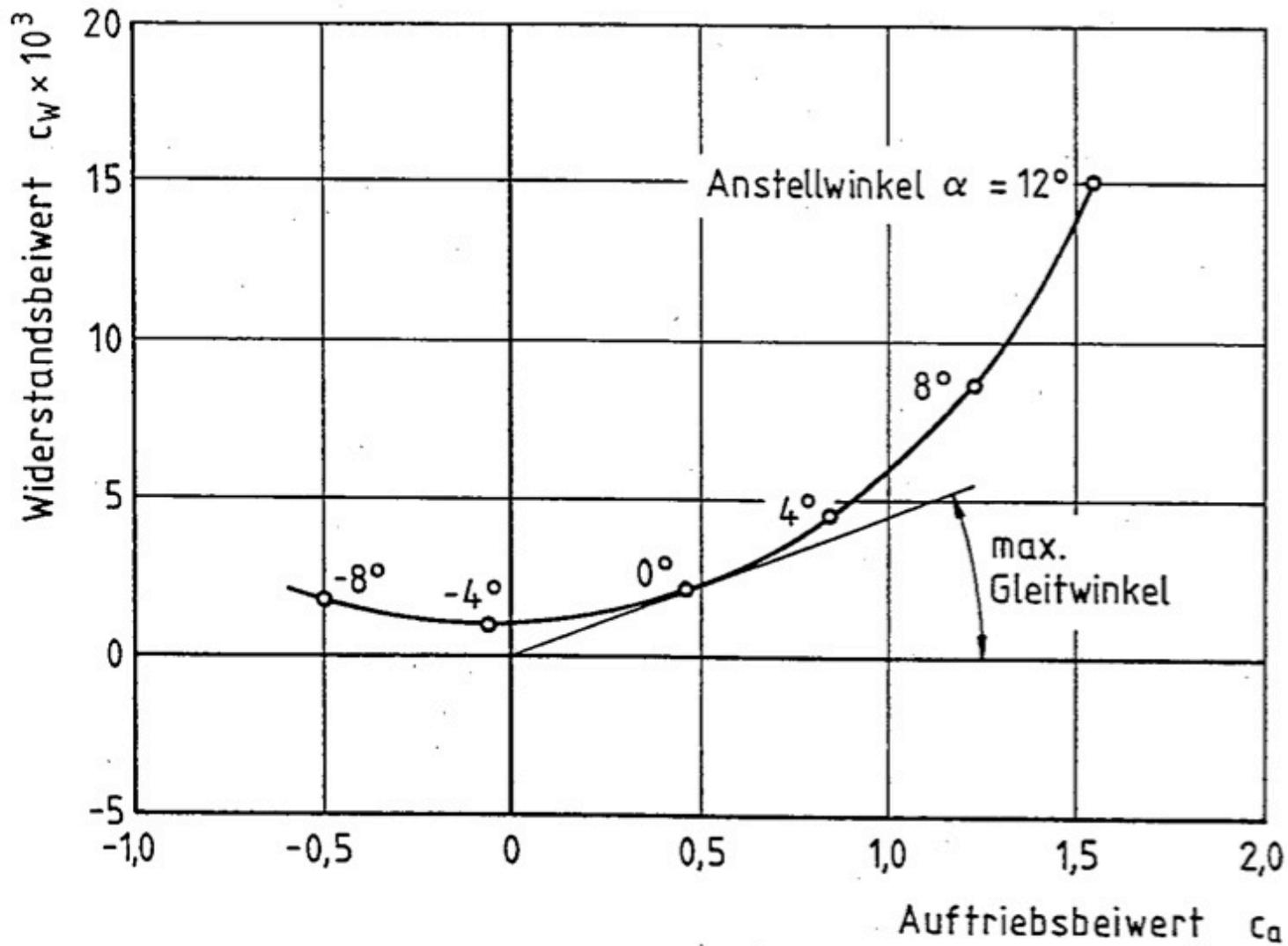




Leistungsregelung

Lilienthalsche Polare – aufgelöstes Polardiagramm

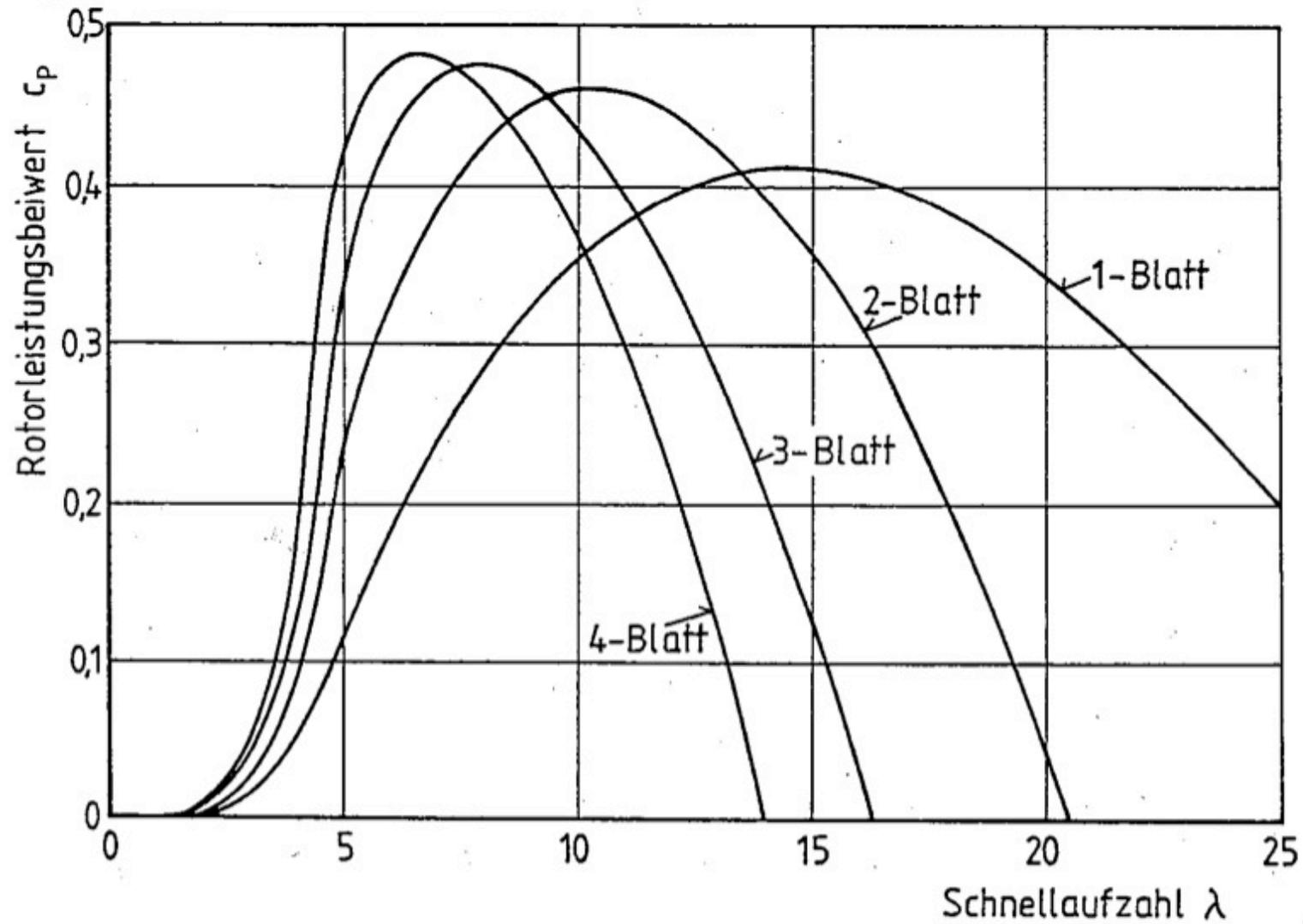






Aerodynamische Zusammenhänge

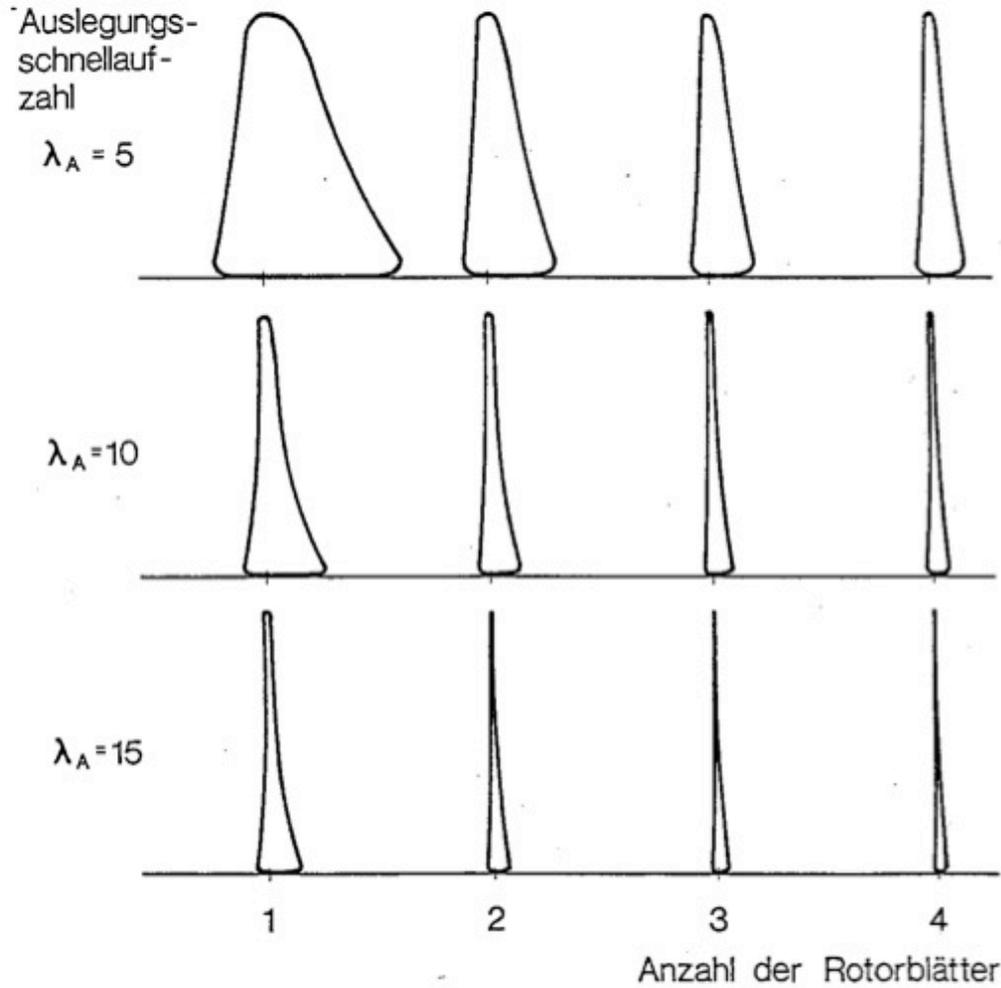
Blattzahl





Aerodynamische Zusammenhänge

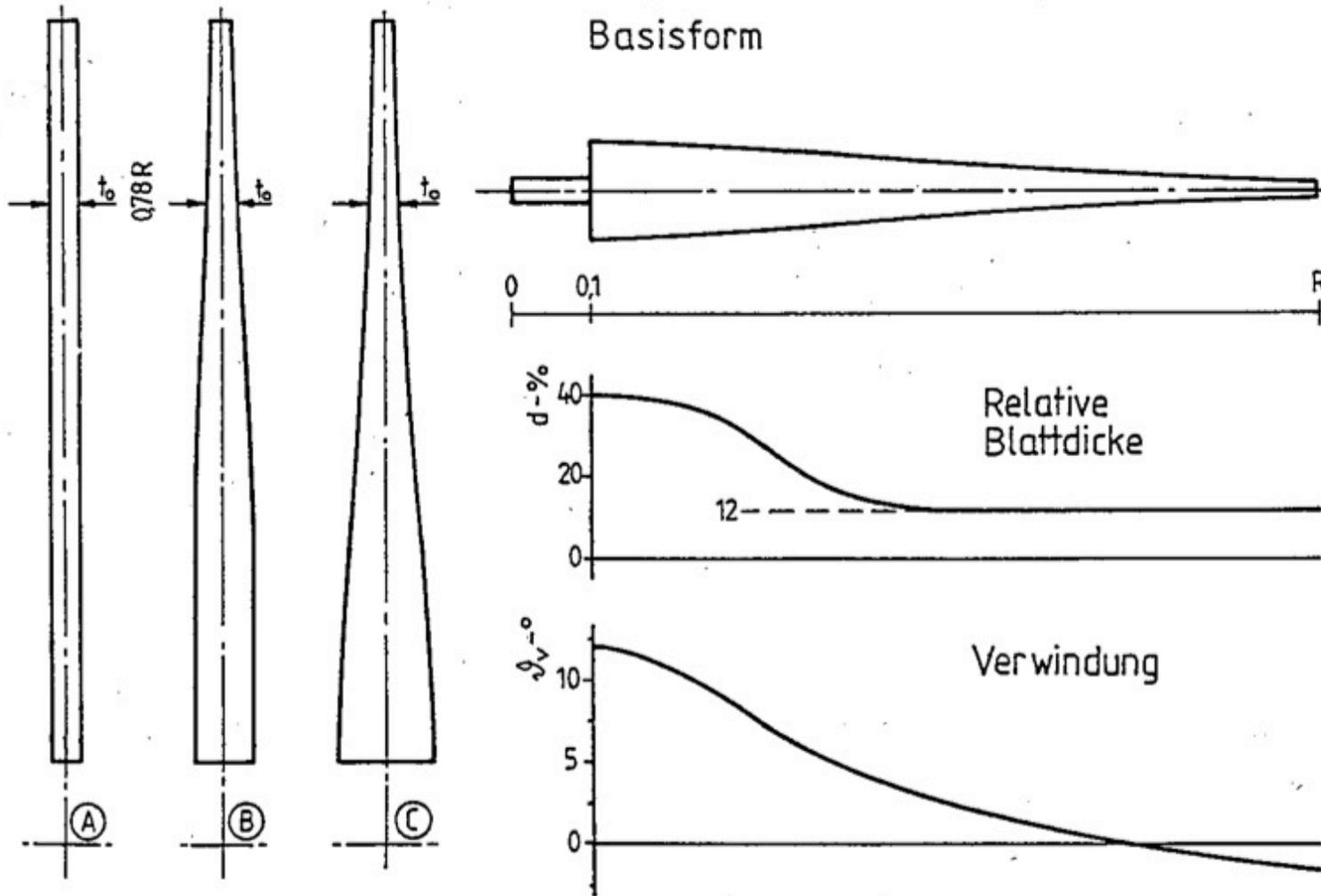
Blattformen/zahl

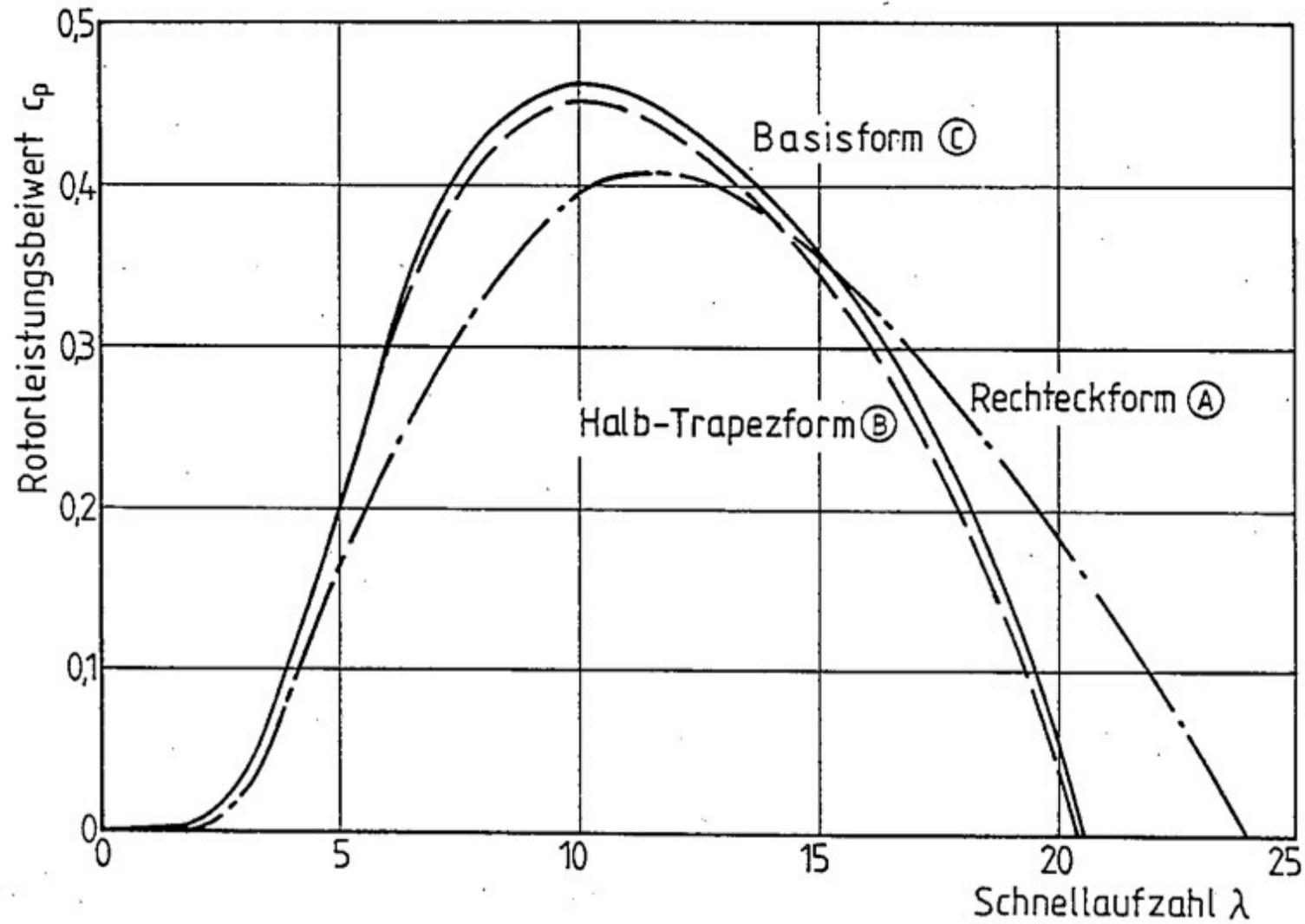




Aerodynamische Zusammenhänge

Blattformen II

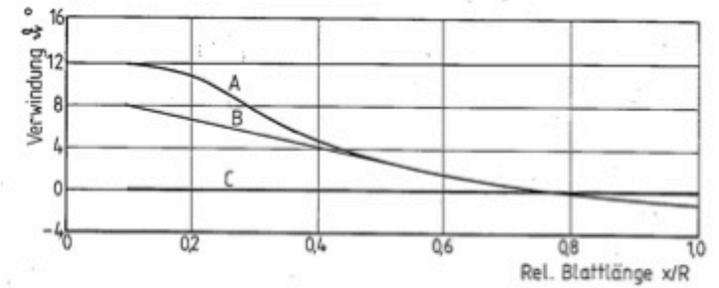
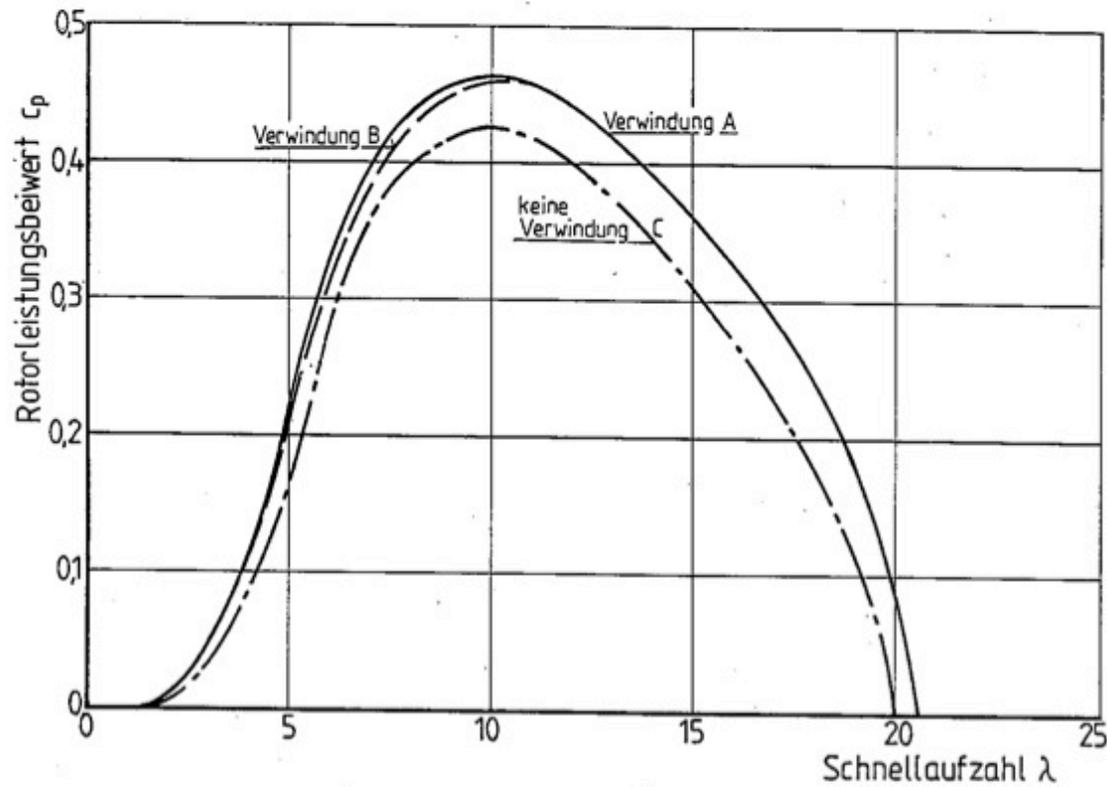






Aerodynamische Zusammenhänge

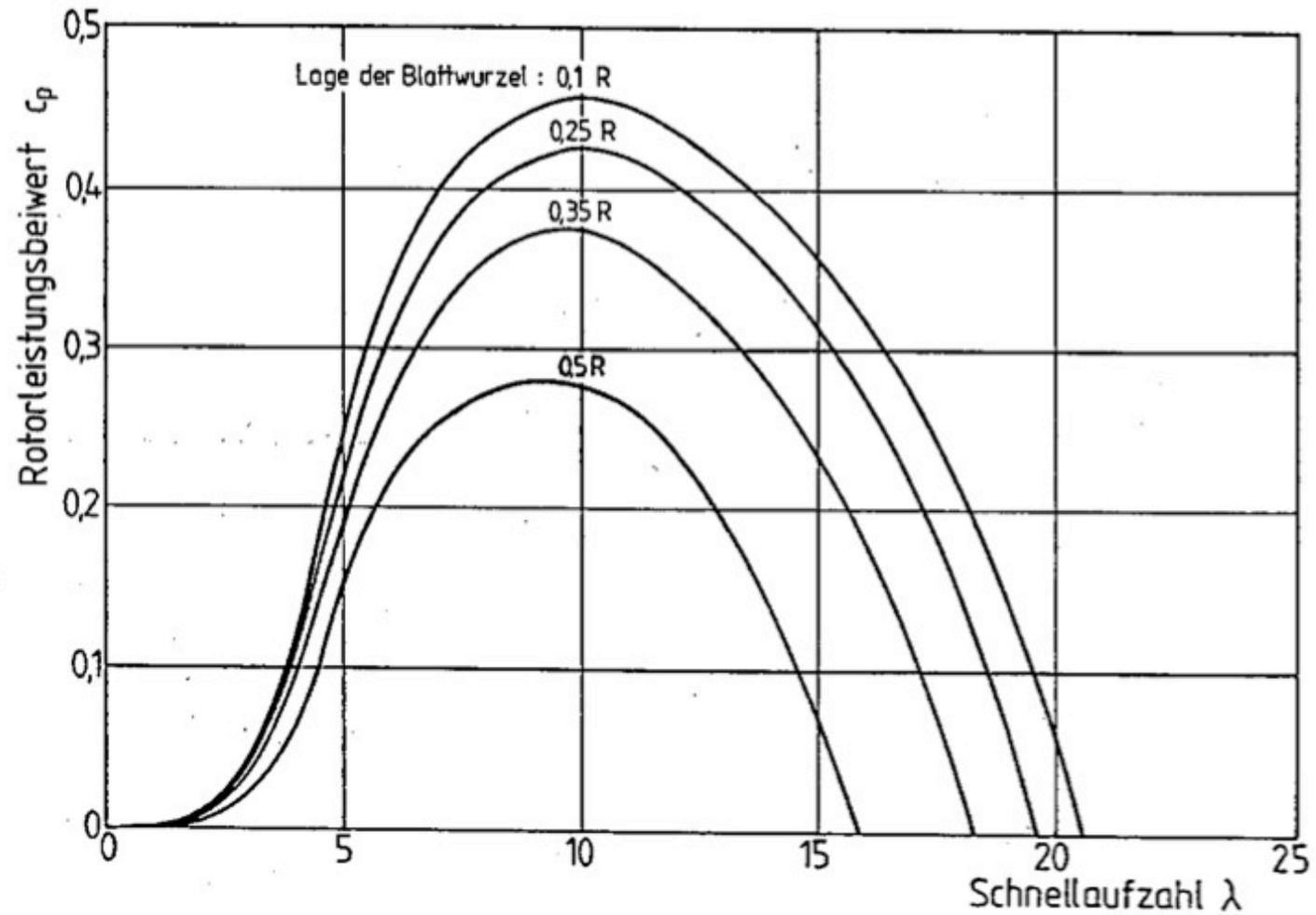
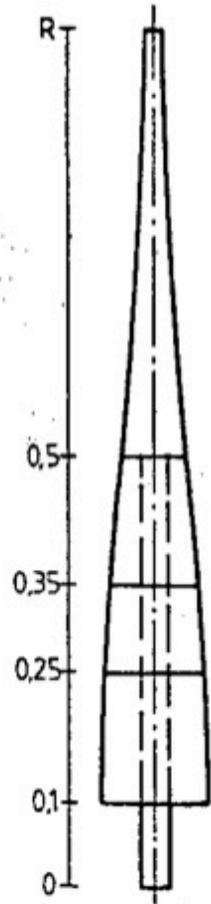
Verwindung





Aerodynamische Zusammenhänge

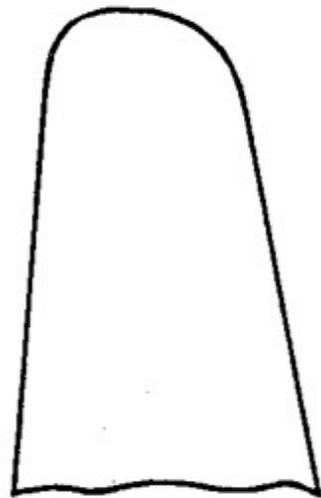
Blattwurzel



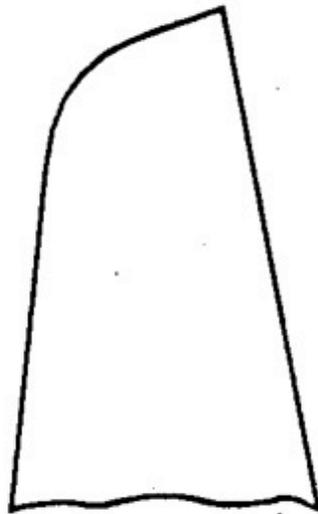


Aerodynamische Zusammenhänge

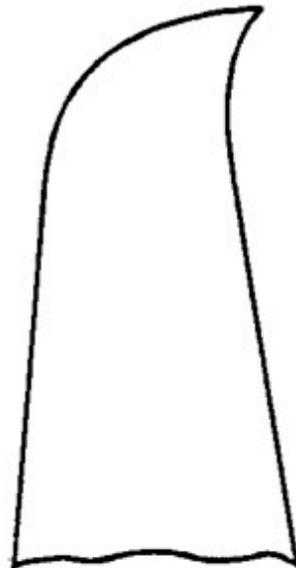
Blattspitzen



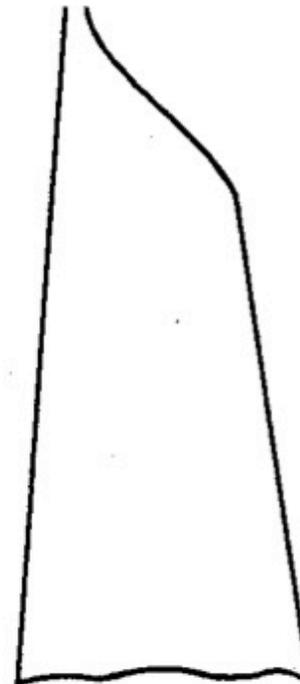
Standard



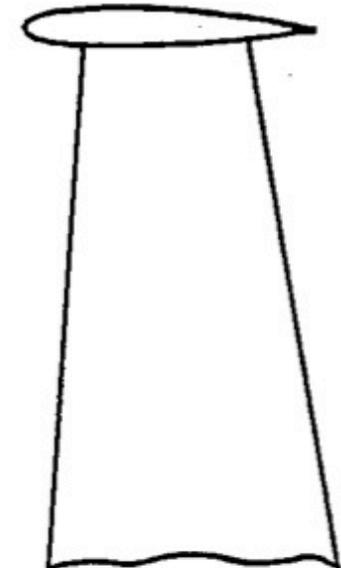
gerade Hinterkante



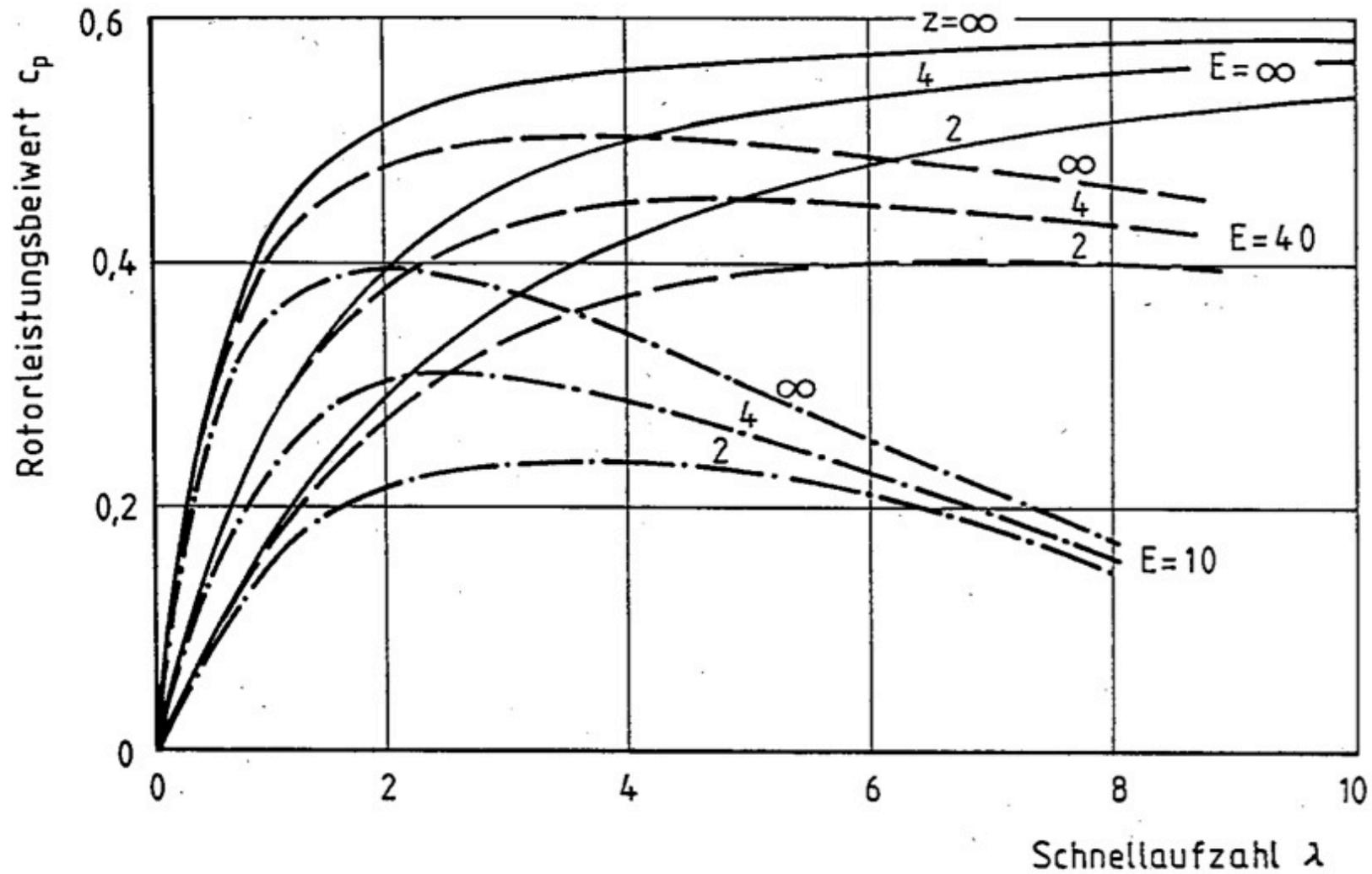
Shark



Ogee



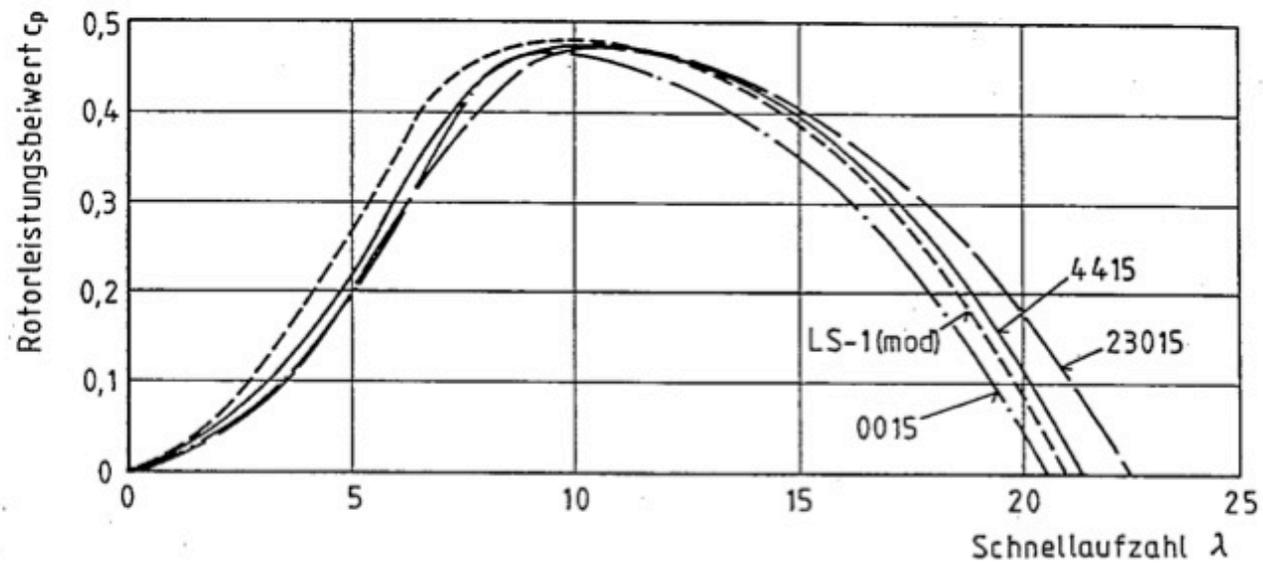
Endscheibe





Aerodynamische Zusammenhänge

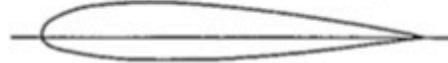
Profilarten



NACA 0015



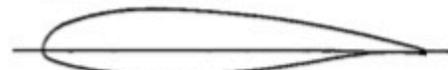
NACA 23015



NACA 4415



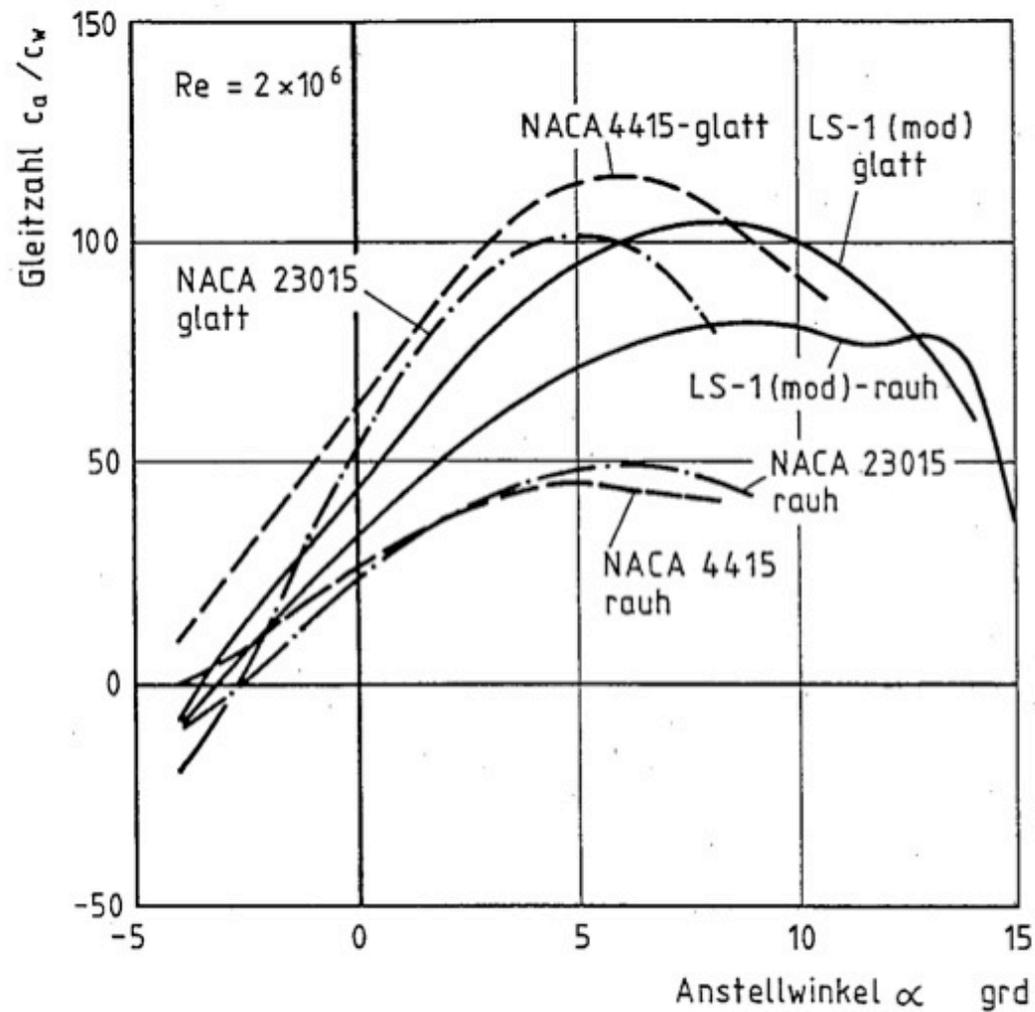
LS-1 (mod.)





Aerodynamische Zusammenhänge

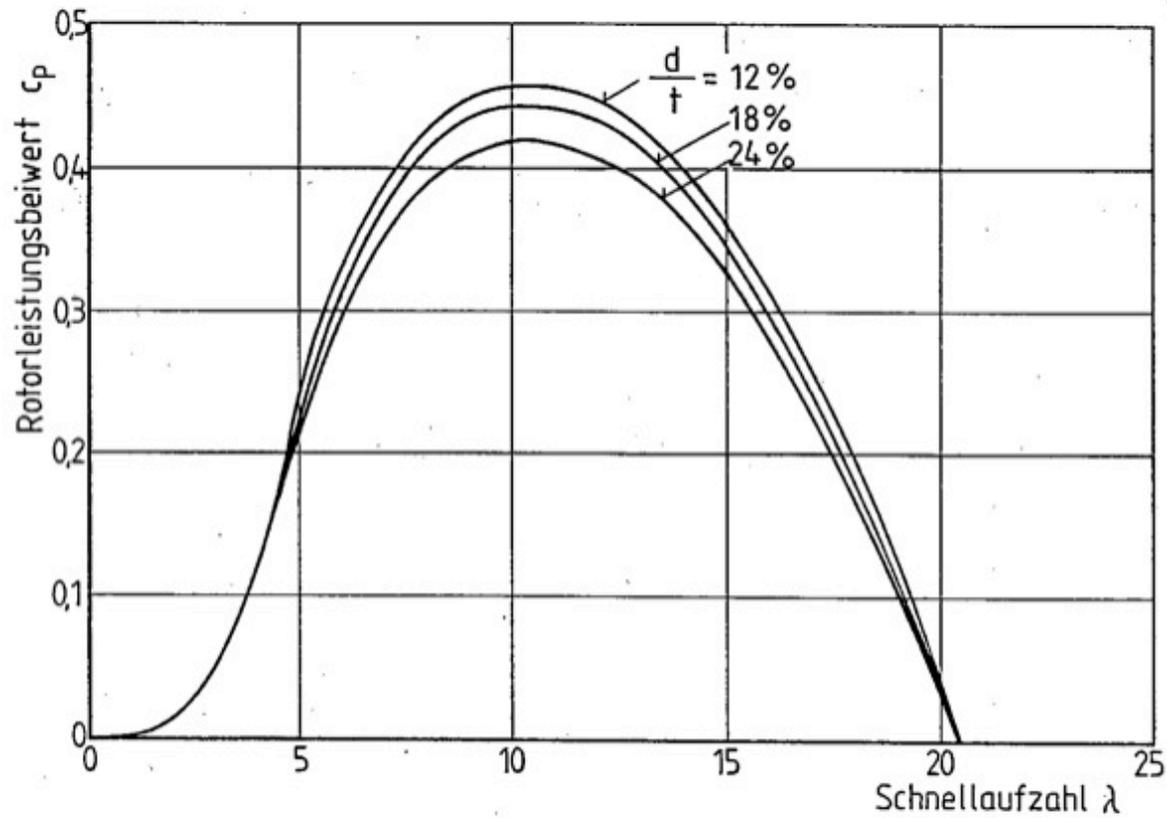
Oberflächengüte





Aerodynamische Zusammenhänge

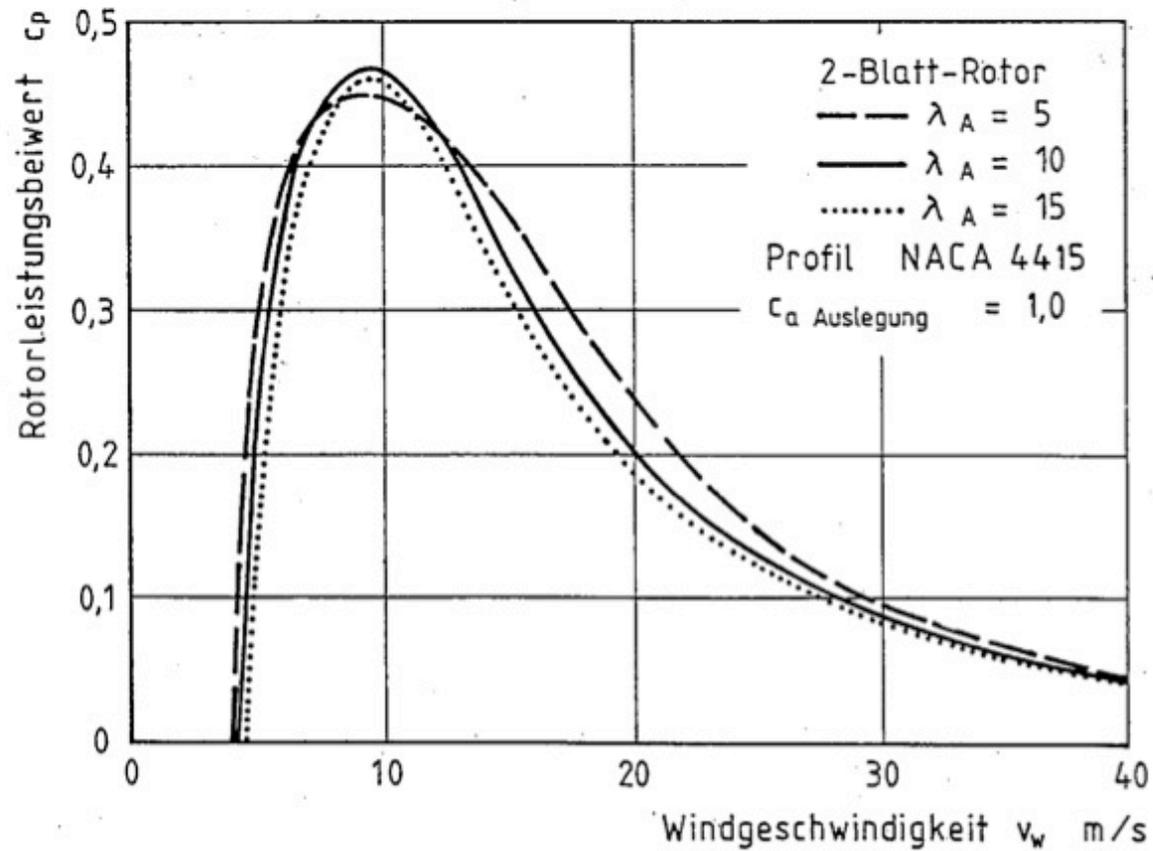
Profildicke

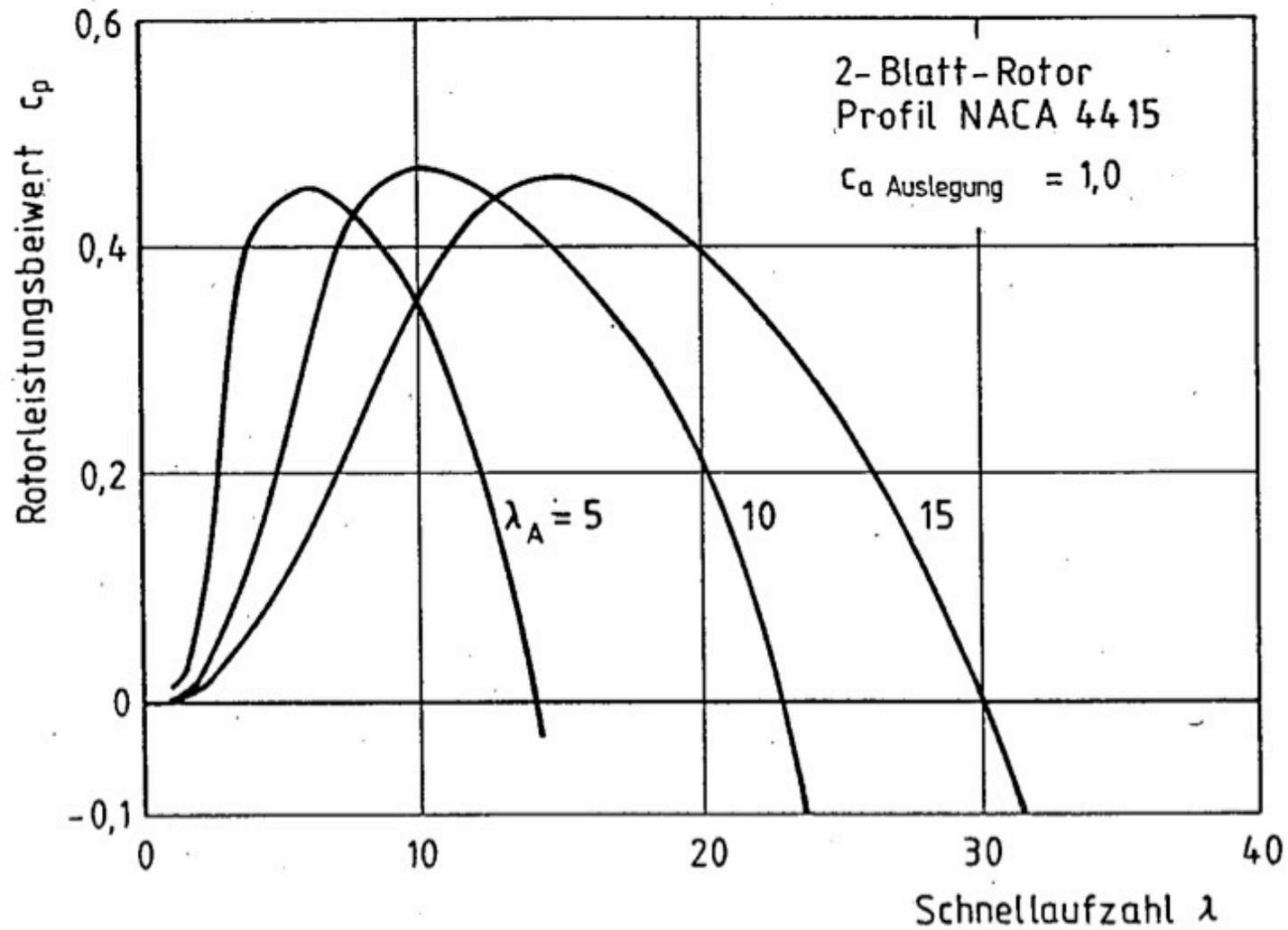




Aerodynamische Zusammenhänge

λ/v





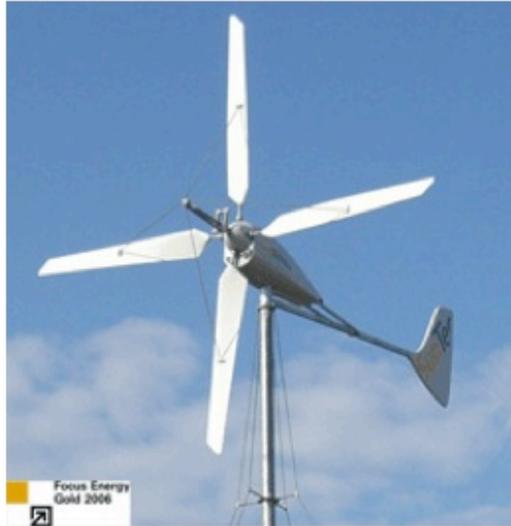


- Windfahne
- Seitenrad
- Lee-Läufer
- Azimutantrieb
- Darrieus



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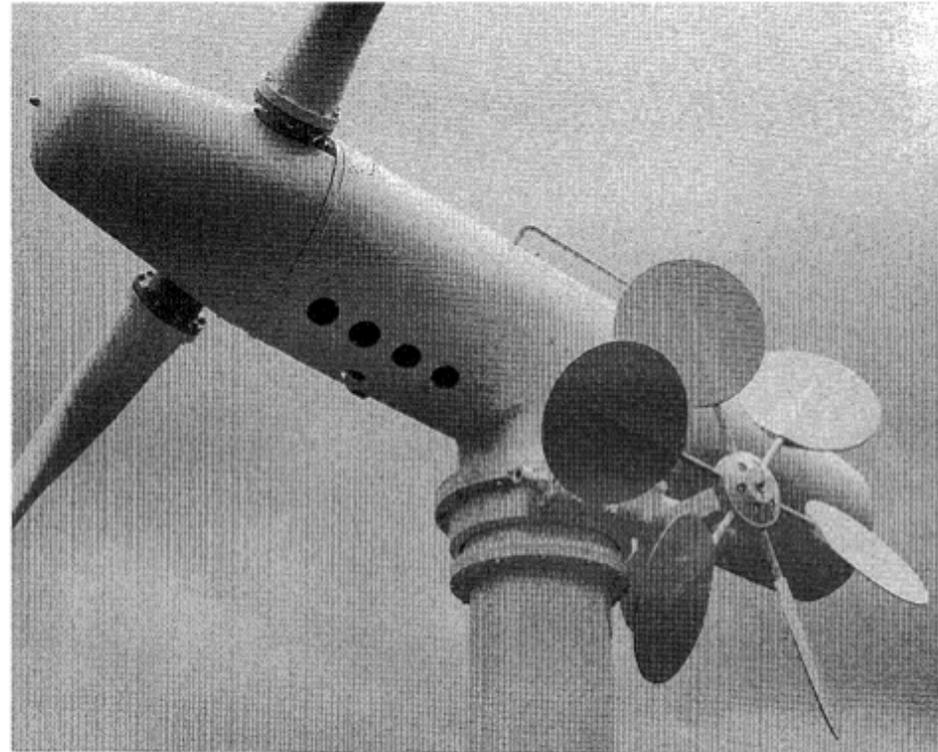
Windrichtungsnachführung Windfahne





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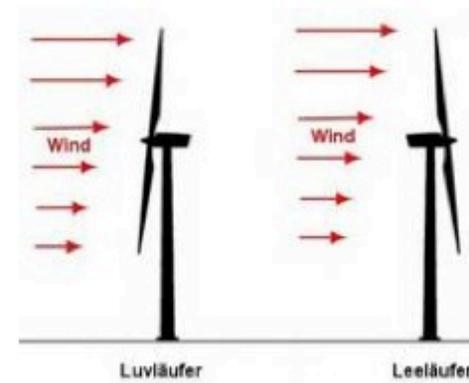
Windrichtungsnachführung Seitenrad





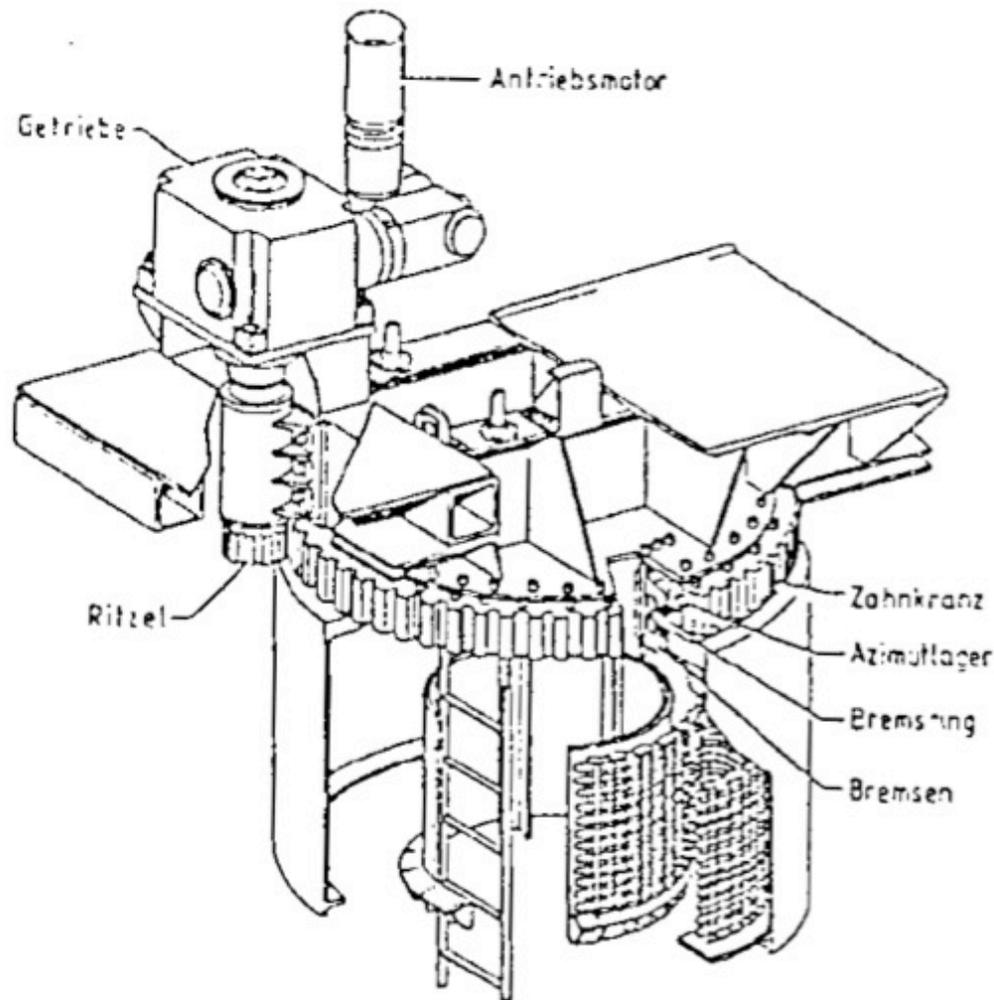
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Windrichtungsnachführung Lee-Läufer





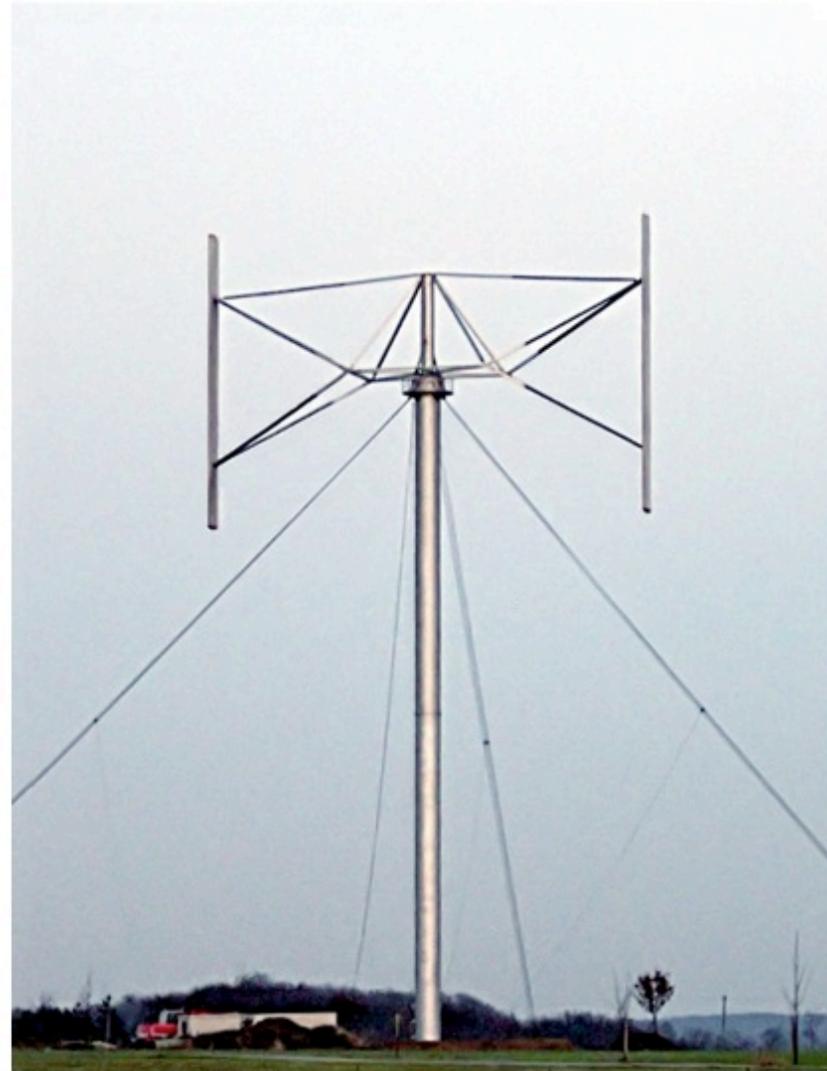
Windrichtungsnachführung Azimutantrieb





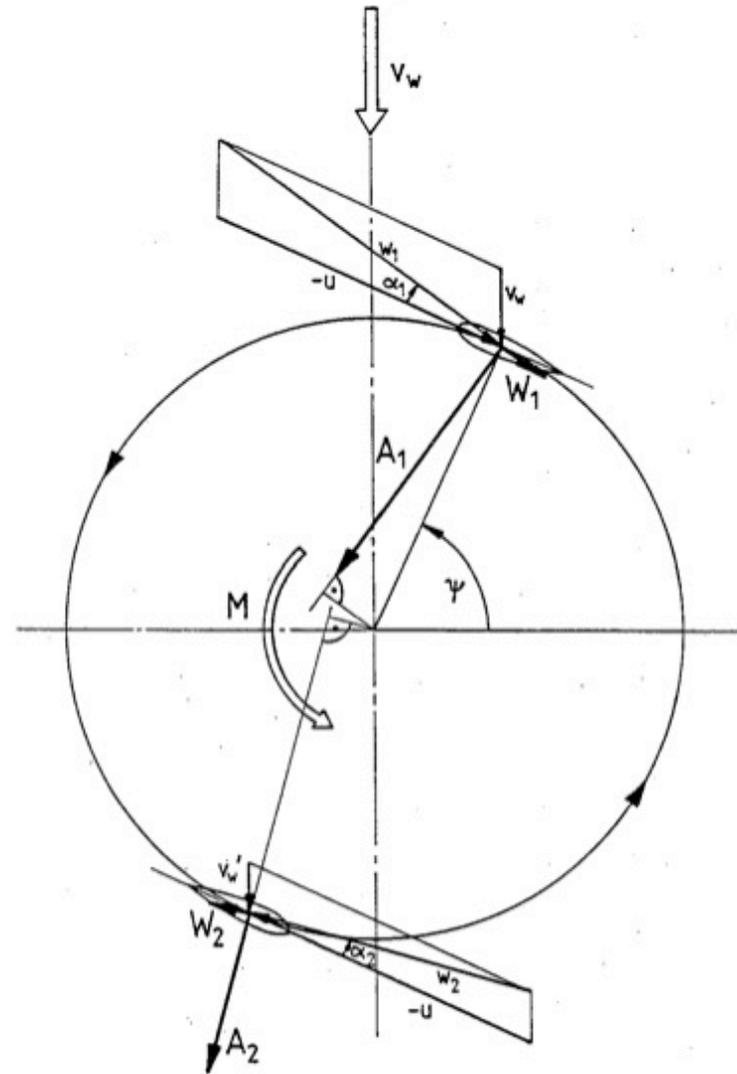
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Windrichtungsnachführung Darrieus



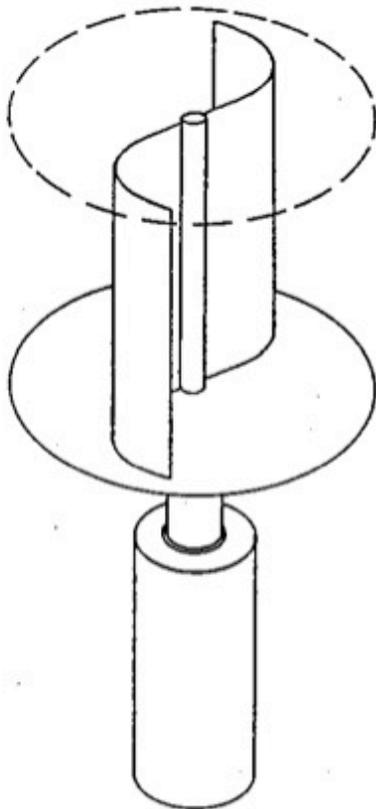


Darrieus Funktion

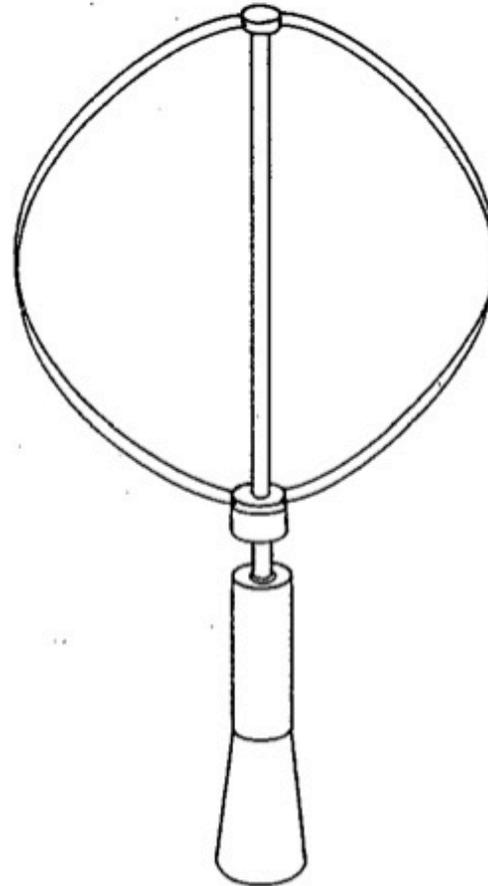




Savonius-Rotor



Darrieus-Rotor



H-Darrieus-Rotor

