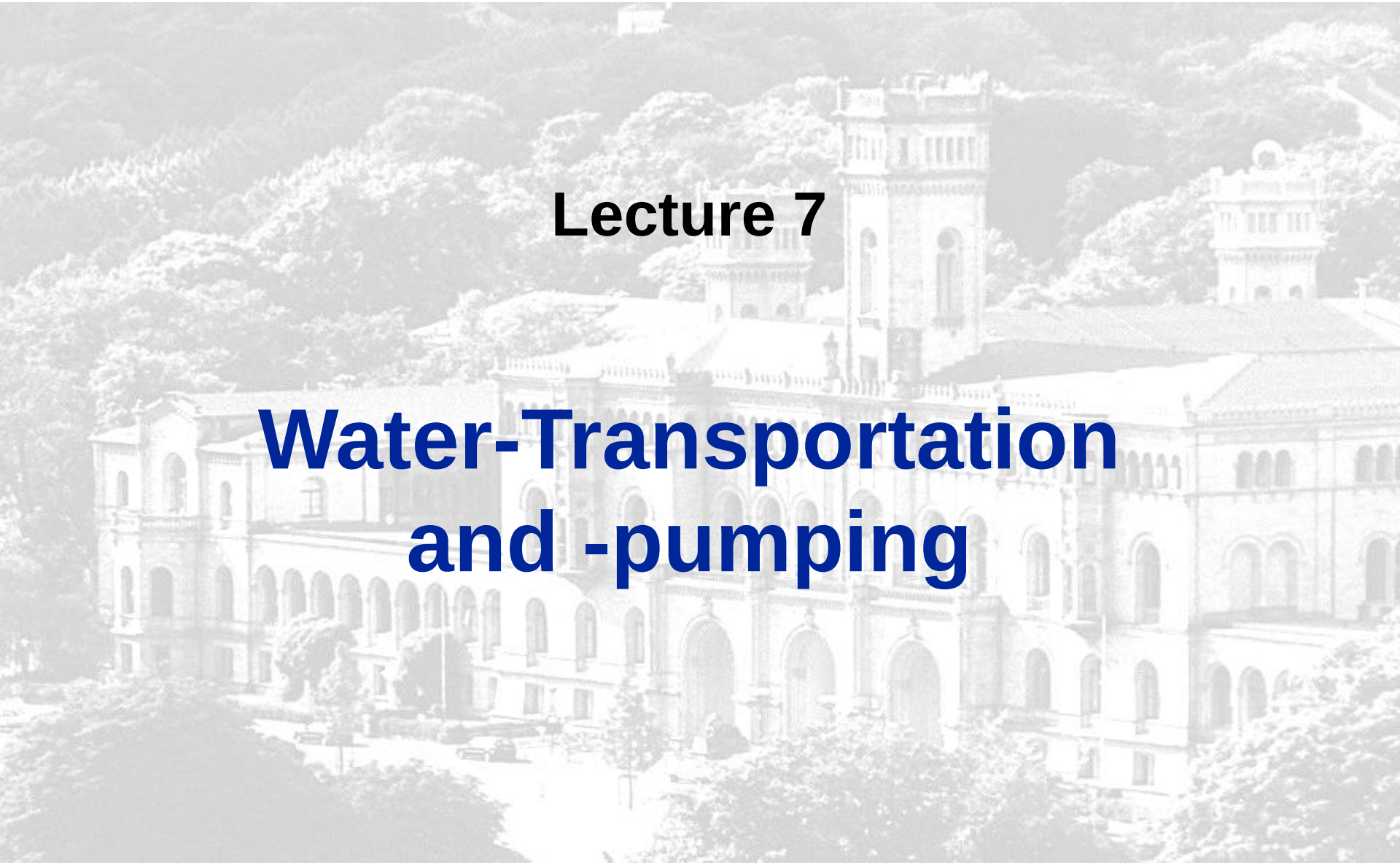


Lecture 7

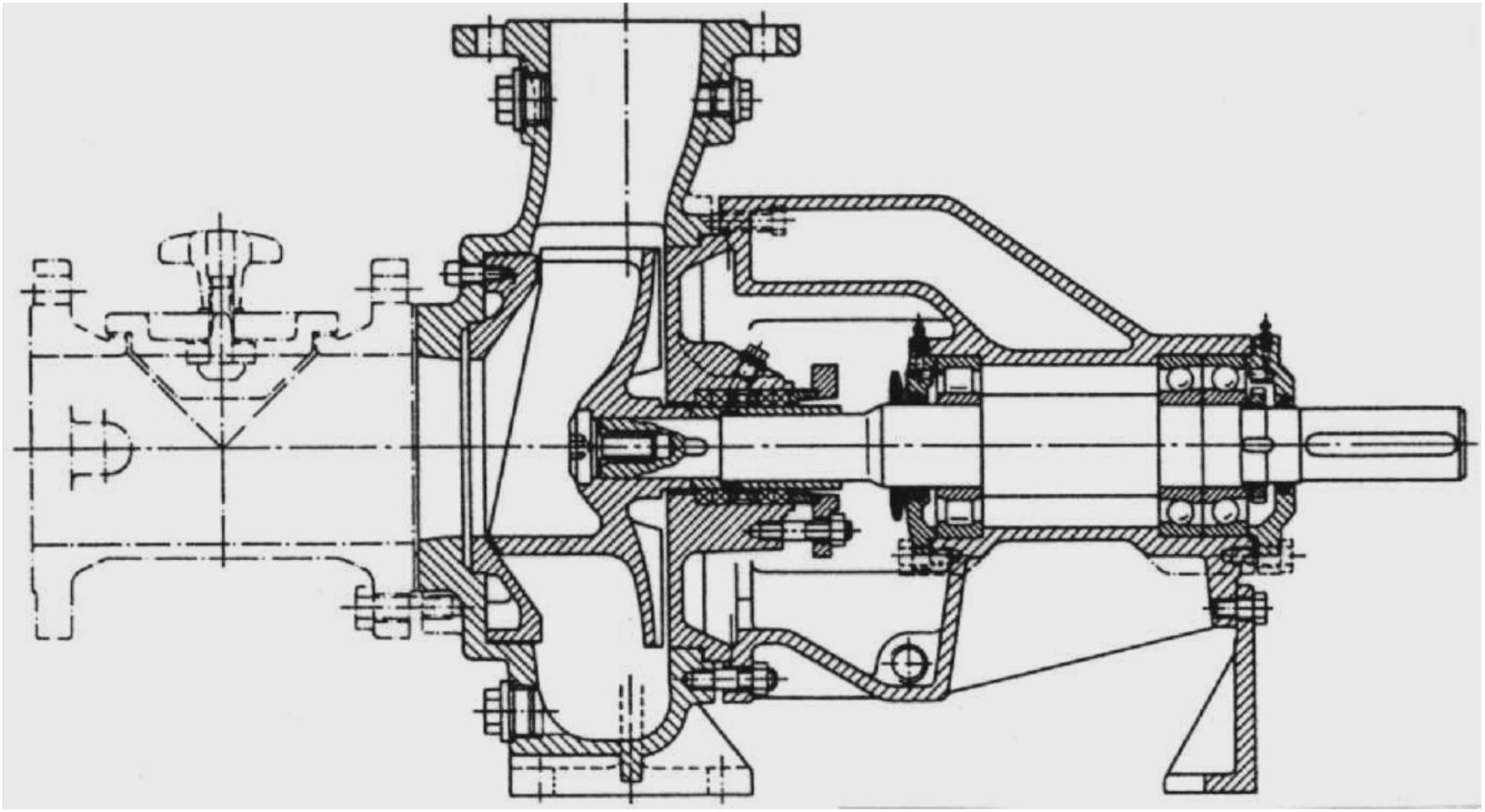
Water-Transportation and -pumping

Effluent pump requirements

Depending on the operating conditions *(Betriebsverhältnisse)* pumps should meet the following requirements:

- wear-resistant and corrosion-proof materials
- high operation safety
- automatic start-up *(selbsttätige Inbetriebnahme)*
- good adaptability *(Anpassungsfähigkeit)* to changing operating conditions
- low-vibrations and quiet run

Construction of centrifugal pump with one channel propeller



Advantages and disadvantages of centrifugal pumps

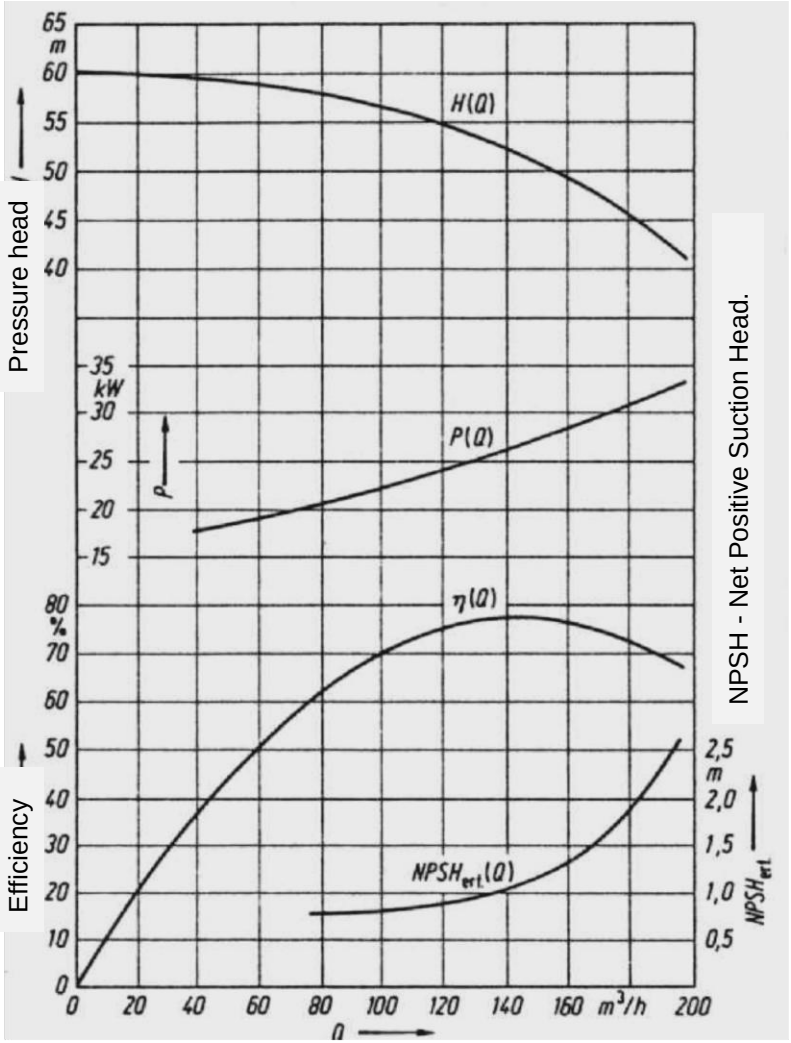
Advantages:

- little space required
- inexpensive
- low maintenance
- almost vibration-free run

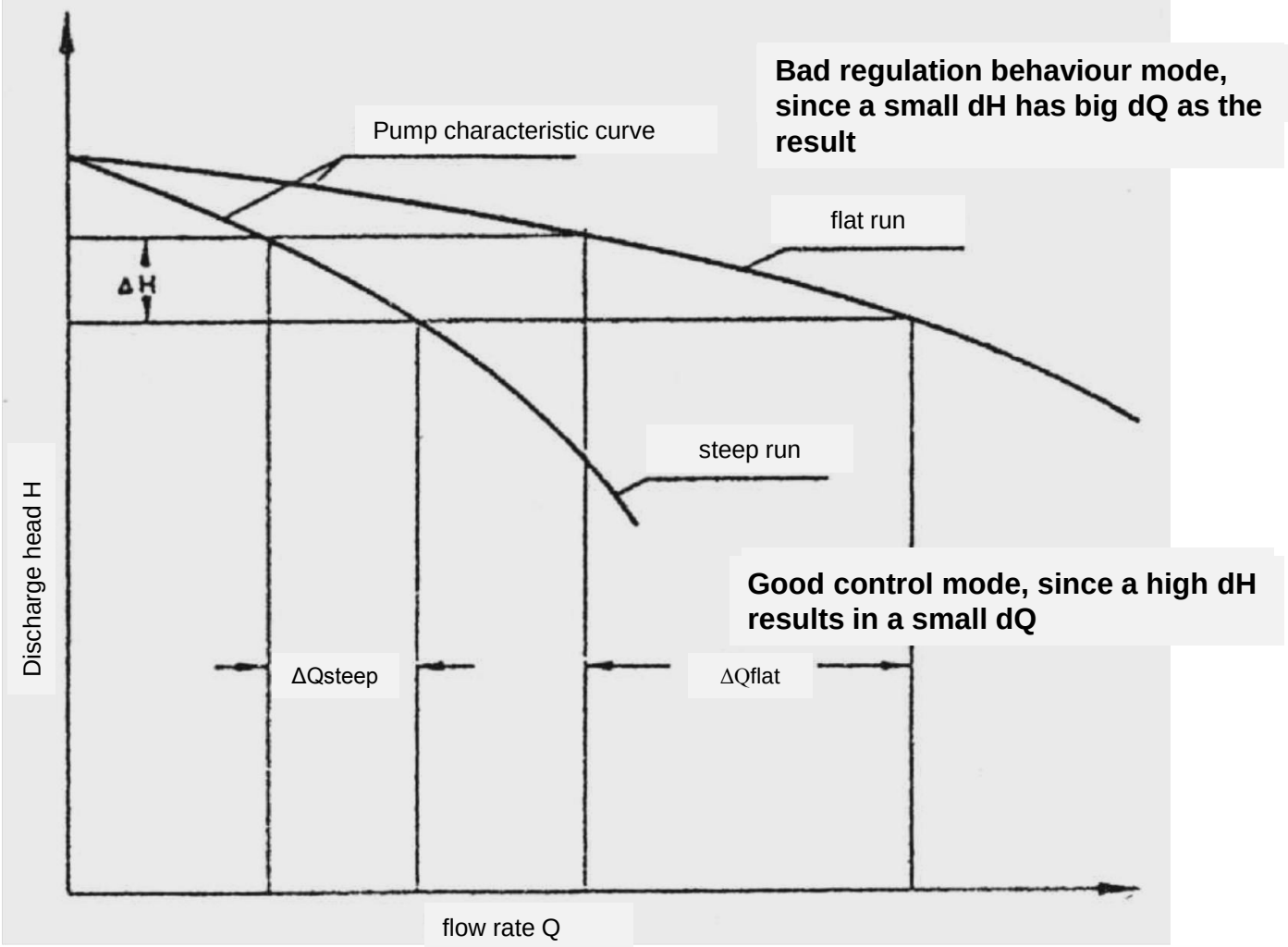
Disadvantages:

- no self-priming capability
- no water stop effect *(Sperrwirkung)* when pump stops
- risk of obstruction with small impeller profiles *(Laufradquerschnitten)*

Characteristic curve of a centrifugal pump with constant speed per minute (rpm)



Characteristic pump curves



Engine power

The required engine power can be estimated with the following formula:

$$P = \frac{\rho \cdot g \cdot Q_P \cdot h_D}{1000 \cdot \eta_P \cdot \eta_M \cdot \eta_K} \quad [kW]$$

with:

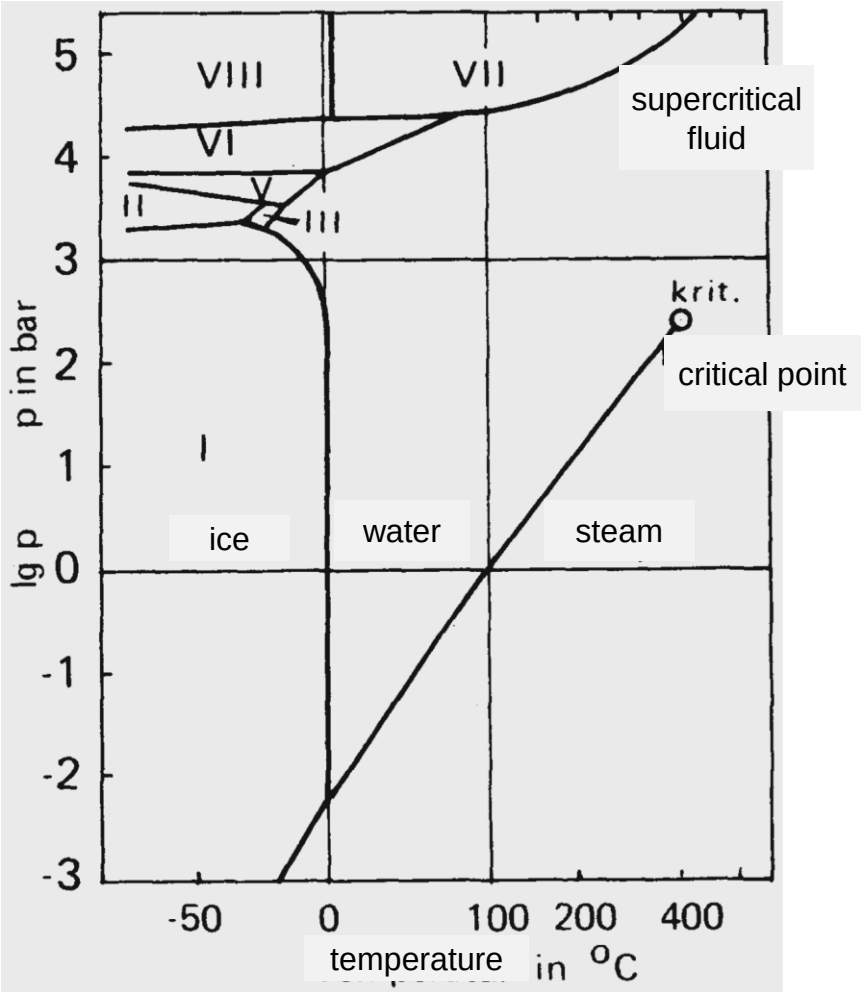
ρ	= density of hauling fluid	[kg/m³]
g	= gravity	[m/s²]
h_D	= manometric head	[m]
Q_P	= pumping capacity	[m³/s]
η_P	= pump efficiency	
η_M	= engine efficiency	
η_K	= coupling and gear efficiency	

Pump efficiencies η as a product of single efficiencies

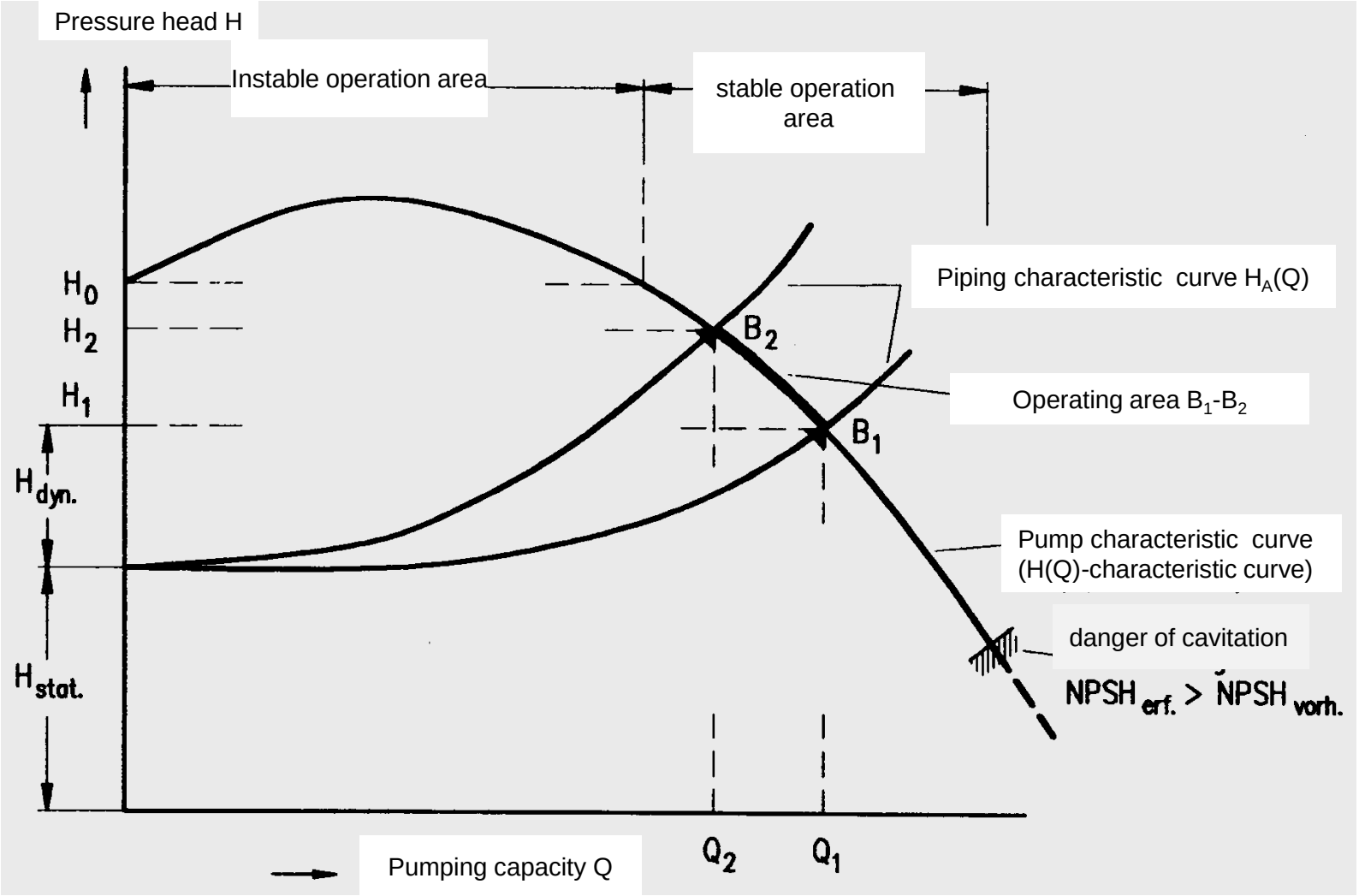
Pump construction type	η
Centrifugal pump with:	
Torque flow propellers	till 0,5
Single vane propellers	till 0,8
Three passage propellers	till 0,85
Spiral non-clogging propellers	till 0,8
Screw conveyors	till 0,8
Pneumatic pump stations	till 0,4

Water phase diagram

Cavitation

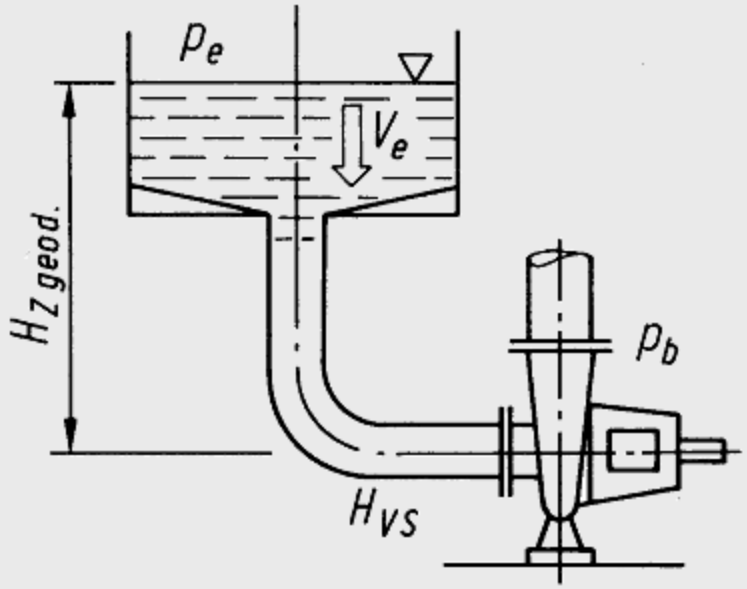


Typical pump characteristic curve, cavitation area



NPSH-value of a pumping system during free-intake operations

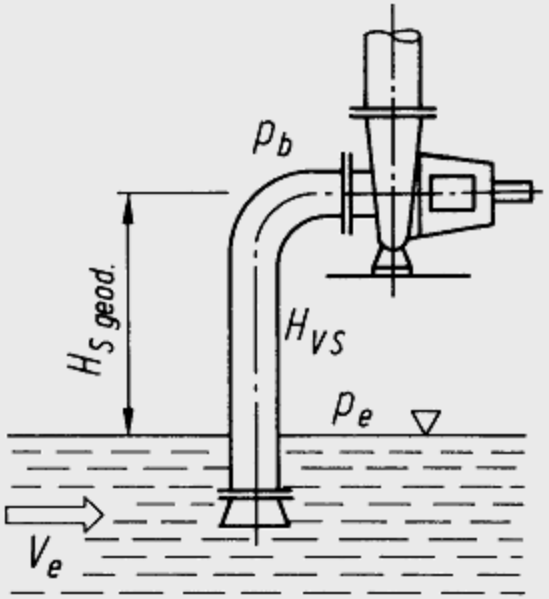
Intake operation



$$NPSH_{vorh.} = \frac{p_e + p_b - p_D}{\varrho \cdot g} + \frac{v_e^2}{2g}$$

$$+ H_{z\,geod.} - H_{vs} > NPSH_{erf.}$$

NPSH-value of a pumping system during suction operation



Suction operation

$$NPSH_{vorh.} = \frac{p_e + p_b - p_D}{\varrho \cdot g} + \frac{v_e^2}{2g}$$

$$- H_{s\,geod.} - H_{vs} > NPSH_{erf.}$$