What it means in technical terms
- the work done so far with Ecopump -

Presented at the EUROPUMP roundtable
Brussels, October 6, 2011
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Outline

- The role of pump systems for energy consumption
- Minimum Efficiency Index (MEI) for pumps
- Extended Product Approach for pumps
Types of pump systems

Process:
circulation of liquid

Need of the process:
- flow rate Q,
- pump head H*)

*) pump head H: measure for the usable energy transferred to the liquid
Types of pump systems

Process:
- Transport of liquid to
  - other location,
  - higher elevation
  - and/or higher pressure

Need of the process:
- flow rate Q
- pump head H
Power need of pump systems

Need of the process:
- flow rate $Q$
- pump head $H$

hydraulic power

$$P_{\text{hyd}} \sim Q \cdot H$$

pump power input

$$P_{\text{pump}} \sim \frac{(Q \cdot H)}{\eta_{\text{pump}}}$$

electric power input

$$P_{\text{el}} \sim \frac{(Q \cdot H)}{\left(\eta_{\text{pump}} \cdot \eta_{\text{drive}}\right)}$$
Pumps and applications in the focus of work

EUROPUMP / Ecopump work

- already done
- presently in progress

focuses on

- pump types
- pump applications

with

- highest contribution to energy consumption
- highest potential for energy saving
Pumps and applications in the focus of work

Pumps in the focus:

- circulators
- water pumps

Examples of relevant applications:

- Commercial buildings, drinking water supply, agriculture
- Heating, ventilation, air condition (HVAC)
- Water distribution, pressure boosting in high buildings
Pumps as EuP´s

Need of application:
- flow rate Q
- Pump head H

hydraulic power
\[ P_{\text{hyd}} \sim Q \cdot H \]

pump power input
\[ P_{\text{pump}} \sim \frac{(Q \cdot H)}{\eta_{\text{pump}}} \]

Improvement!

pump efficiency \( \eta_{\text{pump}} \)

electric drive efficiency \( \eta_{\text{drive}} \)

electric power input
\[ P_{\text{el}} \sim \frac{(Q \cdot H)}{(\eta_{\text{pump}} \cdot \eta_{\text{drive}})} \]
Requirements on pump efficiency

\[ \eta_{pump} \]

actual pump efficiency

\( (\eta_{\text{BEP}})_{\text{min,requ}} \)

\( (\eta_{\text{PL}})_{\text{min,requ}} \)

\( (\eta_{\text{OL}})_{\text{min,requ}} \)

covered range of requirements on \( \eta_{\text{pump}} \):
75 – 110 % of \( Q_{\text{BEP}} \)
Minimum required pump efficiency

Values of minimum required pump efficiency

- were elaborated by a study at TU Darmstadt
- are based on
  - statistical evaluations of data of nearly 2,400 „state of the art“ pumps of European manufacturers
  - general fluiddynamic laws and technological aspects
Minimum required pump efficiency

Values of minimum required pump efficiency

- are dependent on
  - pump type (ESOB, ..... )
  - pump nominal speed $n_N$
  - pump size ($Q_{BEP}$)
  - pump specific speed $n_s$ (characterizing impeller shape)
  - the Minimum Efficiency Index (MEI)
Minimum Efficiency Index (MEI)

- is a decimal number < 1.0
- serves for EU regulation on water pumps
- has a competitive effect on the market
- quantifies the „cut-off effect“
Minimum required pump efficiency

Diagram valid for:
pump type ESOB
n_N = 2900 rpm
Q_{BEP} = 32 m^3/h

MEI = 0.1 → MEI = 0.4:
Δη ≈ 5%

(corresponding
impeller shape:)

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Minimum Efficiency Index (MEI)

Standardization for MEI

- Draft Standard elaborated by EUROPUMP WG
  - defines MEI
  - describes methodology of qualification and verification
- EN standard
  - procedure in progress
  - publication expected in 2012
Typical features of relevant applications

For applications in the focus

- at most part of operating time, the needed flow rate $Q < Q_{100\%}$
- the head $H_{\text{process}}$ needed by the process decreases with decreasing flow rate $Q$
- representative „load profiles“ (time fractions at $Q/Q_{100\%}$) can be defined
- representative „control curves“ $H_{\text{process}} = f(Q)$ can be defined
Load profile representative for HVAC
Process control curve representative for HVAC
Typical pump characteristics at constant rotational speed
(related values)
Extended Product Approach (EPA)

Need of application:
- flow rate $Q$
- pump head $H$

$pump$ efficiency $\eta_{pump}$

hydraulic power

$$P_{hyd} \sim Q \cdot H$$

$pump$ power input

$$P_{pump} \sim (Q \cdot H) / \eta_{pump}$$

Reduction!

Electric drive efficiency $\eta_{drive}$

electric power input

$$P_{el} \sim (Q \cdot H) / (\eta_{pump} \cdot \eta_{drive})$$
Pump units as Extended Products

- Electric Motor
- Pump
- Coupling
- Fluid Outlet
- Fluid Inlet
- VSD, Control, Monitoring
- Electric Motor
- Power Drive System (PDS)
- Mains
- Pump Unit
Ratio of electrical power input \( P_{el}/P_{el,n=const} \)

- at 44% of operating time
- at 35% of operating time
- at 15% of operating time
- at 6% of operating time

Typical example for HVAC applications of water pumps.
Energy Efficiency Index (EEI)

Quantification of energy efficiency of pump units:

\[ \text{EEI} = \frac{P_{el,\text{avg}}}{P_{el,\text{ref}}} \]

- EEI already established in EN-Standardization and EU-Regulation for circulators
- Determination of $P_{el,\text{avg}}$, $P_{el,\text{ref}}$ for pump units to be standardized
Energy Efficiency Index (EEI)

Project of EUROPUMP Working Group with TU Darmstadt
on development and validation of EEI methodology for water pump units

- started Jan. 2011
- shall be finished end of 2013 with Draft Standard
Thank you for your attention