Energy Effiency of Circulators

December 2011

Europump

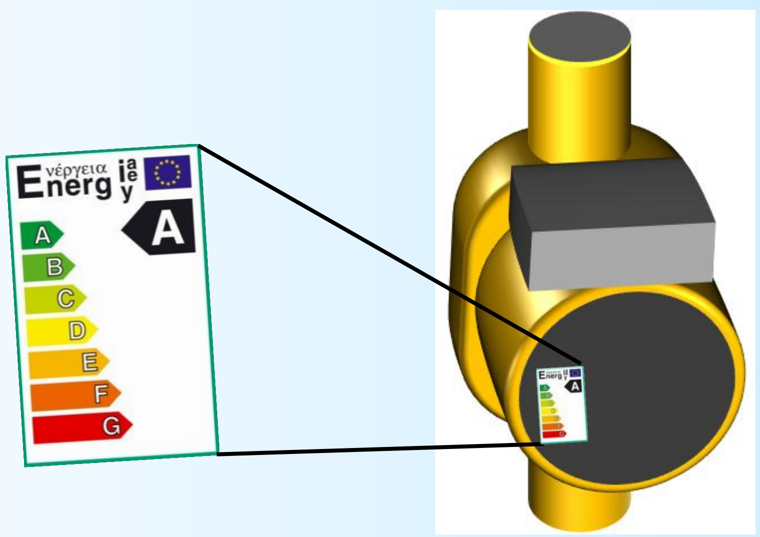
the European Association of Pump Manufacturers

Energy efficiency of circulators

Voluntary industry commitment (since 2005)

In March 2005 ‘Europump’ launched the voluntary industry commitment to improve the energy performance of stand-alone circulators

Energy Efficiency Label



... the voluntary industry commitment will finish to end of 2012. Then from 1.1.2013 the *European regulation for circulators* will become active...

Legislation from European Commission (start 2013)

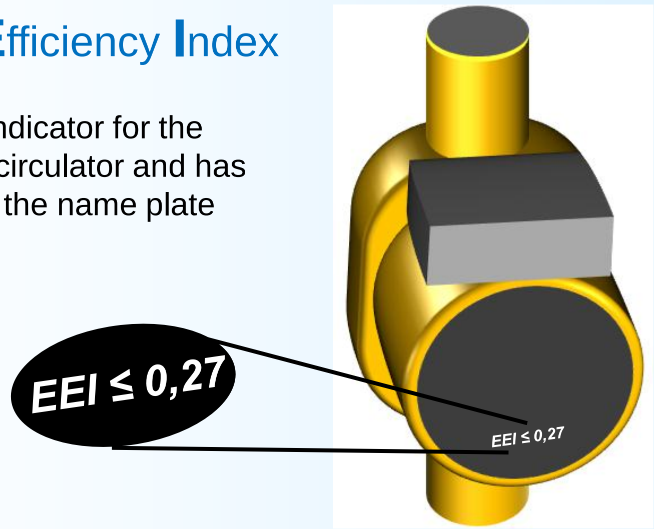
Based on the Eco-design directive 2005/32/EC (revised through 2009/125/EC) the European Commission has published the regulation (EC) no. 641/2009 for circulators.

The regulation establishes ecodesign requirements for the placing on the market of

1. **glandless standalone circulators**
2. **glandless circulators integrated in products***

EEI → Energy Efficiency Index

→ The **EEI** is an indicator for the efficiency of the circulator and has to be marked on the name plate



Scope:
Glandless circulators with a rated hydraulic output power between 1 W and 2500 W and designed for use in heating systems or in secondary circuits of cooling distribution systems.

*) ‘product’ means an appliance that generates and/or transfers heat

Time table and EEI requirements

Standalone circulators

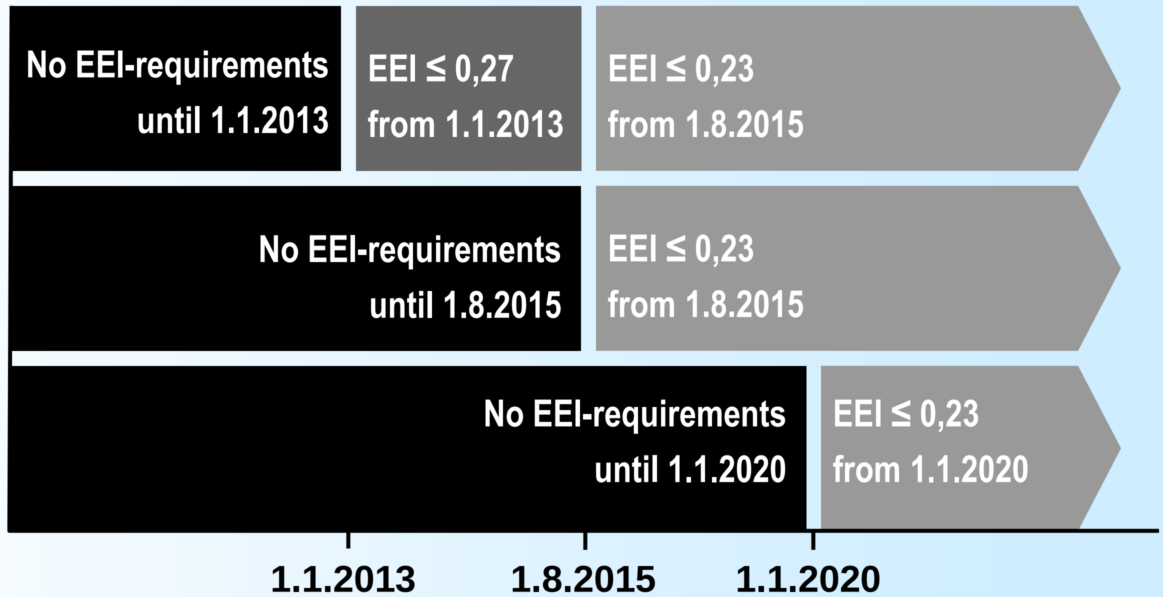
for heating systems and secondary circuit of cooling distribution systems; except those specifically designed for primary circuits of thermal solar systems and of heat pumps until 1.8.2015

Circulators integrated in a product

New installed products

Circulators integrated in a product

Replacement case



Marking The *EEI* of circulators, calculated in accordance with the legislation, shall be indicated on the name plate (EEI ≤ 0,xx) and packaging of the product and in the technical documentation.

Declaration The declaration of conformity to the Ecodesign-Directive (2009/125/EC) in a CE declaration is mandatory.

Benchmark At the time of the adoption of the regulation, the ***benchmark*** for the best available technology on the market for circulators is ***EEI ≤ 0,20***.

! EEI values less than 0,27 are reached by current high efficiency *A'-class circulators*

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The regulation differentiates between two kinds of circulators

Standalone circulator

Circulator integrated in a product

How to differentiate between
'Standalone circulators' *and*
'circulators integrated in a product' *?*

Click here

Definitions and calculation method for the EEI

$$EEI = \frac{P_{L,avg}}{P_{ref}} \; C_{20\%}$$

where is ...

$P_{L,avg}$ = weighted average electrical power input of the actual circulator
(considering standardized load profile having 4 operating points and reference pressure control curve)

P_{ref} = Reference power
is the power input of a reference circulator having the same hydraulic power output as the actual circulator

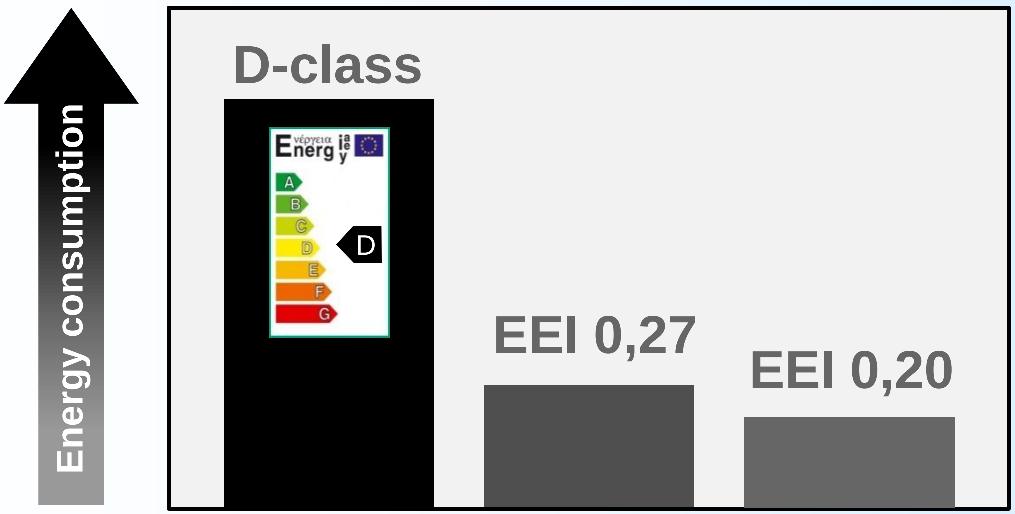
$C_{20\%}$ = “Calibration factor“ = 0,49
the calibration factor - fixed by the legislation – ensures that only 20% of a certain type have an EEI ≤ 0,20 (Benchmark)

For further details of EEI calculation... Click here

Example: Energy consumption*) of typical circulators

Comparison:

- Non-controlled Circulator with induction motor (D-class)
- 'High Efficiency' Circulator (EEI 0,27)
- 'Benchmark' Circulator (EEI 0,20)



Non-controlled Circulator with induction motor

'High Efficiency' Circulator

'Benchmark' Efficiency Circulator

Note:
Non-controlled Circulators with induction motor use up to 4-times more electrical energy than modern 'High efficiency' circulators!

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*) assuming the standardized load profile for circulators in heating systems

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Differentiation

'Standalone' or ***'Integrated in a product'*** circulator ?

A ***'Standalone Circulator'*** operates independently to a product (otherwise a 'circulator integrated in a product' operates dependently).

The standard prEN 16297-1 includes a table with several design details which allows to identify a ***'Circulator integrated in a product'***.

<table>
<tr><th>Design</th><th>Details</th><th>Examples
(non exhaustive list)</th></tr>
<tr><td rowspan="2">Pump Housing</td><td rowspan="2">Designed to mounted and used inside a product</td><td>Housings designed for use inside products e.g. with clip connections, with back panel connection or plate heat exchanger connections</td></tr>
<tr><td>Housings integrating thermally driven valve functions</td></tr>
<tr><td>Control</td><td>Designed to be speed controlled by the product</td><td>Circulators with product specific control signal interface</td></tr>
<tr><td rowspan="2">Safety measure</td><td>Designed with safety features not suitable for stand alone operation</td><td>Product takes over safety features
(ISO IP classes)</td></tr>
<tr><td>Circulator is a defined part of product approval or product CE marking</td><td>Circulator is part of the component list of product approval or prodcut CE marking</td></tr>
</table>

"... a circulator is considered to be operated dependently of a product if it carries at least one of the design details".

Further details of EEI calculation

$$EEI = \frac{P_{L,avg}}{P_{ref}} C_{20\%}$$

This formula is valid for …

a) ***'Standalone circulators'***
b) ***'circulators integrated in a product'***

Exception:
EEI for ***'Circulators integrated in products'*** designed for primary circuits of thermal solar systems and for heat pumps has to be calculated as:

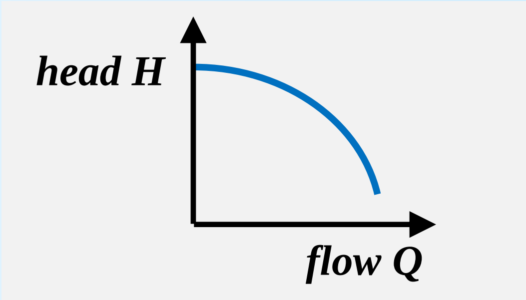
$$EEI = \frac{P_{L,avg}}{P_{ref}} C_{20\%} \left(1 - e^{\left(-3,8 \left(\frac{n_s}{30}\right)^{1,36}\right)}\right)$$

where is ... n_s = specific speed

Definitions and calculation steps

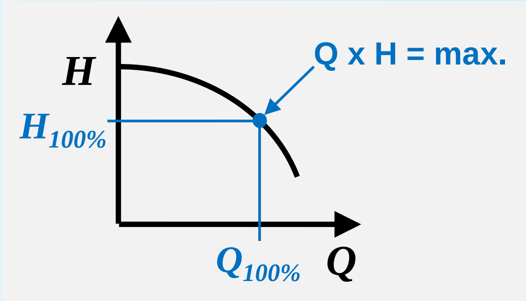
1. Measurement of max. hydraulic curve

- head “H“ (in metres)
- flow “Q“ (in m³/h)



2. find the point where Q x H is maximum

- head at this point is called $H_{100\%}$
- flow at this point is called $Q_{100\%}$



3. Calculation of maximum hydraulic power P_{hyd}

- $P_{hyd} = Q_{100\%} \times H_{100\%} \times 2{,}72$

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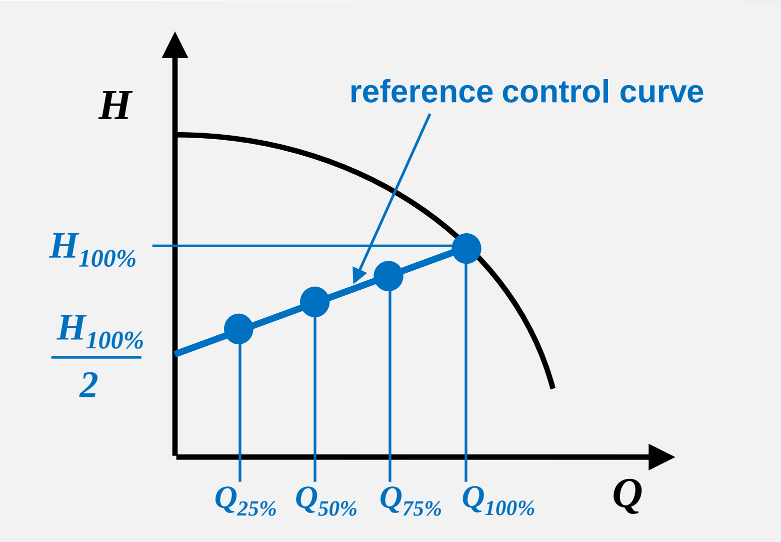
4. Calculation of reference power P_{ref}

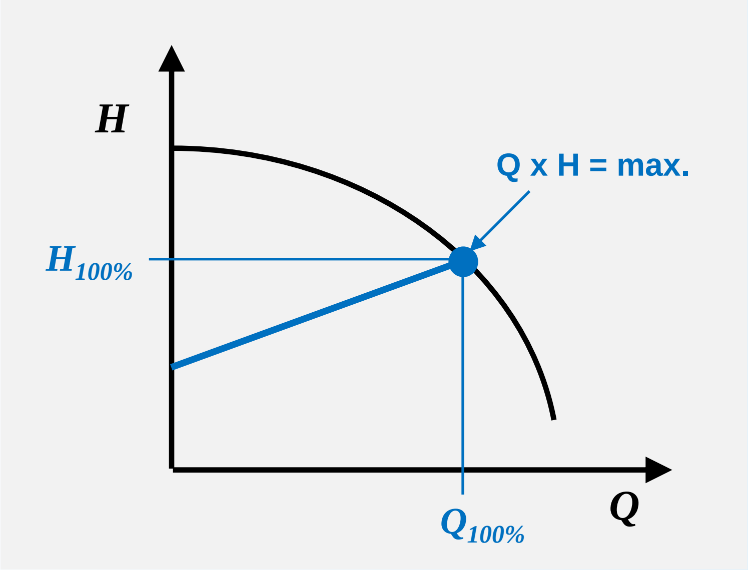
$$P_{ref} = 1{,}7 \times P_{hyd} + 17 \times (1 - e^{-0{,}3 \times P_{hyd}}) \qquad 1 \text{ Watt} \leq P_{hyd} \leq 2500 \text{ Watt}$$

P_{ref} is the average power input of real existing high efficiency circulators determined in 2008 by a german University (TU Darmstadt)

5. Definition of reference control curve

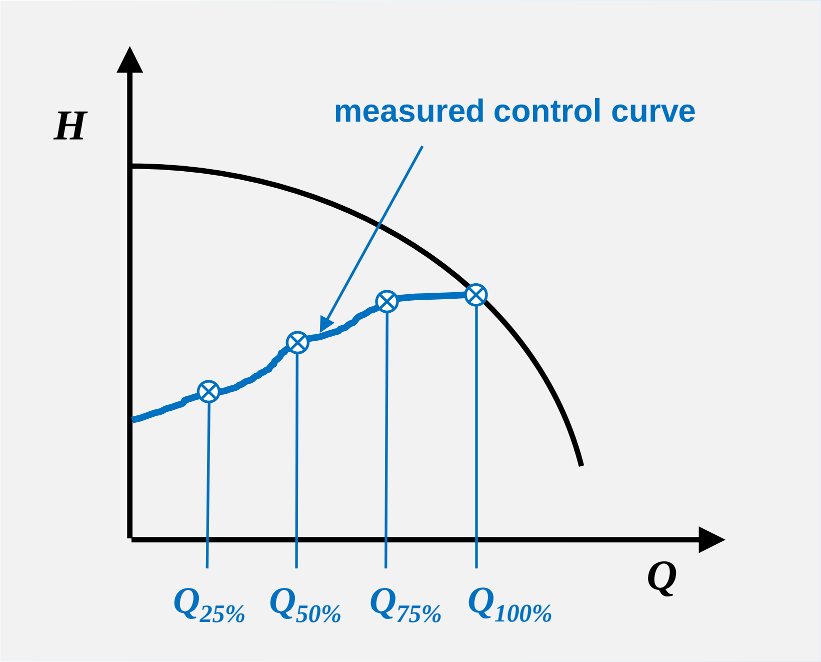


6. Select a setting of the circulator ensuring that on the selected curve the circulator reaches the operating point Q x H = max



7. Measurement of the circulator

- 4 operating points: $Q_{100\%}$, $Q_{75\%}$, $Q_{50\%}$ and $Q_{25\%}$
- Measuring **H** and electrical power **P_1** at these points

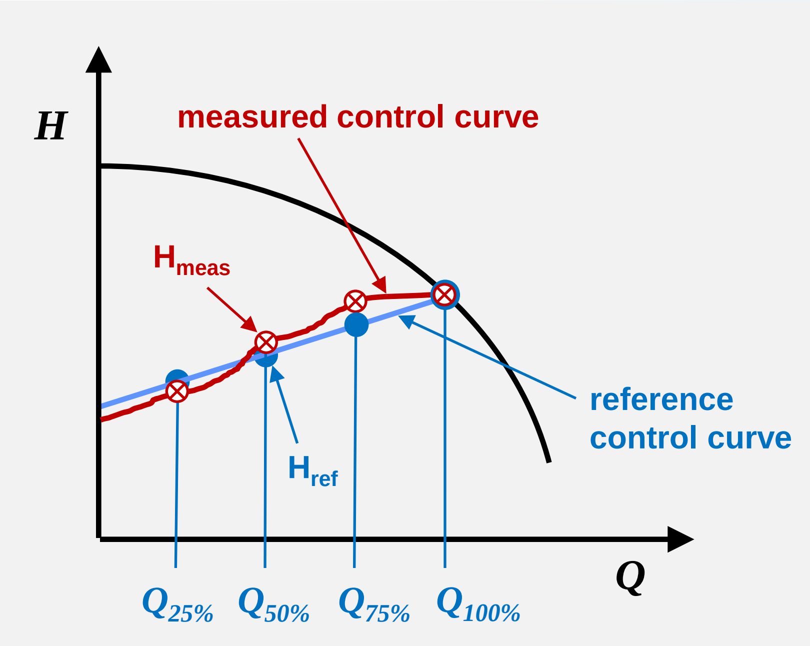


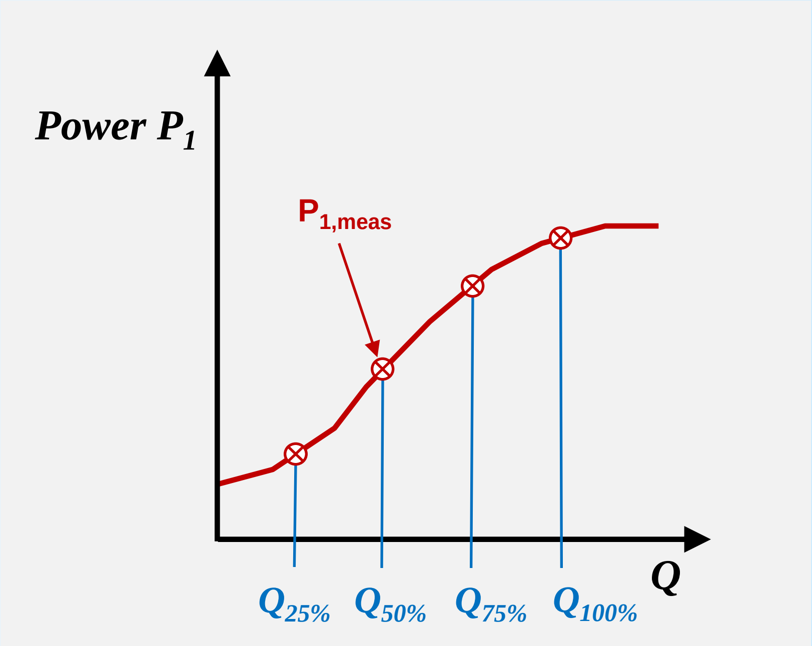
8. Interpretation and Calculation

- ***measured*** values of head and power are called H_{meas} and $P_{1,meas}$
- the head on the ***reference control curve*** at the different flows is called H_{ref}

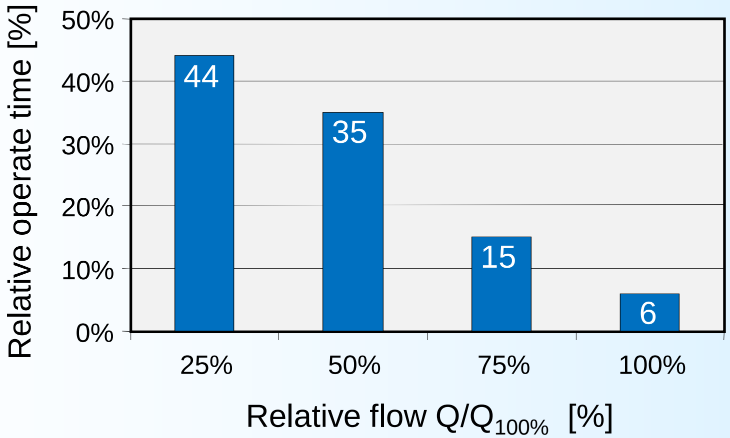
... if $H_{meas} > H_{ref}$ → $P_L = P_{1,meas}$

... otherwise → $P_L = \frac{H_{ref}}{H_{1,meas}} P_{1,meas}$





9. Calculation of the weighted average power P_{avg} by use of part load profile



Relative flow $Q/Q_{100\%}$ [%]	Relative operate time [%]
100	6
75	15
50	35
25	44

$$P_{L,avg} = 0{,}06\ P_{L,100\%} + 0{,}15\ P_{L,75\%} + 0{,}35\ P_{L,50\%} + 0{,}44\ P_{L,25\%}$$

10. Calculation of EEI

$$EEI = \frac{P_{L,avg}}{P_{ref}} C_{20\%}$$

where $C_{20\%} = 0{,}49$

the calibration factor $C_{20\%}$ - fixed by the legislation – ensures that only 20% of a certain type have an EEI ≤ 0,20 (Benchmark)

<u>Exception:</u>

EEI for ***'Circulators integrated in products'*** designed for primary circuits of thermal solar systems and for heat pumps has to be calculated as:

$$EEI = \frac{P_{L,avg}}{P_{ref}} C_{20\%} \left(1 - e^{\left(-3{,}8 \left(\frac{n_s}{30}\right)^{1{,}36}\right)}\right)$$

where n_s = the specific speed defined as

$$n_s = \frac{n_{100\%}}{60} \frac{\sqrt{Q_{100\%}}}{H_{100\%}^{0{,}75}}$$

$n_{100\%}$ is rotational speed in r.p.m. in this instance defined at $Q_{100\%}$ and $H_{100\%}$