HEATING AND COOLING
KNOWHOW AND SOLUTIONS

D3.2 - Topten HACKS Criteria Paper
Circulation Pumps

Picture 1: a glandless standalone circulation pump
Source: https://storage.topten.eu/source/5d0148d745e05-bgrundfosalpha22540-productimage---1560365271-grundfos-alpha2.jpg

Nadja Gross, Bush Energie GmbH, nadja.gross@topten.ch
Andrea Berger-Wey, Bush Energie GmbH, andrea.berger@topten.ch
Eric Bush, Bush Energie GmbH, eric.bush@topten.ch
Maike Hepp, Bush Energie GmbH, maike.hepp@topten.ch

April 2020

HACKS coordinator: ADEME – www.ademe.fr
European portal www.topten.eu/hacks
Project partners and websites

Austria, AEA www.topprodukte.at	Belgium, GoodPlanet www.topten.be	Czech Republic, SEVEn www.uspornespotrebice.cz	France, Guide Topten www.guidetopten.fr
Germany, co2online www.co2online.de	Italy, Eliante www.topten.it	Lithuania, LNCF www.ecotopten.lt	Luxembourg, Oeko-Zenter www.oekotopten.lu
Norway, Naturvernforbund www.energismart.no/	Poland, FEWE www.topten.info.pl	Portugal, Quercus www.topten.pt	Spain, ECODES www.eurotopten.es/
Sweden, SSNC www.toptensverige.se	Switzerland, Bush Energie www.topten.ch	UK, EST www.toptenuk.org	Politecnico di Milano www.eerg.polimi.it

About HACKS

The objective of the Heating and Cooling Knowhow and Solutions (HACKS) project is to achieve market transformation for heating and cooling (HAC) appliances and improve comfort and health of European citizens.
Across the EU almost half of all buildings have individual boilers that were installed before 1992 with efficiency of 60% or less. The expected energy savings from a speedy replacement are immense.
To achieve this goal, 17 HACKS partners in 15 countries are working together, thanks to the financial support of the European Horizon 2020 programme.
After scanning market actors, current policies and most commonly used products in each country, starting from April 2020 the HACKS partners will implement involvement campaigns to raise awareness of the economic and environmental benefits brought by good HAC products and solutions:

- HACKS will motivate households equipped with old and inefficient devices – boilers, water heaters, air conditioners, certain types of boilers and stoves, etc. – to replace them with new super efficient equipment.
- In each country, partners will set-up dedicated on-line platforms to assist consumers in their purchasing process. The platforms will propose: tools to assess households' needs and provide customised information; best product lists with technical specifications; direct links to suppliers of most efficient products; and advice on how to use and maintain equipment.
- For those households who need to improve their situation because they feel too hot, too cold, or too humid but who cannot invest in new equipment or can avoid getting equipped, HACKS will propose simple and low costs solutions. It is possible to reduce energy consumption and energy bills while improving winter and summer comfort, air quality and health conditions through the installation of shading devices, thermostats, water saving taps and showerheads, etc.

Beyond households, HACKS will target all relevant stakeholders ("multipliers") that participate in the decision-making process of consumers by setting up strategic partnerships to facilitate the purchase of energy efficient appliances. HACKS places a strong emphasis on installers but also retailers and consumer organisations because of their proximity to consumers, their capacity to involve them and bring them guidance on energy efficient equipment.
More information on the HACKS project can be found at www.topten.eu/hacks

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 845231.

Executive summary

With these criteria papers the intention is to be able to identify and select the most energy efficient models available on the market. The primary objective is to help partners on their territory for their Topten and HACKS website, but the technical content may also support anyone willing to find good products from an environmental point of view.

This document gives an overview on circulation pumps for heating systems in buildings. It does not include pumps for drinking water or other purposes, and pumps with a power higher than 200 W. The selection criteria and the products selected according to them for the website topten.eu are presented and explained. They are based on the Ecodesign regulation for this product group.

A brief technical overview is given, while a more conclusive view is given in the annex. Important to note is the influence of the correct dimensioning of the circulation pump. Often oversizing is a problem.

Furthermore, the current EU regulations such as the Ecodesign requirements are presented in detail. They include requirements on energy efficiency as well as on product information and documentation. The impact of the implemented Ecodesign requirements is presented.

The presented products are characterized with a number of attributes which can be used as filters for easier grouping, for example by Energy Efficiency Index, size, head, etc. These attributes are presented and discussed with regards to their relevance. In addition, recommendations are given on how to find the data for each product.

Finally, useful information is collected, such as various links, terms and a glossary. Inputs for consumers are given with a FAQ-section on important topics.

Table of Contents

1 Topten.eu: Circulation Pumps - current selection criteria and products selected

1.1 Scope

Circulation pumps transport the hot water from the heat generator (boiler, heat pump) or heat storage tank (solar etc.) to the heat consumption, i.e. underfloor heating or radiators. In most cases, a hot water storage tank is also supplied via the heat generator.
Old, inefficient circulation pumps use a substantial amount of energy, because they run constantly without being regulated (up to 10% of the household electricity consumption). By installing a new, efficient pump which can also be regulated, tremendous energy savings can be made and save the owner up to 100 Euro a year and more.
For HACKS, the scope are single-family-houses. That means the range of the circulation pumps is usually between 25-200 W. For larger buildings, it is possible to find pumps with a power of more than 200 W. The focus of this paper is on glandless[1] standalone circulators and glandless circulators integrated in products, whereas drinking water circulators are not included.

1.2 Current selection criteria on Topten.eu

Topten presents the most energy efficient circulation pumps with low energy consumption. With this stricter definition, there are still enough models for the whole market and range of products available.

Table 1: Selection criteria for circulation pumps (Topten.eu)

Criteria	Circulation pumps
Energy efficiency index (EEI)	0.18

The EEI is calculated according to EC 641/2009, where the maximal hydraulic power is compared to the reference hydraulic power.

1.3 Best available products

Here you can find the circulation pumps presented on topten.eu
https://www.topten.eu/private/products/circulation_pumps

Table 2: Product list and distribution of models

Manufacturer	Number of models	Website
Biral	22	http://www.biral.ch
Grundfos	18	http://www.grundfos.ch/
HALM	4	http://www.halm-pumps.de
WILO	32	http://www.wilo.ch
Total	76	

Source: https://www.topten.eu/private/products/circulation_pumps

1.4 National selection criteria

Energy consumption is the most relevant issue for circulation pumps (annual consumption for EU-25 is estimated at 50’000 million kWh). The circulation pump market is very similar all over Europe and it is not necessary to differ for different countries.

[1] See Terminology p.10

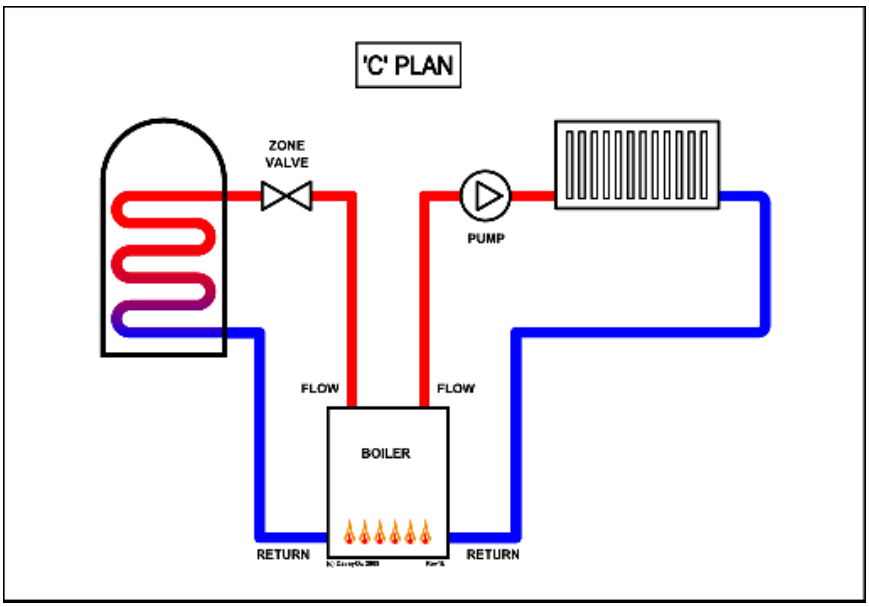
1.5 Expected future selection criteria

It is expected that EEI requirements can be further increased in the future as quite a lot of products are below 0.18 already now. It is expected that the topten criteria can go to 0.17 or even lower. The review of the regulation is already ongoing and will further push the development of more efficient pumps.

1.6 Technical background

Circulation pumps transport the heating water from the heat generator (boiler, heat pump) or heat storage tank (solar etc.) to the heat consumption, i.e. underfloor heating or radiators. In most cases, a hot water storage tank is also supplied via the heat generator.

Picture 2: Functioning of a heating system with a boiler, hot water tank, a radiator, a valve, a circulation pump



Source: http://www.gasboilerforums.com/images/cplanschematic.gif

The circulation pump itself moves the liquid in a closed circuit. Therefore, this is not equal to the work a pump has to do to e.g. pump up water from a well, but it is mainly moving water through the pipes, similar as to if there was no height difference to overcome at all. The only resistance the pump has to overcome is from the friction of the piping system or the differences in volume created by the thermostats.

Circulation pumps are also used for solar systems, ground probes (heat pump systems), air conditioning systems, heat recovery systems, district heating systems, in industry, etc.

1.6.1 The use for hot water

In one-way plumbing without a circulation pump, water is piped from the water heater through the pipes to the tap. Once the tap is shut off, the water remaining in the pipe cools. The next time the tap is opened, there is a delay before the water is hot again. By adding a circulator pump and constantly circulating a small amount of hot water through the pipes from the heater to the place of demand and back to the heater, the water in the pipes is always hot, and no water is wasted during the waiting time. The trade-off is the energy wasted in operating the pump and the additional demand on the water heater to make up for the heat lost from the constantly hot pipes. Thermal insulation applied to the pipes helps mitigate this second loss and minimize the amount of water that must be pumped to keep hot water constantly available. In the end it is a question of comfort (not having to wait too long for hot water, water waste while you wait). For single-family houses, it is not recommended to install a circulation pump for the hot water

system, as the constant heat energy losses through the hot water pipes are far too big. The energy of the circulator pump is not that relevant for this issue.

1.6.2 The use for heating

Hot water is also required in the radiators or underfloor heating for heating the building. Here the demand is not created by opening the tap, but by a regulator such as a thermostat that measures the temperature of the liquid going to place of demand depending on the setting for the desired room temperature. If the temperature is too high, the thermostat signals « less demand », if it is too cold, it signals « more demand ». The volume is then reduced, resp. increased.

1.6.3 Energy saving potentials

New pumps save up to 75% energy compared to conventional pumps just because of their better efficiency of the pump motor. The built-in automatic speed control results in additional savings through automatic adjustment to the required pump quantity (volume flow), e.g. if some of the thermostatic valves on radiators or underfloor heating circuits are closed. However, even efficient circulation pumps must not be greatly oversized, otherwise they run at an inefficient operating point.

1.6.4 Speed control

In the case of speed-controlled pumps, two different control modes can usually be selected, each with several setting values (possibly also infinitely variable). The setting value determines the delivery head: for radiator heating systems, 1 - 2 m (metres of water column, corresponding to 10 - 20 kPa kilopascal) is a good setting to start with depending on the size of the system. Above 2 m the risk of valve noises increases, especially with thermostatic valves. Slightly higher values of 1.5 to 3 m are required for floor heating systems.
With the "proportional" control mode, the delivery head (pump pressure) is reduced appropriately at a reduced volume flow. This is usually useful. The control mode "constant" is suitable for other applications such as solar systems, hot water circulation, geothermal probes etc.; and possibly for supply problems with proportional control mode.

1.6.5 Heating controller settings

For optimum overall efficiency it is also important that the heating control system switches off the pump when no heat is required. For this purpose, the operating mode "day normal, night off" must usually be selected (frost protection is usually automatically guaranteed), and the pump must be operated via a control line with the corresponding controller signal. It is not recommended to disconnect the new pumps from the mains via a heating controller switching output, because then the monitoring functions are also switched off. To avoid unintentional heating operation on cool summer mornings, the operating mode "Summer" or "Off" (if without hot water preparation) should be selected at the end of the heating period.

1.6.6 Correct dimensioning

The electrical power consumption of the pump is about one per mil (1 ‰) of the required thermal heat output. The per mil rule applies to heating-group pumps of conventional design in small to medium-sized apartment buildings. In detached and semi-detached houses, pumps of older design may require 2 ‰ to 3 ‰, in larger systems (pump capacities above 200 W) and for new pumps with EEI = 0.23, 0.5 ‰ should be sufficient.
It is calculated as follows: Ratio of the electrical pump power to the maximum required thermal heating power (standard heating load): per mil rule, 1 ‰ = 0.001. For very cold climates shift downwards (approx. 30% less), for warm ones up. For underfloor heating up to 50% more.

1.6.7 Types of circulators (details see Annex)

The "standalone" circulator is separate from the boiler, designed to operate independently from the product and is purchased as a separate product. The typical size of a circulator used in a single-family house is 65 W, and that of commercial or residential buildings is 450 W.
The "integrated" circulator is supplied to the user already integrated into the boiler, a circulator with the shaft of the motor directly coupled to the impeller and the motor immersed in the pumped medium. It has a typical power consumption of 90 W.

2 Policy measures, standards and labels

2.1 List of existing regulations (Energy Labelling, Ecodesign)

2.1.1 European Energy label

The industry established a voluntary energy label which was terminated in 2012 when Ecodesign requirements were enforced. Today, there is no European energy label for circulation pumps.

2.1.2 Ecodesign (EC 641/2009 and its amendment EC 622/2012)

The regulation applies to impeller[2] pumps in heating systems or secondary circuits of cooling systems with rated hydraulic output up to 2500 W (the effective output of a pump). This can be standalone or integrated products.

Table 3: Ecodesign requirements

	641/2009
Energy efficiency index (EEI)	0.23

Information on the product plate and in additional product documentation is necessary. They are as follows:

- 2013: For standalone circulators: information requirements (EEI and EEI benchmark = 0.2 needs to be labelled on product plate; disassembly, recycling, disposal information)
- 2015: for integrated circulators: information requirements (EEI on product plate, technical product documentation)

The regulation is currently under revision, a proposal for the revision has been submitted in 2019. In this revision, the minimum requirement for EEI is not stricter (still 0.23), but the EEI benchmark is lowered to 0.17 (instead of currently 0.2). The best products on topten.eu are currently 0.15.

2.2 Market analysis and potential energy savings

In the preparatory study in 2008 for circulation pumps, the following estimations have been made:

- In the EU-25, there is a stock of about 140 million circulators in the market. Each year, 14 million units are sold (6.5 million standalone, 7.5 million integrated).
- The most significant environmental impact out of all life-cycle phases is the use phase energy consumption amounting to 50'000 million kWhpa in 2005, corresponding to 23 million tonnes of CO_2 emissions per year. If no specific measures are taken, electricity consumption is predicted to increase to 55'000 million kWhpa by 2020.

[2] See Terminology p.10

- The preparatory study shows that use phase electricity consumption can be significantly improved. With the Ecodesign requirements from 2012, this will lead to ultimate energy savings of 15’600 million kWhpa by 2022, with savings of 13’000 million kWh pa by 2020.

2.3 Policy recommendations

Minimum requirements should be lowered for all European markets to 0.18.
As circulation pumps have a very long lifespan, there should be subsidy programs developped to enhance early substitution of older, less efficient pumps.

3 How to gather data

Topten.eu serves as reference and starting point for national Topten product lists.
National product lists should reflect market availability of most efficient products for each country. The following procedure is recommended for data gathering:

- Check what products are listed on topten.eu
- Check which of those products are available in your country
- Check national products which are only available in your country to see if they comply with the selection criteria. Inform Topten.eu about them so they can be added to the topten.eu list.

Manufacturers are required to display the energy efficiency index on the product. Product catalogues and manufacturer websites are the places to find product details.

3.1 Attributes

The following attributes are the information shown on the Topten.eu website for each product, because they are important to buyers and / or relate to the Topten selection criteria.

3.1.1 Attributes on Topten.eu

Energy Efficiency Index (EEI)
The EEI is an indicator of a circulator's efficiency. The EEI is defined in the Ecodesign Regulation for circulators No. 641/2009, and it must be indicated on the name plate, the packaging and the technical documentation. The lower the EEI, the higher a product's energy efficiency.
Flow rate (m3/h)
Flow rate (Q) at maximum hydraulic power (where Q*H is maximum, according to EU Regulation No 641/2009). The flow rate is the primary criteria for dimensioning a pump. Well insulated single-family houses require less than 0.5 m3/h - most such houses have oversized pumps installed. Older houses (up to four-family houses) need from 1 to 2 m3/h.
Head (m)
Head (H) means head (produced pressure of the pump measured in meters) produced by the circulator at the specified point of operation. The pressure is influenced by the friction of the piping system, losses due to the distribution, regulation and emission in the closed water circuit. In the Topten list the head is given at the maximum hydraulic power operation point.
Diameter (mm)
Is the diameter of the pipe.

Table 4: Attributes for circulation pumps on Topten.eu

Product Data	Example

Brand	Grundfos
Model	ALPHA2 25-40
Further models	15-40, 32-40
Energy Efficiency Index (EEI)	0.15
Flow rate (Q) (m3/h)	1.7
Head (m)	3
Diameter (mm)	25

4 Input for Consumer Recommendations

4.1 Input for Recommendation pages

For Topten.eu, there are policy recommendations added to the recommendation page, as it is not specifically designed for consumers.

In general, circulator pumps are well regulated and established. By choosing a new product, it is fairly easy to purchase the best product. The only critical issue is dimensioning it correctly (usually over-dimensioning is the problem, causing the pumps to run constantly at an inefficient range).
In addition, there are some control settings that need to be optimized as well, assuring that the pump runs only when needed (check chapter "Heating controller settings" above for details).

For national Topten recommendation pages, detailing some topics of special relevance for consumers such as what types of circulator pumps exist, what the important aspects to consider are and links to pre-filtered product lists on Topten are suggested.
An example of an advisor page can be found in German, French and Italian on https://www.topten.ch/private/adviser/ratgeber-heizungspumpen .

On Topten.eu the most efficient products are shown. However, if a country has stricter regulations or not enough products to list, the criteria can be slightly adapted.

4.2 FAQ

- **How do I decide how to correctly dimension my circulator pump?**

Use the per-mil-rule, which is the result of the ratio of electric pump energy and the heat energy. It is calculated as follows: Ratio of the electrical pump power to the maximum required thermal heating power (standard heating load) = per mil rule, where 1 ‰ = 0.001.
In detached and semi-detached houses, pumps of older design may require 2 ‰ to 3 ‰, in larger systems (pump capacities above 200 W) and for new pumps with EEI = 0.23, 0.5 ‰ should be sufficient.
The resulting per-mil-value can be adjusted: for very cold climates -30%, for warm climates +30%, for underfloor heating up to +50%.

- **What is the correlation between the head and the height of the building?**

Contrary to popular belief, the head does not equal the height of the building. A pump transports liquid from A to B and in doing so transfers usable work, i.e. kinetic energy, to a pumped medium. The usable work produced by the pump must be large enough to overcome the weight of the pumped medium and the flow resistance in the heating system at a certain flow rate. The

pressure is a unit of measurement for the resistance. Therefore, the delivery head of a pump is an indication of the required pressure in the heating system. The delivery head of a pump is given in "metres of water column", which is a unit for measuring pressure. That means the head of the pump can be much smaller than the building height as one indicates pressure, the other one is a length, but both are measured in meters.

- **When new pumps are able to work in partial load, why should it still not be over-dimensioned?**

If an over-dimensioned circulation pump is installed to ensure that even very unlikely heat demands can be met, this pump will most likely always run on a low partial load. While this is technically possible, it is a lot less efficient and thus wastes energy. It is therefore not recommended. Proper dimensioning using the pro-mil-rule is crucial to realize all the energy gains which are possible with new pumps (See above Chpt. Technical background).

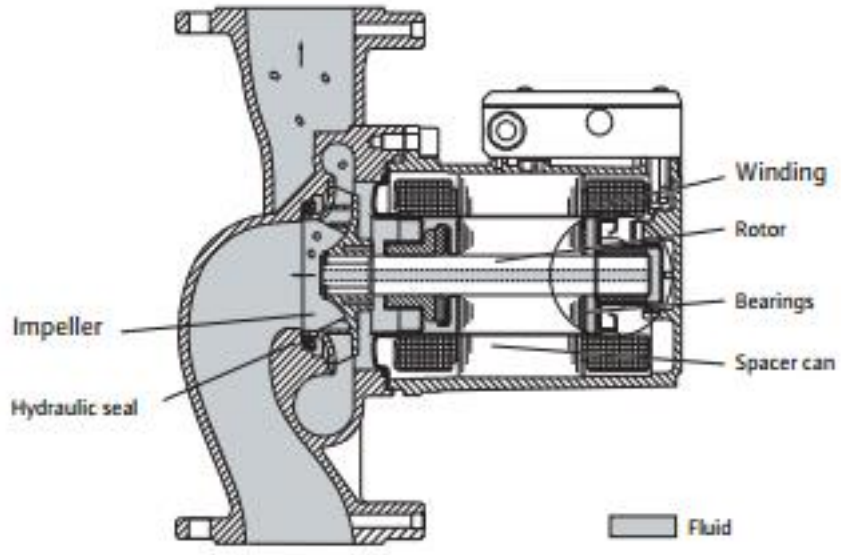
- **I recently replaced my old circulator pump with a new, efficient one, but I am still not saving energy, what could be the reason?**

One of the main issues is incorrect installation. Make sure that after everything is installed, your installer proofs to you that the target values are met and especially the thermostats are coupled to the pump. Otherwise they cannot regulate it and the pump keeps running even though there is no demand at the radiators.

5 Terminology

Glandless circulator is a pump whose rotating parts, including the rotor or rotor of the driving electric motor, rotate in the liquid medium. This eliminates the need for a shaft seal (the gland) that many conventional pumps must use.

Picture 3: Functioning of the glandless circulation pump



Source: https://upload.wikimedia.org/wikipedia/commons/7/78/Pump_diagram.PNG

Impeller: An impeller is a rotor that produces a sucking force (in comparison to a propeller which is a fan which propels a fluid by pushing against it: it converts rotational motion into linear motion).

Integrated circulator is supplied to the user already integrated into the boiler, a circulator with the shaft of the motor directly coupled to the impeller and the motor immersed in the pumped medium.

Standalone circulator: is separate from the boiler, designed to operate independently from the product and is purchased as a separate product.

6 References and links

6.1 Useful links

- Topten.eu product list
  https://www.topten.eu/private/products/circulation_pumps
- Topten.eu selection criteria
  https://www.topten.eu/private/selection-criteria/circulation-pumps
- Policy recommendations
  https://www.topten.eu/private/adviser/policy-recommendations-circulation-pumps
- Topten Switzerland Advisor Umwälzpumpen:
  https://www.topten.ch/private/adviser/ratgeber-heizungspumpen

6.2 References

- **EU regulations**
  - Commission Regulation EC 641/2009 regarding ecodesign requirements for glandless standalone circulators and glandless circulators integrated in products https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:191:0035:0041:EN:PDF
  - Revision proposal EC 641/2009 https://www.eceee.org/static/media/uploads/site-2/ecodesign/products/Circulators%20in%20building%20ENER%20Lot%2011/draft-wd-ed-review-circulators---eelcf.pdf
  - Commission Regulation EC 622/2012 regarding ecodesign requirements for glandless standalone circulators and glandless circulators integrated in products https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0622&from=EN
  - EC Website on circulators https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/circulators_en
  - Commission Communication: Harmonised standards for circulators 2013/C 254/04 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013XC0904(02)&from=EN
- **Prep. Studies**
  - Review study of ecodesign for circulator pumps, 2008 https://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Lots/Final_Documents/Lot11_Circulators_FinalReport.pdf
- **Other papers and presentations**
  - EN 16297-1:2012 Pumps — Rotodynamic pumps — Glandless circulators — Part 1: General requirements and procedures for testing and calculation of energy efficiency index (EEI)
  - EN 16297-2:2012 Pumps — Rotodynamic pumps — Glandless circulators — Part 2: Calculation of energy efficiency index (EEI) for standalone circulators
  - EN 16297-3:2012 Pumps — Rotodynamic pumps — Glandless circulators — Part 3: Energy efficiency index (EEI) for circulators integrated in products
  - Europump, the European Association of Pump Manufacturers http://www.europump.eu/

7 Appendix

7.1 Models with less strict criteria (EEI 0.2 instead of 0.18)

Until March 2020, the criteria on topten.eu was 0.2. Due to technical progress the criteria has been increased to 0.18.

Table 5: Product list and distribution of models

Manufacturer	Number of models	Website
Biral	35	http://www.biral.ch
Grundfos	25	http://www.grundfos.ch/
HALM	14	http://www.halm-pumps.de
KSB	16	http://www.ksb.com
Taco	2	http://www.taconova.com
WILO	102	http://www.wilo.ch
Total	194	

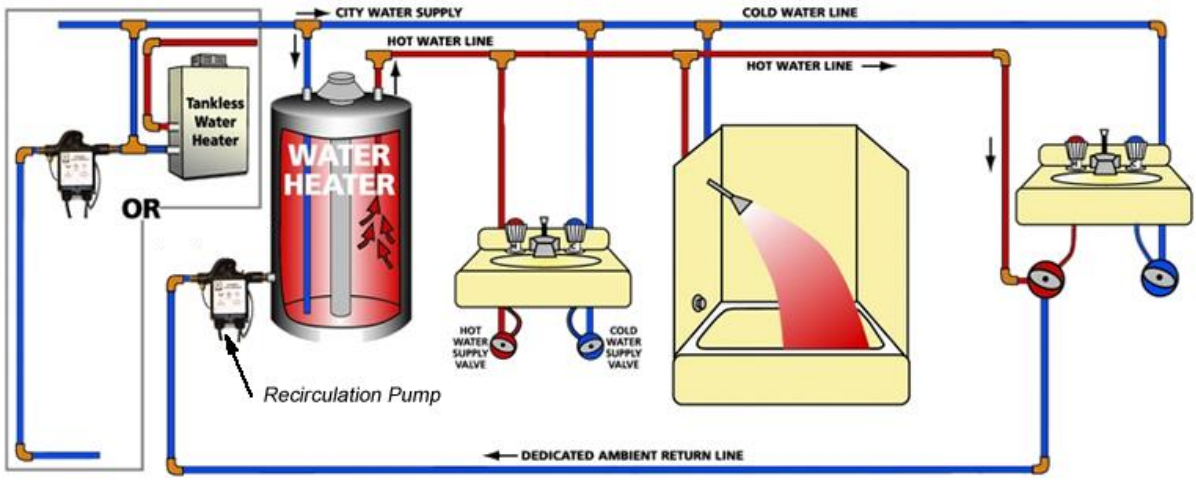
Source: https://www.topten.eu/private/products/circulation_pumps

7.2 Basic function of a circulation pumps

7.2.1 Hot water system

Two different options are shown with a hot water tank and a tankless water heater. The circulation pump moves the water from the tank to the place of demand and back to the tank.

Picture 4: Functioning of the hot water system

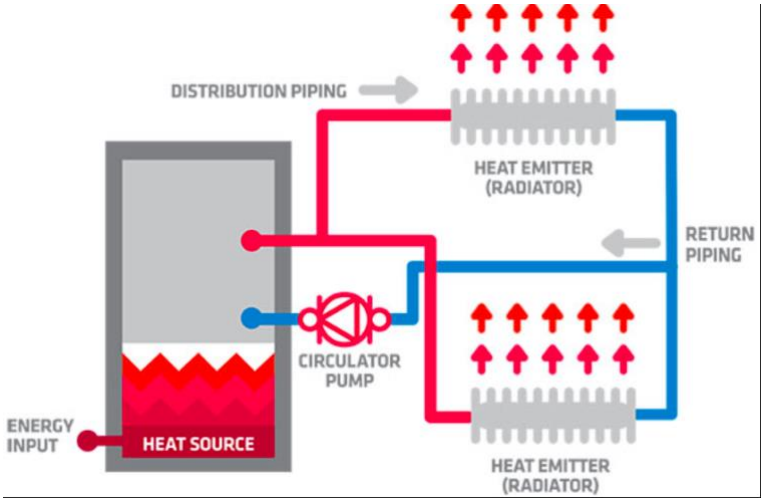


Source: http://diyplumbingadvice.com/images/hotwatersystem_return.png

7.2.2 Heating system with radiators (not regulated)

The circulation pump transports the hot water to the radiator (or floor heating coils) where heat is transmitted to the air to heat the room. The cooled down water is transported back to the hot water tank, where it is reheated.

Picture 5: Functioning of the heating system

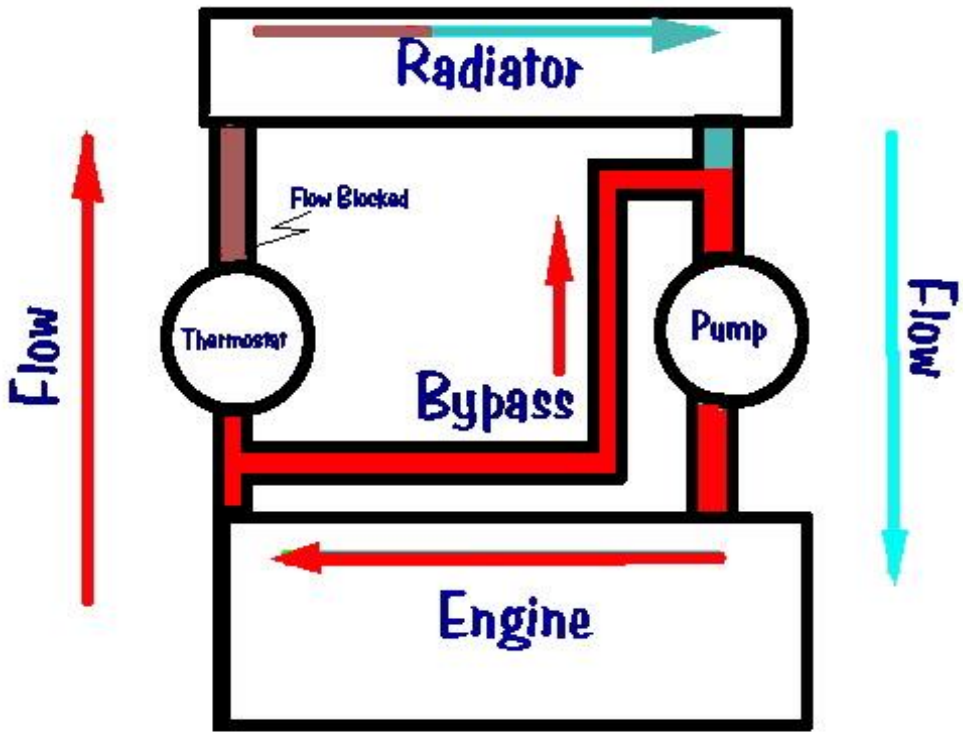


Source : https://images.squarespace-cdn.com/content/v1/5d604962e210920001ec1834/1567492791087-1F4NP939E0RM84I87SZY/ke17ZwdGBTodd8pDm48kEy5GSBGGLXr2kFejsW9uGBZw-zPPgdn4jUwVcJE1ZvWQUxwkmyExglNqGp0IvTJZamWLI2zvYWH8K3-s_4yszcp2ryTI0HqTOaaUohrI8PI8OVB2KDBhYedTZO4n8ppmrdNka4B7FfTjQe17SZTMGw/hydronic1.png

7.2.3 Heating system with radiators and thermostats

What happens, when you have radiators and the thermostat is closed ? the hot water is bypassed by the radiator and goes back into the hot water tank (here labelled « Engine »).

Picture 6: Functioning of the thermostat



Source: https://www.coolcatcorp.com/thermostats/Bypass%20Block.jpg

7.3 Circulator motors

This section is an excerpt from the preparatory study (2008), AEA/ED02287/Issue 1 EUP Lot 11 Circulators, Chapter 1.1.7.

The motors used may be one of three types:

- **Fixed speed AC**. Fixed speed units are fitted with ac motors and typically run at about 2,800rpm.
- **Multiple speed AC**. Multiple speed units are by far the most common and in addition to an AC motor include a speed selector switch with 3 to 5 speed settings typically (800 – 2,800rpm). Speed selection is used to reduce the flow rate through the pump in order to limit excessive flow velocities and/or head within heating circuits and consequently reduce noise; an added benefit is reduced power consumption due to a better match between the pump and the hydraulic performance of the heating circuit.
- **Variable (modulating) speed**. Of more recent design are variable speed circulators, which use either conventional induction motors or electrically commutated (EC) motors. The advantage of variable speed is the ability of the control electronics to continually adjust the speed of the pump to match the hydraulic performance of the system at any given time. These products also tend to demonstrate improved hydraulic performance due to improvements in hydraulic design. EC motors use permanent magnet rotors and are able to achieve higher efficiencies. (See Lot 11 Motor study for further information on the performance of these other types of motor).

Circulators integrated into boilers are in the main fixed speed (selectable) ac induction units with a customised pump component (volute) to suit the specific boiler model. The volute may be cast as part of a larger manifold into which other components such as directional valves or transducers may be fitted. Boiler designers tend to size pumps in line with the maximum performance of the boiler and possible system operating head, typically 6 metres.

Picture 7: Variable speed circulators (Grundfos Alpha and Wilo Stratos series)

Picture 8: Conventional 3-speed circulator (Grundfos)

Picture 9: Boiler integrated circulator with associated components (Grundfos, Wilo)