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Eco-efficient Substations for District Heating

Öko-effiziente Unterstationen

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Eco-efficient Substations for District Heating

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European Foreword

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CWA 16975 was developed in accordance with CEN-CENELEC Guide 29 "CEN/CENELEC Workshop Agreements – The way to rapid agreement" and with the relevant provisions of CEN/CENELEC Internal Regulations - Part 2. It was agreed on 2015-09-11 in a Workshop by representatives of interested parties, approved and supported by CEN following a public call for participation made on 2015-09-11. It does not necessarily reflect the views of all stakeholders that might have an interest in its subject matter.

The final text of CWA 16975 was submitted to CEN for publication on 2015-11-19. It was developed and approved by: Paolo Arrus - Giacomini, Anna Boss - SP Swedish National Testing and Research Institut, Aleš Cjuha - Energetika Ljubljana, Daniele Delboca - Giacomini, Mieczyslaw Dzierzgowski - OPEC Gdynia, Bertrand Guillemot- Dalkia France, Niklas Jeppsson - SWEP International, Markus Köfinger - AIT, Alexander Midtsjø - Hafslund Varme, Gunnar Nilsson - Svensk Fjärrvärme, Timo Peltola-Ouman, Igor Radovic - Grundfos Holding, Fabrice Renaude - Gylergie Cofely's Research Center, Henrik Rietz - SWEP International, Marko Riipinen - Helsinki Energy, Janusz Rozalski - OPEC Gdynia, Jaroslaw Szczechowiak - OPEC Gdynia, Jan Eric Thorsen – Danfoss, Jonas Wallenskog - Svensk Fjärrvärme, Wim Wolfs- Giacomini, Teijo Aaltonen - Alfa Laval Nordic.

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1 Scope

The target is to describe what is an eco-efficient substation (EES), how this eco-efficient substation is considered, tested and certified. EES concept includes as much substation efficient design as possible, without trying to cover an exhaustive point of view. The scope of the EES is to focus on a reachable future, realistic compliance with the existing system and ways of handling substation issues in a harmonized manner across Europe.

The proposed standard is compliable with the expected development in Europe in the future such as:

- New buildings with less demand for energy and more demands for lower temperatures.
- The connection systems should be standardized in order to make the substation replacement as easy as possible.

The aim is to consider the whole life of the system, including all seasons and not only the peak load operation. The most important period to consider, is the long duration time with both heating and domestic hot water demands.

EES should be certified, and marked according to certification that is given according to testing result and environmental ranking. Only EES with capacity up to 500kW per heat exchanger for heating and domestic hot water respectively, can be certified. Small substations intended for single-family houses or flats, shall not be certified. A certificate can include one specific substation or a series of substations.

This document contains 3 main parts:

Technical: Describes the main and optional components of the EES

Environmental: Describes the various parameter and components that give the efficiency to the substation, how these are ranked and the marking procedure

Testing and certification: The testing and certification procedures.

2 Conformance

All DH equipment and the system as a whole shall be approved in accordance with international, European Union and national laws, regulations, building codes and standards. In addition, all laws and rules from the national health and environmental authorities shall be taken into consideration.

National DH organizations and Euroheat & Power should make efforts towards harmonizing such rules and standards throughout the EU, in order for these rules and standards to be as much as possible in line with the characteristics of DH. The aforementioned organizations may also issue technical recommendations themselves.

The following EU directives and standards are relevant for this document:

- Directive 2012/27/EU (EED directive): Energy efficiency directive introduces a framework of measures to use energy more efficiently at all stages of energy chain. The directive is especially focused on energy efficiency improvements in households, industry and transport sector.
- Directive 2010/31/EU (EPBD directive): Energy performance of buildings directive introduces the new methodology for calculating the energy efficiency of buildings, minimum requirements for energy efficiency of new and renovated buildings, minimum requirements for energy

efficiency of building equipment, plans for implementing more nearly zero energy buildings, regular inspections of heating and air conditioning systems in buildings and implementation of energy performance certificates for buildings.

- Directive 2010/30/EU: Directive establishes a framework for labelling and introducing general product information on consumption of energy and other energy-related products.
- Directive 2009/125/EC: Directive represents a framework for minimum Eco design requirements of product that use energy and water (light bulbs, refrigerators, heat Owen, insulation materials, etc.).
- Regulation No. 641/2009 with amending regulation No. 622/2012 and regulation No. 547/2012: Regulations present eco-design requirements for water pumps.
- Directive 2004/22/EC (MID directive): Measuring instrument directive specifies methodology and requirements for measuring instruments such as heat, water, gas and electric energy meters, exhaust gas analysers, taximeters, etc.
- Directive 98/83/EC (DWD directive): Drinking water directive sets the minimum standards for quality of drinking water in distribution systems, regarding microorganisms and chemical parameters.
- Directive 97/23/EC (PED directive): Pressure equipment directive presents requirements for design and fabrication of pressure equipment such as pressure vessels, piping, safety valves and other components subjected to pressure load.

- Regulation EC 66/2010 (ECO labelling): Regulation presents rules for application of voluntary environmental labelling system for eco-friendly products.
- European standard EN 1434 (Heat meters standard): Standard specifies minimum requirements for heat meters regarding construction, data exchange, testing, verification, installation, commissioning, monitoring and maintenance.
- European standard EN 13445 (Pressure vessels standard): Standard specifies requirements for design, construction, inspection and testing of unfired pressure vessels made from steel, cast iron and aluminium.
- European standard EN 1148:1998, EN 1148:1998/A1:2005 (Heat exchangers standard): Standard specifies test procedures for establishing the performance data of water to water heat exchangers for district heating.
- European standard EN 247:1997 (Heat exchangers standard): Standard specifies heat exchangers terminology.
- European standard EN 12828:2012 (Heating systems in buildings standard): Standard specifies the design of water based heating systems.
- European standard EN 14336:2004 (Heating systems in buildings standard): Standard specifies the installation and commissioning of water based heating systems.

- European standard EN 15316 series (Heating systems in buildings standard): Standard specifies methods for calculation of system energy requirements and system efficiencies; with special focus on Part 4-5 'Space heating generation systems, the performance and quality of district heating and large volume systems.

All electrical components of the EES shall be electrically protected according to the applicable rules.

3 Technical Part

3.1 Introduction

The aim of this part is to describe the technical specifications that a substation has to fulfil to be regarded as an Eco-efficient substation.

3.2 Terms and definitions

Here is a simplified drawing of a substation that gives the location of the various components described in the definition.

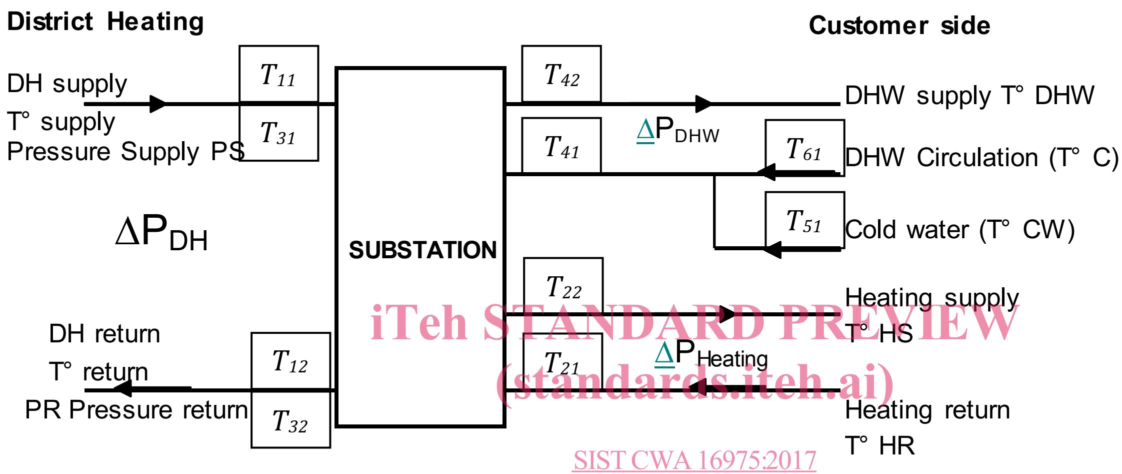

Figure 1 - Definition drawing

DHW: Domestic Hot Water: Water heated for sanitary use.

DHW circulation loop: Piping where DHW continuously flows in order to keep the system active and the temperature on such a level that both comfort and health requirements are delivered to the customer.

Cold Water: Is the fresh water coming from the water services that feed the DHW system.

DH: District Heating Network.

ΔP: Pressure difference between supply and return pipes.

Definition of variables in a counter-flow heat exchanger

T_{11}: Primary supply temperature from DH,

T_{22}: Heating supply temperature, to customer,

T_{12}: Primary return temperature to DH,

T_{21}: Heating return temperature, from customer,

T_{31}: DHW: Primary supply temperature from DH,

T_{42}: DHW supply temperature to customer,

T_{32}: DHW Primary return temperature to DH,

T_{41}: DHW cold water and circulation loop temperature,

$\Delta T2$ Temperature difference secondary side,

T51: Cold Water temperature,

T61: Circulation loop return temperature,

ϑ_1 Temperature difference heating (T12–T21) or DHW side (T32– T41),

ϑ_2 Temperature difference Primary side (T_{11}–T_{22}) or (T_{31}–T_{42}).

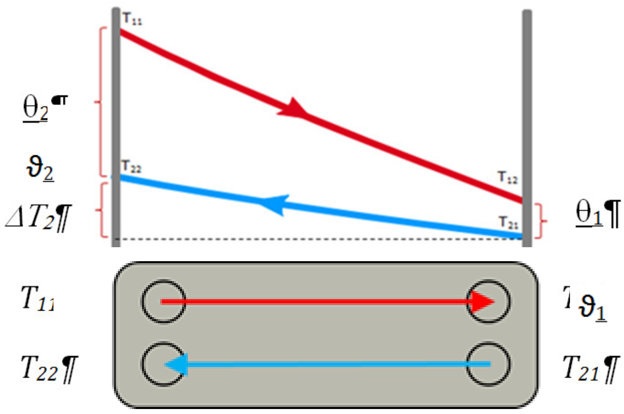

Figure 2 - Variables in a heating counter-flow heat exchanger

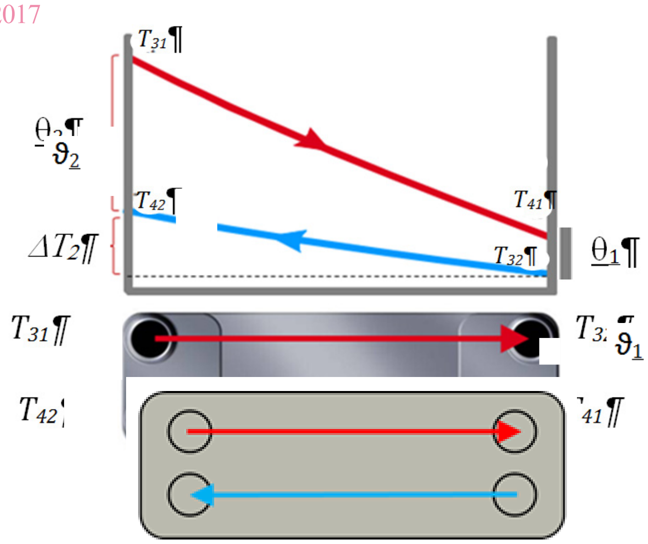

Figure 3 - Variables in a DHW counter-flow heat exchanger

In this document, the following verbal forms are used:

- "Shall" indicates a requirement
- "Should" indicates a recommendation;
- "May" indicates a permission;
- "Can" indicates a possibility or a capability.

3.3 Eco-efficient substation (EES) definition

3.3.1 General

The purpose of this document is to describe what an Eco-efficient substation is. The substation is the system in a district heating network, that connects the customer or group of customers to the network. It complies with European and local regulations. Many various system designs are existing and this document will describe those that provide the best ratio between energy efficiency, life cycle cost, the most common use and new services that the substation might provide.

The EES provides both heat service (HS) and domestic hot water production (DHW) or the systems might be considered separately if just one of the two is needed. It is suitable to consider Rehva request and/or bacteriological risks according to national regulations when DHW is planned and installed.

To be efficient the Eco-efficient Substation (EES) shall deliver a reasonably low return temperature to the network and create a reasonably low-pressure drop across the system on the secondary side.

The EES shall be equipped to provide the customer and the district heating company with a secure, energy effective and economically reliable connection to the DH-network. To achieve this target, the EES shall include at least:

- One efficient heat exchanger per service such as brazed heat exchanger or any other technology that provide the similar efficient service.
- Each heat exchanger shall be insulated.
- Control valve to control the energy delivered and control the temperature delivered to the customer in an as efficient manner as possible. A control valve for temperature control acts on the primary side for each service, heating and DHW.
- Filter should be installed on primary side
- Heat meter should be mounted according to EN 1434.

The number, quality and range of the devices shall be adjusted to the size of the substation. EES shall be insulated to prevent heat losses, risk of injury and high ambient temperature in the substation room.

Other components can increase the scope of the services of the EES, but as they are strongly linked to where they have to be implemented in the sizing and design, they are not in the scope of this document.

These components are for example: Storage or any tank, circulation pumps, pressurization devices, water treatment devices, secondary side filter and other possible components.

3.3.2 Marking of EES

Substations shall have a permanent and visible attached plate containing the following information:

- Manufacturer; Article No.; Type; Manufacturing No.; Manufacturing year;
- Design temperature; Design pressure; Leakage test pressure; Volume per side; Safety valves settings (when fitted);
- Heating capacity and DHW capacity; Temperature program for heating, DHW; Voltage;
- Fluid group; Directive 97/23/EC - PED Category or article 3.3;
- EES certification level.

3.3.3 Commissioning, service and maintenance of EES

Customer satisfaction is essential for maintaining and increasing the market position of DH. Guaranteeing a smooth and economic operation of the district heating supply requires commissioning, regular inspection and maintenance of the substations and their components. Although the substations are extremely reliable and have a long lifetime, it is recommended for a specialist to make commissioning at the first installation and regular inspections to verify that the operation is optimized. Apart from smaller maintenance work, looming malfunctions will be recognized and eliminated at an early stage. Valid technical regulations contain only a recommendation to carry out technical inspections; specified periods are not prescribed, monitoring and surveillance can give indication when needed.

3.3.4 Choice of materials

To ensure a high quality service, there are a number of criteria that all used materials shall fulfil:

- They shall be selected in order for them to withstand the maximum pressure that the system is designed for. The materials shall also withstand the maximum temperature that the system is designed for.
- If there is a mix of materials they shall be chosen in such a way, that corrosion shall be minimized when-considering the whole circuit they will be connected to;
- Water is the most common existing solvent and can in some cases be very aggressive. When choosing materials for a domestic hot water system, attention shall be paid to the quality and chemical composition of the local water source to avoid corrosion in the system;
- Both metals and polymers are used in the circuits. For example in gaskets. The same care has to be taken in choosing gaskets for the system. They shall withstand the working conditions in the system for the period that the system is designed for.

The choice of material shall also follow national requirements and regulations.