Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 146 (2016) 415 – 423

Procedia Engineering

www.elsevier.com/locate/procedia

8th International Cold Climate HVAC 2015 Conference, CCHVAC 2015

Importance of Increased Knowledge on Reliability of District Heating Pipes

Tymofii Tereshchenko*, Natasa Nord

Norwegian University of Science and Technology (NTNU), Department of Energy and Process Engineering, Kolbjørn Hejes vei 1d, NO-7491 Trondheim, Norway

Abstract

District heating (DH) is a service that satisfies customers' demands in the areas of heating, hot water preparation and the supply of heat to ventilation systems. Three generations of DH distribution technology are already in operation; the next generation of low temperature district heating (LTDH) will soon be upon us. However, without a reliable distribution system, it is quite difficult to utilize the concept of LTDH and remain competitive in the energy market. For that reason, this paper provides a comprehensive review of pipe reliability issues associated with DH systems. In this regard, discussions have been concentrated on factors leading to pipe degradation processes. Three groups of factors, namely physical, environmental and operational, were identified and examined. Allowable heat losses in the DH network and the creation of a pipe failure database were also discussed. The information collected in this paper leads to a better understanding of pipe degradation mechanisms and can be used as a tool for pipe failure prevention.

Peer-review under responsibility of the organizing committee of CCHVAC 2015

Keywords: District heating; distribution system; pipe reliability; pipe accidents.

1. Introduction

District heating (DH) is an energy service based on moving heat from available heat sources directly to customers for immediate use [1]. This service is flexible and allows renewable energy sources to be utilized as a primary energy input. In turn, this leads to decreasing CO_2 emissions and energy savings. Currently three generations of DH distribution technology are in use. The research society is moving towards the fourth generation of low temperature

* Corresponding author. Tel.: +47-92-55-33-22; fax: +47-73-59-38-60.
E-mail address: tymofii.tereshchenko@ntnu.no

Peer-review under responsibility of the organizing committee of CCHVAC 2015
doi:10.1016/j.proeng.2016.06.423

district heating (LTDH) [1]. The development of LTDH is impossible without a reliable distribution system. It is well known that a DH system is rarely developed from a scratch and huge DH networks are a result of extension and merging. Therefore, it is highly desirable that old DH pipes provide reliable operation and do not influence heat distribution through unpredicted failures.

In order to stay competitive in the energy market, DH should provide a reliable heat supply to customers throughout the year. In reality, this is not an easy task. Different malfunctions and accidents associated with the operation of a DH system and the distribution of heat lead to a decrease in the security of supply. The possibility of losing the heat supply is particularly dangerous during the winter season in countries with extremely low outdoor temperatures.

Accidents in the DH networks are inevitable and can occur for various reasons: wear and tear, equipment failures, pipeline breaks and so on [2]. Accidents lead to financial and capital losses, incurred by the repair and restoration of the network. Failures reduce the reliability of the network due to lowering of the pressure or due to interruption of the DH supply, which ultimately leads to customers' dissatisfaction. Sensitive customers, such as industrial centres, governmental buildings and hospitals, are most likely to be affected [3]. One serious problem in DH supply is deterioration of the distribution network; this can occur for different reasons. Pipe deterioration can lead to pipe breaks and leaks, which may result in a reduction in the water-carrying capacity of pipes and lead to substantial repair costs [4]. Pipe breaks incur large direct and indirect economic and social costs, such as water and energy loss, repair costs, traffic delays, and factory production loss due to inadequate DH service interruptions. Unfortunately, it is difficult to locate breaks in the pipe network because most parts of the pipes are buried underground and inaccessible [5]. Component failures in flow networks lead to disappearance of flow capacity, and the expected level of the throughput flow may not be guaranteed. As a result, the quality of service received from the network can be seriously affected [6].

With their further development, it is important to provide high reliability and availability of DH systems for existing and future customers. Piping failures can be prevented through reliability measures and these are subject to improvement.

Nomenclature

HL	heat losses
PL	length of DH pipelines
Q_h	heat production in the DH system
$Q_{h,f}$	heat production affected by pipe failures
Q_{loss}	heat losses in the DH system
ΔQ	decrease in heat delivery due to pipe failures
$\Delta Q_{h,f}$	relative deviation in the heat delivery due to pipe failures
a	model coefficient
b	model coefficient
f	pipe failure factor

2. Factors affecting pipe reliability

In their work, various researchers have tried to identify the main causes leading to pipe deterioration [7-9]. Al-Barqawi and Zayed [10] classified three groups of factors resulting in pipe degradation; these are presented in Table 1.