Climate change: melting glaciers, diminishing water resources, trapped sunrays increase global warming

INTERNET OF THINGS FOR HVAC/R

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Abstract

ASERCOM has started a new working group “Control and Communication” focusing on Internet of Things (IoT) – solutions for Air Conditioning and Refrigeration systems. Data and connectivity are expected to contribute to energy saving in those systems and to improved maintenance. It is also expected that the availability of such a system can be increased and technical failures can be reduced if components are interconnected and not stand-alone. Nevertheless, cyber security is a potential threat and risk analyses have to be done to make sure no malware can influence and damage the functionality of the Heating, Ventilation, Air Conditioning and Refrigeration (HVAC/R) circuit. In this paper, opportunities of IoT in HVAC/R are listed and an overview of a risk analysis for a condensing unit is given.

1. Introduction

Klaus Schwab, Founder and Executive Chairman of the World Economic Forum, describes the disruptive nature of recent changes driven by the Internet, 3D-Printing and mobile communication in his article “The Fourth Industrial Revolution: what it means, how to respond“ [1]. HVAC/R industry is part of our daily life when we eat and drink (cold chain of food and beverage), when we are inside buildings or travel by car, train or plane (air conditioning) or when we order goods online with our smartphone or computer (data center cooling). Those systems have obviously a significant influence on our daily life and are installed in all parts of the earth. Distributed systems of high importance are very likely to be affected by Internet of Things, the megatrend to connect more and more machines to the internet.

Billions of machines like pumps, compressors or fans are today in the field without any connectivity. It is not possible to measure their current health-status or to use their data to update control algorithms to save energy. Those machines do the groundwork in our building- and factory-automating systems like pumping fluids, compressing refrigerants or blowing air. These machines consume a major part of our electricity and failures in these systems have an immediate effect on our life. Due to this it is an important target to use data derived from within these machines to improve their maintenance, avoid shutdowns and save energy.

2. Key Success Factor: Connectivity

2.1 Connecting Technology and People

All those advantages are only achievable if these machines will be equipped in future with data interfaces and connectivity. This has technical aspects: physical connectors and cables, IT-parameters like baud rate or encryption algorithms have to be defined.

Nevertheless, connectivity is not only a technical topic: it also means that components manufactured by different companies have to communicate. Due to this, also employees of these companies need to interact. ASERCOM as a business association is supporting and facilitating this interaction between different players in the HVAC/R market. E.g. there is probably a technical benefit if the temperature of the compressor motor is communicated to the frequency inverter driving this motor. It is expected that shutdowns can be reduced and energy can be saved if these data are used in the frequency inverter. In many cases the motor and the inverter are developed and manufactured by different companies. In the new working group of ASERCOM those ideas can be shared, data interfaces can be defined and an idea can become reality.

2.2 Energy saving

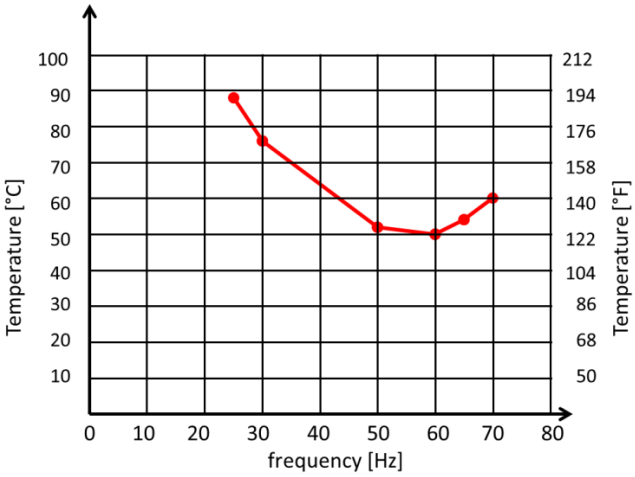


Figure 1: Motor-temperature of a compressor driven by an inverter [2]

Figure 1 shows the motor-temperature of a compressor which is driven by an inverter over the frequency of the inverter. There is a significant increase for higher frequencies (>50/60Hz): in this area, the motor is running in field weakening mode. Today the highest possible frequency is not really known and for safety reasons the max frequency is limited rather low. To save energy it would be useful to know the real limit.

Smaller compressors with less power consumption could be used in this case. A temperature increase can also be seen at lower frequencies (<50/60Hz): the reduced flow of refrigerant is cooling the motor winding not so much in this area. Due to this, there is a risk of an overheating. In this region, unexpected shutdowns of the compressor can be avoided if the motor-temperature is known. The compressor could go back to start-stop mode at 50/60Hz until the temperature is uncritical again. The availability of the cooling system could be increased by usage of data in this case.

2.3 Improved maintenance

Data also need to be made available to service and maintenance staff in the field. Visualizing the current machine status, failure history and warning can help a lot to find a failure of the machine quicker and bring it back to work. It was seen in many cases that it is a great advantage if a smartphone can be connected to a machine, e.g. a compressor, and data can be downloaded, visualized at the phone and even be sent as a PDF document to the manufacturer of the machine (example shown in Figure 2). Such “connectivity” in a technical sense but also between people and organizations can help to maintain machines better and increase the availability.

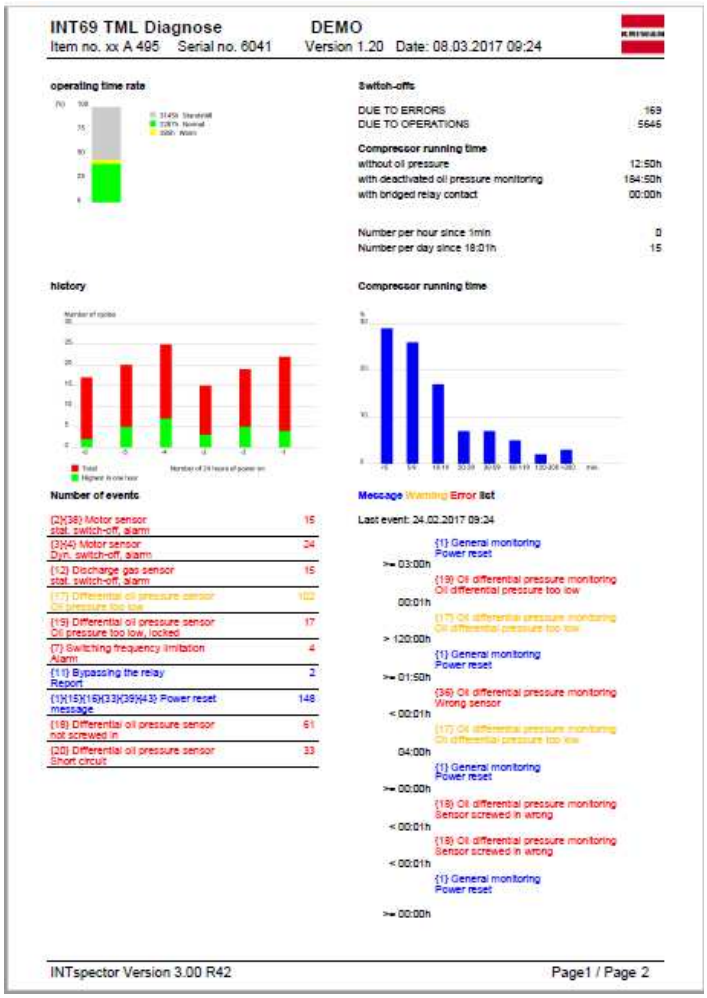


Figure 2: PDF report of the health status of a compressor

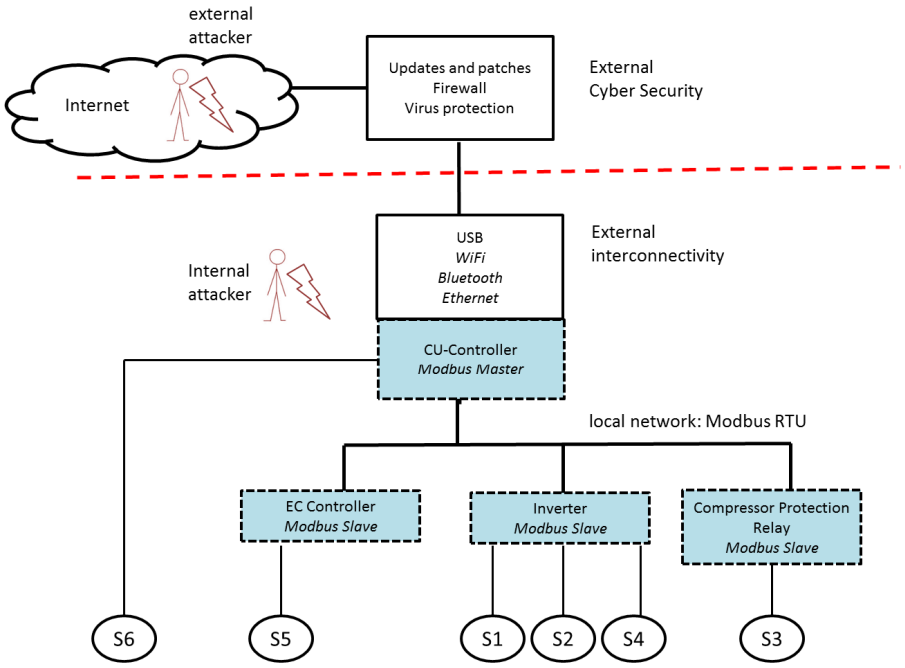
3. Risks and Cyber Security

Internet of Things and connectivity can bring significant advantages to our daily business. Nevertheless there are also risks involved. The most severe risk probably is the threat of a cyber-attack which could damage or shut down machines like compressors, pumps or fans remotely.

One important task of the ASERCOM working group is also to do risk analyses and assess those risks. A risk analysis of a generic condensing unit was already performed. It is based on VDI/VDE 2182 guideline *IT-security for industrial automation*.

In Figure 3 the network topology of a generic condensing unit is shown. This diagram is part of the cyber security risk analysis performed in the ASERCOM working group. To prepare against cyber-attacks it is necessary to give recommendations to installers and owners of HVAC/R equipment like supermarkets or maintenance staff. Part of the security needs to be done with firewalls and virus scanners under their responsibility. Nevertheless there is also significant responsibility of the manufacturers of HVAC/R equipment: their components need to be hardened and as secure as possible to avoid unnecessary risks. Also well established technologies like the frequently used Modbus RTU need to be discussed. This bus system has no security at all and it needs to be discussed within the ASERCOM working group if this bus is meeting nowadays requirements or if it needs to be substituted by a more modern technology.

Figure 3: Network topology of a generic condensing unit



4. Summary

Internet of Things offers great opportunities to save energy and improve maintenance. Parallel with those chances there are also challenges and risks. Especially cyber-security is of great importance for a technology like HVAC/R which plays a vital role in our daily life. Many of these opportunities and challenges can only be faced if companies are working together. *Connectivity* is not only a technology, it is also a way of collaborating in the internet age. Due to this ASERCOM is supporting this transition with the new founded working group *Control and Communication*.

5. Literature

[1] Schwab, Klaus: *The Fourth Industrial Revolution: what it means, how to respond*; Foreign Affairs; December 12, 2015
[2] Bouchareb, M., Gibson, J.P. and Lubich, F. 2003. Drehzahlregulierung von Kälteverdichtern mit intelligenten Frequenzumrichtern. KI Luft- Klimatechnik; p. 25:30