Fault Detection and Diagnosis for Chiller

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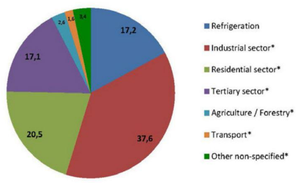
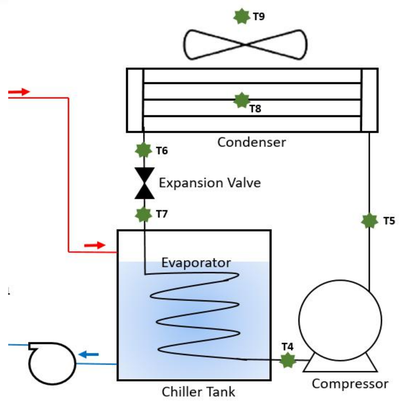
EECOMOBILITY (ORF) & HEVPD&D CREATE

Motivation

- **17%** of global electricity is consumed by refrigeration sector
  - ➢ Improper maintenance of these systems cause **15-30%** loss of energy
- Detect and Diagnose commonly occurring faults in vapour compression chillers
- AI based classification for fault and normal conditions using measurement data



Chiller System



- A chiller consists of 5 main components: evaporator, condenser the two heat exchangers, compressor.
- The pressure and temperature of these components are indicator of the health of the system.

Types of Faults

- 7 faults are identified which have the highest frequency of occurring in a chiller as well as most cost intensive to repair.

Sr No.	Faults
1	Refrigerant Leak
2	Condenser fouling
3	Reduced Condenser Water Flow
4	Reduced Evaporator Water Flow
5	Non-Condensables in Refrigerant
6	Refrigerant Overcharge
7	Excess Oil

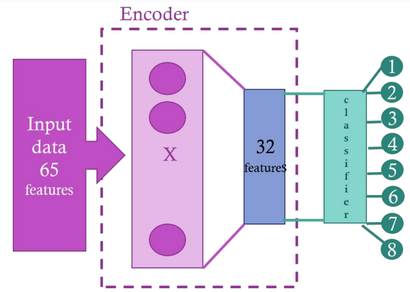
- Each fault displays a unique pattern of rise and fall of the measured parameters such as temperatures and pressures at different locations on chiller system

	kW	PRE	PRC	TRC_sub	Tsh_suc	Tsh_dis	TEA	TCA	TEI-TEO	TCO-TCI	kW/ton	TO_sump	TO_feed
Reduced Condenser Water Flow	▲▲	▲	▲▲	▲▲	▼	·	▼	▲▲	·	▲▲▲	▲▲	▲	▲
Reduced Evaporator Water Flow	▲	▼	·	▲▼	▼	▲▼	▼	·	▲▲▲	·	▲▲	·	·
Refrigerant Leak	▼	·	▼▼	▼▼▼	·	·	·	▼▼	·	·	▼	·	·
Refrigerant Overcharge	▲▲	▼	▲▲	▲▲▲	·	▲	·	▲▲	·	▲	▲▲	▲	▲
Excess Oil	▲▲	·	·	▲	·	·	·	▲	·	·	▲▲	▲▲▲	▲▲▲
Condenser Fouling	▲▲	·	▲▲	·	·	·	·	▲▲	·	▲	▲▲	·	·
Non-condensables in Refrigerant	▲▲▲	▲	▲▲▲	▲▲▲▲	·	▲▲	▼	▲▲▲▲	·	▲	▲▲▲	▲	▲
Defective Pilot Valve	▲	▲▼	·	▲▼	▲▼	▲▼	▲▼	▼	·	·	▲▲	·	·

AI based FDD

- The unique pattern which each fault presents makes application of AI more prudent.
- The dataset used is publicly available by ASHRAE. The experimental data was collected by inducing faults in a chiller at various severity fault levels in different operating conditions.
- A hybrid approach which combines AI feature extraction with machine learning classifier was developed due to the high dimensionality of the data set.

Hybrid Model



- High dimensional data set is compressed by autoencoder which is trained using unlabelled data
- The compressed data is used as input in the classifier to diagnose normal or fault condition
- Different classifiers such as neural network and SVM are implemented
- The Hybrid model was able to classify all the classes with above 93% of accuracy.
- The machine learning classifier (SVM) performed better than the neural network classifier

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